Mechanisms of the Game Transfer Phenomena: The role of cognitive, emotional, and personality variables

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A thesis submitted in partial fulfilment of the requirements of the University of Hertfordshire for the degree of Doctor of Philosophy

This program of research was carried out in the Department of Psychology, Geography and Sports Sciences

School of Life and Medical Sciences
University of Hertfordshire (UK)

December 2023

Acknowledgments

The completion of this thesis has been made possible thanks to the support of several individuals. However, there is one person who played a particularly crucial role. First, I would like to express my deepest gratitude to my principal supervisor, Lia Kvavilashvili. I vividly recall our first meeting on March 19, 2019, outside the Main Reception at College Lane Campus. Since then, Professor Lia has not only provided invaluable professional guidance but has also been a pillar of support at every level. She was there for me when I arrived at the UK without knowing anyone, she extended her friendship, trust, and made me feel truly valued. Professor Lia has stood by me through both the highs and lows, offering wise advice and unconditional help. I feel incredibly fortunate to have had the opportunity to work with her, I hope we can continue to do so in the future. Additionally, I want to extend my gratitude to Professor Lia for her unwavering passion throughout the entire thesis process. There were moments when I felt down, distressed, and unmotivated, but her infectious enthusiasm served as a powerful energy boost. I appreciate the countless meetings we had, often at unconventional hours and even on weekends. Please accept my sincere apologies for any challenges or headaches I may have caused, but I genuinely believe that the journey was worthwhile. I have evolved into a more adept researcher and, more importantly, a better person. Thank you for your dedication and support.

I am also grateful to my co-supervisors, George Georgiou, whose kindness and passion for the thesis were unwavering, and Angelica Ortiz de Gortari. Dr. Angelica was the primary reason for my journey to the UK and my exploration of Game Transfer Phenomena. Thank you both for your assistance from the outset and your wise guidance throughout.

My heartfelt thanks go to my parents, Jose and Angela, and my siblings, Pepe and Alejandra, who have consistently believed in and supported me throughout this entire Ph.D. journey abroad. However, I want to extend a special mention to my twin brother, Luis, who has always been there for me during moments of stress, worry, or when I needed advice. Thank you for your constant presence and patience with all our projects. I promise you we will do great things in the near future.

Furthermore, I want to express gratitude to Clare Mason, Brigita Brazauskiene, and Ioanna Markostamou. While pursuing a Ph.D. is a challenging and rewarding journey, it can also be quite lonely. Thank you all for offering your friendship and support, for visiting my office, and for always expressing genuine interest in my progress and my person, you know you can count with me.

Furthermore, my sincere appreciation goes to my wife, Mayra Almanza. This thesis would not have been possible without her. I extend my apologies for the times I did not devote quality time to our relationship and for the moments of frustration I could cause you when I encountered challenges with the thesis. Yet, I am deeply thankful for her unwavering support during this stage of life. Thank you for traveling to the UK to assist me, for your patience, love, kindness, emotional support, and professional support. This achievement is also yours, thank you for not giving up on me.

Also, I want to thank my dearest friends, Gustavo, Dale, Robert, Karl, Ben and Ika. Thank you for your friendship beyond campus boundaries, trips adventures, for assisting with airport trips and moving my belongings between flats, but most importantly, for engaging in meaningful conversations and offering valuable advice. Your friendship has been a true source of support.

Finally, I would like to send my deepest gratitude to all the research participants of this thesis, without them anything of this would have been possible. Thanks for your time and effort.

Abstract

Game Transfer Phenomena (GTP) refer to the involuntary transfer of video game experiences into the real world and can manifest as altered sensory perceptions, automatic mental processes, and behavioural responses with video-game content. These experiences are often prompted by external cues related to the video game and occur while performing automatic and cognitively non-demanding tasks. Such habitual daily activities are also conducive to experiencing a variety of spontaneous cognitive phenomena (e.g., mind-wandering, involuntary memories, musical earworms) and previous research on GTP has shown that the content and circumstances of GTP experiences bear strong similarities with these spontaneous cognitive phenomena, with the main difference being the video game content in case of GTP.

The central aim of this thesis was to explore a novel hypothesis that GTP can be considered as part of a family of spontaneous cognitive phenomena in terms of their frequency, nature and underlying mechanisms. To address this aim, three online and one laboratory study investigated the frequency of GTP and its relation to involuntary cognitive phenomena (daydreaming and mind-popping frequency), psychopathology variables (e.g., schizotypy, anxiety, depression and impulsivity) and cognitive processes (e.g., creativity, working memory capacity) that had been previously associated with involuntary cognitions. The second aim was to provide new evidence about the nature and frequency of GTP in daily life using a structured (online) diary method. The third major aim was to examine the hypothesis that gaming sessions activate a large number of game-related representations that act as primes for subsequent GTP experiences in response to game-related stimuli in one's environment.

Findings across four studies showed that the occurrence of GTP, as assessed by questionnaire and diary methods, tended to be low and closely resembled the frequency reported in the literature for mind-pops. The most prevalent type of GTP were involuntary inner cognitions in the form of thoughts, memories and musical earworms with game-related content, which occurred under very similar circumstances to other spontaneous cognitive phenomena (Study 2). The results of multiple hierarchical regression analyses showed that GTP were predicted by spontaneous cognitions (daydreaming and mind-popping scores) as well as positive schizotypy and the internet gaming disorder (IGD) (Studies 1 to 3). Furthermore, mediation analysis showed that the association of IGD with GTP was partially mediated by positive schizotypy and frequency of mind-pops (Study 1). Results of Study 3

also confirmed that creativity scores predicted GTP, providing further support for potential links between GTP and spontaneous cognitive phenomena.

Results of diary Study 2 supported the long-term priming hypothesis by showing that GTP experiences were often reported as being preceded by prior exposure to video games related to the GTP content. The evidence of long-term priming of GTP-related concepts, resulting from playing a video game, was also supported in the laboratory using a lexical decision task over short (10 minutes) and longer delays of 24 hours (Study 4). However, no associations were found between GTP and priming scores in the online word-fragment completion task (Study 3) and the laboratory lexical decision task (Study 4), which calls for further examination of the priming hypothesis in the context of GTP.

Taken together, these findings have significant theoretical, methodological and practical implications for research on GTP and involuntary cognitions. Indeed, not only did they replicate some of the findings reported in previous research on GTP, but they also significantly extended the current knowledge on the frequency, nature, and possible underlying mechanisms of GTP. The consistent similarities of GTP with other spontaneous cognitive phenomena demonstrate that this phenomenon can be considered part of a broad family of spontaneous cognitions and open up interesting avenues for future research.

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1.1 Introduction

Playing video games has become one of the most popular forms of entertainment for people of all ages (Entertainment Software Association, 2020). One of the main features of this activity, compared to non-electronic games, is that video games are more rewarding, with quantifiable progress that can generate sensations of achievement and satisfaction in shorter time periods (Zimmerman, 2004). In addition, the video games industry has evolved substantially in the past two decades, resulting in potentially important applications in medicine (e.g., Bonnechère et al., 2016), education (Dondlinger, 2007; Franceschini et al., 2015), professional sports (Reitman et al., 2020) and real-life simulations (Roitberg et al., 2021). In cognitive psychology and neuroscience, video games have been studied to assess their positive and negative effects on human behaviour and cognitive and emotional processes (for meta-analyses see Ferguson, 2007; Halbrook et al., 2019; Marker et al., 2022).

However, the globalization of internet in late 1990s and the implementation of online features on video games has also brought about strong concerns among researchers and the general public about potential risks of addiction in consumers. Indeed, it was at this time that a new set of online game genres started to gain widespread popularity, such as casual browser games (CBGs), multiplayer online role-playing games (MMORPGs), life simulators, strategy cooperative games, and competitive first-person shooters (FPSs) (Kuss & Griffiths, 2011). Most of these games have a particular feature in common, i.e., they all occur in real-time, leading to an increased urge in gamers to be connected at all time, to avoid feeling the "fear of missing out", which may result in neglecting essential matters of daily life.

In line with these concerns, numerous studies have found that prolonged gaming sessions are related not only to psychological problems such as sleep deprivation, attention and perception deficits (Ko, 2014), but also to the internet gaming disorder (IGD) , which has been included in the 5th edition of the "*Diagnostic and Statistical Manual of Mental Disorders",* (DSM-5), American Psychiatric Association (American Psychiatric Association, 2013) by the American Psychiatric Association (APA, 2013), as well as in the 11th revision of the International Classification of Diseases (ICD-11) by the (World Health Organization, 2021, (WHO, 2021). According to the diagnostic criteria, IGD may lead to several issues in daily life such as lack of interpersonal relationships, deceiving family members, jeopardizing job and school performance, or escapism from the reality (Pontes & Griffiths, 2015).

Another concern that video games have brought along with technology is the misperception of reality. Due to the improvements in software and hardware technologies

such as virtual reality (VR), 3D audio, and 4k graphics resolution, video games keep becoming more immersive, resulting in more meaningful, vivid, and realistic experiences. These, in turn, can lead to increased frequency of involuntary phenomena in real-life such as misperceptions, thought intrusions, urges and automatic behaviours that have prompted researchers to investigate these post-gaming phenomena in more detail.

For example, initial research using questionnaires and focus groups on gamers aimed to identify, describe, and categorize what players kept experiencing after playing the game, both in short term (e.g., feelings of frustration in a difficult game or satisfaction after completing a game), and long term (e.g., applying attitudes or phrases learned in the game to real-life situations) (Poels et al., 2010). Together, these experiences were referred to by Poels et al. (2010) as "a set of postgame experiences that emerge from specific in-game or game-related experiences" (p. 151) and are related to game enjoyment, immersion, flow, or social gaming interactions, etc. In addition, some gamers also reported to have experienced more severe postgame effects when playing specific video games for long sessions (e.g., "the Call of duty effect", "the Tetris effect", "Minecraft sickness", "the Guitar hero effect", etc.). Although no formal research has been conducted on the effects caused by these specific games, a variety of experiences associated with them have been posted on popular websites such as the "Urban Dictionary". For example, several gamers have described "The Minecraft Sickness effect" as the experience of seeing objects and surroundings as if they were pixels or hexagons from the game (Minecraft Sickness, 2010). Another example commonly reported by gamers is the "Call of Duty effect", which may occur after playing "Call of Duty 4" for long sessions at night and result in abrupt reactions to transient images in peripheral vision when waking up in the morning ("Call of Duty Effect", 2008).

More recently, researchers have started to integrate and investigate all types of cognitive phenomena, broadly referred to as cognitions in the present thesis (e.g., sensations, misperceptions, behaviours, and thoughts), that are related to the transfer of video game experiences into the real world. An initial seminal study by Ortiz de Gortari et al. (2011),[1] using semi-structured interviews and thematic analyses, was able to identify and categorise postgame experiences described by gamers who played different types of video games for long periods of time. Findings revealed that transfers from the virtual to the physical world could manifest in different dimensions, for example, in the form of altered sensory perceptions, automatic mental processes, behaviours, and actions with video game content.

[1] Data presented in this paper was based on Ortiz de Gortari's master's thesis (see Ortiz de Gortari, 2010).

Indeed, gamers were reporting hearing music, sounds, or voices, or seeing images from the video games while being engaged in their daily activities. They were also reporting experiencing intrusive thoughts and memories as well as having tactile sensations, or involuntary movements and urges or verbal outbursts with game-related content.

Together, this broad variety of postgame experiences were referred to as the Game Transfer Phenomena (GTP) (the main outcome variable of the present thesis), the term that was first coined by Ortiz de Gortari (2010) who launched a systematic investigation into this phenomenon and developed a unified approach to studying and understanding the transfer effects of video games (Ortiz de Gortari, 2016; Ortiz de Gortari, 2019). This research has shown that experiences of GTP in everyday life can be triggered by associations between incidental external or internal stimuli and the video game content without any deliberate intention to have these experiences. This type of associative process may result in altered mental processes that affect one's perception, thoughts, and behaviours, and can be perceived by gamers as neutral, pleasant, or even disruptive in some cases (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2015).

GTP usually occur under low levels of concentration while carrying out automatic activities such as riding a bike or brushing the teeth (Ortiz de Gortari, 2019). Such activities are often accompanied by episodes of spontaneous mind-wandering (daydreaming) about matters unrelated to ongoing activities (Smallwood & Schooler, 2006, 2015), and instances of GTP can be experienced while being engaged in such task-unrelated thinking (Ortiz de Gortari & Griffiths, 2012; Ortiz de Gortari & Griffiths, 2014a; 2014b, 2014c). It is also interesting that research on mind-wandering has demonstrated that when individuals are having task-unrelated thoughts, they can experience a wide variety of spontaneous cognitive phenomena that are similar to GTP experiences such as involuntary autobiographical memories (IAMs), involuntary semantic memories or mind-pops, repetitive musical imagery (i.e., the earworms), spontaneous future thinking or even intrusive memories (e.g., Faber et al., 2018; Plimpton et al., 2015). For example, IAMs involve spontaneous (unintended) retrieval of memories of personal and meaningful experiences of past events, which have been clearly described by gamers in previous studies of GTP (Ortiz de Gortari et al., 2011; Poels et al., 2010). On the other hand, involuntary mind-pops involve isolated semantic knowledge (e.g., words, images, or music) popping into mind unexpectedly while being engaged in unrelated activities, for example, the name "Tom Cruise" or a popular song coming to mind when washing up (Kvavilashvili & Mandler, 2004). These types of semantic memories with the video game content have also been described by gamers in previous

studies (Ortiz Gortari et al., 2011; Poels et al., 2010). Given that these spontaneous cognitive phenomena can be experienced in a similar way to GTP, the main aim of this PhD is to examine a novel hypothesis that instead of being an isolated experience, GTP may be part of the broad family of spontaneous cognitive phenomena in terms of frequency, nature, and underlying mechanism.

The concept of GTP and its classification have evolved over time. Recently, GTP has been categorized as a multi-faceted phenomenon on a continuum, ranging from endogenous and common everyday spontaneous cognitions (e.g., mind-pops, IAMs, music imagery, etc.), which occur in the general population on a daily basis, to less frequent and exogenous cognitions (e.g., hallucinations, dissociations, etc.) that may be associated with symptoms of clinical disorders (A. B. Ortiz de Gortari & Diseth, 2022). Nevertheless, this thesis will mainly focus on investigating the association of GTP to everyday involuntary cognitive phenomena such as IAMs, mind-pops, and mind-wandering due to their high prevalence in the general population, and their potential similarities with GTP experiences reported by gamers.

This chapter will be divided into two major sections. The first will provide a comprehensive overview of a small but growing body of research on the transfer of experiences. It will start by summarising the initial pre-GTP research on "postgame experiences" (Buckley & Anderson, 2006; Poels et al., 2010), and will then provide a more detailed overview and discussion of the existing research on GTP, from its inception to the present moment, covering a broad selection of topics including the nature, frequency, and the manifestation of GTP in everyday life. The second major section will provide a general overview of research on spontaneous cognitive phenomena with a primary focus on mind-wandering (daydreaming), IAMs, and mind-pops including earworms. The chapter will end with a brief outline of the four studies included in the present thesis, as well as brief summaries of each of them described in the empirical chapters of the thesis.

1.3 Overview of research on the transfer of gaming experiences prior to GTP research

Before the first GTP paper was published in 2011, there was a small body of research that investigated the transfer of gaming experiences to everyday life. Some studies focused on the effects that occurred during or immediately after the gameplay such as seizures in photosensitive epileptic patients (for a review, see Bureau et al., 2004). Other studies focused on the effects of immersion in gamers while playing. This phenomenon was referred to as "presence", which has been defined as an overall subjective sensation of "being there", i.e., being inside the video game where the virtual world and the real world subjectively merge for the gamers (Barfield et al., 1995; Ijsselsteijn et al., 2000). On the other hand, constant improvements in technology resulting in the creation of more ambitious games in terms of realism and immersion, had prompted researchers from several research fields (e.g., psychology, neurosciences, design, philosophy, etc.) to focus their attention on the effects of video games on gamers' experiences in real life after they had stopped playing.

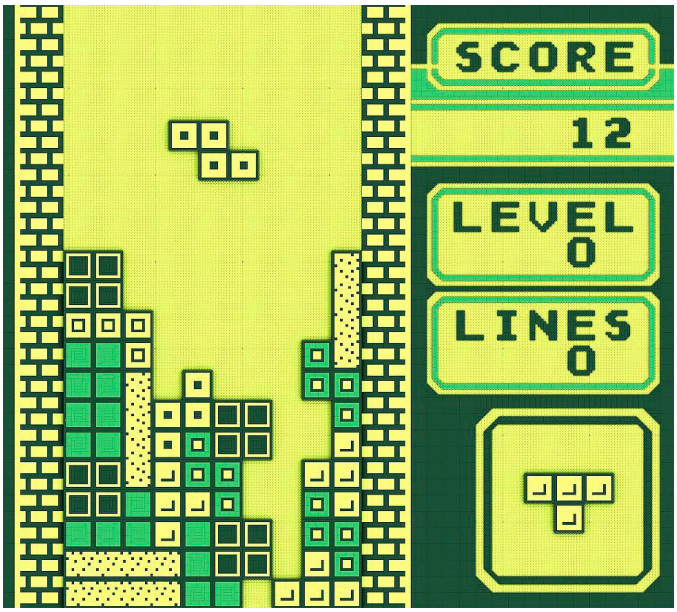
There are several studies focusing on specific effects that video game playing may have on the gamers' postgame skills. For example, Green and Bavelier (2003) conducted several studies which showed that playing action video games for a few hours per week (e.g., first person shooters) resulted in significant improvements in visuo-perceptual attention skills when performing laboratory perceptual tasks (Green et al., 2010; Green & Bavelier, 2006, 2008). Another research area has focused on attitudes and behaviours after playing, for example, studying the negative effects of violent games and how they can affect behaviour after playing (Buckley & Anderson, 2006; Carnagey & Anderson, 2005). There are also studies focusing on the positive effects of gaming on social skills such as strengthening the bonding with friends (Colwell et al., 1995; Selnow, 1984).

In addition, there were several phenomena involving the transfer of images or sounds, coming from specific video games, that have been reported by gamers on online forums. Each effect was named after the game in question (e.g., "Minecraft", "Fortnite", "Rock Band", "Grand Theft Auto", etc.). The first reported phenomenon of this kind involved the popular tile puzzle game "Tetris" released in 1984 and was described as the "Tetris Effect". In this puzzle game, the main aim is to complete horizontal lines by moving descending shapes that must be aligned along with incomplete lines in a playing field (see Figure 1-1). The Tetris effect involves altered visual perceptions and automatic mental processes, and has been described as a situation in which " people, after playing Tetris for more than one hour

straight, report being plagued by after-images of the game for up to days, afterwards, an ability to play the game in their head, and a tendency to identify everything in the world as being made of four squares and attempt to determine where it fits in" (Kidd, 1996, p 78).

Figure 1-1

Representative gameplay screenshot in Tetris (Tetris, 1984)



Moreover, Tetris has been used in studies investigating intrusive and stereotypical visual images during hypnagogic states (at sleep onset) after prolonged exposure to the game. For example, Stickgold et al. (2000) tested amnesic and non-amnesic participants after playing Tetris for a total of 7 hours, equally distributed over mornings and evenings, over a 3-day period. During the first hour of attempted sleep, all participants were intermittently prompted for verbal reports of what was going through their mind. Although there was no intention to investigate game intrusions, results provided interesting insights about postgame experiences. For instance, amnesic participants with bilateral medial temporal lobe damage produced very similar hypnagogic reports to those of non-amnesic participants even though they did not recall having played the game. On the other hand, non-amnesic participants also reported seeing images from older versions of the game that had not been played in the past one or five years. Overall, these findings suggest that hypnagogic images can arise from the declarative memory system with older memories triggering images from recent waking experience. However, the contribution of medial temporal structures is not mandatory for

their occurrence as shown by amnesic participants, instead implicit memory processes might be more important for these perceptual representations (Schacter & Tulving, 1994).

These findings were extended by subsequent research that examined the experience-dependent induction of hypnagogic hallucinations during daytime naps using polygraphic recordings (Kusse et al., 2012). This study included one experimental and two control groups. The experimental group (n = 16) played Tetris for 2 hours during three consecutive mornings, the first control group (n = 13) did not play Tetris at all (controlling for the experience of playing), while the second control group (n = 14) played the game after having a nap (controlling for the anticipation of playing). All participants were asked to have afternoon naps and were repetitively awakened 15, 45, 75, 120 or 180 seconds after the onset of sleep Stage 1 to report their mental content. Results showed that hypnagogic hallucinations were significantly more likely to be induced by the actual experience of playing than no experience or mere anticipation. Thus, in the experimental group, 48 out of 485 of sleep onset reports (10%) were associated with Tetris. By contrast, only 1% and 3% of reports were associated with the game in the experience and the anticipation control groups, respectively. In addition, results from polygraphic recordings showed that hypnagogic hallucinations induced by playing Tetris were associated with Stage 1 and early segments of Stage 2 sleep in the experimental group as demonstrated by increased activity in sensory cortices and regions linked to the default mode network (DMN). These findings align with the typical neural signatures of hypnagogic hallucinations during the transition from wakefulness to sleep (Hori et al., 1994). The induced hallucinations primarily involved visual and auditory elements of Tetris that often-included mnemonic components (e.g., familiar objects arranged spatially as in Tetris), suggesting a potential connection between hypnagogic hallucinations and memory related activity in mesial frontal and parietal regions, as well as other components of the DMN.

Overall, the psychological literature prior to GTP research included a variety of research streams studying the effects of video games during and after playing had finished. However, the very first studies identifying and categorizing transfer of video game experiences into everyday life were conducted not by psychologists, but researchers studying user experiences and human computer interaction. For example, to explain postgame experiences, Fritz (2005) proposed a model-oriented paradigm, using data from interviews conducted on gamers (see also Witting & Esser, 2003). This model proposed ten different types of transfers from the virtual to the real world (see Table 1-1). However, Fritz (2005)

suggested that transfers can be conscious and intended, which implies that they do not occur without at least a certain degree of on willingness (or intentionality) on the gamer's part.

Although this statement somewhat contradicts the main assumptions about GTP and spontaneous phenomena being involuntary, the most common transfers associated with computer games, reported by this author, are similar to GTP characteristics described earlier. For instance, Fritz (2005) proposed three main transfers that have been also described in GTP research (Ortiz de Gortari et al., 2011; Ortiz de Gortari, 2019). Firstly, problem solving transfers, involved thinking about solving real-life problems using gameplay elements, for example, gathering information from people around, or asking experts as one would ask their fellow players. Secondly, emotional transfers were defined as feelings aroused during the game session that continued after the game (e.g., joy, pride, horror, tension, anxiety, etc.). Lastly, associative transfers were defined as the spontaneous association between the real-life stimuli and the images, sounds or experiences from the video game, with associations occurring more frequently when the video game was more realistic and comparable to real-life elements or sensations (e.g., feeling horror, the architecture of a building, the realistic face of game-character, etc.).

Table 1-1

Main types of transfers described in the non-GTP literature (Fritz, 2005; Witting & Esser, 2003)

1.	Problem solving transfer (e.g., resolving real-life problems as they would be resolved in the game).
2.	Emotional transfer (e.g., distress, anxiety during the game persisting in real life)
3.	Instrumental and action-oriented transfer (e.g., transferring specific action skills acquired in the game, to real-life situations)
4.	Ethical and moral transfer (e.g., changing values as a result of gaming)
5.	Associative transfer (e.g., identifying associations or relationships between various external stimuli or cues in everyday life to the elements of experiences of the game)
6.	Reality structuring transfer (e.g., acquisition of real-life experiences or skills through gameplay)
7.	Transfer of information (e.g., information learned in the game that can be useful in real-life scenarios)
8.	Memory related transfer (e.g., using memories of specific game elements in real life)
9.	Loss of time (e.g., Players can become so immersed that they lose track of time, and this state can remain even after they have stopped playing).
10.	Dreaming (e.g., dreams including elements from the game)

In addition, based on Fritz's (2005) classification, Bigl (2009, 2013) conducted a follow-up study on online forums (n = 1,146), and showed that 87% of participants reported having experienced at least once a type of transfer stipulated by Fritz (2005) with the transfer of dreams (31%) and information (21%) being most common (Bigl, 2009, 2013).

Furthermore, shortly before the start of GTP research in 2010 (Ortiz de Gortari et al., 2011), Poels and colleagues published a couple of papers that investigated the qualitative descriptions of game-related experiences during both playing (Poels et al., 2007) and postgame periods (Poels et al., 2010). The classification and conceptualization of game-related experiences was derived from the qualitative data obtained from focus groups of gamers who played massive multiplayer online role play games (MMORPGs). As a result of this analysis, two types of postgame experiences were established: long- and short-term postgame experiences (Poels et al., 2010). The former were defined as those occurring immediately after gamers had finished playing, for example, feeling satisfaction after having played with friends or even a feeling of guilt having spent too much time on playing while neglecting more important activities. The latter were proposed to occur after repetitive and intensive gaming sessions involving specific games or genres, and it was assumed that such games could potentially induce postgame experiences affecting the perception, emotions, and cognitions of gamers over a longer term (Poels et al., 2010). Long-term postgame experiences were divided into four main categories: i) association of game elements with environmental stimuli in real world (e.g., direct association between video game elements with real-life stimuli and events); ii) sounds and music that trigger vivid memories about games or game elements; iii) elements of the game showing up in daydreams, fantasy, and dreams; and iv) the use of words and expressions from the game in real-life conversations (see Table 1-2 for actual examples reported by gamers; Poels et al., 2010).

Table 1-2

Examples of each of the four categories of long-term postgame experiences reported by gamers (Poels et al., 2010)

Associations of game elements with real-life stimuli	*"Sometimes, I see something in real life and relate it back to the game. For instance, signposts I noticed on the university campus. Those reminded me of World of Warcraft (WoW), where you have similar signposts, for example, Store-wind that way! and Iron-forge that way!* (Male participant, 22 years, p-160). *"A while ago, I was going out with a group of friends with whom I played WoW. We were at a concert and there were children playing with a toy bow and arrow. We immediately said to each other: "Hey, there are the hunters!".* (Male participant, 31 years, p-160).
Sounds and music that trigger lively memories about games or game elements	*"When I hear songs that I often play in the background while I am playing WoW, then I immediately start thinking about the game and how fun it is to play WoW".* (Male participant, 21 years, p-190). *"I have certain music I can no longer listen to, because it reminds me of a game, I used to play a lot (i.e., Diablo II). When I hear those songs, I just have to play Diablo II again. And then I'm busy for another year, ha-ha* (Male participants, 23 years, p-160).
Daydreaming and fantasizing about the game world	*"If our train is delayed, I often think I wish I had a Hearthstone; a WoW object that transports you to a specific location in no time".* (Male participant, 23 years, p-161 *"I often daydream about my gear, what I can still improve about my character's equipment.* (Male participant, 23 years, p-161).
Language and expressions used in the game	*"If I have gamed very intensively, I notice that I start using game related words and expression more often.* (Male participant, 23 years, p-161). *"I sometimes use WoW words when talking to my kids. For example, if they ask: dad, can I get some money, I say: Gold? Eh, money. Or if someone does something really stupid, I use the word "noob", a word that is often used in MMORPGs to refer to someone who does not know the rules.* (Male participant, 31 years, p-161).

Although, Poels and colleagues did not specifically discuss possible causes of postgame experiences, they suggested that long-term experiences could originate from repeated exposure to a game environment. This idea appears to be similar to the long-term priming hypothesis proposed to explain the occurrence of spontaneous cognitive phenomena (Kvavilashvili & Mandler, 2004). It is possible that GTP also occurs due to constant exposure to video game content that eventually might be primed by associated stimuli in the environment or thoughts resulting in a GTP experience (see below a section on spontaneous cognitive phenomena). Poels et al. (2010) also suggested that both short- and long-term game-related experiences could rely on individual differences in how individuals perceived their environment in everyday life, which can be affected by previous knowledge such as beliefs, concepts, and expectations (Gregory, 1970). Therefore, differences in postgame experiences could be a result of perceptual biases, due to prior knowledge, which in turn could explain why different gamers may interpret the same stimuli differently (Poels et al., 2010).

Overall, the initial research conducted by Poels et al. (2007, 2010) represents an important first step towards the categorization of a wide variety of postgame experiences, more recently referred to as "game-biased perceptions and associations" (Poels et al., 2015). However, it is important to note that research conducted by Poels and colleagues was exclusively focused on MMORPGs players, did not distinguish between voluntary and involuntary phenomena, and considered dreams as postgame experiences. To date, there are more than 15 video game genres (Qaffas, 2020) with millions of gamers playing games from each of these genres, in addition to several sub-genres that have also been identified (Clarke et al., 2015). This highlights the importance of conceptualising GTP research from a broader perspective that would encompass all types of cognitive transfers across multiple video game genres and types of gamers.

1.2 Overview of GTP research

1.2.1 Initial research and classification of GTP

The term Game Transfer Phenomena was coined in 2010 by Angelica B. Ortiz de Gortari (one of the co-supervisors of this thesis). The first study on GTP was a qualitative study on 42 participants examining the role of immersion, and how this important video game characteristic affected gamers' behaviours during and after the gameplay. Results of the thematic analysis showed that the majority of participants reported experiencing GTP, and

most of them experienced different types of it. The contents of many GTP descriptions also referred to experiences of 'immersion', which was defined as the feeling of being deeply absorbed and mentally engaged in a game to the point where the player may lose awareness of their real-world surroundings or the passage of time (for review see Michailidis, Balanguer & He, 2018). Moreover, most of the reported experiences referred to an integration of video game elements into real-life situations, which the authors classified as using video game elements as mediums or tools in the real world, for example, modelling game characters, game events or even daydreaming about video games (Ortiz de Gortari et al., 2011). Such experiences were then classified as either automatic (spontaneous) or intentional, and triggered by external stimulus (i.e., game-related cues) or not (Ortiz de Gortari et al., 2011).

Automatic or spontaneous GTP were described as occurring involuntarily without premeditation or intention and were further divided into four main types (dreams, automatic thoughts, alteration of sensory perception, and automatic behaviours). By contrast, intentional GTP were described as focusing on the intentional integration of video game elements or experiences into the real life by premeditation and were divided into three sub-types: (1) using video games as interactive mediums or tools, (2) modelling game characters and game events, and (3) daydreaming about video games (for examples, see Table 1-3) (Ortiz de Gortari et al., 2011). Therefore, at this initial stage, the GTP were defined as situations "when video game elements are associated with real life elements triggering subsequent thoughts, sensations and/or player actions". It should be noted that in this initial classification night-time dreams were considered part of GTP (Ortiz de Gortari et al., 2011, p.17).

Although this first study obtained rich data through qualitative interviews allowing the authors to propose an initial conceptualization and categorization of the phenomenon, it was conducted on a small and homogeneous sample (n = 42). It was, therefore, necessary to conduct research with larger samples to provide more in-depth understanding and detailed classification of every dimension of this novel phenomenon. To address this, three qualitative studies were conducted focusing on the nature of GTP in a large sample of over 2,000 gamers who reported their thoughts about gaming at multiple online forums (Ortiz de Gortari & Griffiths, 2014a; 2014b; 2014c). Across the three studies, over 1900 GTP experiences posted by gamers were collected, coded and analysed. This resulted in establishing the main dimensions of GTP and some of their key characteristics (e.g., the context of manifestation). Findings from these studies showed that, contrary to what was initially assumed, not all GTP were triggered by external cues (Ortiz de Gortari & Griffiths, 2014a). GTP were then defined as "the transfer of experiences from the virtual to the physical world that can manifest as

altered sensorial perceptions, sensations, automatic mental processes, behaviours and actions with video game content" (Ortiz de Gortari, 2019). In addition, this research established three main dimensions as well as several sub-categories of GTP (Ortiz de Gortari & Griffiths, 2014a; 2014b; 2014c). The first dimension involved altered sensory perceptions, which was sub-divided into three sub-categories (altered visual, auditory and body perceptions). The second dimension involved automatic mental processes or spontaneous cognitive phenomena such as involuntary memories (e.g., involuntary autobiographical memories and mind-pops). Finally, the third category referred to automatic behaviours and actions which consist of unintentional behaviours and actions.

Table 1-3

Examples of intentional GTP described in Ortiz de Gortari et al., (2011)

Type of Intentional GTP	Examples
Video games as interacting mediums or tools	*"I send spells to others, moving hands"* (Male, 15 years old). *"I did hide in a box like Solid Snake does to scare a friend of mine"* (Male, 21 years old).
Modelling game characters and game events	*"I was in a big crowd looking for my older brother and after looking for like 5 minutes I thought: Ooh, I'm so stupid I'll just use the/ who function. But then I realised how stupid it sounded"* (Male, 19 years old).
Daydreaming about video games	*"What I wanted was to live in the Final Fantasy universe and be one of the characters. So, all of the time, I imagined living in that world. It wasn't really bad thoughts, more like wishful thinking*" (Milton, 19) *"Every time I'm in the subway, I picture myself running on top of it and dodging poles and stuff, and then running on the track and avoiding another train by centimetres, like I did in the game Mirrors Edge"* (Male, 15).

1.4. Altered sensory perceptions

GTP experiences related to altered sensory perceptions have been reported in several sensory modalities, making this dimension the widest GTP category. Studies have mainly focused on three modalities: visual, auditory, and body-related perceptions (Ortiz de Gortari & Griffiths, 2014a). Overall, altered sensory experiences, reported in previous GTP studies, can manifest in different forms such as distorted perceptions, misperceptions, perceptions of video game elements that are not present on the environment (e.g., aural, kinesthetic, somatosensory). Importantly, most of the reported altered sensory perceptions involve visual experiences (e.g., hallucinations, pseudo-hallucinations), and auditory phenomena such as earworms, and musical imagery. The following sub-sections will describe in more detail each of these GTP dimensions with typical examples.

The practice of playing video games involves constant exposure to multiple modalities of sensory information, including visual stimuli in the form of moving images, figures, shapes, and auditory stimuli such as musical tunes and sounds. Haptic technology is also sometimes used in game controllers for producing feedback in the form of vibration with the purpose of creating a more immersive experience for gamers. Previous studies have found a positive correlation between higher frequency of altered sensory perceptions and long gaming sessions (Ortiz de Gortari & Griffiths, 2014a). In line with this, other studies have found an association between overloads of sensory information with further sensory alterations in individuals who were exposed to these stimuli for long periods of time (Sacks, 1970).

1.4.1. Altered Visual Perceptions

Gamers have reported a wide range of altered visual perceptions during hypnagogic states such as seeing video game images while trying to sleep. They have also reported seeing video game images projected or overlaying in the front of their eyes in fully awake state that sometimes may be triggered by associations between stimuli in the environment and video game elements (Ortiz de Gortari et al., 2011). A study with 483 gamers reported 656 visual GTP experiences collected from 54 online gaming forums (Ortiz de Gortari & Griffiths, 2014a). Using thematic analysis, players' experiences were identified and classified into several distinct categories. These included: (i) mind visualisations which involve creating or experiencing mental representations or images of something (e.g., an object, scene, concept or even an abstract idea), and can resemble sensory experiences like seeing, hearing, or

feeling (Pearson & Kosslyn, 2015) and (ii) visual hallucinations or perceptual experiences in which one perceives something that is not present in the external environment while being fully awake. Hallucinations have been associated with schizophrenia, substance abuse disorders, and certain neurological conditions (Waters et al., 2016).

They are distinct from visual misperceptions (also called illusions), which are misinterpretations of real sensory stimuli (Waters et al., 2014). It is also important to distinguish hallucinations from pseudo-hallucinations. While both involve perceptions that are not present in the external environment, pseudo-hallucinations are often less vivid and intrusive, and are experienced as being of internal origin (Bell & Halligan, 2012). Pseudo-hallucinations can occur during states of altered consciousness, such as the hypnagogic states (the transition between wakefulness and sleep) or as after-images following exposure to bright lights or environments. These experiences are typically less intense and more transient than true hallucinations (Cheyne, 2003).

Furthermore, GTP including mind visualization could involve flashbacks or picturing elements from a video game in real-life. Also, distorted perceptions of objects and environments in colour or shape (e.g., visual after-effects) involving real scenarios or environments as well as any object or physical stimuli that can be associated with an element from a video game. Mind visualizations can also include experiences associated to misperception of time (e.g., visual effects of velocity) (Ortiz de Gortari & Griffiths, 2014a).

Finally, visual misperceptions are defined as the perception or real-world objects as if they were derived from a video game. This encompassed situations in which gamers became uncertain about real-life stimuli or believed that they had observed a component from a video game (Ortiz de Gortari & Griffiths, 2014a) (for examples, see Table 1-4).

Moreover, researchers have also investigated the after-effects of particular video games, for instance, rhythm, music, or dance video games such as “Rock-Band Guitar Hero”, “Dance-Dance Revolution”, etc. Several gamers have also been reporting motion effects in the form of images scrolling down after playing these types of games for long periods of time. This phenomenon was later described as waterfall effects (Dyson, 2010), with gamers describing them as experiences of wavy vision in the form of objects appearing to float aside from the TV and sensations of dizziness (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2014a).

Table 1-4. *Examples of different types of altered visual GTP taken from Ortiz de Gortari & Griffiths, 2014a, pp. 7-10), and Study 2 of the present thesis*

Altered visual GTP	Examples
Mind visualizations	• *"Whenever I have a pleasant interaction I still picture the positive social icon from The Sims above people's heads. (Londyx")* • *"This happen with "Meteos" to the point where I could really play the game in my head. Not only watch the game but play it" ("Alb").*
Visual Misperceptions	• *"A website was loading on my laptop with the typical spinning circle symbol, and for a split second, I saw the little loading screen island symbol of Animal Crossing New Horizons instead ("DS")*
Distorted perceptions	• *"Our real world turned monochrome. The red and white tile made an optical trick in our eyes, and we could only see in green, yellow and the shades in between" ("Raceman").*
Hallucinations	• *"I saw the Grenade indicator when scanning the video store. Fortunately, I realized it was a hallucination before I went commando rolling" ("Janus").*

1.4.2 Altered auditory perceptions

Although the main sensory modality to interact with video games is visual, the games are always accompanied by auditory stimuli such as environmental music, sound effects, melodies, theme songs and, in some games, the voice of in-game characters. Altogether, these multiple stimuli increase the immersion in games, leading to more satisfying, vivid, and realistic playing experiences (Nacke et al., 2010; Van Elferen, 2016).

There are many studies that have investigated the physiological and psychological effects of auditory stimuli (for a review, see (Grosso et al., 2015; Lotto & Holt, 2011). For instance, it has been demonstrated that musical cues can induce emotions as well as produce changes in the affective processes, including emotions and mood (Reybrouck & Eerola, 2017; Vastfjall, 2001). Another study, using positron emission tomography, investigated the neural mechanisms of pleasant emotional responses to music (Blood & Zatorre, 2009). The study found that most participants reported higher excitement in response to music, manifested by physiological changes in the heart rate, respiration, and electromyogram measurements. Additionally, it was found that simultaneous increases in the cerebral blood flow and decreases in brain regions (e.g., amygdala, orbitofrontal cortex, midbrain, etc.) were

associated with emotion, arousal, reward, and motivation (Blood & Zatorre, 2009) (for meta-analysis, see Mas-Herrero et al., 2021).

However, there are only few studies that have examined possible effects of auditory cues after gaming sessions. For example, there is an isolated case study of a young woman with multiple background of psychopathologies (depression, suicidal attempts, persecutory delusions, and auditory hallucinations). After interrupting treatment at the age of 20, this patient reported having experienced third person auditory hallucinations related to the popular Super Mario Brothers soundtrack for a week. These types of hallucinations are suggested to be an example of how environmental stimulus can be integrated into the nature of a psychotic illness and therefore suggest that different video games can trigger similar phenomenological experiences in different types of patients (Spence, 1993). More recently, a study investigated if video game music influenced players' enjoyment using positive and negative affect scales. Participants played an action video game with and without the original soundtrack and completed a self-report enjoyment measure. Results from mediation analyses showed that soundtrack music predicted enjoyment and was mediated by positive, but not negative emotions (Klimmt et al., 2019).

Overall, the effects of auditory cues, music imagery and earworms have been broadly investigated and described as very common phenomena within a separate research field of involuntary musical imagery (for a review, see Liikkanen & Jakubowski, 2020). However, almost no attention has been paid to the possible relationship between auditory imagery and the constant use of more immersive technology such as video games. Most studies have just investigated the phenomenon of "phantom ring or ringing syndrome" which involves individuals who re-experience (e.g., keep hearing) the ringtone of their phones (Lin et al., 2013; Subba et al., 2013). Other studies on auditory cues in video games have highlighted a variety of effects that they may have such as improvement of memory, or sense of presence (higher immersion), and aggressive behaviours related to auditory cues set in video games and virtual media (Anderson & Casey, 1997; Dinh et al., 1999; Hendrix & Barfield, 1996; Herbert et al., 2016).

Regarding GTP research, initial studies collected reports of GTP experiences from online forums. After qualitative coding, a total of 192 experiences obtained from different gamers (n= 155) were identified with auditory content, and then classified as altered auditory perceptions (Ortiz de Gortari & Griffiths, 2014b). These experiences were classified into i) auditory imagery (constant hearing of game-related music), ii) inner speech (e.g., a game-related phrase or sound effect popping into mind), iii) auditory misperceptions (e.g.,

confusion of real sounds with those from the game), and iv) multisensorial auditory experiences (e.g., hearing music while involuntarily moving the fingers) (for further examples, see Table 1-5).

Table 1-5

Examples of different types of altered auditory GTP (Ortiz de Gortari & Griffiths, 2014b)

Altered auditory GTP	Examples
Auditory imagery	• *"I played the sims 3 for too long and tried to sleep, I could not get the music out of my head" ("Yoell")* • *"Command & Conquer: Red Alert was an exception. I used to wake up with Hell March in my head for weeks after finishing the game" ("RockerLao").*
Inner speech	• *"Sometimes I think in voice commands from Team Fortress, especially Go Go Go! To make people move in the subway ("FashionXo").* • *"Once after I played Battlefield 2 for long, I kept hearing "Enemy boat spotted, Enemy boat spotted" ("Se13")*
Auditory misperceptions	• *"Quite often I mistake sounds in real-life for sounds I hear in video games ("Trevor_Class").*
Multisensorial auditory experiences	• *"I once played Tetris for so long that when I stopped I could still hear the music in my head for hours and my fingers kept twitching occasionally ("Pachis").*

1.4.3 Altered body perceptions

Most studies on altered body perceptions before GTP research were conducted on virtual simulators (Champney et al., 2007) and virtual reality headsets (Stoffregen et al., 2008) to induce and investigate the psychophysiological effects of virtual immersion. Initial research found that the use of virtual technology in young adults for at least 60 minutes could lead to issues in postural stability as well as symptoms of motion sickness such as nausea, temporal difficulties in walking, driving, or performing motor tasks that required coordination and precision (Häkkinen et al., 2003). Additionally, in some extreme cases, more severe symptoms of motion sickness were reported such as disequilibrium (e.g., postural instability; Gray Cobb & Nichols, 1999), proprioceptive errors (Stanney et al., 2002), ataxia (e.g., lack of motor flexibility), dyskinesia (Cobb et al., 1999), and clumsy and jerky movements. For example, after using a virtual environment system at home for long

periods of time, a child accidently inserted a cue stick into his eye while playing pool. Similarly, after using a virtual reality headset, a woman tried to drink soda-water through her eye instead of her mouth (Stanney et al., 2002). Despite these consistent findings, more recent studies on children (Tychsen & Foeller, 2020) and adults (Chattha et al., 2020) have found lower prevalence of such symptoms due to improvements in virtual technology. However, it is strongly recommended to read health and safety warnings before using these devices to prevent possible motion sickness and postural stability issues.

Another case related to altered body perceptions was reported in a study of a 31-year-old man diagnosed with the internet addiction disorder (excessive use of online video games) (Yung et al., 2015). This man was a patient at a residential substance abuse treatment program, and one of his more frequent symptoms involved excessive hand lifting towards his forehead with the intention to use a "Google glass" device even though he was aware of not wearing it, also known as a withdrawal symptom (Yung et al., 2015).

Table 1-6

Examples of GTP involving altered body perceptions (Ortiz de Gortari & Griffiths, 2014c)

Altered body GTP	Examples
Whole body sensations	• *"After playing "Formula 1" for more than 5 hours with my PlayStation VR, I felt that all my body was vibrating as I were inside the car at maximum speed ("Male, 32)*
Tactile sensations-Impulses	• *"When Just Cause 2 got released, I played it a lot for about two weeks. But when I tired of the game, and I was sitting at my windows, four floors up, I thought It would be so awesome if I could (tie a) a hook to that car and get to town that away and felt like pressing the F (button on the game pad) but it was like a reflex (Milton)*
Misperceptions of time	• *" After playing Crysis for a long period of time with infinite ammo, just blowing things up with a rocket launcher (which can slow down the frame rate), I experienced the world in a slower frame rate. It was kind of awesome. (Luyi)*
Feeling as the mind has disconnected from the body	• *"When playing a lot of "Grand theft auto" I felt like I was still in the game. So, I walked to the bike and thought about taking it when I realized what I was doing ("Simon,15")*

1.4.4 Other altered sensory perceptions and sensations of unreality

There are several other unusual altered sensory perceptions that have been described in the GTP literature. These include chronoceptive perceptions, which refer to the sensations of events occurring at slow pace and can be accompanied, in some instances, with lack of body flexibility. This phenomenon has been reported to occur after playing video games that involve moving at high speed and visual effects of slow motion such as movement of objects or bodies in the environment at faster or slower pace than normal (Ortiz de Gortari & Griffiths, 2014a).

Other sensations of unreality have also been reported in GTP research such as feeling that one is still in the game (e.g., derealization-like experiences) or feeling like being a video game character (e.g., depersonalization-like experiences). This depersonalization between the user and online avatars have been also referred to as the "Proteus effect", which refers to the god Proteus from Greek mythology who had a power to transform his physical form into any desired one (Yee et al., 2009). In psychology, this effect refers to how virtual avatars can affect or influence behaviours from the video game into gamers' real life (for a review see, (Szolin et al., 2023).

Furthermore, increased dissociation and reduced sense of presence in objective reality has been reported after using virtual reality technology, mainly in individuals with dissociative tendencies (Aardema et al., 2010). Acute dissociation has been induced even in laboratory conditions with healthy participants after using virtual reality (Van Heugten-van der Kloet et al., 2018).

1.4.5 Automatic mental processes

Similar to other dimensions of GTP, there is little knowledge about involuntary cognitive phenomena and video games. For instance, research on gaming addictions has investigated the role of intrusive thoughts as a symptom of gaming addition, including recurrent thoughts about playing as symptoms of the internet gaming disorder (IGD) (King & Delfabro, 2014; for a review, see Casale, Musico, & Spada, 2021). In line with this, IGD has been demonstrated to be one of the most important factors to predict GTP (Ortiz de Gortari, 2016; Ortiz de Gortari & Panagiotidi, 2023).

Initial information on automatic mental processes in GTP were obtained by (Ortiz de Gortari & Griffiths, 2014a) who subjected to qualitative thematic analysis over 1,000 descriptions of GTP experiences reported by 762 gamers on online gaming forums. Results

of this analysis showed that in addition to various types of GTP described in previous sections, gamers also reported GTP in the form of involuntary/intrusive thoughts, automatic mental actions, and urges (see Table 1-7 for examples) which, in some cases, could even lead to changes in the behaviour. More specifically, these GTP included spontaneous and/or ruminative thoughts about the game, cognitive biases (e.g., paying attention to game-related cues) or jumping to conclusions such as expecting that something in real life would occur as it did in the game. They could also involve source monitoring errors such as mixing up real events with ones from video games, or action slips confusing game controls or functions with those in the real world (e.g., wanting to use gameplay mechanics in the real-world environment) (Ortiz de Gortari, 2019).

Table 1-7

Examples of GTP in the form of automatic mental processes (Ortiz de Gortari & Griffiths, 2014b)

Automatic mental processes GTP	Examples
Spontaneous/ intrusive thoughts about the games	• *"Every time I hear old school music I think of Fallout" ("SamuellX")* • *"I cannot stop thinking about Minecraft. It's ruining my life" (Becareli)*
Urges and impulses	• *"I'm having a really tough time. I played Super Mario Galaxy on the Wii, every time I see something shiny, I want to point out at it and pick it up" ("Vivala")*
Cognitive biases	• *"Sometimes get my Sims mixed up with people. "remember when you2…. Oh no, wait that was my Sign (Lorela).*
Jumping to conclusions	• *"I was freaked out when I went outside, and trees were round and not square like the videogame I had been playing ("IneedAce")*
Source monitoring errors	• *"Once, I stand at store in the lighting bulbs department trying to remember why I needed to buy one. Then I remember I need it for a room in the video games I was playing" ("Draven")*
Mixing up game controls or functions or events with those in the physical world	• *"I had play Mass Effect 2 for seven hours, my mum walked into the room and said something. I paused for about five seconds looking at her waiting for a wheel of options to appear. Weird" ("Priceless Wil").*

1.4.6 Behaviours and Actions

Most research, conducted in this field, has focused on understanding the influence of video games on behaviour under controlled laboratory settings, using simulated scenarios and indirect measures of behaviour influenced by the gameplay, for example, how gamers' behaviour can change after playing a violent game (Gentile et al., 2014). It has been found that exposure to violent video games increased association to aggressive traits measured with an implicit association test (for review, see Uhlmann & Swanson, 2004; Groves & Anderson, 2017). Nonetheless, such findings have been focused on short-term effects of violent gameplay. A longitudinal study, focused on long-term violent gameplay in adult gamers, did not find effects of violent games over two months between experimental and control participants (Kühn et al., 2019). In contrast, it has been suggested that constant practice of video games can enhance pro-social behaviours (Wulansari et al., 2020; for review see Nicola, 2020).

Initial research on GTP differentiated voluntary from involuntary behaviours with the video game content (Ortiz de Gortari et al., 2011), referred to as intentional and involuntary/automatic GTP. In general, these behaviours comprise an extensive variety of simple actions to more elaborated behaviours (Ortiz de Gortari, 2019). For instance, intentional GTP include behaviours comprising copying or modelling game characters or movements just for entertainment, joking or using slang words to speak with fellow players, also intentionally applying knowledge learned in the game to real life scenarios. By contrast, automatic behaviours and actions tend to be triggered by external cues and occur without premeditation or intention (Ortiz de Gortari & Griffiths, 2014a). These include slips of actions such as saying out loud a thought that was not intended in the first place. Slips of actions occur due to habitual (routine) behaviours, which can be transferred to non-habitual and/or inappropriate contexts (Norman, 1981, p.3). For example, in relation to GTP, they may involve a gamer carrying out automatic actions as they would do in the game (e.g., experiencing involuntary verbal outbursts, movements of limbs, and mimicking of video game characters). Furthermore, such GTP may also involve involuntary mental actions (e.g., gamers trying to replay the game in everyday situations such as tracking objects or evaluating surroundings as they would do it in the game) that appear to be based on procedural memory (following steps, scanning scenarios, items associated with the game). Finally, they may include behaviours influenced by video games such as an attitude change due to the video game (for further examples, see Table 1-8).

Table 1-8

Examples of GTP in the form of automatic behaviours and actions (Ortiz de Gortari & Griffiths, 2014a)

Automatic Behaviours and Actions	Examples
Automatic actions	• *"I played Megaman one to six. After this, my arms would come up automatically like they were going to push the reload save button. It was actually kind of embarrassing ("Cornspeed").* • *"Many times! Quake 2 made me literally strafe my way around corners in real life" ("Jamal6").*
Involuntary body reflexes	• *"Once after a marathon Halo 2, I heard a sound far away and I tried to "zoom in". My right thumb even moved to where "B" would be in the gamepad" ("Megamanxin").*
Verbal outbursts	• *"I had been playing lots of war games. We had to get the student in a line so I was trying to tell other teacher to go first, and I said, "you take point, I will cover rear" ("Rocksdeal").* • *"I once had the Tank theme from Left for dead as my ringtone, but after it went off in public and I yelled "TANK" I changed it" ("Glitz").*
Behaviours influenced by video games	• *"After 2 days of playing Team Fortress 2 straight, I started to wonder if people were spies…. I slapped my friend because he came behind me" ("Loremore").*

1.5 The latest classification of GTP

These initial studies of GTP allowed researchers to categorize and classify several types of experiences reported by hundreds of gamers. Most of these studies investigated the content, manifestation, and emotional impact of transfers with video game content. In addition to making an important distinction between voluntary and involuntary GTP, as well as externally or internally triggered GTP, three major dimensions/modalities of GTP such as altered perceptions, automatic mental processes, and behaviours and actions described above were proposed. Based on this initial classification of GTP, Ortiz de Gortari, Pontes, and Griffiths (2015) developed a 20-item questionnaire to measure the frequency and the nature of GTP – the Game Transfer Phenomena Scale (GTPS) and validated its psychometric properties. Confirmatory factor analysis, based on responses of 1,736 gamers, resulted in one

overall factor as well as five subscales, which were labelled as altered visual, auditory, and bodily perceptions, automatic mental processes, and automatic behaviours with 4 items per subscale. Overall, the GTPS represents a reliable instrument to measure the frequency of a broad variety of GTP reported by gamers.

However, the latest research on GTP has highlighted the need for a clearer conceptual framework underpinning different dimensions of GTP and emphasized the importance of contextualizing GTP experiences within a broader context of involuntary phenomena (Ortiz de Gortari, 2016; Ortiz de Gortari, 2019). For instance, it has been consistently reported that most GTP experiences reported by gamers in several studies are common everyday (non-pathological) experiences that mostly occur as inner phenomena in the head of gamers. In other words, most of these GTP are not external (perceptual-based) but rather internally-based experiences (Ortiz de Gortari et al., 2011; Dindar & Ortiz de Gortari, 2017; Ortiz de Gortari, 2016; Ortiz de Gortari, 2019; Ortiz de Gortari & Diseth, 2022), which can be considered as involuntary phenomena similar to IAMs, mind-pops, daydreaming, earworms, and musical imagery but just adding the video game element. However, the nature and characteristics of some GTP experiences that are less frequent have been also classified as symptoms of mental/cognitive disorders. Several gamers' reports have shown that most of these experiences are perceptual-based and occur outside the head of gamers in the form of altered perceptions. These experiences range from behavioural urges, impulse actions, mix-ups to even hallucinations, and dissociations that can lead to distress states (Ortiz de Gortari, 2019).

Consequently, the latest classification of GTP by Ortiz de Gortari and Diseth (2022) makes a significant emphasis on the need to differentiate and categorize GTP experiences into two primary categories of endogenous and exogenous experiences, commonly referred to as *inner* and *outer* GTP. By doing this, Ortiz de Gortari and Diseth (2022) aimed to enhance the precision of identifying and classifying the manifestation of such experiences. Overall, this new conceptualization of GTP resulted in the development of a more comprehensive 38-item assessment tool (Ortiz de Gortari & Diseth, 2022) – the Game Transfer Phenomena Multidimensional Scale (GTP-MDS) that enables researchers to distinguish more clearly key dimensions of GTP that had been originally introduced in the 20-item GTPS (Ortiz de Gortari et al., 2015). This new scale was validated on a large sample (N = 1,301, 83.4% male), and consists of three sub-scales: i) inner phenomena referring to involuntary or intrusive cognitions, ii) outer phenomena referring to various perceptual distortions and hallucinatory

experiences, and iii) dissociative experiences and mix-ups (see Table 1-9 for examples of items from these sub-scales).

Table 1-9

The Game Transfer Phenomena Multidimensional Scale (GTP-MDS) subscales, and examples of items in each subscale (Ortiz de Gortari & Diseth, 2022)

GTP-MD subscales	Items examples
Inner phenomena	***Intrusive thoughts:*** I have tried to think of something else, but thoughts from the video game kept popping up Example: Tried to solve a math's problem, but thoughts from a video game popped into my mind ***Misperceptions/mental imagery:*** I have visualised video game elements in my mind. Example: imagined power bars above people's heads; imagined the environment from game in my mind. I have misperceived or confused a physical-word object and/or scene with something from a video game. Example: seen a plane or bird and though it was an attack plane from a video game. ***Inner auditory:*** I have heard music or sounds from a video game inside my head" Example heard melodies, steps, or gunshots from a video game in my head.
Outer phenomena	***Hallucinations:*** I have seen video game elements with eyes open, without seeing, hearing, or doing something else associated with a game" Example seen a video game image floating on the wall. ***Perceptual distortions:*** I have heard music, sounds or voices distorted or changed by the characteristics of a video game. Example: heard music slower than usual; heard someone's voice with the pitch of a character from a video game.
Dissociations and mix-ups	***Dissociations/corporeal adaptation:*** I have felt as if my body was detached from myself or seen my body from a third-person view perspective as in a video game. Example: seen my body from above as in a video game. ***Action mix-ups:*** I have unintentionally moved my limbs when seeing, hearing, or thinking about something from a video game. Example: raised an arm automatically to use the hook shot to swing when I saw a bridge. ***Cognitive mix-up:*** I have felt the urge to do something in the physical world as in a video game but, did not do it. Example: felt the urge to climb; felt the urge to roll over things.

Although there are no published studies that have investigated the underlying mechanisms of GTP, it has been suggested that inner GTP appear to be more related with memory processes (declarative and implicit) while outer GTP appear to be more associated with the exposure/perception of external stimuli for long periods of time leading to activation of neural adaptative mechanisms resulting in outer-based GTP in the form of altered perceptions (Ortiz de Gortari & Diseth, 2022). In summary, the confirmatory factor analyses obtained from the GTP-MDS has enabled a more specific classification of GTP experiences by focusing on the continuum between inner and outer-based involuntary cognitive

phenomena. However, most of the presented findings in the following sections regarding prevalence of GTP and associated factors have been obtained using the traditional GTPS (Ortiz de Gortari, Griffiths, & Pontes, 2015).

1.6 Prevalence of GTP

The majority of GTP studies have been conducted using the GTP scale with 20 items, and results have shown that GTP are fairly common with most gamers reporting to have experienced at least one type of GTP in their lifetime or during the last 12 months (Ortiz de Gortari, 2019). For example, results from several GTP studies with over 7,000 video game players from different cultural and ethnic backgrounds have shown that the reported lifetime prevalence of GTP was 95% or higher (Dindar & Ortiz de Gortari, 2017; Ortiz de Gortari, 2016; Ortiz de Gortari et al., 2016; Ortiz de Gortari & Larøi, 2017; Sifonis, 2019). The prevalence of GTP with the GTP-MDS has been equally high at 95.2 % (A. B. Ortiz de Gortari & Diseth, 2022) and, importantly, results also showed that GTP manifesting as internal mental experiences were significantly more common (94.7%) than those manifesting as externalized intrusions, such as hallucinations (49.3%) (Ortiz de Gortari & Diseth, 2022).

However, there are also some isolated reports of lower prevalence of GTP. For example, (Ortiz de Gortari, 2018) reported the prevalence of 82%, but this study was focused only on gamers playing a specific mobile phone game “Pokemon Go”. Similarly, in a sample of 276 Norwegian teenagers who were mainly playing games on mobile phones, the reported GTP prevalence was 51% (Ortiz de Gortari, 2023), and a study using a short form of the GTPS with only 5 items (GTP5-SF) reported the lowest prevalence of 50-52% (Ortiz de Gortari, 2023).

When it comes to understanding the severity levels of GTP (referring to number of different types of GTP and how frequently they occur) it has been found that, in most cases, players experience mild levels of GTP and only a minority of participants report experiencing GTP very frequently and in multiple forms of manifestation (Ortiz de Gortari, 2023; Ortiz de Gortari et al., 2016). In other words, most gamers tend to obtain low to medium scores on the GTPS, with highest scores usually obtained on the automatic thoughts’ subscale, intermediate scores on altered perceptions’ subscales and the lowest scores on the automatic behaviours sub-scale (Ortiz de Gortari & Griffiths, 2016, 2017; Ortiz de Gortari & Diseth, 2022).

1.7 Contexts and manifestation of GTP

The circumstances of GTP manifestation can vary among participants. The majority of gamers have reported experiencing GTP after finishing a game session, either immediately, minutes or some hours later. Most GTP tend to be of short duration (seconds or barely minutes), however some gamers have experienced GTP for longer periods of time (longer than a day). In some extreme cases, GTP including sounds and images have been reported to last hours or longer but have also been reported as being experienced periodically (Ortiz de Gortari & Griffiths, 2014a, 2014b).

Regarding contexts of manifestation, the GTP usually occur under a variety of conditions, for instance, when gamers are by themselves but still in social contexts, while doing routine activities that require low levels of concentration (e.g., walking, driving, taking a shower), or when zoning out or daydreaming (Ortiz de Gortari & Griffiths, 2016). However, these conditions are not mandatory for the occurrence of GTP, as they can also occur while gamers are carrying out more controlled activities (e.g., reading a book, writing an essay, talking in work call, etc.). Although GTP can occur when gamers have closed eyes without external stimulation from their surroundings, most of the GTP experiences are triggered by cues in the environment that resemble elements from the game (Ortiz de Gortari, 2019). In other words, GTP are usually triggered by game-related cues which can be either internal or external. For example, physical objects, memories from the game triggered by sound and music, inner thoughts, states of daydreaming, etc. (Ortiz de Gortari, 2019).

1.8 Variables associated with GTP frequency

Several factors have been associated with frequent GTP experiences. Most studies have used a correlational design using participants' scores on the GTPS and GTP-MDS as the main outcome variable (Ortiz de Gortari et al., 2016; Ortiz de Gortari & Diseth, 2022), although there are also few studies that have used a dichotomous variable of having experienced at least one type of GTP in binary logistic regression analysis (Ortiz de Gortari & Gackenbach, 2021). The factors that have been investigated so far cover a broad selection of variables such as socio-demographics (age, gender, occupation), numerous gaming related variables (e.g., gaming habits such as playing time or playing contexts, type of player, etc.), tendency to recall dreams, appraisal, psychopathological factors (e.g., gaming disorder, substance use), and other variables linked to psychopathology such as having a clinical diagnose, and distress. Another factor that has been associated with GTP refers to a tendency

towards experiencing cognitive failures with video game content. This can be represented by different types of failures in the control of impulses involving verbal and motor slips with video game elements (Ortiz de Gortari & Griffiths, 2014). Additionally, cognitive failures have been associated with GTP in multiple hierarchical regression analyses (Ortiz de Gortari & Panagiotidi, 2023).

1.8.1 Socio-demographic factors

Even though most gamers who have taken part in GTP research have self-identified as men, no gender differences have been found in GTP frequency in multiple samples (Dindar & Ortiz de Gortari, 2017; Ortiz de Gortari, 2023), nor even when the sample was gender balanced (Ortiz de Gortari, 2017a). However, there is just one study (n= 867) that was focused on gamers who usually played location-based augmented reality games (e.g., "Ingress") where female participants were more likely to report experiencing GTP than males (Sifonis, 2019).

Regarding age, most of the studies on GTP have been conducted among adult samples, and it has been found that young adults aged between 18 to 22 years as well as minors (around 15-year-olds), seem to be more prone to experiencing GTP than older adults (Dindar & de Gortari, 2017; Ortiz de Gortari & Griffiths, 2015, 2016; Ortiz e Gortari & Larøi, 2017). However, one previous study reported that although minors had higher overall GTP scores, the difference between them and adults was significant only for the dimensions of altered body perceptions and automatic mental processes (Ortiz de Gortari & Larøi, 2017).

Furthermore, a study by Ortiz de Gortari & Griffiths, (2015) investigated a total of 2281 gamers who responded to an online survey about their demographics and frequency of GTP. The study examined several demographic factors associated with different levels of GTP based on participants' total scores on the GTP scale (low, medium, and high). Results from regression analysis showed that the factors more associated with higher frequencies of GTP were being a student, being aged between 18 to 22 years, having gaming sessions of 6 hour or more, sleeping less due to gaming, playing to escape from the real world as motivation for playing, dysfunctional gaming, and having experienced distress or dysfunction due to GTP (Ortiz de Gortari, Oldfield, & Griffiths, 2016).

1.8.2 Gaming Habits and GTP

Several variables related to gaming habits have been explored as possible predictors of GTP such as gaming hours per week, per session, proficiency at gaming and motivations for playing (e.g., playing for immersion, exploration, to escape from real world), but results have been inconsistent. For example, playing longer sessions (between 3-6 hours), playing for immersion, and for escaping from the real world have been positively correlated with higher GTP scores (Ortiz de Gortari & Griffiths, 2015). However, Dindar and Ortiz de Gortari (2017) reported that only gaming hours per session was significantly associated with GTP frequency, and more recently, no associations between GTP scores and gaming hours per session were reported (Ortiz de Gortari & Panagiotidi, 2023).

Another variable related to gaming habits that is relevant for GTP and has produced inconsistent findings is the level of experience in gaming or gaming proficiency (e.g., identifying the self as a casual, mid-core, hardcore, or professional gamer). For instance, the majority of gamers, who have participated in GTP research, have self-identified as hard-core gamers (Ortiz de Gortari & Griffiths, 2015), while being a professional gamer has been shown to be less likely to be associated with GTP (Ortiz de Gortari & Griffiths, 2015). However, a subsequent study found that participants with higher frequency of GTP, as measured by scores on GTPS, were those who self-identified as professional gamers and played game sessions of 6 or more hours (Ortiz de Gortari, Oldfield, & Griffiths, 2016). The authors suggested that despite previous evidence showing that professionals were less likely to report experiencing GTP, if they did experience the GTP, it was likely to occur more frequently in all dimensions (Ortiz de Gortari & Griffiths, 2016). Furthermore, no differences were found in proficiency of gaming between participants who reported having experienced GTP and those who reported to have never experienced it (Dindar & Ortiz de Gortari, 2017).

More recently, the association of GTP with additional gaming-related variables were investigated in a sample of high school students (M_{age} = 16.74) who took part in esports programs to become professional players. This study examined problematic gaming factors, including dysfunctional gaming cognitions (e.g., inflexible thinking patterns and gaming-based self-esteem, overvaluing rewards), as well as GTP. Participants were compared according to their motivations for playing such as pursue an esports career to become professional or become rich or famous through esports. Results showed that participants who enrolled in the esports program with the purpose to become famous and rich had higher mean

scores on time playing esports video games, engagement in competition-gambling, problematic gaming (e.g., immersion, withdrawal, preoccupation, and interpersonal-isolation conflicts), dysfunctional gaming cognitions and GTP. Moreover, mediation analyses showed that becoming rich and famous along with problematic gaming was partially mediated by GTP, whereas becoming rich or famous and problematic gaming were fully mediated by dysfunctional gaming cognitions (Ortiz de Gortari, Diseth, & Wasson 2019). Authors highlight the relevance of identifying dysfunctional gaming cognitions in order to make students aware of problematic gaming behaviours and how to avoid them. Overall, gaming hours, motivations for playing, and proficiency at gaming might be important variables to predict GTP, however, these associations may be substantially increased in the presence of problematic and dysfunctional gaming factors.

1.8.3. Psychopathological factors

The majority of participants who have participated in studies of GTP have reported no history of mental illness diagnosis, nor the use of drugs (Ortiz de Gortari et al., 2016; Ortiz de Gortari & Griffiths, 2015, 2016; Ortiz de Gortari & Larøi, 2017; Ortiz de Gortari & Panagiotidi, 2023). Currently, there are only a couple of studies that have investigated GTP within a clinical sample. For example, a study by Basche and Ortiz de Gortari (2021) was conducted on a sample of 150 patients diagnosed with schizotypal disorders and primary diagnosis of IGD, psychosis and depression. All participants completed the GTPS, and results showed that the ratings of GTP frequency were higher for items referring to auditory intrusions with the video game content. Another study involved the examination of two male patients diagnosed with gaming disorder and attention deficit-hyperactivity disorder GD-ADHD who completed scales measuring GTP, IGD, ADHD, and daily reports of craving to evaluate the influence of GTP on craving to play. Results showed that GTP experiences in both patients influenced craving to play that were difficult to control (Ortiz de Gortari & Basche, 2021).

Some studies have indicated that psychopathological factors might make gamers more susceptible to experiencing GTP (Ortiz de Gortari, Oldfield, & Griffiths, 2016). For example, Ortiz de Gortari, Oldfield and Griffiths (2016) showed that those with high severity levels of GTP (i.e., those who experience frequent GTP of various types) were significantly more likely to have a sleep disorder and problematic gaming habits. Nonetheless, a more recent study contradicts these findings by showing no correlation between experiencing GTP

and having a mental disorder (Ortiz de Gortari & Larøi, 2017). Similar results have been found between drug use and GTP frequency, with one study reporting no significant correlation between GTP and drug use or side effects of drug consumption (e.g., flashbacks) (Ortiz de Gortari & Griffiths, 2015), and another more recent study finding a significant association (Ortiz de Gortari & Larøi, 2017).

The investigation of specific forms of GTP has showed that not all forms of GTP are associated with psychopathology. Additional analyses to explore the association between some of the most frequent dimensions of GTP such as illusions of self-motion and hearing music, and psychopathology variables (e.g., mental disorder, drug use and IGD) showed variable results. However, nearly all dimensions of GTP have led to distress which can be considered a symptom of an underlying mental health disorder or a pathological condition (e.g., anxiety disorder, major depressive disorder, or PTSD). Most of the distress due to GTP has been correlated with outer intrusions and dissociations/mix-ups, but not with inner intrusions. Additionally, significant correlations between outer GTP and involuntary phenomena without game content (e.g., tactile sensations, altered visual and auditory perceptions in general) and biased perceptions (e.g., the insertion of game elements in thoughts, perceptions, and dreams) were recently reported by Ortiz de Gortari and Diseth, (2022). Participants in this study also reported whether GTP had positive or negative impact, and results showed that most gamers perceived GTP as positive (86.9%), and only few (26.8%) reported experiencing distress due to GTP (Ortiz de Gortari & Diseth, 2022). Overall, not all dimensions of GTP can be associated with psychopathological factors regardless of how frequently they are experienced.

Finally, a more recent study by Ortiz de Gortari and Panagiotidi (2023) investigated the interplay between deficits in executive functions in relation to GTP. The psychopathological factors examined included attention-deficit/hyperactivity (ADHD), and dysfunctional gaming, as well as fatigue and poor gaming-related sleep hygiene. Results showed that GTP was associated with attention deficit, and a hierarchical regression analysis resulted in IGD along with poor gaming-related sleep hygiene as the most significant predictors of GTP. These results showed the relevance of cognitive failures and reaffirm the crucial role of dysfunctional gaming habits in the gamers' tendency to experience GTP.

1.8.4 Internet gaming disorder and problematic smartphone use

Internet gaming disorder (IGD) has been one of the main foci of GTP research. For example, Ortiz de Gortari (2016) has suggested that gamers with higher frequency of GTP might share very similar gaming habits with gamers with IGD diagnosis. For instance, playing excessively (6 hours or more per day), playing with the purpose of escaping from the real world, and feeling symptoms of distress or dysfunction. Considering oneself as having trouble with gaming or having an addiction have been demonstrated to be strong predictors of GTP (Ortiz de Gortari et al., 2016). Another study found that frequency of GTP correlated with IGD in a sample of 678 participants (Ortiz de Gortari & Larøi, 2017). Additionally, the association of GTP and addictive use of mobile phones in gamers who play the popular augmented reality mobile game "Pokemon Go" has been investigated. Results showed a significant correlation with problematic mobile use and GTP frequency (A. B. Ortiz de Gortari, 2018). Overall, the frequency of GTP and mobile phone addiction was correlated significantly with risks of IGD such as neglecting responsibilities, aggressive arguments, and fights than those with GTP but not having IGD or mobile phone addiction (Ortiz de Gortari & Larøi, 2017).

1.8.5 Types of video games related to GTP

Even though no studies have compared the effect of different video games genres on GTP, it has been suggested that the structural characteristics (game mechanics) can be related to eliciting different dimensions of GTP (Ortiz de Gortari, 2019). Another characteristic that could facilitate GTP is realistic graphics leading to higher levels of game immersion and resulting in GTP being easily triggered by those external cues in the environments that are associated to game elements. However, it is important to mention that GTP is not exclusive to just realistic graphics or just one type of video game, it has been found across all genres of video games, in more than 400 different video games (A. B. Ortiz de Gortari, 2016), and across different types of video game platforms (e.g., mobiles, PC, consoles, virtual and augmented reality devices) (Ortiz de Gortari, 2019). Nevertheless, studies have reported higher frequencies of GTP associated with playing MMORPGS (Ortiz de Gortari & Griffiths, 2016; Poels, Ijsselsteijn, & Kort, 2015). Additionally, simulators, adventure games, first-person shooters (FPS), music, puzzle and dance games have been associated with high levels of GTP, while those with low to medium levels of GTP were more likely to play action and racing games (Ortiz de Gortari, 2019).

For instance, a study focusing exclusively on “Pokemon Go” players found that prevalence of experiencing GTP while playing could be more common in augmented reality games (ARG) (A. B. Ortiz de Gortari, 2018). Also, this technology can be more important to elicit somatosensory experiences such as tactile sensations or tactile hallucinations (e.g., feeling vibrations or feeling the fingers pressing the mobile screen) and game-related proprioceptive experiences (e.g., feeling whole body self-motion) instead of visual misperceptions (Ortiz de Gortari & Griffiths, 2016). This could be explained by constant requests from the game to press the screen to attend to all the alerts related to the game. On the other hand, the lack of visual misperceptions while playing Pokémon go might be due to the need for constant switching between looking at the mobile screen and the external environment, which emphasizes the importance of immersion for gamers to experience GTP.

To conclude, the past decade has seen steady growth in research on postgame experiences and especially on the frequency and nature of GTP using qualitative interviews and forum data as well as newly developed and validated questionnaires of GTP. While qualitative studies have been important in establishing the existence of the phenomenon and proposing different classifications of post-game experiences, quantitative studies, using GTP questionnaires, have been instrumental in obtaining new information about key variables that might be associated with different types of GTP. Although some studies, reviewed above, have produced inconsistent findings in relation to certain variables (e.g., hours played, consuming drugs, etc.), other variables have produced replicable findings especially in relation to contextual factors of experiencing GTP as well as their unintentional spontaneous nature. Most importantly, research on the contents of GTP experiences has shown that the most prevalent types of GTP involve automatic inner experiences, supporting our main hypothesis that GTP may be very similar in terms of its nature and frequency of occurrence to other spontaneous cognitive phenomena studied in several related, but separate research areas. Therefore, the next major section of this chapter will provide a selective overview of those spontaneous phenomena that may have strongest similarities with GTP manifestations in everyday life.

1.9 Research on mind-wandering: Brief overview

Conscious thoughts are transient mental experiences that rarely belong to one exclusive topic, and their fluctuations were described by William James in 1893 by coining the term ‘stream of consciousness’. In recent decades, the dynamic nature of everyday

conscious thought has been studied in a rapidly growing research field of mind-wandering, which has been defined as a shift in the contents of thoughts away from the external situation to matters that are unrelated to the task(s) at hand (Smallwood & Andrews-Hanna, 2013; Smallwood & Schooler, 2006; 2015). Everyday examples of mind-wandering include thinking about what to do over the weekend or a family holiday last year while having a breakfast, driving to work, or sitting in a boring lecture. Mind-wandering can vary greatly from person to person and even from one situation to another, but on average, people tend to engage in it up to 25-50% of their waking hours (Kane et al., 2007; Killingsworth & Gilbert, 2010; Klinger, 2012). In other words, mind-wandering is a common and normal aspect of human cognition, occurring in adults and adolescents across different cultures and ethnic groups (Cherry et al., 2022; Smallwood & Schooler, 2006; 2015).

Pioneering studies of mind-wandering in the second half of the 20th century mostly used the term daydreaming to explore and describe different forms and characteristics of task-unrelated thinking (Antrobus, Coleman, & Singer, 1967; Giambra, 1966; Singer & Antrobus, 1963; Singer & McCraven, 1961), but over the past couple of decades " mind-wandering" has become a dominant term used by the majority of researchers (see Callard et al., 2013). Despite interesting findings that emerged from these early studies on how attention shifted between external and internal events, mainstream research at that time was focused primarily on how attention shifted between external sources or stimuli (Posner & Petersen, 1990; Treisman & Gelade, 1980). In addition, there was general skepticism about the formal study of consciousness due to strong behaviorist influences in psychology (Callard et al., 2013; Cohen & Schooler, 1997). It was not until the beginning of this century that research on mind-wandering really took off, coinciding with the development of neuroimaging tools such as the functional magnetic resonance imaging (fMRI), which played a crucial role in the acceptance of the scientific study of consciousness and therefore, mind-wandering research (Gilbert et al., 2007; Mooneyham & Schooler, 2013; Schooler et al., 2011; Smallwood & Schooler, 2006). In addition, this physiological measure characterized by a high spatial resolution, allowed researchers to propose a triangulation strategy to study mind-wandering, whereby behavioral measures, self-reports, and neurocognitive measures could be used as an all-inclusive approach to infer and explain inner mental processes (Schooler & Schreiber, 2004; Varela & Thompson, 2003). Due to the fMRI, researchers were able to identify the association between mind-wandering states and functional activities in the DMN (Domhoff & Fox, 2015), showing that DMN regions become more active when individuals' mind starts wandering, with contents of such thoughts often being oriented to the future that involve

individuals' own or other people's experiences (Andrews-Hanna et al., 2014; Mason et al., 2007; Mckiernan et al., 2003; McKiernan et al., 2006). However, instances of mind-wandering can also involve thoughts about personally meaningful memories of past events (D'Argembeau & Mathy, 2011).

Although several questionnaires have been developed and used to study mind-wandering in general adult population (Carriere et al., 2013; Giambra, 1995; Mrazek et al., 2013) as well as in clinical conditions (e.g., ADHD; see Mowlem et al., 2019), the majority of studies have used thought sampling procedures during sustained attention (vigilance) tasks in the laboratory (Smallwood & Schooler, 2015). For example, in the probe-caught method, participants are interrupted at random times during the vigilance task and are asked to report on the content of their thoughts at that specific moment (for a review of types of probing used, see (Weinstein, 2018). In the majority of studies, rather than describing their thoughts participants are asked to make a series of multiple-choice responses asking them whether they were on-task or off-task, and contents of their thoughts if they were off-task (e.g., *'everyday things', 'current state of being', 'personal worries', 'daydreams', 'external environment', 'other', etc.)* (e.g., Kane et al., 2017). In addition, participants may be asked to rate their thought content on several dimensions (e.g., vividness, emotion) and indicate the temporal focus of their thought (e.g., past, present or future). Overall, the probe-caught method is a valuable tool for understanding the dynamics of mind-wandering both in the laboratory and in naturalistic experience sampling studies. Laboratory studies, in particular, have provided important insights into the nature and processes involved in task-unrelated thoughts and cognitive and emotion-related factors associated with mind-wandering in different experimental conditions.

For example, several studies have investigated the role of ongoing performance during mind-wandering states, mainly how having task-unrelated thoughts is associated with negative effects on ongoing task performance. Generally, mind-wandering has been conceptualized as an undesirable cognitive state that may have negative consequences on the performance of a task at hand. For example, mind-wandering has been correlated with poor task performance (Jackson & Balota, 2012; McVay & Kane, 2012; Unsworth & McMillan, 2017), reading comprehension (Smallwood, 2011), slower reaction times on sustained attention tasks (Farley et al., 2013), impaired memory encoding in lectures or long meetings (Szpunar et al., 2013), as well as attentional disengagements in educational settings (Unsworth & McMillan, 2017).

Although mind-wandering has been mostly linked with poor performance, it is generally less disruptive in tasks which low cognitive demands. For example, the more difficult (or cognitively demanding) a task is, participants tend to stay focused on it for longer periods of time (Ruby et al., 2013). Conversely, when the task is easy and flexible, performance gets automated and participants tend to start mind-wandering (Smallwood & Schooler, 2006; Teasdale et al., 1995). Overall, the costs of sustaining attention that could affect ongoing performance during mind-wandering rely on the complexity of the task at hand.

On the other hand, while several studies have reported the consequences of mind-wandering on task performance, there are also numerous studies showing that this phenomenon can also lead to positive emotional and cognitive states (Franklin et al., 2013). For example, positive thoughts in mind-wandering episodes have been associated to beneficial future planning and prospection (Baird et al., 2012; Baumeister et al., 2011; Smallwood & Schooler, 2015). Moreover, mind-wandering might also facilitate mental breaks from monotonous and boring activities as well as the reduction in negative thinking (Baird et al., 2012; Ruby et al., 2013).

One of the most important benefits of mind-wandering has been its association with creative thinking. Generation of creative ideas has been theorised to occur spontaneously and unintentionally suggesting that it may share similar cognitive processes as well as neural basis with mind-wandering (Fox & Beaty, 2019; Sun et al., 2021). The generation process of creativity involves searching processes in the individuals' memory where already stored thoughts or concepts must combine with remote or new associations to create original ideas (Christensen-Salem et al., 2018; Madore et al., 2019; Sowden, Pringle, & Gabora, 2015). During the creative process, individuals evaluate the efficacy of their potential creative ideas, modify, and select the best ones to reach the primary goal of a creativity task (Christensen-Salem et al., 2018; Madore et al., 2019; Sowden, Pringle, & Gabora, 2015). In line with this, Baird et al., (2012) found an association between the tendency of participants to mind-wander and their performance on the alternative uses test which was used to measure divergent thinking (Guilford & Smith, 1959). It has been also demonstrated that circumstances that facilitate mind-wandering episodes generate a better incubation benefit in relation to those that required either continuous external attention or periods of idle rest (Baird et al., 2012). In a similar study, a positive correlation was found between mind-wandering and the tendency to create solution steps in social problem-solving tasks (Ruby et al., 2013). Therefore, another link between mind-wandering and creativity might be the self-generation of pathways to

problem solutions (beneficial future planning) (Smallwood & Schooler, 2015). This could occur because mind-wandering and being creative depend on the ability to generate mental contents that are different from the current reality (Smallwood & Schooler, 2015).

1.9.1 Conceptual and theoretical issues of mind-wandering

Despite all the advances made in this fast-growing research field, there are still several conceptual issues to consider both in terms of defining what constitutes a mind-wandering episode (for a debate, see Christoff et al., 2018; Seli et al., 2018) and how to measure it reliably and objectively (e.g., Kawashima, Hinuma, & Tanaka, 2023; Weinstein, 2018). For instance, there are several debates about the nature of mind-wandering that have not been resolved at the time of writing this thesis, for example, whether mind-wandering is stimulus independent or not (i.e., what is the role of cues in eliciting mind-wandering), spontaneous (unintentional) or intentional, as well as possible cognitive mechanisms involved in this phenomenon.

The thoughts that occur during mind-wandering episodes have been referred to by a variety of terms such as task-unrelated thoughts and images or simply task-unrelated-thoughts (Giambra, 1989; Smallwood & Schooler, 2006, 2015; Vannucci, Pelagatti & Marchetti, 2017), self-generated thoughts or stimulus independent thoughts (Antrobus et al., 1966), to name a few. Some studies have made a distinction between the content of mind-wandering thoughts depending on whether they are stimulus-independent thoughts (i.e., internally triggered) or stimulus-dependent (triggered by stimuli in the environment). The pre-dominant view in the field is that mind-wandering episodes are internally generated, but this may be due to types of vigilance tasks used which contain non meaningful stimuli (e.g., numbers, shapes, etc.) that are unlikely to trigger any task unrelated thoughts. However, more recent studies using experience sampling methods in daily life as well as laboratory vigilance tasks that contain meaningful material, which may trigger task-unrelated thoughts, have demonstrated that mind-wandering states can be triggered by external cues in the form of locations, people, sounds as well as words or phrases presented on the screen during the ongoing laboratory vigilance tasks (Faber et al., 2018; McVay & Kane, 2012; Plimpton, Patel, & Kvavilashvili, 2015; Song & Wang, 2012). For example, in a laboratory study by Plimpton et al. (2015), participants completed a vigilance task with incidental verbal cues with equal numbers of positive, negative, and neutral cues (e.g., winning a prize, angry boss or crossing the street). While performing the vigilance task, participants were stopped

randomly at 11 time points to record their thoughts at that moment. Results showed that most of the spontaneous task-unrelated thoughts were triggered by irrelevant cue phrases presented during the vigilance task (86%). Regarding the temporal focus of reported thoughts, most of the spontaneous task-unrelated thoughts were associated with past memories compared to thought about the future and the present. In addition, negative cues were more likely to elicit past memories while positive cues were more likely to elicit future thoughts (Plimpton et al., 2015).

Vanucci, Pelagatti and Marchetti (2017) replicated and extended these findings by comparing rates of mind-wandering in the vigilance task with and without incidental cue words to test idea that significantly more task-unrelated thoughts would be reported in the vigilance task with incidental cues than no cues (a standard situation in most mind-wandering studies). Results indeed showed that participants exposed to verbal cues in the vigilance task reported twice as many spontaneous task-unrelated thoughts (M = 7.27, SD = 5.51) than participants in the no cue condition (M = 3.42, SD = 2.69). In addition, while the majority of thoughts in the cue word condition referred to events in the past, in the condition with no cues (i.e., no meaningful stimuli), they referred to the future. Overall, this study demonstrated that frequency and temporal focus of mind-wandering can be manipulated by the presence or absence of meaningful stimuli in the ongoing vigilance task. In line with these findings, a couple of experience sampling studies with thought probes obtained in everyday life also found that the majority of spontaneous task unrelated thoughts were reported to be triggered by external and internal cues rather than emerging from nowhere (Song & Wang, 2012). In sum, these results showed that while mind-wandering can occur independently of external stimuli, especially in the environments with reduced number of meaningful stimuli, in stimulus rich environment it is almost always prompted by cues perceived in the environment or by one's own thoughts.

Another important discussion in mind-wandering research has revolved around whether it can occur spontaneously or intentionally. Several empirical studies have shown that mind-wandering measured inside and outside the laboratory can be both, spontaneous and intentional, depending on the context and individual circumstances (for a review, see Seli et al., 2016). In these studies, using self-report questionnaires or sustained attention tasks, participants are usually asked to indicate whether they had intentionally or spontaneously engaged into mind-wandering (Forster & Lavie, 2009; Seli et al., 2016). Results suggest that at least in some tasks, a substantial portion of mind-wandering can occur intentionally. For example, studies investigating intentional mind-wandering in people's everyday have shown

that individuals frequently engaged in intentional mind-wandering when the difficulty of the task was low (Carriere et al., 2013a; Seli et al., 2016, 2018). Nevertheless, in the vast majority of studies, instances of mind-wandering have been primarily rated by participants as occurring spontaneously without intention (Axelrod et al., 2015; Mason et al., 2007; McVay & Kane, 2012), and the majority of researchers in the field consider it a spontaneous phenomenon linked to the activation in key regions of DMN.

1.9.2 Proposed underlying mechanisms of mind-wandering

Several hypotheses have been proposed to elucidate the mechanisms and processes underlying the occurrence of spontaneous mind-wandering. For example, Smallwood and Andrews-Hannah (2013) proposed the context regulation hypothesis, which states that individuals' capacity to self-regulate mind-wandering within a particular context may reduce its potential negative impact on the primary task performance (Smallwood & Andrews-Hanna, 2013). For example, increase in mind-wandering frequency has been shown during ongoing tasks with low perceptual and/or cognitive demands (Antrobus et al., 1966). Similarly, other studies have shown shifts from task-related to task-unrelated thoughts during undemanding cognitive tasks (Stawarczyk et al., 2012; Thomson et al., 2014) One assumption of the context regulation hypothesis is that optimal cognitive functioning might occur when mind- wandering is restricted to undemanding situations rather than completely avoided (Smallwood & Andrews-Hanna, 2013). This perspective is supported by studies exploring the connection between mind-wandering, working memory and cognitive control (Unsworth & McMillan, 2013; McVane & Kane 2009; 2011). Overall, this hypothesis suggest that the availability of mind-wandering depends on the nature of the ongoing task and both the task and mind-wandering thoughts compete for limited cognitive resources available.

By contrast, McVay and Kane (2010) suggest that mind-wandering per se is always automatic and does not consume attentional resources (i.e., executive control and working memory capacity). Instead, task-unrelated thoughts are seen as a cognitive control failure to maintain focus on the ongoing task, particularly when task demands are high, requiring executive resources (Kane & McVay, 2012). This perspective predicts a negative correlation between working memory capacity and task-unrelated thoughts, specifically in tasks demanding high attention and executive resources, while no significant correlation between these variables is predicted for tasks with low cognitive demands.

In a study by McVay and Kane (2013), participants completed a working memory capacity task and performed either a demanding sustained attention reaction time task (SART) requiring response inhibition or a less demanding choice reaction time task without response inhibition. The results revealed a weak negative correlation between working memory capacity and task-unrelated thoughts in the SART, but no significant correlation in the choice reaction time task without response inhibition. McVay and Kane (2010) similarly reported a small negative correlation using the same version of SART. This suggests that the association between working memory capacity and mind-wandering is context-dependent, primarily evident in tasks with high attention and executive demands.

Another hypothesis that also predicts a negative correlation between working memory capacity and task unrelated thoughts while conducting attentional demanding ongoing tasks is the cognitive flexibility hypothesis (Rummel & Boywitt, 2014). This hypothesis stems from the idea that individuals with high working memory capacity possess greater cognitive flexibility, enabling them to effectively allocate attentional resources in response to the demands of ongoing tasks. In situations where task demands are high, those with high working memory capacity can leverage their executive control abilities to maintain focus on the task, avoiding distractions. By contrast, individuals with low working memory capacity may struggle to adapt to heightened task demands, leading to increased mind-wandering. This perspective suggests that working memory capacity plays a crucial role in regulating attention and preventing cognitive distractions under challenging task conditions. Further support for this hypothesis was recently obtained in the study by Robison et al. (2020).

Research on the role of executive resources and working memory capacity in mind-wandering is ongoing and is becoming more complex. However, the associations reported in correlational designs are fairly small. In addition, Barzykowski and colleagues (2022) investigated the effects of inhibitory control capacity and cognitive load on task-unrelated thoughts in vigilance task and found non-significant differences in the prevalence of task-unrelated thoughts between individuals with low and high levels of inhibitory control capacity. Overall, these findings indicate that in addition to cognitive resources and working memory capacity there may a variety of factors that determine the occurrence of mind-wandering episodes (e.g., triggers, current mood, personality factors etc.).

1.9.3 Mind-wandering and psychopathology

Although it is widely accepted that mind-wandering is a common phenomenon and mostly considered as non-pathological, some studies using an introspective approach have suggested that the content of thoughts generated during these states is limited mainly by the scope of each participant's imagination as well as their psychological profile (Smallwood & Schooler, 2014). For example, past-related thoughts might have more distinct psychological profiles than future-oriented thoughts, as several studies have found a correlation between unhappiness and mind-wandering states with past-oriented thoughts (Killingsworth & Gilbert, 2010; Smallwood, 2007; Smallwood et al., 2004). In addition to emotional states, self-generated thoughts with perseverative characteristics have been related to pathological emotional states such as anxiety and depression (Ottaviani & Couyoumdjian, 2013). Moreover, Kanske et al. (2016) investigated the amount of specific content of self-generated thoughts across different psychopathologies and personality traits such as borderline personality, major depression, narcissism, and aggressive behaviours. Results showed that patients with borderline and major depression had more negative thoughts with past-oriented content, while participants with aggressive behaviours had more negative thoughts about others, while narcissistic participants had more positively valence thoughts about themselves. These findings suggest that different psychopathological conditions are associated with different patterns of self-generated thought content confirming that the content of mind-wandering will depend greatly on the psychological profile of each individual.

Moreover, recent studies have found that excessive frequency of mind-wandering can even predict specific psychopathologies such as cognitive disengagement syndrome, and ADHD in young adults (Gionet, Arseneau, & Plourde, 2023). In line with this, it has been also reported that intrusive memories during spontaneous mind-wandering states are also a sign of pathology in mood disorders such as major depression (Ottaviani et al., 2015) and post-traumatic stress disorder (PTSD) (Brosowsky et al., 2022), but they have been studied as part of a separate field of research on intrusive memories. There is also another research field that focuses on the non-pathological manifestation of involuntary memories such as involuntary autobiographical memories and semantic mind-pops that can often occur as constituent elements of trains of thought during mind-wandering episodes.

1.10 Research on involuntary memories: A brief overview

While involuntary memory retrieval was considered to be a key mode of remembering by Ebbinghaus (1964), research on involuntary memories did not begin until late 1990s. Before this, research was almost exclusively focused on voluntary memory retrieval. The main reason for this neglect in cognitive psychology was probably due to the difficulty of studying involuntary phenomena under controlled laboratory conditions (Berntsen, 1996; Rasmussen & Berntsen, 2009). However, several studies have made it possible to induce and investigate involuntary memories in the laboratory by examining the cues and retrieval times with the use of undemanding vigilance tasks (Mazzoni, 2019; Plimpton et al., 2015; Schlagman & Kvavilashvili, 2008). Outside the laboratory, the spontaneous nature of involuntary memories has been studied by diary (Berntsen, 1996, 1998; Mace, 2004; Schlagman & Kvavilashvili, 2008) and experience sampling methods (Gardner & Ascoli, 2015) as well as questionnaires (Berntsen, Rubin, & Salgado, 2015). The use of structured diaries allows individuals to record involuntary memories as they occur in everyday life, and participants also provide information about ongoing activities, possible cues that triggered the involuntary memory as well as ratings of memory characteristics such as their emotional valance, vividness, and specificity.

The diary method can provide reliable information about the frequency and nature of involuntary memories in everyday life (Kvavilashvili & Mandler, 2004a; Schlagman et al., 2006; 2009; Schlagman & Kvavilashvili, 2008). In addition, if by the time participants can access the diary to record the memory, they have forgotten some details, they are given an option to simply acknowledge the memory instead of completing a questionnaire, allowing researchers to obtain more accurate measurement of memory frequency. It is, however, important to note that the length of diary keeping period must be taken into consideration, because the number of diary entries may vary as a function of length of the study (e.g., 1 day vs 7 days). For example, Laughland and Kvavilashvili (2018) found that shorter periods of diary keeping resulted in higher number of recorded IAMs.

Diary method has also demonstrated replicable results concerning other key aspects of IAMs. For example, several studies have shown that IAMs are consistently rated as more vivid and specific, as well as more likely to be triggered by negative cues than voluntarily retrieved memories (Berntsen, 1998; Berntsen & Hall, 2004; Schlagman & Kvavilashvili, 2008). IAMs also tend to have a stronger impact on participants' mood (Berntsen & Jacobsen, 2008), and they tend to occur when individuals are under diffuse states of

awareness or attention when being engaged in habitual, cognitively undemanding activities (Berntsen, 1998; Berntsen & Jacobsen, 2008; Johannessen & Berntsen, 2010; Kvavilashvili & Mandler, 2004; Schlagman et al., 2006).

Moreover, several diary studies have reported that most IAMs have easily identifiable triggers (Kvavilashvili & Mandler, 2004). Across different studies, participants have identified the existence of a trigger for a majority of recorded memories (80% to 94%) (Kvavilashvili & Mandler, 2004; Berntsen, 1996; Roberts et al., 1994). Such triggers are predominantly stimuli in the external environment (74%) (Berntsen, 1996). However, there is still a minority of memories triggered by internal thoughts (26%), or even a mixture of both. The percentage of IAMs where the trigger is not identifiable varies considerably (around 7% to 28%). This variability has been reported to occur due to age differences between participant samples (Berntsen, 1996, 2001; Berntsen & Hall, 2004; Berntsen & Jacobsen, 2008; Schlagman et al., 2006; Schlagman & Kvavilashvili, 2008).

Despite important contribution to the study of IAMs, the diary method has several limitations (e.g., issues with participant recruitment and compliance levels), which have prompted researchers to develop laboratory techniques to study them under more controlled settings. One of the most reliable techniques to study involuntary memories in the lab was developed by Schlagman and Kvavilashvili (2008), which involves engaging participants in an easy but boring vigilance task while exposing them to incidental cues that may trigger IAMs (Schlagman & Kvavilashvili, 2008; Plimpton, Patel & Kvavilashvili, 2015; Vanucci, et al., 2019). Since this task requires minimum cognitive resources to success, it is almost impossible for participants to not read the cues. In the initial study by Schlagman and Kvavilashvili (2008), participants were instructed to stop the task every time they experienced an IAM during the vigilance task and fill in a brief questionnaire (self-caught probing method). However, later studies have adopted a probe-caught method (often used in mind-wandering studies) by stopping the vigilance task at random intervals and asking participants to record their thoughts at the time of the probe using the same questionnaire as in the self-caught method. Using this method, several studies have demonstrated that incidental verbal cues, presented in the vigilance task are reliable triggers of IAMs (Kvavilashvili & Schlagman 2011; Schlagman & Kvavilashvili, 2008). Overall, findings from laboratory and diary studies complement each other and in addition, laboratory studies allow researchers to manipulate different variables and investigate their effects on the characteristics of IAMs and individuals' psychological well-being.

1.10.1 Involuntary memories and psychopathology

Although the connection between involuntary cognitive phenomena and psychopathology is still not well understood, several studies have demonstrated a link between autobiographical memories and psychopathology. For example, a diary study by Watson et al. (2012) examined the emotional content of voluntary vs involuntary autobiographical memories recorded by never depressed and depressed participants with intrusive memory symptoms. Results showed that although depressed participants recorded both positive and negative involuntary memories, they reported more frequent negative reactions to their IAMs than never depressed participants. However, when they were asked to recall voluntary autobiographical memories in response to cue words, most of the events recalled were positive (50%) in comparison to neutral (15%), and negative (34%) (Watson et al., 2012). These results suggest that retrieval of involuntary memories in individuals with psychopathological symptoms tends to result in stronger emotional reactions than in participants without such symptoms.

Another study under laboratory settings reported similar results when compared differences in IAMs between dysphoric and non-dysphoric individuals (Kvavilashvili & Schlagman, 2011). Results showed no differences in the frequency of IAMs, and retrieval time, vividness, or the content of reported memories. However, the important group difference was found in self-rated emotional valence of memories, with dysphoric participants reporting more negative memories as well as more internal triggers than non-dysphoric participants.

In addition to this, several experimental and diary studies have found an association between IAMs and schizophrenia. For instance, Allé and collaborators (2020) conducted both diary (memory diary) (n = 40) and laboratory studies (involuntary and autobiographical memory sessions) (n = 50) in patients with a schizophrenia diagnosis. Results from both studies confirmed that the conditions of involuntary memory elicitation differed among patients and control participants. For example, patients were more sensitive to memory triggers, especially internal triggers in comparison to controls. Similarly, a majority of patients showed a higher prevalence of involuntary memories associated to mundane events with low emotional content. In addition, involuntary memories were more poorly contextualised and more central to themselves in comparison with non-patients. Overall, results from these diary and laboratory studies demonstrated that conditions of occurrence and the content of IAMs are altered in patients with schizophrenia.

Moreover, similar results have been found for individuals on the psychosis continuum[2] (e.g., delusions, false beliefs, and hallucinations) (Allé, Berna & Berntsen, 2019). In this study, participants who reported high levels of psychotic like experiences were compared with matched controls (n = 44). Both groups completed online questionnaires that included qualitative and quantitative measures about the content characteristics of their IAMs and spontaneous future thoughts. Results showed that emotional intensity, feeling of reliving and intrusiveness were increased in the psychotic group, and the content of IAMs was more frequently referred to traumatic events and were associated with negative mood impact during retrieval, which supports a potential association between involuntary memories and hallucinations.

Overall, the content of involuntary memories has been reported as predominantly positive in non-clinical individuals (Walker, Skowronski & Thompson, 2003), nonetheless, in clinical settings, the content of involuntary memories has been mostly rated and interpreted as stressful and negative (Ehlers et al., 2004; Van Der Kolk1s2 & Fisler2, 1995). Moreover, a study using correlational design with validated questionnaires, found similar associations between the frequency of involuntary future thoughts and involuntary autobiographical memories and emotional distress (Berntsen, Rubin & Salgado, 2015). Altogether, these findings suggest a strong link between spontaneous phenomena and emotional distress.

1.11. Research on involuntary semantic memories or mind-pops: A brief overview

There are very few studies on involuntary semantic memories or mind-pops, in contrast to IAMs. In daily life, many people have expressed their surprise upon experiencing involuntary memories that appear to have no apparent connection to their ongoing activities and current thoughts (Kvavilashvili & Mandler, 2004). The most distinguishable characteristic of mind-pops that sets them apart from IAMs is that when people report experiencing a mind-pop, often, they are not able to identify any immediately preceding trigger in their external environment or in the internal train of thoughts (Kvavilashvili & Mandler 2004). Moreover, these memories do not appear to have an autobiographical content

[2] The psychosis continuum suggests that psychotic experiences can vary in intensity and duration, and not all individuals who experience psychosis necessarily have full-blown psychotic disorder like schizophrenia (the extremity of the psychosis continuum). Instead, psychotic experiences can be viewed as existing on a spectrum or continuum, with various levels of severity and impairment (for a review, see Van Os et al., 2009).

and, instead, may consist of single words and images without any contextual or relevant information about *when* and *where* a particular event occurred. For example, while an individual is waiting in a supermarket queue, a completely unrelated word or phrase (e.g., corporal punishment) may suddenly pop into mind, or during a work meeting, an individual may start thinking of a random tune. Although some of these words, images, or tunes may occur during altered states of consciousness such as waking up or falling asleep, lack of awareness is not a necessary pre-condition for their occurrence. In fact, most of these involuntary memories tend to occur during waking hours when individuals are engaged in habitual daily activities (Kvavilashvili & Mandler, 2004).

Although there are some descriptions of this phenomenon in creative (Shalamov, 1994)and autobiographical literature (Nabokov, 1966), the first empirical study on involuntary semantic memories or mind-pops was published by Kvavilashvili and Mandler (2004). These authors conducted four studies to investigate the nature and the occurrence of mind-pops in everyday life. In the first two studies, a structured diary was kept by the first author for four months, and the remaining two studies were conducted on samples of undergraduate students to replicate and extend the initial findings of Studies 1 and 2. For example, in Study 3, a total of 205 participants completed a short mind-popping questionnaire to estimate the frequency of the phenomenon in a population of young adults, and in Study 4, a group of 50 students kept two 7-day diaries of mind-pops and IAMs over a 2-week study period (one week for each memory type) in order to compare their frequency and nature (Kvavilashvili & Mandler, 2004).

Results of Study 1 showed that the participant (LK) recorded a total of 126 memories over a period of 19 weeks, and in Study 2 two years later, the same participant recorded 302 memories during a period of 18 weeks. Similar patterns of findings were obtained across the two studies. Thus, all the recorded mind-pops were coded into three categories: known words, unknown words, and visual images. There were also a few occasions when LK involuntarily started to hum a melody, however, musical mind-pops were quite infrequent compared to other three types of mind-pops in this participant. Results of Study 3 replicated and extended initial results from two diary studies by showing that 84% of undergraduate students reported being familiar with the phenomenon, and the mean frequency of mind-pops on an 8-point rating scale was 5.35 (SD= 1.65), suggesting that most participants reported experiencing them between 1-2 or 3-4 times per week. However, unlike the results of diary studies on a single (middle-aged) participant, 80% of participants reported experiencing

musical mind-pops indicating that this phenomenon may be particularly prevalent in young participants.

It is important to mention that musical mind-pops can be seen as a subtype of so called 'earworms', which involve songs and tunes coming to mind repeatedly in a more intrusive way and have been referred to in the literature as "music stuck in the head" phenomenon (Beaman, 2018; Beaman & Williams, 2010). Several studies have suggested that earworms usually involve well-known songs and most of them are cued in the same way as IAMs or mind-pops without musical content (Kvavilashvili & Mandler, 2004; Kvavilashvili & Schlagman, 2011). More importantly, their prevalence is similar to other involuntary memories in non-clinical populations (72% to 91%) (Halpern & Bartlett, 2011; Hyman et al., 2015; Liikkanen, 2009).

Finally, in Study 4, before the study began, the lecturer (L.K) clearly explained the distinction between IAMs and mind-pops to undergraduate students taking a course on memory psychology and were asked to complete a mind-popping questionnaire (MPQ) to measure the frequency of their involuntary semantic memories in everyday life. Once this was done, participants were informed that as part of their course, they had to keep two diaries and record their IAMs and mind-pops (one week of each memory type). Results showed a higher prevalence of recorded IAMs (n = 205) than mind-pops (n = 74): over two weeks, more IAMs (M = 4.01) than mind-pops (M = 1.47) were reported by undergraduate students. Overall, the results of Study 4 replicated the findings of previous diary studies of IAMs (Berntsen, 1996; Roberts et al., 1994) as well as the results of the questionnaire study of mind-pops in undergraduate students in terms of prevalence, type of triggers and ongoing activities at the time of the memory occurrence. In addition, the results showed that the frequency of mind-pops may be more prevalent than the frequency revealed using the questionnaire method. In addition, results also confirmed that one of the key differences between mind-pops and IAMs was that mind-pops were less likely to be triggered by easily detectable triggers than IAMs (Kvavilashvili & Mandler, 2004).

Furthermore, several studies have reported an association between mind-pops and psychopathology, mainly for the presence of schizotypal traits. Schizotypal experiences have been commonly sorted into three dimensions (positive, negative, and disorganised), though the positive dimension which includes delusional beliefs and experiences related to altered perceptions such as auditory and visual hallucinations or distortions is the schizotypal trait that has been most often related to involuntary phenomena (Kwapil et al., 2013; Wongupparaj et al., 2015). For instance, it has been reported that individuals with higher

schizotypy scores have lower control in filtering auditory stimuli as well as abnormal sensory experiences (Croft et al., 2001; Ettinger et al., 2018). These results suggest that individuals with high schizotypal traits might be more prone to experiencing involuntary imagery, primary auditory imagery, or earworms (Ettinger et al., 2015; 2018; Cotter, Christensen, & Silvia, 2016; Lagioia et al., 2010). Similarly, this pattern has been found in patients with a schizophrenia diagnosis in two studies by Elua and colleagues, using a questionnaire and a diary method, who found that patients with schizophrenia reported significantly higher frequency of verbal mind-pops as assessed by mind-popping questionnaire than the clinical (depressed) and non-clinical control participants (Elua, Laws, & Kvavilashvili, 2012) and recorded more mind-pops in a 7-day diary than healthy controls (Elua, Laws, & Kvavilashvili, 2015).

1.11.1 Other key findings in research on mind-pops

Despite the prevalence of mind-pops in daily life, there are only a few published studies on this phenomenon. First, Zhang et al., (2015) used the same mind-popping questionnaire developed by Kvavilashvili and Mandler (2004) in a sample of young healthy Chinese adults' participants ($N = 256$). The main aim of the study was to investigate the relationship between mind-popping frequency, creativity, openness, and brain morphometry. Multiple regression analyses between voxel-based morphometry and mind-popping frequency revealed that higher frequency of mind-pops was predicted by smaller gray matter volume in the left middle temporal gyrus, and larger gray and white matter volume in the right medial prefrontal cortex. Also, levels of creativity measured by the Torrance Creativity Test (Torrance, 1974) were positively correlated with the frequency and different types of mind-pops, which supports previous studies suggesting a link between spontaneous cognitive phenomena and the facilitation of creative thinking (Fox & Beaty, 2019; Cristoff et al., 2012; Smallwood & Schooler, 2015). Finally, the frequency of mind-pops was positively correlated with creativity (Zhang et al.,2015), as well as with some of the big five personality traits such as openness, which has been associated to creativity (Hoseinifar et al., 2011). Openness has suggested to reflect a tendency to process abstract and perceptual information in a flexible and efficient way (DeYoung et al., 2010). In other words, individuals higher on trait openness may be more receptive to their surroundings, involuntarily activating a broader array of concepts within their semantic networks enhancing the occurrence of mind-pops (Zhang et al., 2015).

Altogether, the findings of this study are in line with those presented by Kvavilashvili and Mandler (2004) by showing that mind-pops are a common phenomenon in adult samples across Western and Eastern populations. Also, results showing larger grey matter volume in the medial prefrontal cortex of participants with higher frequency of mind-pops suggests that there may be a link between the engagement in self-generated thoughts and the tendency to experience mind-pops in everyday life (Zhang et al., 2015).

In addition, Liu et al. (2019) used a resting-state functional connectivity analysis to examine the frequency of mind-pops, measured by the mind-popping questionnaire, and its relationship with resting-state brain functions in healthy undergraduate students ($N = 397$). Results showed that mind-popping frequency scores were positively correlated with functional connectivity in the para-hippocampal gyrus, and supplementary motor area suggesting that the neural circuit involved in mind-popping may be similar to the one known for implicit memory (Liu et al., 2019. Previous studies on mind-wandering have suggested that this network is activated when individuals are engaging in thoughts that usually occur during mind-wandering states (e.g., personal thinking, about the future, the past or other people in particular) (Andrews-Hanna et al., 2014). In general, the findings in relation to DMN have provided a reliable foundation to understand the brain basis of spontaneous cognitive phenomena such as mind-wandering, IAMs, and mind-pops.

1.12 Underlying mechanisms of involuntary cognitive phenomena

Although the DMN has been closely related to mind-wandering states, and recently with mind-popping (Liu et al., 2019), there is also another more cognitively based hypothesis that tries to explain the occurrence of involuntary memories such as IAMs, mind-pops, and earworms by proposing the so called long-term priming mechanism that may be in operation in everyday life. This hypothesis was initially proposed by Kvavilashvili and Mandler (2004) to explain the underlying mechanisms of mind-pops and was subsequently subjected to intensive empirical testing by Mace in relation to IAMs (Mace, 2005; Mace & Hidalgo, 2022; Mace & Petersen, 2020; Mace & Unlu, 2020). It is also possible that the same type of priming mechanism is involved in the occurrence of GTP in gamers who constantly expose themselves to game-related stimuli by extended periods of playing (see Study 2 in Chapter 3).

The long-term priming hypothesis by Kvavilashvili and Mandler (2004) argues that mind-pops in the form of words, images and music may be primed by previous encounters with them (repetition priming), or with semantically related content (associative priming).

Priming effects have been also found during IAM retrieval using a diary method (Mace, 2005) and in the lab using a vigilance task (Barzykowski & Niedźwieńska, 2018; Mace et al., 2019; Mace & Hidalgo, 2022). It appears that certain objects, words, sounds, etc. encountered during a daily life activate mental representations, which stay active long after one has encountered them (probably for minutes, hours or even days). Subsequently, due to incidental encounters with other stimuli in the environment or one's thoughts some of these representations get additional boost in activation levels, resulting in a conscious experience of a word, image, or an autobiographical memory.

Initial support for this long-term priming hypothesis was found in several diary studies of mind-pops in which participants reported recent encounters with the content of their mind-pops in 42% of recorded cases (Kvavilashvili & Mandler, 2004). More recently, several studies have provided evidence for the priming mechanism in autobiographical memories under laboratory conditions, by showing that the activation of semantic representations can also prime autobiographical memories. For example, the word 'video game' (e.g., seen in a TV commercial or social media) can activate (prime) unconsciously a lot of autobiographical memories of both repeated or general events (e.g., *"I often played video games on Sundays when I was young"*) as well as more specific events that happened at a particular time and location (e.g., *"I played Final Fantasy 10 with my best friend when I visited him during my school holiday"*). These autobiographical memory representations are likely to remain active over time so that when a word "friendship" is encountered hours or even days later, a memory about playing Final Fantasy with a friend may pop into mind while in a meeting or watching news (Mace, 2005; Mace et al., 2019; Mace & Petersen, 2020). For example, in Experiment 1 by Mace et al. (2019), participants were asked to rate words (prime cues) in relation to their familiarity (e.g., music, summer, trip, etc.). Results showed that primed participants recalled more voluntary autobiographical memories associated with the primed words in comparison to control participants when, later in a cue word task, they had to recall a memory in response to a different set of words that were unrelated to prime words that they had to rate for familiarity. In the second experiment, participants were primed with similar words, and then were asked to complete a vigilance task with unrelated incidental verbal cues (Schlagman & Kvavilashvili, 2008), and results again supported the priming hypothesis, by showing that participants who were primed reported a higher number of IAMs associated with the primed content in comparison to control participants. A subsequent study by Mace and Unlu (2020) replicated and extended these findings by using sentences and pictures as primes in Experiment 1 and 2, respectively, and showed that both types of stimuli

consistently primed IAMs in a subsequent vigilance task. More recently, Mace and Hidalgo (2022) replicated and extended previous findings by showing that such semantic to autobiographical memory priming was found even after a delay of one week.

Furthermore, support for the priming hypothesis has also been obtained within research on musical earworms. For example, it has been found that individuals who regularly listen to music, often experience earworms with the content that aligns with specific characteristics of the music they had been listening to previously (e.g., tempo or lyrics). This suggests that earworms are likely to be primed by exposure to music, as well as music engagement (Liptak et al., 2022).

Overall, these laboratory studies have provided strong evidence for the long-term priming hypothesis, as well as the fact that various types of semantic stimuli can effectively prime involuntary memories. In line with this, it is possible that GTP experiences are primed in a similar way.

1.13 GTP as part of involuntary cognitive phenomena: a new framework

The GTP have been recently conceptualised as a multidimensional involuntary phenomenon that can manifest as inner or outer experience depending on the nature of each dimension (Ortiz de Gortari & Diseth, 2022). Considering possible links between GTP and other spontaneous cognitive phenomena presented in this thesis, a descriptive model of GTP is presented that considers GTP as part of other involuntary cognitive phenomena (see Figure 1-2). This model attempts to make a clear distinction between inner and outer-based GTP as well as type of involuntary experiences that can be considered as pathological and non-pathological.

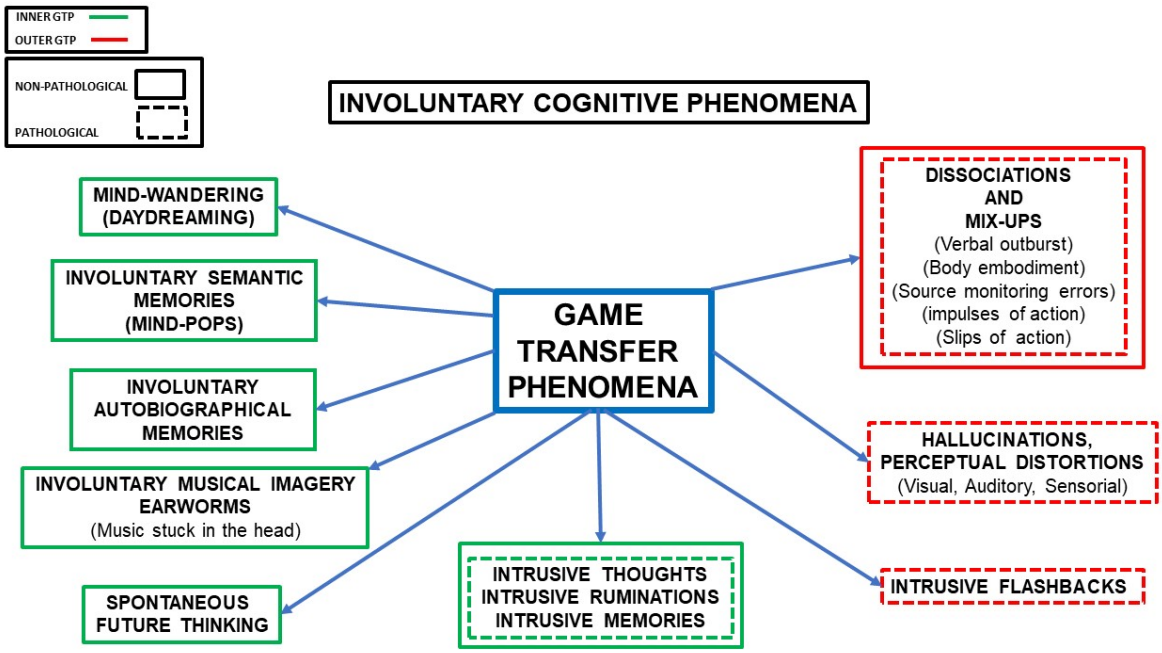
As depicted in Figure 1-2, inner GTP, represented by green boxes, encompass a variety of internal mental experiences with video game content perceived to be originated in one's head. For example, a GTP may manifest as a constituent element of task-unrelated thoughts about a particular game during mind-wandering episodes, or they can be experienced as IAMs about one's prior experiences of playing a particular game or involuntary thoughts about future gaming episodes (e.g., thinking about an upcoming gaming session with friends over the weekend). Similarly, inner GTP can be experienced as mind-pops, earworms or musical imagery with the words and music encountered in a particular video game. Although most of these phenomena have been considered as non-pathological and fairly common everyday experiences among normal populations (represented by boxes

with solid lines), it has been reported that some of these inner involuntary phenomena in the form of intrusive thoughts, ruminations and memories can be perceived as disruptive and pathological (represented by boxes with dotted lines) in some psychological profiles or diagnosed mental illness such as obsessive-compulsive disorder, depression or PTSD (Jones & Steel, 2012; Julien et al., 2007; Speckens et al., 2007).

On the other hand, most involuntary experiences that are perceived to be located outside one's head (represented by red boxes), can be considered as symptoms of different mental disorders within clinical populations and are presented by dashed lines. These phenomena represent different types of sensorial and perceptual dissociations, intrusive flashbacks in PTSD (Kvavilashvili, 2014) as well as different types of hallucinations and distortions. However, it is important to mention that some outer phenomena that involve dissociations (e.g., disruption in the normal integration of thoughts) including mix-ups such as verbal outbursts, body embodiment, source monitoring errors, impulses and slips of actions are not necessarily considered pathological in the context of GTP. Considering their links with psychopathology, it is perhaps not surprising that when gamers complete scales measuring GTP, they score higher on types of GTP that are located in one's head and refer to more benign (non-pathological) involuntary phenomena that had been studied by several different areas of research reviewed earlier in this chapter.

Figure 1-2

Multidimensional classification of GTP conceptualised as part of involuntary cognitive phenomena



Overall, the evidence presented in this chapter along with the proposed descriptive model reflects possible connections between GTP and other spontaneous cognitive phenomena. However, links with other involuntary phenomena has been somewhat neglected in GTP research, and it is of important to investigate these links taking into consideration the contents of GTP, the role of cues in inner and outer experiences, as well as personality and psychopathological traits, and other possible cognitive variables that may contribute to the experience this non-volitional phenomenon.

1.14 Brief outline of empirical chapters

The following five chapters will present data from four different studies. The primary objective of Study 1 presented in Chapter 2 was to examine, for the first time, the relation of GTP with other spontaneous cognitive phenomena such as mind-wandering and involuntary semantic memory or mind-pops as well as its possible association with other cognitive (e.g., working memory capacity), emotional (e.g., stress, anxiety, and depression), and personality variables (e.g., schizotypy and impulsivity). It was anticipated that GTP would be predicted by several of these important variables that had not been studied before (especially by mind-wandering, mind-popping scores, and positive schizotypy). Additionally, this study aimed to replicate and extend previous findings on gaming habits reported in GTP research such as gaming hours per session and internet gaming disorder (Ortiz de Gortari, 2019).

Chapter 3 will present the results of a 7-day diary study in video game players with different levels of GTP (Study 2). This study aimed to examine the frequency, nature, and potential triggers of GTP experiences in everyday life. It was anticipated that the frequency of GTP experiences reported in the diary would be very similar to the frequency of mind-pops reported in previous studies during a 7-day period (Kvavilashvili & Mandler, 2004). Also, that GTP would occur mostly during non-demanding ongoing tasks, be triggered by incidental cues in the environment, and that GTP experiences would be mostly vivid, with short duration, and related to more immersive video games. Most importantly, in terms of GTP dimensions described in Figure 1-2, it was expected that the majority of GTP instances, recorded in the diary, would be related to automatic inner mental processes (mind-pops and IAMs). Finally, because all participants of the diary study had also completed Study 1, in which they completed the GTP scale, it was expected that there would be a positive correlation between the number of GTP recorded in the diary and the total scores on the GTP scale.

As reported earlier in this chapter (in section 1.12), evidence from research on IAMs and mind-pops suggests that long-term priming, resulting from prior exposure to the contents of involuntary memories, may be an important variable contributing to the occurrence of involuntary memories in a particular time and place (Kvavilashvili & Mandler, 2004; Mace et al., 2019; Mace & Petersen, 2020). In relation to GTP, the findings from diary Study 2 provided initial evidence that a long-term priming mechanism may also be in operation in the instances of GTP recorded in the diaries. It was therefore necessary to replicate and extend these initial findings with a more controlled methodology. Chapter 4 describes Study 3 that adopted individual differences approach and examined the association of GTP frequency measured by the GTP scale and levels of priming measured by the implicit memory task (i.e., word fragment completion). Additionally, the study also examined the association of GTP frequency and participants' creativity scores to further assess possible links between GTP and involuntary cognitive phenomena such as mind-wandering and mind-pops that had been associated with creativity (Agnoli et al., 2018; Baird et al., 2012; Fox & Beaty, 2019). It was expected that individuals with higher scores on the GTP scale would also have higher priming effects in the word-fragment completion task. In addition, it was hypothesised that higher scores in creativity measures (free association and alternate uses tasks) would be good predictors of GTP.

Chapter 5 will present data from a face-to-face experiment (Study 4) that will extend the findings from priming obtained via online Study 3. The main aim of this study was to examine the role of an immersive video game in the generation of long-term priming effects during the performance of a lexical decision task using cue-words that previously appeared in the game. Long-term priming effects were measured over two periods of time (right after playing the game and approximately 24 hours after). In line with the results of Studies 2 and 3, it was expected that participants with higher GTP frequency as measured by the GTP scale would be more likely to be primed in the lexical decision task in response to words and concepts encountered previously in the computer game than participants with lower GTP frequency scores.

Finally, Chapter 6 provides a brief summary of the main aims of the research and key findings from the four studies presented in this thesis. The discussion of the most relevant findings will be focused on the role of the strongest variables among the four studies conducted (e.g., IGD, mind-pops, daydreaming, and positive schizotypy) as well as the importance of priming effects as a potential underlying mechanism of GTP. Also, the methodological and theoretical implications of studying GTP with different methods will be

discussed. Finally, some limitations of the studies will be discussed and the possible future avenues of research on GTP will be outlined.

Chapter 2: Mechanisms of Game Transfer Phenomena: The role of gaming addiction, positive schizotypy and involuntary cognitions (Study 1)

2. Introduction

Research on GTP has started only recently (Ortiz de Gortari et al., 2011). Although several advances have been made in terms of understanding which psychological and game-related variables are potential predictors of one's tendency to experience GTP in everyday life, there are still several unanswered questions about the nature and mechanisms of GTP, especially in terms of their potential relation with other involuntary cognitive phenomena. A brief overview of research on some of these involuntary phenomena, presented in Chapter 1, showed that they may share important similarities with the content and manifestation of GTP (cf. Ortiz de Gortari, 2019). Despite large variability in how GTP manifest in everyday life, they often involve remembering scenes and actions that had happened in the game, or having an experience of a name, words, or images and music from the game popping into mind when the gamer has stopped playing and is not thinking about the game at that moment. Furthermore, similar to IAMs and mind-pops, GTP also tend to occur while carrying out undemanding and habitual daily activities that require low levels of concentration (Ortiz de Gortari & Griffiths, 2016). Moreover, some GTP experiences are elicited in a similar way as mind-pops because initial qualitative studies have shown that not all GTP are cued by environmental contexts (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2012).

In addition, we still know very little about the specific role of internet gaming disorder (IGD) in the experience of GTP. The initial studies suggesting the possible role of gaming addiction as an important factor contributing to the experience of GTP did not measure IGD with validated scales. Instead, the presence and magnitude of IGD was inferred by participants' responses to surveys measuring gaming habits and sleep patterns (Ortiz de Gortari & Griffiths, 2016; Ortiz de Gortari, Oldfield & Griffiths, 2016). However, recently studies have started to use structured questionnaires to investigate this association. For example, Ortiz de Gortari and Gackenback (2021) used a scale to measure problem with video game playing, which was developed considering the DSM-IV criteria of addiction for gambling and substance abuse. Results showed significant association between GTP and problematic video game playing.

Subsequently, Ortiz de Gortari and Panagiotidi (2023) used the validated internet gaming disorder scale (Pontes & Griffiths, 2015) which is based on the diagnostic criteria of IGD included in the DSM-5. This study investigated the role of IGD along with the measures of cognitive failures (e.g., attentional and memory errors, and action slips), inhibitory control, fatigue, and poor gaming-related sleep hygiene as predictors of GTP using more complex

statistical methods such as multiple hierarchical regression and mediation analysis. Results showed that IGD, cognitive failures, and poor gaming-related sleep hygiene were significant predictors of GTP in the hierarchical regression analysis. Moreover, mediation analysis showed that the associations between IGD and GTP as well as cognitive failures and GTP were partially mediated by poor gaming-related sleep hygiene. Overall, this study confirms the possible strong link between IGD and GTP, proposed initially, and emphasises the importance of using multiple predictor variables and more complex statistical analysis.
It is crucial to replicate and extend these initial findings, by examining the role of IGD in GTP, especially when controlling for other variables. It is possible, for example, that the effects of IGD on GTP are mediated by some other factors than poor gaming-related sleep hygiene (e.g., impulsiveness, schizotypal traits). Overall, a combination of several other variables (both cognitive and emotional) could lead to increased frequency of inner and outer involuntary cognitive experiences in real-life such as GTP.

In addition to problematic gaming, experiencing GTP has been also linked to negative emotional and physiological states. For instance, previous studies have found increased self-reported distress in response to outer GTP experiences such as perceptual experiences and hallucinations located in the environment rather than inside one's head (Ortiz de Gortari et al., 2016; Ortiz de Gortari & Griffiths, 2012), and GTP experiences have been also associated with problematic sleep patterns (Ortiz de Gortari & Panagiotidi, 2023). However, the relationship of GTP with psychological distress in general and other cognitive-behavioural variables, such as impulsivity, remains unclear because they have not been assessed using standard questionnaires designed to measure depression, anxiety, and impulsivity. Understanding and measuring these variables will yield valuable information about the potential emotion and cognitive-behavioural variables related to GTP, which may help clarify the primary factors contributing to susceptibility to experiencing this non-volitional phenomenon.

Overall, the main objective of the present study was to investigate previously studied predictors and several new, potentially important predictors of GTP that had not been examined in previous literature. The primary focus was on studying a possible relationship between spontaneous cognitive phenomena and GTP frequency as measured by the GTPS in a sample of gamers who reported playing at least four hours per week in the last 12 months. Given that GTP often occur during diffused states of attention that are conducive of mind-wandering as well as similarities between the contents of GTP and mind-pops, participants completed questionnaires assessing the frequency of daydreaming or mind-wandering

(Giambra, 1995b) and involuntary semantic memories or mind-pops (Kvavilashvili & Mandler, 2004) in addition to the GTP scale. It was predicted that higher rates of mind-wandering and mind-pops would be positively correlated with GTP scores.

It was also anticipated that there might be similarities in underlying mechanisms of spontaneous cognitions and GTP. One potentially important variable that has been shown to have strong links with involuntary autobiographical memories (Allé et al., 2023), musical imagery or earworms (Cotter et al., 2016; see also Seeman, 2016), and mind-pops (Elua et al., 2012, 2015) is schizotypal personality traits (especially positive schizotypy). For example, in a questionnaire study of Elua et al. (2012), patients with schizophrenia reported higher frequency of mind-pops than patients with depression and healthy controls. In a 7-day diary study, schizophrenia patients also recorded significantly more word and image mind-pops than a group of healthy controls (Elua et al., 2015). If GTP are similar to involuntary cognitions such as mind-pops, as proposed in the present study, then they should be positively associated with schizotypal traits in the gamers tested in the present study.

Another potentially important variable that has been linked to mind-wandering frequency is the working memory capacity (WMC), which has been described as a component of executive control that appears to be involved in conscious involuntary phenomena. For example, according to McVay and Kane (2010), instances of mind-wandering can be considered as a failure of attentional control to maintain one's focus on the ongoing task. In line with this view, some previous studies have shown that there is a negative relationship between tasks assessing WMC and mind-wandering frequency, i.e., individuals with low levels of WMC tend to report higher frequency of task-unrelated thoughts than those with high WMC (e.g., McVay & Kane, 2009; Robison & Unsworth, 2017;for meta-analysis, see Randall et al., 2014) It is therefore possible that gamers with lower levels of WMC will have higher rates of GTP than those with higher WMC. To assess this hypothesis, participants also completed two tasks assessing their WMC such as automated symmetry and reading span tasks (Unsworth & Randall, 2005).

An additional aim of the study was to significantly extend previous research on predictors of GTP by examining its associations with measures of psychological distress and impulsivity. Although GTP in gamers has consistently been found to be related to higher levels of IGD, there is little research on its relationship with other psychopathology variables. A few studies that examined a link between GTP and the presence of a pre-existing mental illness have resulted in contradictory findings: while Ortiz de Gortari and Griffiths (2015) reported a positive link, other studies did not find an association between the two variables

(Ortiz de Gortari & Laroi, 2018; Ortiz de Gortari & Panagiotidi, 2023). In addition, previous studies have investigated mental illness as a categorical variable (YES or NO). Therefore, a more targeted approach is needed by using validated scales assessing different aspects of mental distress and impulsivity. In the present study, we used validated questionnaires to assess self-reported levels of depression, anxiety, and stress (Henry & Crawford, 2005) as well as behavioral impulsivity (Spinella, 2009) given that some GTP can manifest as impulsive actions or urges suggesting poor cognitive control (Ortiz de Gortari & Griffiths, 2014; Ortiz de Gortari & Panagiotidi, 2023). It was hypothesised that higher scores on psychological distress (especially anxiety and stress) and impulsivity would be positively associated to GTP.

Given that previous studies have consistently reported IGD as one of the most important predictors of GTP, the final aim of the study was to investigate if IGD and other game-related variables (e.g., the number of hours played per week, length of gaming sessions, etc.) remained as important predictors of GTP when entering all the other variables of interest into a hierarchical multiple regression model. Most importantly, given the special emphasis on involuntary cognitive phenomena, the present study used the mediation analysis to examine if involuntary cognitive phenomena (i.e., mind-popping and daydreaming) and schizotypal traits would mediate the relationship between IGD and GTP.

To address the aims of the study, participants completed several validated questionnaires and scales assessing the GTP and other variables, discussed above, and completed two cognitive tasks measuring their WMC. The study was conducted in a face-to-face format at the University of Hertfordshire. However, the data collection process was disrupted by COVID-19 lockdown restrictions in the UK, which led to the adoption of an online methodology. This unexpected change in the mode of data collection presented an excellent opportunity to assess the validity of online data on GTP and its associated variable to the data obtained by face-to-face testing. Given concerns raised in the literature about online data collection (e.g., lack of experimental control, technical issues, response, and non-response bias, etc.) and its comparability to face-to-face testing (Cantrell & Lupinacci, 2007) and the fact that most previous studies of GTP and its associated factors were conducted online, this change in method allowed us to examine the validity of these concerns in the context of research on GTP.

2.1 Method

2.1.2 Participants

A power analysis was performed using G-power (Faul et al., 2007) (G-power for Mac version 3.1.9.3), with a medium effect size of 0.15, power of 0.95 and 18 predictors. Based on these values, a minimum of 213 participants was required. However, it was decided to recruit a larger sample due to possible exclusions and dropouts especially after switching to online mode of testing.

Based on the power calculation and these considerations, a total of 420 participants were tested. All participants had to meet the following inclusion criteria: (1) having played any kind of video games for at least 4 hours per week on a regular basis in previous 12 months, (2) being 18 to 45 years old, (3) having a minimum of 11 years of formal education and (4) for non-native English speakers, it was necessary to have at least medium level of proficiency in the English language (level 4 and above) on "The London School of English" 9-point scale (The London School of English, n.d.).

A total of 57 participants were removed from the data analyses. Out of these, 33 participants dropped out from the study at different points, 16 reported having played less than 4 hours per week in the past 12 months, and four participants reported less than 11 years of formal education. One further participant was removed because of being the only outlier in the GTP scale achieving a maximum score of 80 points. Finally, three participants were not included as they reported English proficiency below the cut-off point of 4. The final sample comprised 363 participants (270 males; M_{age} = 25.53 years; *SD* = 6.08; age range: 18-45). Demographic information of the sample is presented in Table 2-1.

Table 2-2 presents details about participants' gaming habits (e.g., years of playing, gaming hours per week and per session), sleep patterns due to gaming and what type of video gamer participants perceived themselves to be (casual, mid-core, hard-core, or professional). The majority of participants classed themselves as mid- and hard-core players (49.6% and 39.7%, respectively), and reported playing games for 20.86 (*SD* = 14.08) hours per week.

2.2 Design

This study utilized a correlational within-groups design. Originally, this study was planned to be completed face-to-face under laboratory-controlled conditions, however, due to COVID-19 pandemic, only 64 participants were tested face-to-face on campus (18%) and the remaining 299 participants were tested online (82%).

Table 2-1

Participants' Age and Other Demographic and Background Variables

Variables	Total sample (n = 363)
Participants' Age	
- Mean Age in years (SD)	25.53 (6.08)
Gender, n (%)	
- Male	273 (75.2)
-Female	89 (24.5)
-Prefer not to say	1 (.4)
Years of formal education, mean (SD)	16.62 (3.02)
Occupation, n (%)	
-Student	143 (53.6)
-Employed	77 (30.8)
-Self-Employed	24 (9.6)
-Unemployed	13 (5.2)
-Unable to work	1 (.4)
-Homemaker	1 (.4)
Drug use, n (%)	
-Never	210 (84.0)
-Once or twice	24 (9.6)
-3 to 5 times	3 (1.2)
-6 to 10 times	2 (.8)
-More than 10 times	8 (3.2)
-Daily	2 (.8)
-More than once a day	1 (.4)
Mental Illness, n (%)	
-No	216 (86.4)
-Yes	34 (13.6)

Table 2-2
Participants' Gaming Habits and Sleep Patterns

Variable	Total sample (n=363)	Min, Max
Video Game Experience		
-Years of playing, mean (SD)	16.40 (7.38)	1, 38
-Gaming hours per week, mean (SD)	20.86 (14.08)	4, 91
-Gaming sessions in hours, mean (SD)	3.71 (2.15)	1, 20
Playing days per week, n (%)		
-1-2 days	26 (7.2)	
-3-5 days	146 (40.2)	
-6-7 days	191 (52.6)	
Type of video game player = n (%)		
-Casual	34 (9.4)	
-Mid-core gamer	180 (49.6)	
-Hardcore gamer	144 (39.7)	
-Professional gamer	5 (1.4)	
Sleeping less because of gaming = n (%)	23 (6.3)	
-Never	134 (36.9)	
-Rarely	147 (40.5)	
-Sometimes	46 (12.7)	
-Often	13 (3.6)	
-Very often		

Note: Casual/leisure gamer (e.g., I enjoy playing games, but my time/ interest is somewhat limited); Mid-core gamer (e.g., I play different kinds of games enthusiastically, but I do not play as long or as hard as a hardcore gamer); Hardcore gamer (e.g., I spend a huge amount of time playing games. I like to search the latest news and updates in gaming. I have a good console/Pc made especially for gaming) and Professional gamer (e.g., I like to play video games constantly as a fulltime job to make profit by competing in official tournaments).

2.3 Study Materials

2.3.1 Demographics Questionnaire

A brief 8-item questionnaire was developed to measure socio-demographic variables such as participants' age, sex, education, English proficiency, occupation, country of residency, and history of mental illness. The following questions were included: what is your gender (*Male, Female, prefer not to say*); What is your age (*please type in the box how old are you*); What is your current occupation (*Student, employed, self-employed, unemployed, unable to work, homemaker, retired*); Which is your current country of residency? How many years of formal education have you completed? (*e.g., if you are first year university student*

in the UK, and started your education at 5 years of age, you would have 13 years of formal education); Do you currently have a mental illness diagnosis? (*Yes, No*); are you currently taking any prescribed medication for the diagnosed condition mentioned above? (*Yes, No*); How often have you used recreational drugs or psychoactive substances other than alcohol in the last month? (*Never once or twice*, *3 to 5 times*, *6 to 10 times*, *daily*, *more than once a day*) (see Appendix I).

2.3.2. Gaming habits Questionnaire

This 15-items questionnaire was developed to measure gaming habits throughout different periods of time (e.g., years of playing, hours played per week, per session, type of video game player, sleep deprivation due to gaming) as well as proficiency, playing alone or accompanied, online-offline, type of video games genres most played, and frequency of which they sleep less due to gaming. Additionally, participants also provided some demographic details about what platforms (e.g., console, handheld devices, PC, etc) they play the most, most preferrable genres of games, favourite game of all time, and current game most played at the moment. (see Appendix II for full questionnaire).

2.3.3. Game Transfer Phenomena Scale (GTPS)

The GTP scale was developed by (Ortiz de Gortari et al., 2015) to measure the frequency of GTP experiences in video game players during the past 12 months. The scale consists of 20 items with response options ranging from 0 (*Never*), 1 (*Once*), 2 (*A few times*), 3 (*many times*), and 4 (*All the time*). It has a five-factor structure with 4 items each, based on the analysis of gamers self-reports comprising the following dimensions: (1) altered visual perceptions, (2) altered body perceptions (3) altered auditory perceptions, (4) automatic mental processes, and (5) behaviours and actions. The scale was developed and structured using a confirmatory factor analysis in a heterogeneous sample, with Cronbach's alpha of 0.94. Population cross-validity, and criterion-related validity was achieved. Examples of the items included are: *"seen video game images with eyes open when not playing", "experienced bodily sensations of movement as in a video game", "heard game music when not playing", "wanted or felt the urge to do something in real life after seeing something that reminded of the video game" and "acted differently in real life situation because an experience in a video game".* It is important to note that in this study, we slightly changed some of the response options in the scale to avoid the situation where participants did not

choose the maximum point of 4 "*All the time*". In most previous studies, GTP total scores ranged between low to medium levels, and having the option "*all the time*" might not reflect the frequency accurately and reduce the chances of obtaining higher scores on the GTP scale. The modified response options used in this study were as follows: 0 = *Never*, 1 = *Once or twice*, 2 = *A few times*, 3 = *Several times*, and 4 = *Many times* (see appendix III).

2.4 Scales assessing spontaneous cognitive phenomena

2.4.1. Daydreaming Frequency Scale (DDFS)

The 12-item DDFS is part of the Imaginal Process Inventory with 28-subscales (J. L. Singer & Antrobus, 1963). For this study, only the daydreaming sub-scale was used which assesses the frequency of mind-wandering or task-unrelated thoughts in everyday life (e.g., '*When I am not paying attention to some job, book, or TV, I tend to be daydreaming*' or '*On a long bus, train, or airplane ride I daydream'*) (Giambra, 1993). Each item is rated on a 5-point Likert scale where "A = 1" represents the lower frequency score and "E = 5" the highest. The total daydreaming frequency score is computed by adding scores on each question of the scale. The scores on this scale range from 12 to a maximum score of 60 (see Appendix IV).

2.4.2. Mind-Popping Questionnaire (MPQ -4)

This 4-item questionnaire was developed by (Kvavilashvili & Mandler, 2004) to assess the nature and frequency of involuntary semantic memories or mind-pops in everyday life. The MPQ begins with a short description of the phenomenon and how it differs from involuntary autobiographical memories. In the first question, participants indicate whether they have ever experienced the phenomenon of mind-popping (*Yes/No*). If *yes* response is chosen, in the second question, participants are asked to rate the frequency of its occurrence on an 8-point scale where 1= *only a few times in my entire life*; 2 = *once or twice a year*; 3 = *once or twice per 6 months*; 4 = *once or twice a month*; 5 = *once or twice a week*; 6 = *three or four times a week*; 7 = *once or twice a day*, and 8 = *three or more times a day*. Question 3 asks participants to indicate those involuntary semantic memories or mind pops which they think they have experienced at least once in their life, and participants can choose as many options as they want out of nine possible options. Finally, in the last question, participants are given an option to describe, in their own words, some concrete examples of mind-popping as they have experienced it in their everyday life. For this study, mind-popping frequency was

assessed by participants' responses to Questions 1 and 2 with the minimum score of 0 (for participants who responded negatively to Question 1) and the maximum score of 8 points (for participants who chose the option "three or more times a day" in Question 2) (see Appendix V).

2.5 Scales measuring psychopathology variables

2.5.1. Internet Gaming Disorder Scale Short – Form (IGDS9-SF)

The short form of IGD contains 9-items (Pontes & Griffiths, 2015), and is used to evaluate nine criteria for the IGD suggested by the American Psychiatric Association. It has a cross-cultural validity and has been shown to be highly suitable for measuring IGD. Responses on IGD-9 are provided on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Very often*) with total scores ranging from 9 to 45. Examples of the items included are: *Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity*? *Have you deceived any of your family members, therapists or other because the amount of your gaming activity*? *Have you lost interests in previous hobbies and other entertainment activities as a result of your engagement with the game*? (see Appendix VI)

2.5.2 Multidimensional Schizotypy Scale – Brief version (MSS-B)

The 38-item MSS-B using a *Yes-No* answer format was used to assess Schizotypal personality in three different dimensions (Gross, Kwapil, Burgin, et al., 2018). The positive or psychotic-like dimension contains 13 items and involves disruptions in the content of thoughts (ranging from odd beliefs to delusions), and perceptual oddities (including illusions, hallucinations, and paranoia). The negative or deficit dimension comprises 13 items, and involves diminished functioning such as alogia, avolition, anhedonia, flattened affect, and disinterest in others and the world. Finally, the disorganized sub-scale has 12 items, and is characterised by disruptions in the ability to organize and express thoughts and behaviours ranging from mild disturbances to formal thought disorder to grossly disorganized actions. The scale was adapted from the full-length multidimensional schizotypy scale and has been cross-validated (Gross et al., 2018). To measure schizotypal personality, we computed the total score on each dimension taking into consideration reversed scores for items 4, 10, 25, and 37. The maximum score for the disorganized and negative dimension is 12 while for the positive dimension it is 13 points (see Appendix VII).

2.5.3 Short version of the Depression, Anxiety, and Stress scale (DASS-21)

The short version of DASS-21 contains 21 items to measure depression, anxiety, and stress (Henry & Crawford, 2005). It has a three-factor structure with 7-item self-report scales taken from the full version. This brief 21-item version has adequate construct validity, and the reliability of each of the scales is high. Participants responses are provided on a 4-point Likert scale ranging from 0 (*Did not apply to me at all*) to 3 (*Applied to me very much, or most of the time)*. The maximum score for each dimension is 21 points (see Appendix VIII).

2.5.4 Short form of the Barrat Impulsiveness Scale (BIS-15)

BIS-15, with 15-items, evaluates impulsivity in three different dimensions (Patton, Stanford, & Barrat 1995). The motor impulsivity (M-IMP) is defined as the tendency to act without thinking, and includes items related to motor impulses (e.g., *I do things without thinking*). The non-planning impulsivity (NP-IMP) refers to the lack of future orientation and includes items relating to planning (e.g., *I plan tasks carefully*) and self-control (e.g., *I save regularly*). Finally, attentional impulsivity (A-IMP) is defined as the inability to concentrate or focus attention (Bari et al., 2016) and includes items to assess cognitive instability (e.g., *I am restless at lectures or talks*). Each dimension comprises 5 items and answers are rated on a 4-point Likert scale (1 = *rarely/never,* 2 = *occasionally,* 3 = *often*, 4 = *Almost Always/ Always).* The total score for each dimension is computed by adding up response options while using reversed scores for items 1, 5, 7, 8, and 15. The maximum score for each dimension is 20 points (Spinella, 2009) (see Appendix IX).

2.6 Tasks measuring Working Memory Capacity

All instructions and practice trials for tasks measuring WMC were given prior to completing two main tasks of WMC which lasted for approximately 30 minutes. A total of 223 participants completed both WMC tasks. Both tasks were administered using Inquisit software (Inquisit 5, 2016).

2.6.1 Automated symmetry task

Automated symmetry task assesses visuospatial WMC (Unsworth et al., 2005). Participants have to make a judgement whether a figure is symmetrical or not across a vertical axis, followed by remembering the location of a distractor stimulus (e.g., a coloured

square) in a 4 x 4. This process is repeated several times until a recall screen appears (this will depend on the size of the span), when participants have to indicate the locations of coloured squares in the same order as they were presented to them (Conway et al., 2005). The experimental set-up consisted of 4 practice trials of recalling sequences of squares of set sizes of 2 to 3 in ascending order; 15 practice trials of symmetry judgments of images and 3 combined practice trials of recalling sequences of squares (set size 2 only) and symmetry judgements, with each square being preceded by either a symmetrical or an asymmetrical image. The main automated symmetry task consisted of 12 trials with 3 repetitions of 4 set sizes in ascending order. This included recalling sequences of squares (sets of 2-5), with each square being preceded by either a symmetrical or an asymmetrical image, by clicking the cells on the 4 x 4 matrix. This task was scored by using the total span score which is the sum of all correctly recalled sets (see Appendix X).

2.6.2 Automated reading span task

This complex span task has been designed to assess WMC and reading comprehension (Unsworth et al., 2005). Participants need to make a judgment whether a short phrase makes sense, followed by remembering a distractor stimulus (a random letter). This process is repeated several times until a recall screen appears (this will depend on the size of the span) with a 4 x 3 grid filled with random letters, including the ones shown before, and participants must indicate all the letters seen and in the order in which they appeared (Conway et al., 2005b; Daneman & Carpenter, 1980). The experimental set-up consisted of four practice trials of recalling sequences of letters of set sizes 2-3 in ascending order, 15 practice trials of semantic evaluations and three trials of combined practice of recalling the sequence of letters (set size 2 only) and semantic evaluations of sentences with each letter being preceded by either a sentence that made sense or did not make sense (3 trials). Letter recall was completed by picking out letters from a letter matrix provided. The test session consisted of 15 trials of recalling sequences of letters with set sizes of 3 to 7 and each letter being preceded by either a sentence that did or did not make sense (15= 3 repetitions of 5 set sizes; order of set sizes was randomly determined). Letter recall was achieved by picking out letters from a provided letter matrix. The task was scored by calculating the sum of all correctly recalled sets (see Appendix XI).

2.7 Procedure

Participants were recruited from several sources such as the University of Hertfordshire website and social media advertisements (e.g., Facebook, Twitter). Those who expressed interest in taking part in the study, received an information sheet via email and signed a digital consent form before commencing the study. Upon signing the consent form, an anonymity ID was created for each participant, granting them access to the study. All participants completed the questionnaires and scales in the following order: Demographics and gaming habits questionnaires, the MPQ-4, the GTPS, the DDFS, MSS-B, DASS-21, BIS-15, and IGDS9-SF. All questionnaires were hosted on the Qualtrics platform (Qualtrics, 2019), and participants received written instructions on how to complete each one. Upon the completion of these questionnaires, participants were asked to perform two final cognitive tasks: the automated symmetry task and the automated reading span task, both of which were hosted on an online computer software INQUISIT (Inquisit 5, 2016). Because the study took approximately 90 minutes to complete, all participants who were tested online had the option to either complete the study in one go or in two sessions, if needed. In Part 1 of the study, participants were asked to complete nine questionnaires that took up to 60 minutes to complete. In Part 2, participants were asked to perform two cognitive tasks which lasted approximately 30 minutes. All participants who completed the whole study, completed both parts.

2.8 Results

Table 2-3 shows participants' mean total scores on the GTP scale as well as the mean scores on each subscale. For all the analyses, presented in this section, the GTP total score was used as the only outcome variable because of its highly positive correlations with each of the sub-scale scores: altered perceptions (r = .963), automatic mental processes (r = .825), and behaviours and actions (r = .844), (all p_s =<.001).

A total of 64 participants were recruited face-to-face, the remaining 299 were recruited and tested online in either one or two sessions. To examine the validity of online testing, the data of the outcome variable across online and face-to-face testing were compared. An independent samples t-test showed that there were no differences in participants' total GTP scores between face-to-face (M = 20.73, SD = 14.55) and online testing (M = 19.52, SD = 16.80) conditions, t (361) = .533, p = .131. Also, there were no

significant differences between online and face-to-face groups in terms of their scores on all predictor variables (all p_s = > .05).

Once all the data was collected, an Expectation Maximization (EM Algorithm) was conducted, a total of two missing values in the outcome GTP variable were found, and another four in the schizotypy variable representing 0.8% and 0.021%, respectively. This approach was adopted to perform maximum likelihood estimation in the presence of latent variables to optimize and merge missing data.

Table 2-3

Means and Standard Deviations of GTP Total Score and Each Subscale

	M	SD
GTP total score	19.74	16.41
Automatic Mental Processes	4.19	3.69
Altered Behaviours and Actions	3.45	3.43
Altered Auditory Perceptions	4.58	3.73
Altered Bodily Perceptions	2.78	3.33
Altered Visual Perceptions	3.68	3.55

2.8.1. Statistical Analysis

All statistical analyses were performed with IBM SPSS Statistics version 28. Before conducting the analyses, the assumptions of regression analysis were tested, and no violations were found. Overall, multicollinearity was low except for the correlation between anxiety and stress (r = .766, n = 363, p = <.001), and therefore, to ensure reliability of the data, the variable stress was removed from further analyses. Regression analyses showed a variance inflation factor (VIF) below 2 among predictors (see Table 2-5). Continuous variables had an approximate normal distribution with no significant outliers except for one case in the GTP scale, which was removed from all analyses. Mediation analyses were conducted using model 6 of the PROCESS package, version 4.1 (Hayes, 2013).

2.8.2. Bivariate Correlation Analysis

Pearson bivariate correlations were conducted to examine the relationship between GTP and all the variables of interest (see Table 2-4 for correlations). The variables of internet gaming disorder (IGD), mind-popping (MP), daydreaming (DD), positive schizotypy (PS), disorganised schizotypy (DS), stress (STR) and anxiety (ANX) had the highest correlations with total GTP scores (all r_s = > .30). In addition, the variables hours per week (HPW), hours per session (HPS), depression (DEP), motor impulsivity (M-IMP), non-planning impulsivity (NP-IMP), and sleeping less due to gaming (SLDG) were also significantly correlated with GTP scores, just with lower coefficients (all r_s <.30). There were no correlations between years of playing (YOP), negative schizotypy (NS), attentional impulsivity (A-IMP) and GTP. In addition, there were no correlations between GTP and the two WMC variables: memory reading total span (MRTS) and memory symmetry total span (MSTS).

2.8.3. Regression analysis

To examine direct associations of GTP frequency with gaming-related variables, psychopathology, and cognitive variables, a multiple (5-block) hierarchical regression analysis was conducted with the GTP total score as the dependent variable. Gaming variables such as sleeping less due to gaming (SLDG), gaming hours per week, per session, and internet gaming disorder (IGD) were entered in Block 1. Gaming related variables were entered in the first block because it is important to control factors in direct association with GTP and gaming (Ortiz de Gortari & Griffiths, 2015), as well as those factors that have emerged as strong predictors of GTP in previous multiple hierarchical regression analyses (Ortiz de Gortari & Panagiotidi, 2023). Mind-popping (MP) and daydreaming (DD) were entered in Block 2 to control the susceptibility to involuntary cognitions that share phenomenological characteristics with GTP (e.g., form of manifestation and frequency). Positive schizotypy (PS) and disorganized schizotypy (DS) scores were added in Block 3 as both variables were positively associated with GTP in correlational analyses positive schizotypy has been shown to be strongly associated with involuntary cognitions such as mind-pops (Elua et al., 2012; 2015). Mood-related variables such as anxiety, and depression were entered in Block 4 since GTP experiences have been reported in conditions of stress and anxiety (Ortiz de Gortari, Aronsson & Griffiths, 2012) and stress has been also associated with GTP (Ortiz de Gortari, 2024). Moreover, anxiety and depression disorders tend to be comorbid with IGD (American Psychiatric Association, 2013) and have

been also associated with frequency of mind-popping (Elua et al., 2012). Finally, impulsivity related variables such as non-planning and motor impulsivity, were entered in Block 5 as previous studies have found an association between GTP and failures in cognitive control (Ortiz de Gortari, 2019) particularly when gamers execute actions without awareness (Ortiz de Gortari & Griffiths, 2014).

In Block 1 of the hierarchical multiple regression, gaming hours per week, per session, sleeping less due to gaming and IGD accounted for a significant 23.9% of the variance in GTP, p<.0001. Nonetheless, IGD was the only significant predictor in Block 1. When mind-popping and daydreaming scores were entered in Block 2, these variables accounted for an additional and significant 10.4% of variance in the GTP frequency, R^2= .344, ΔR^2=*.104,* p <.0001. When the scores of positive and disorganised schizotypal traits were added as predictors in Block 3, they accounted for an additional and significant 7% of the variance in GTP frequency, R^2= .413, ΔR^2=*.070* p <.0001. However, only positive schizotypy was the significant predictor out of the two added variables. In Block 4, when depression and anxiety scores were added as predictors, this accounted for an additional 2.2% of the variance, R^2= *.435,* ΔR^2=*.022* p <.001, although anxiety was the only significant predictor. In the final Block 5, motor impulsivity and non-planning impulsivity predictors accounted for an additional and significant 2.0% of the variance in the frequency of GTP, R^2= .455, ΔR^2=*.020*, p < .002, but only motor impulsivity was a significant predictor.

The full hierarchical regression model explained a total of 45.5% in the variance of GTP frequency. This 5-block hierarchical model revealed that the strongest predictors of GTP were the IGD, mind-popping, daydreaming and positive schizotypal traits. The results of each step in the regression analysis and individual beta coefficients with associated significance are provided in Table 2-5.

To determinate if any specific dimension of GTP *(Altered Perceptions, Automatic Mental Processes or Behaviours and Actions)* was particularly contributing to the pattern of results obtained in the analysis, several simple linear regression analyses were conducted using each dimension as outcome variable. Each regression analysis showed significant differences at p < .001, and consequently, it was determined that utilizing the entire GTP score as the sole outcome variable was appropriate, mirroring the findings obtained with total GTP scores. Therefore, it was decided to use the whole score of GTP as the only outcome variable.

Table 2-4

Correlations of GTP with Associated Variables.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	GTP	1																		
2.	HPW	.127*	1																	
3.	HPS	.139**	.640**	1																
4.	YOP	-.013	-.036	-.112*	1															
5.	SLDG	.206**	178**	156**	-103*	1														
6.	IGD	.486**	.196**	.257**	-.070	.335**	1													
7.	MP	.388**	.094	.079	-.013	.113*	.212**	1												
8.	DD	.375**	.072	.060	-.053	.135*	.326**	.352**	1											
9.	PS	.490**	.026	.089	-.171**	.141*	.426**	.199**	.330**	1										
10.	DST	.332**	.033	.112*	-.059	.196**	.509**	.273**	.379**	461**	1									
11.	NST	.110*	.063	.077	.092	.107*	.183**	.030	.165**	.197**	231**	1								
12.	DEP	.299**	.024	.064	-.030	.163**	.452**	.190**	.401**	.369**	.585**	.332**	1							
13.	ANX	.459**	.035	.110*	-.105*	.137**	.514**	.303**	.370**	.429**	.569**	.130*	.659**	1						
14.	STR	.407**	-.056	.022	-.015	.140**	.504**	.247**	.386**	.360**	.609**	.092	.717**	.766*	1					
15.	A-IMP	.101	-.150**	-.027	-.088	.040	.241**	.080	.236**	.142**	.333**	.061	.267**	.234**	316**	1				
16.	M-IMP	.248**	-.112*	-.054	.027	-.057	.054	.130*	.050	.180**	.091	.034	.133*	.196**	.213**	.246**	1			
17.	NP-IMP	-.181**	-.156**	.040	.074	.022	-.251**	-.075	-.177**	-.163**	-311**	.021	-.193**	-.259**	-.342**	-.522**	-3.88**	1		
18.	MRTS	-.048	-.054	-.039	-.076	-.034	-.107	-.093	-.029	.079	-.088	.003	-.057	-.125	-.050	.022	.028	.079	1	
19.	MSTS	.048	.005	-.039	.056	-.001	-.049	-.151*	-.196**	-.017	-.174**	.030	-.114	-.110	-.075	-.076	-.038	.050	.290**	1

Note: Pearson correlation was conducted to measure the relation between outcome variable game transfer phenomena (GTP) and predictor variables: hours played per week (HPW), hours played per session (HPS), years of playing (YOP), sleeping less due to gaming (SLDG), internet gaming disorder (IGD), mind popping frequency (MP), day dreaming (DD), disorganised schizotypy trait (DST), positive schizotypy trait (PS), negative schizotypy trait (NST), depression (DEP), stress (STR), anxiety (AXN), attentional impulsivity (A-IMP), motor impulsivity (M-IMP), non-planning impulsivity (NP-IMP), memory reading total span (MRTS), memory symmetry total span (MSTS) * = $p < 0.05$, ** = $p < 0.01$

Table 2-5

Hierarchical Multiple Linear Regression for Variables Predicting the Outcome Variable of GTP Frequency (Five Blocks)

		Unstandardized coefficients		*Standardized coefficients*							
Block	*Predictors*	β	SE	β	*p-value*	R^2	*Adjusted* R^2	ΔR^2	*F*	*p-value*	*VIF*
1	Sleeping less due to gaming	.761	.822	.046	.355	.239	.231	.239	28.13	.001***	1.143
	Gaming hour per week	.036	.064	.034	.578						1.712
	Gaming hours per session	-.065	.424	-.009	.879						1.746
	Internet gaming disorder	8.753	.941	.467	.001***						1.184
2	Sleeping due to gaming	.514	.766	.031	.503	.344	.332	.104	28.31	.001***	1.145
	Gaming hour per week	.014	.060	.013	.813						1.716
	Gaming hours per session	.015	.395	.002	.970						1.749
	Internet gaming disorder	6.886	.922	.367	.001***						1.309
	Mind-popping	1.379	.258	.248	.001***						1.160
	Daydreaming	.289	.085	.162	.001**						1.237
3	Sleeping due to gaming	.559	.727	.034	.442	.413	.400	.070	21.06	.001***	1.147
	Gaming hour per week	.034	.057	.032	.551						1.739
	Gaming hours per session	-.038	.375	-.005	.920						1.753
	Internet gaming disorder	5.369	.981	.286	.001***						1.651
	Mind-popping	1.323	.246	.238	.001***						1.181
	Daydreaming	.207	.083	.116	.014*						1.326
	Positive schizotypy	1.675	.258	.312	.001***						1.393
	Disorganised schizotypy	-.311	.218	-.073	.155						1.598

4	Sleeping due to gaming	.751	.717	.045	.296	.435	.419	.022	6.77	.001*	1.153
	Gaming hour per week	.045	.056	.042	.424						1.744
	Gaming hours per session	-.093	.370	-.013	.802						1.758
	Internet gaming disorder	4.583	1.004	.244	.001***						1.784
	Mind-popping	1.172	.256	.290	.001***						1.217
	Daydreaming	.202	.236	-.105	.061						1.382
	Positive schizotypy	1.558	.256	.290	.001***						1.419
	Disorganised schizotypy	-.443	.236	-0.105	.061						1.931
	Anxiety	5.137	1.396	.218	.001***						2.190
	Depression	-1.856	1.149	-.094	.107						2.090
5	Sleeping due to gaming	.896	.710	.054	.208	.455	.437	.020	6.50	.002*	1.165
	Gaming hour per week	.060	.056	.056	.289						1.794
	Gaming hours per session	-.096	.364	-.014	.792						1.759
	Internet gaming disorder	4.755	1.004	.253	.001***						1.840
	Mind popping	1.076	.244	.193	.001***						1.237
	Daydreaming	.220	.083	.124	.008**						1.400
	Positive schizotypy	1.429	.256	.266	.001***						1.456
	Disorganised schizotypy	-.385	.238	-.091	.106						2.023
	Anxiety	4.589	1.385	.195	.001**						2.222
	Depression	-2.017	1.136	-.102	.077						2.106
	Motor impulsivity	5.063	1.466	.154	.001***						1.269
	Non-planning impulsivity	.471	1.413	.016	.739						1.393

*Note. N= 363; $\Delta R^2 = R^2$ Change, * = p< .05, ** = p<.01, *** = p<.001*

2.8.4. Mediation Analysis, IGD-GTP mediated by MP, PS (Model 6)

Before conducting the mediation analyses, the total effect of IGD on GTP without the presence of mediators was significant (c = 4568, p<. 001). The subsequent mediation analyses were conducted using GTP as an outcome variable and IGD as a predictor variable with the presence of mind-popping frequency and positive schizotypy trait as mediators (see Figure 2-1). This model indicated that the effect of IGD on GTP remains and is partially mediated when the mediators MP and PS were added (c' = 2800, p<. 001), which means that the impact of IGD to predict GTP is influenced by MP and PS as mediators. The indirect effects were assessed using 95% bias-corrected confidence interval based on 5,000 bootstrap samples and showed that the total of indirect effects (.1768) as well as all remaining three indirect effects were entirely above zero when holding the other mediators constant. This demonstrated with 95% certainty that these indirect effects were all positive (see Table 2-6 for all coefficients of the model 6 mediation analysis).

Figure 2-1

Results of Mediation Analysis with 2 Mediators (model 6). Internet Gaming Disorder (IGD) as a Predictor of Game Transfer Phenomena (GTP) and Mind-popping (MP), and Positive Schizotypy (PS) as mediators

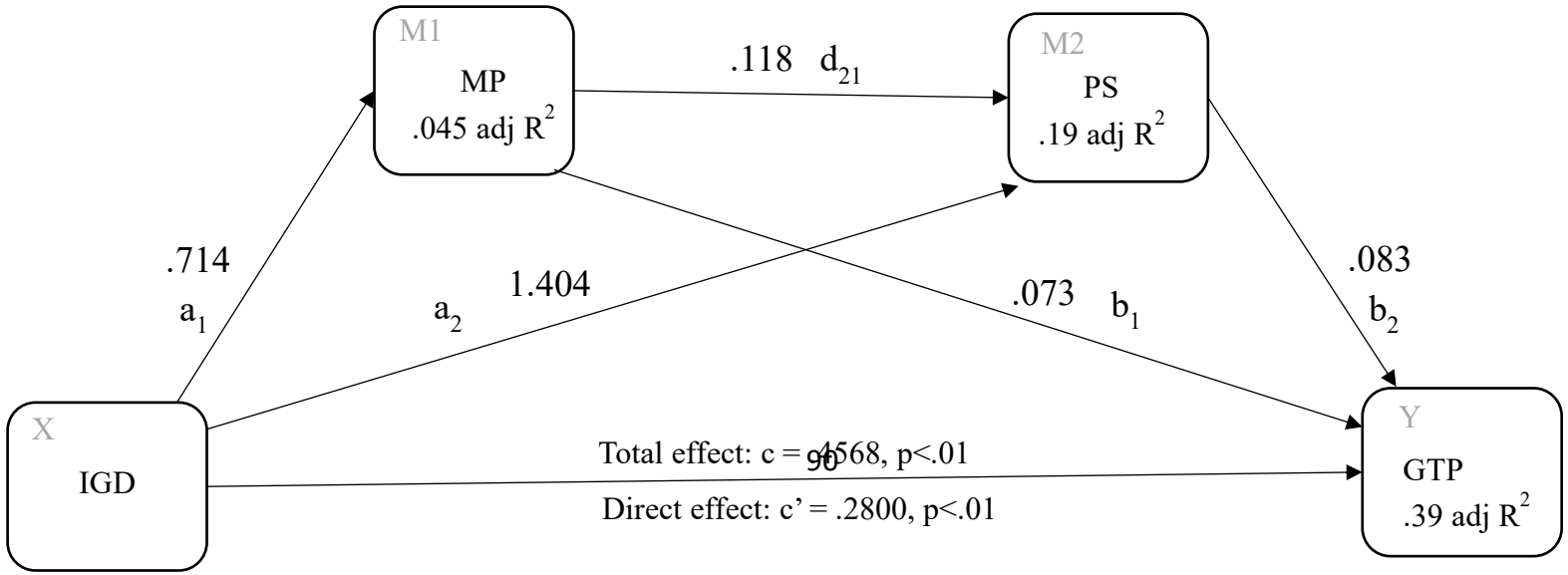


Table 2-6

Results of Mediation Analysis with Internet Gaming Addiction (IGD) as a Predictor of GTP and Mind Popping and Positive Schizotypy as

Path	Variable	Coefficient	SE	t	p	Adj. R^2	95% CI low	95% CI high
	Outcome: MP	.2120				.0450		
a_1	IGD>MP	.7143	1733	4.122	<.001		.3736	1.0550
	Outcome: PS	.4407				.1942		
a_2	IGD>PS	1.4044	.1690	8.3090	<.001		1.0720	1.7368
d_{21}	MP>PS	.1180	.0502	2.3511	.0193		.0193	.2166
	Outcome: GTP	.6320				.3995		
b_1	MP>GTP	.2800	.0429	6.526	<.001		.1956	.3643
b_2	PS>GTP	.0837	.0123	6.8292	<.001		.0596	.1078
c’	Direct effect	.2800	.0429	6.5263	<.001		.1956	.3643
c	Total effect	.4568	.0432	10.5803	<.001		.3719	.5417
Path	Indirect effects	Coefficients	SE	95% CI low	95% CI high			
a_1 *b_1	IGD>MP>GTP	.0523	.0160	.0245	.0865			
a_2 *b_2	IGD>PS>GTP	.1175	.0273	.0692	.1759			
a_1 *d_{21} * b_2	IGD>MP>PS>GTP	.0071	.0037	.0011	.0154			

Mediator Variables.

*Note. CI= confidence interval; IGD = Internet gaming disorder; PS = Positive schizotypy; GTP = Game transfer phenomena; Mind popping; se = standard error; Adj. R^2 = adjusted R-square (standardized); * = p<.05; ** = p<.01; *** = p<.001*

2.9 Discussion

Several novel findings were obtained in this study. Firstly, significant associations were found between GTP scores and the frequency of self-rated mind-pops and daydreaming or mind-wandering with both measures explaining significant variance in GTP frequency in the hierarchical regression model, even when several other predictor variables were controlled for. In addition, schizotypal traits (i.e., positive schizotypy) that have been strongly associated with both clinically relevant intrusions (e.g., hallucinations) and benign involuntary cognitions in the general population, was also a significant predictor of GTP.

Secondly, results replicated and significantly extended previous research on GTP by showing that not only was IGD one of the strongest predictors of GTP, but that the relation between IGD and GTP was partially mediated by scores on positive schizotypy and mind-popping scores.

Thirdly, results also showed that anxiety and motor impulsivity scores were adding small but additional variance to the final model in the hierarchical regression analysis which suggests that they may, too, be important variables when considering GTP frequency that merit further attention.

Finally, and contrary to our predictions, none of the measures of WMC correlated with GTP frequency (Table 2-4) and therefore these measures were not subjected to further analyses. One possible reason for this finding is that on-line measurements of WMC might not be reliable (Leidheiser et al., 2015). There is also growing research to show that the relation between WMC and spontaneous cognitions appears to be mediated by attentional demands of ongoing tasks (Robison & Brewer, 2020; Rummel & Boywitt, 2014). Given that the GTP scale does not have items distinguishing the frequency of certain types of GTP occurring during demanding versus undemanding ongoing activities it is perhaps not surprising that a significant association between GTP scores and measures of WMC was not found in the present study.

2.9.1. GTP as part of a family of spontaneous cognitive phenomena

The results showed that GTP frequency was predicted by higher frequencies in daydreaming and mind-pops. Moreover, these variables added significant variance in a hierarchical regression analysis after game-related variables and IGD were entered in the first step and remained as significant predictors when several other variables, including the IGD

scores were controlled for. This provides strong initial support for the theoretical prediction of GTP being part of a family of diverse spontaneous cognitive phenomena and sharing important similarities with them in terms of content and manifestation.

The connection between daydreaming and GTP is somewhat generic in nature given that mind-wandering that occurs during habitual daily activities may be conducive to the occurrence of specific GTP experiences as part of a train of thought during a particular mind-wandering episode. By contrast, the similarities between instances of GTP and mind-popping are more direct and stronger given that their content is often fairly similar, and they tend to last for fairly short periods of time (seconds or minutes) while being engaged in undemanding daily activities (Kvavilashvili & Mandler, 2004; Noreika et al., 2015).

Further support for the hypothesis about GTP being strongly related to involuntary cognitive phenomena, comes from the finding that GTP frequency was significantly predicted by positive schizotypy traits. Previous research has shown that schizophrenia patients report increased tendencies to experience not only clinically relevant intrusions such as auditory and visual hallucinations, which are defining symptoms of this condition, but also more benign forms of spontaneous cognitions such as IAMs (Allé, Berna, Danion & Berntsen, 2019), mind-pops (Elua et al., 2012, 2015) and mind-wandering(Shin et al., 2015). Similarly, studies on students and the general population have reported significant associations between positive schizotypy and increased frequency of both IAMs (Jones & Steel, 2012b) and intrusive memories (Holmes & Steel, 2004) as well as mind-wandering thoughts related to worry and more fantastical daydreams (Elua et al., 2012, 2015; Seeman, 2016; Welhaf et al., 2020).

2.9.2. GTP and its relationship with other indices of psychopathology

Another set of novel results, obtained in the present study, was that GTP scores correlated positively with several other indices of psychopathology that had not been examined in previous studies, such as disorganised schizotypy, depression, stress, and anxiety, as well as motor impulsivity and lack of planning. However, in a hierarchical regression analysis, only anxiety and motor impulsivity scores remained as significant predictors with each of these variables adding a small but significant amount of variance (around 2%) to the model (Table 2-5). Motor impulsivity could be linked to failures in the control of impulses emanating from past experiences with the video game content, and this variable has been previously suggested as an important factor for GTP (Ortiz de Gortari,

2019). In addition, some GTP that are classed as automatic behaviours and actions appear to be directly linked to lack of intention in behavioural actions with GTP content. Similarly, the finding that anxiety is a significant and independent predictor of GTP seems to be in line with previous literature showing significant associations between anxiety and spontaneous cognitions. For example, several studies have shown that increased anxiety is related to more frequent mind-wandering (Ottaviani & Couyoumdjian, 2013b), earworms (Reuman et al., 2020) and IAMs (del Palacio-Gonzalez & Berntsen, 2020), while links of these phenomena and depression have been found in some studies but not others (Figueiredo, Lima, & Erthal, 2020).

2.9.3. GTP and its relationship to gaming habits and IGD

Several gaming habits such as the number of hours played per week or per session, as well as the number of years playing video games have been suggested to be related to GTP experiences in everyday life (Ortiz de Gortari & Griffiths, 2015). This means that gamers who play frequently and engage in longer playing sessions (e.g., between 3-6 hours in one sitting) should experience GTP more frequently than gamers who play less frequently and for shorter time periods (Ortiz de Gortari, Oldfield, & Griffiths, 2016). However, the results of the present study did not support this prediction as almost none of the gaming-related variables, measured in this study, were associated with GTP. Only the IGD emerged as one of the strongest predictors in a multiple hierarchical regression model (Ortiz de Gortari & Gackenbach, 2021). This is an important finding that may explain why some gamers with very similar gaming habits (e.g., similar years of experience, hours played per week and per session) might not experience GTP with the same frequency or even not at all. It appears that even when playing excessively under potentially addictive and unhealthy settings, characteristic of IGD, it is important to consider other predisposing traits such as positive schizotypy, anxiety, and motor impulsivity as well frequency of involuntary cognitions, when predicting one's tendency to experience GTP.

The importance of IGD in GTP frequency was supported in the additional mediation analysis that was conducted to further understand possible underlying mechanisms of GTP. This analysis aimed to find if the significant effect of IGD on GTP frequency could be fully or partially mediated by positive schizotypy and mind-popping frequency, two theoretically important variables that were also highly significant predictors of GTP in the hierarchical regression analysis. Results of the mediation analysis showed that although IGD remained as

the strongest predictor of GTP, its effects on GTP were partially mediated by scores on mind-popping and positive schizotypy. These novel findings provide further support for the main proposal of the present investigation that GTP is a particular type of spontaneous cognition that has been overlooked in cognitive psychology and needs to be examined in more detail to expand our understanding of involuntary cognitive phenomena in general and their possible links with indices of psychopathology, in particular.

2.9.4 Methodological implications

Results of Study 1 also have important methodological implications by showing that there were no differences in the outcome variable (total GTP score) between online testing and a smaller subset of participants who were tested face-to-face (n = 64). Moreover, when the hierarchical multiple regression analysis was conducted on these 64 participants, the pattern of findings remained identical to the main analysis reported in this study. This indicates that future studies on GTP may continue using online testing to have large samples without compromising the quality of results. However, more caution may be needed when assessing participants' cognitive abilities such as WMC online, and future studies may use a mixture of online and face-to-face testing methods.

2.9.5 Conclusions

In conclusion, this is the first study that has investigated the role of spontaneous cognitions and psychopathology variables in self-reported GTP frequency while using hierarchical regression and mediation analyses. The pattern of findings is both novel and interesting and has important theoretical and methodological implications for the growing field of research on GTP. However, as in most previous studies conducted in this field, GTP was assessed via participants' retrospective self-reports using the GTP scale developed by Ortiz de Gortari, Pontes and Griffiths (2015). Given that the scale asks participants to assess the frequency of GTP occurrence across the previous 12-month period, it is possible that participants' assessments are inaccurate and subject to biases (e.g., recall bias) (for a review, see Shiffman, Stone, & Hufford, 2008). Considering growing popularity of experience sampling and diary methods over the past decade across multiple fields of psychology, it may be desirable to assess the reliability of findings obtained by questionnaire and interview methods by conducting diary studies of GTP. Chapter 3 will describe the first diary study of GTP conducted on a subset of participants who completed Study 1 described in this chapter.

Chapter 3: The nature and frequency of Game Transfer Phenomena in everyday life: A diary Study (Study 2)

3. *Introduction*

Results from Study 1 showed that most participants experienced GTP during the last 12 months (97.5%), which replicates findings reported in previous questionnaire studies of GTP (Dindar & de Gortari, 2017; Ortiz de Gortari, 2019; Ortiz de Gortari et al., 2016; Ortiz de Gortari & Griffiths, 2016; Ortiz de Gortari & Griffiths, 2015). Moreover, as in previous studies, most gamers in Study 1 reported experiencing GTP at a low level (M = 20.73, SD = 14.55). However, remembering all the instances of GTP over the 12-month period (some of them very minor and fleeting) and assessing their frequency may be challenging to participants as they have to rely on their long-term memory, which may be subject to several biases and inaccuracies. A good alternative method to overcome potential recall bias in the frequency of GTP as measured by the GTPS, is to use a diary method. Several studies have investigated the relationship between diary method and self-report questionnaires based on retrospective assessments, by comparing reports from diary averaged over some period with measures of self-report questionnaires over the same time frame (for a review, see Shiffman et al., 2008). Although some studies have found fairly similar estimates in both methods (Shrier et al., 2005), most studies conducted across different fields of research have found multiple overestimations. For example, self-report questionnaires have shown lower estimates of frequency and intensity of drug use in comparison to a diary method (Carney et al., 1998; Litt et al., 2000). By contrast, other studies have shown that retrospective assessments tend to show higher estimated levels of medical symptom frequency, intensity and duration than diary-based recordings of the same target events (Broderick, 2008; Houtveen & Oei, 2007; Shiffman et al., 2006, 2008; for a review, see Van Den Brink et al., 2001). Furthermore, the frequency of certain events or behaviours (e.g., alcohol consumption) tend to be often overestimated in self-report questionnaires (Homma et al., 2002; Shiffman et al., 2003). For instance, some studies have even reported negative correlations between the frequency estimates based on self-report questionnaires and diaries when assessing drinking patterns (Carney et al., 1998; Searles et al., 2000). Discrepancies between self-reports and diary methods appear to occur due to the saliency bias in recall, for example, intense pain is more salient than less pain, anxiety is more salient than low-anxiety, and so on, leading recall data to overestimate clinical symptoms (Shiffman, Stone, & Hufford 2008). Overall, the discrepancies between these findings suggest that GTP, measured by GTPS, could be under or over-reported by participants, raising questions about the true frequency and prevalence of GTP in gamers' everyday life.

To reduce possible retrospective bias when completing the GTP scale, researchers can use diary and experience sampling methods, which have been used to investigate ongoing daily experiences to examine the role of social, psychological, cognitive, and physiological processes in everyday life (Bolger et al., 2003). This tool allows researchers to capture aspects, experiences, and events of daily life as they are immediately or recently lived, which are not possible to measure with standard questionnaires. Additionally, the diary method accounts for the context in which events naturally occur providing additional and exclusive information to researchers collecting data with more traditional designs (Reis & Wheeler, 1991). Moreover, the diary method has been one of the most frequently used tools to study the frequency and nature of involuntary cognitions such as IAMs (i.e., Involuntary autobiographical memories), mind-pops, intrusive memories, earworms, and mind-wandering. In diary studies, participants have to provide extensive detail about specific experiences on a daily basis for predetermined periods of time allowing a more precise assessment of the nature and frequency of to-be-studied phenomena (Berntsen, 2009; Kvavilashvili & Mandler, 2004).

Usually, participants are requested to keep a paper-based diary booklet with themselves for a specific period of time (e.g., 3 days, 1 week,1 month, etc.), and every time they experience an involuntary memory, they are asked to open the diary booklet and fill a diary page which contains a brief questionnaire where all the details related to the experience have to be specified. For example, time and day of occurrence, what was the current activity when the event occurred, what was the memory about? Was there any cue that triggered the memory? Altogether, the diary method appears to be a reliable and accurate tool to measure involuntary cognitive phenomena occurring in everyday life settings (Laughland & Kvavilashvili, 2018).

Although diary methods have advantages over traditional questionnaires, they also have limitations. For example, filling a diary requires a previous briefing session to ensure participants fully understand how to keep a diary and fill it in when the phenomenon under investigation takes place (Gable et al., 2000). Another concern is the compliance, since participants are asked to fill the diary during their daily routines, it is easy for them to forget they are taking part in the study. As a result, they may find themselves compelled to revisit the diary at a later time and fill it in with authentic but potentially biased retrospective entries. In some instances, they can even sense an obligation to fabricate entries (Bolger et al., 2003). To control these issues, researchers have designed external strategies, for example, participants receive prior detailed instructions which are also included and accessible at all

times in the diary. Also, they are clearly informed that they do not need to fill the diary if there is nothing to report (Laughland & Kvavilashvili, 2018).

To further increase compliance, several studies have used reminders which have resulted in an effective tool to make participants adhere better and stay on track, to notice and properly record requested events (Zhang et al., 2016). Reminders have been implemented in several ways to measure involuntary phenomena such as text-messages (Hou et al., 2010), reminder watches (Brazauskiene, Markostamou, & Kvavilashvili, 2022); app notifications on smartphone devices (Laughland & Kvavilashvili, 2018) to name few.

Another benefit of diary method in the context of the present thesis, is that it may enable the identification of possible underlying mechanisms of involuntary phenomena such as priming. The literature reviewed in Chapter 1 has suggested that possible underlying mechanisms for involuntary memories have been related to priming hypotheses (e.g., associative priming, repetition priming, and long-term priming). For instance, mind-pops in the form of words, images and sounds, have been suggested to be primed by previous encounters to the stimuli associated to the experience (e.g., repetition priming) or associations with stimuli in the environments (e.g., visually, semantically, phonologically, etc.) with past events or experiences (Kvavilashvili & Mandler, 2004). It has been suggested that priming occurs due to the spread of activation in one's semantic and autobiographical memory networks. The activation produced by words, images, concepts, etc. does not disappear right away after immediate encounter, but appears to remain active in the mind for some minutes, hours or even weeks (Kvavilashvili & Mandler, 2004). The priming hypothesis can be assessed by asking participants to report when was the last time they were exposed to the content related to their recorded experience (Kvavilashvili & Mandler, 2004). Similarly, it should be possible to identify primes for GTP experiences using the diary method.

The majority of studies on GTP have been conducted with self-report questionnaires, interviews, collection of data from online forums, and online surveys (Ortiz de Gortari & Griffiths, 2014a; 2014b; 2014c; Ortiz de Gortari, Oldfield & Griffiths 2016; Ortiz de Gortari, 2023), which have repeatedly found relatively low GTP frequency across studies, which might suggest that GTP is not a very frequent phenomenon in daily life. Moreover, GTP experiences are usually triggered by incidental triggers (words, images, sounds) in the environment or thoughts (Ortiz de Gortari & Griffiths, 2016), however, the role of cues in GTP is still not clear. GTP has also been reported when engaging in everyday tasks such as walking and cooking (Ortiz de Gortari & Griffiths, 2014a; 2014b; 2014c). On the one hand, it is also known that most IAMs have triggers, while mind-pops have significantly less

identifiable triggers (Kvavilashvili & Mandler, 2004). It is then crucial to investigate the frequency of GTP, as well as the prevalence of triggers making the diary method a suitable approach to explore these experiences after their immediate occurrence in everyday life.

The present study used a diary method with the main aim of investigating the frequency and nature of GTP in terms of triggers, long-term priming and ongoing activities/concentration in everyday life. It was hypothesized that GTP frequency would be more similar to mind pops over a 7-day period of recording than IAMs as reported in Study 4 by Kvavilashvili and Mandler (2004). Most importantly, it was predicted that out of all dimensions of GTP, recorded in the diary by participants, prevalence of non-pathological inner phenomena in the form of automatic mental processes would be higher than other forms of GTP. It was also expected that GTP would occur under similar circumstances to other involuntary phenomena such as mind-pops, earworms, and IAMs supporting our initial hypotheses of GTP being part of spontaneous cognitive phenomena. For instance, it was predicted that most GTP would be triggered by incidental external and internal cues, would occur while performing automatic activities requiring low levels of concentration, and that their contents would be mostly associated to more realistic and immersive video games.

Another key aim of the study was to identify potential primes in the GTP experiences reported in the diary. It was hypothesized that most of the GTP would be associated with a recent encounter with a particular video game featuring in the description of GTP recorded in the diary. Additionally, participants had to rate phenomenological qualities of reported GTP in terms of their level of vividness, pleasantness, and mood before and after experiencing the GTP. Although some outer GTP experiences (altered perceptions) have been perceived as negative and distressful, most GTP have been perceived as neutral and non-disruptive or stressful (Ortiz de Gortari & Griffiths, 2016; Ortiz de Gortari, 2019). It was therefore expected that most GTP would be rated as vivid, as neutral and without major changes in the mood after the experience.

To achieve these aims, a subset of participants who took part in Study 1 were invited to take part in a diary study of GTP. All participants previously recruited agreed to be invited for further studies. Initially, only participants who reported high frequency on the GTPS were invited, however, due to slow recruitment rates, this criterion was expanded and more participants with lower frequency of GTP were invited. Once they agreed to take part, every participant was fully instructed about how to keep and fill a diary to report any possible GTP experiences for a 7-day period. During this timeframe, every participant received daily reminders to increase compliance with the diary. Thus, every time participants experienced a

GTP, they had to open an online link sent to them via email and complete a brief questionnaire about their GTP experience including the description of GTP and which game it was related to. At the end of the recording period participants also completed a diary compliance questionnaire.

Because all participants who took part in a diary study had also completed all the questionnaires and measures used in Study 1, this allowed us to address a couple of additional important questions. First, it was possible to assess the correlation between participants' scores on the GTP scale and the number of GTP recorded in the diary. Second, it was also possible to assess if the pattern of correlations between the GTP scale and involuntary cognitions (daydreaming, mind-pops), IGD, positive schizotypy and other variables would be replicated for the number of GTP recorded in the diary.

3.1 Method

3.2 Participants

Given the exploratory nature of the study using a diary method which includes quantitative and qualitative data, as well as uncertainties involving COVID-19 lockdown restrictions, it was hard to estimate the total sample size for the study. Several diary studies have been conducted with sample sizes ranging from 15 to 50 participants (Berntsen, 1996; Berntsen & Jacobsen, 2008; Mace, 2004; Kvavilashvili & Mandler, 2004).

Moreover, the present study aimed to extend results of Study 1 by conducting further correlation analyses. A minimum sample size between 25 and 30 participants has been suggested to be sufficient to provide meaningful results considering alpha levels of 0.05 (Bonett & Wright, 2000). Therefore, it was agreed to recruit a minimum of 40.

A total of forty-four participants were recruited to take part in the study. They were invited from a large sample of participants (n = 363) who had taken part in Study 1 and agreed to being invited for further studies. The inclusion criteria for the present study were the same as those used in Study 1 (see page 76). The participants were active gamers with a minimum of four hours playing per week over the last 12 months. They were aged between 18 to 45 years and had a minimum of 11 years of formal education.

Out of 44 participants who took part, six participants reported having problems with completing the GTP diary (e.g., had forgotten they had to fill it, or being too busy to do it) and therefore were removed from the study. The final sample consisted of 38 healthy young adults (86.8% males), with a mean age of 26.78 years (*SD* = 6.70) and 17.11 years of formal

education (*SD* = 3.22). Most participants were undergraduate students (55%), who did not have a previous diagnosis of mental illness (79%) and did not report having used recreational drugs or psychoactive substances other than alcohol in the past month (89.5%). Details of participants' gaming habits and what type of gamer they were, are presented in Table 3-1. Most participants reported being mid- to hard-core gamers with several years of gaming experience. Table 3-1 also shows participants' mean scores on all the questionnaires that they had completed in Study 1. The average time between taking part in Study 1 and Study 2 was 132.77 (*SD* =160.30) days.

Table 3-1
Descriptive Information on Participants' (N=38) Gaming Habits and Scores on Questionnaires Completed in Study 1

Variables	Mean	SD	Min	Max	Range
Years of playing	19.55	7.0	8	38	30
Gaming hours per week	22.89	16.86	4	84	80
Gaming hours per session	3.52	2.15	1	12	11
GTPS	26.65	19.88	0	77	77
Daydreaming	31.34	8.41	19	48	29
Mind-popping	3.39	2.38	0	8	8
IGD	20.10	7.59	10	39	29
Schizotypy disorganized	3.57	3.66	0	12	12
Schizotypy positive	3.00	3.00	0	11	11
Schizotypy negative	3.21	2.19	0	9	9
Anxiety	11.15	8.85	0	38	38
Stress	13.42	10.21	0	40	40
Depression	13.21	11.57	0	42	42
NP-IMP	15.47	2.41	9	19	10
M-IMP	11.13	2.18	7	16	9
A-IMP	10.97	2.09	7	17	10

IGD= internet gaming disorder, M-IMP= motor impulsivity, A-IMP= attention impulsivity, NP-IMP= non-planning impulsivity.

3.3 Materials

3.3.1 GTP Diary

The diary was designed to measure the frequency and nature of GTP experiences in everyday life. Each diary questionnaire consisted of 13 items that included both multiple choice and open-ended questions. Question 1 asked participants to indicate when they had the GTP by indicating the date and time of its occurrence. In question 2, participants had to indicate the time when they actually recorded the GTP experience in the diary, responses to

these questions included the following options 1= *"Almost immediately"*, 2 = *"within 10-15 minutes"*, 3 = *"within an hour"*, 4 = *"more than 1 hour"*, 5 = *"next day"*. For question 3, participants were asked to describe their GTP experience including details about the game elements involved (e.g., "Call of duty", "Fortnite", "Minecraft", etc), environment, feelings, etc. Question 4 asked participants to report how vivid their GTP was on a 7-point rating scale with answers ranging from 1= *"Very vague"* (*almost no image, sound, or sensation at all*) to 7= *"Extremely vivid"* (*almost like a normal vision*). In question 5, participants were asked to report if their GTP experience was triggered by something in their thoughts, their environment or whether there was no trigger at all. All participants who reported a trigger were asked to describe it in more detail in question 6.

After this, participants were asked to report on the circumstances around their GTP. For instance, question 7 asked participants to indicate what they were doing immediately before the occurrence of their GTP (Open question). Additionally, in question 8, participants indicated how much they were concentrating on this activity with responses ranging from 1 = *Not at all* ("*I was thinking about something else"*) to 5 = *Fully concentrated* ("*I was not thinking about anything else"*). Moreover, individuals also indicated how much the GTP experience distracted them from the activity they were doing with response options ranging from 1 = *Not at all* (*it did not interrupt what I was doing*) to 5 = *Very distracted* (*I stopped what I was doing*).

The final set of questions explored emotional variables related to the GTP experience and the previous exposure to the game or game related elements referred to in the description of GTP. In particular, question 10 asked participants to report how pleasant or unpleasant their GTP was by choosing one of the following options 1= *Very unpleasant*, 2 = *Unpleasant*, 3 = Neutral, 4 = *Pleasant*, 5= *Very pleasant*. In questions 11 and 12, participants were asked to describe their mood before and after having the GTP, respectively, by choosing one of the following options: 1 = *Very negative (unhappy),* 2 = *Negative*, 3 = *Neutral*, 4 = *Positive*, 5 = *Very positive (happy*). Finally, in question 13, participants were asked to indicate when was the last time they played or heard about the game related to their reported GTP (Open question) (see Appendix XII).

3.3.2 Diary compliance questionnaire

This questionnaire was designed to measure the participants' experience of keeping a diary and their levels of compliance with diary keeping instructions (see Laughland &

Kvavilashvili, 2018). The questionnaire included six multiple choice and two open-ended questions: 1. Did you have access (e.g., your phone, laptop, etc.) to the diary all the time during the requested period? (*Yes, No*); 2. If you could NOT access your diary all the time, what was the reason for this? (open-ended question); 3. How did you find the task of keeping your diary (e.g., phone, laptop, etc.) at hand most of the time? (1= *Very easy*, 2 = *Somewhat easy*, 3 = *Somewhat difficult*, 4 = *Very difficult*); 4. What percentage of all the GTP experiences that you had in 7 days, do you think, you were able to record and acknowledge in your diary? (e.g., if you think you were able to record and acknowledge only half of your GTP or all of them, the respective percentages would be 50 and 100); 5. Which electronic device did you use to record your GTP in the diary? (*You can choose more than one option: (a) mobile phone, (b) laptop, (c) desktop computer, (d) tablet, (e) other*).

Two additional questions about COVID-19 were included at the end of the questionnaire because data for the study was collected from May 2020 to March 2021 (during COVID-19 lockdown restrictions in the UK). In particular, in question 6, participants had to indicate how the lockdown had affected the amount of time they were spending on playing games on a 5-point rating scale where 1 = *I spend considerably less time than before*, 2 = *I spend less time than before*, 3 = *I spend the same amount of time playing games as before*, 4 = *I spend more time than before* to 5 = *I spend considerably more time than before*. Question 7 assessed how the lockdown had affected the frequency of participants' GTP experiences (1 = *Considerably less frequent than before*, 2 = *Less frequent than before*, 3 = *About the same as before*, 4 = *More frequent than before*, 5 = *Considerably more frequent than before*). Finally, participants were given an option to provide any additional comments about the study.

3.4 Procedure

All participants who were invited to the study first received an information sheet via email where all the details of their participation were explained (e.g., the purpose of the study, how long it would take, etc.). Those participants who confirmed their interest in taking part, were contacted to arrange a brief "*Skype"* meeting where the details of their participation and diary recording were explained. During this meeting, each participant received written and verbal instructions about how to keep and fill a diary over a 7-day period (See Appendix XIII). For instance, in the diary instructions provided to participants, they were carefully briefed about what GTP are, and how they can vary along different

dimensions. For example, it was clearly explained that the frequency of GTP greatly varies among individuals, and a minimum or maximum of GTP recordings in the diary was not expected. Therefore, participants were encouraged to not force their occurrence. Also, it was reiterated to try to record their GTP as soon as they occurred. Moreover, each participant was informed that they would receive up to three daily reminders via email at random hours during every day of their recording period to keep them aware about their participation in the study. Finally, every single question included in the diary page was explained in full detail with several examples in the provided diary instructions. After this meeting, all participants who agreed to take part in the study, received a link to sign a consent form and, once the consent form was signed, they received a personal link to access a digital diary to record their GTP experiences which was hosted on Qualtrics software (Qualtrics, Provo, UT). Participants had the option to access and complete the diary from any electronic device of daily use such as laptop, tablet, desktop computer, mobile phone etc. The recording period of each participant started on the following morning after meeting with the researcher.

Once the recording period began, every time participants experienced a GTP, they had to open the link and select one of the two options available, "acknowledge GTP" or "record a diary page". Participants were asked to click the "acknowledge GTP" option if they had a GTP experience but did not remember all the details. This could mainly happen when they were unable to record the experience immediately (e.g., when driving or busy at work). However, if they remembered the details, they had to click on the option "record a diary page". By doing this, they were directed to a brief 13-item semi-structured questionnaire on a digital diary page. Each recording would only take between 2-3 minutes. Also, to increase compliance with keeping a digital diary, all participants received three reminders via email per day at random hours. On completion of the 7-day recording period, participants received a debrief email and a link to an 8-item post-diary questionnaire to evaluate how easy or difficult it was to keep the digital diary of GTP during the recording period. The post-diary questionnaire measured the self-reported compliance or accuracy with which each participant recorded their GTP experiences (see Appendix XIV).

3.4.1 Coding of GTP experiences

At the end of the study, participants' descriptions of GTP experiences were coded independently by JLA and LK into the three main dimensions of GTP following a pre-established criterion on the classification of GTP (Ortiz de Gortari, Pontes & Griffiths, 2016;

Ortiz de Gortari & Diseth, 2022). For example, altered perceptions were all those experiences that included hallucinations, distorted perceptions, or misperceptions in either visual, auditory, or other sensory modalities. Automatic mental processes included involuntary memories (IAMS, mind-pops), thoughts, urges, mind visualizations, and ruminations with video game content. Finally, automatic behaviours and actions were those experiences that included involuntary actions or movements of limbs associated with a game, verbal outbursts, and mimicking game characters (for examples of participants' GTP descriptions in each of the three GTP categories, see Table 3-2). All disagreements (8% of GTP descriptions) between the coders were solved by discussion, and there was a good level of agreement as indicated by Cohen's Kappa coefficient (K = .67, SE = .09).

Table 3-2

Examples of GTP Experiences per Dimension Reported in Diaries.

Type of GTP	Examples
Automatic Mental Processes	*"The music of Gris came to my mind when I was packing my colours"* **This experience was related to the video game "Gris"**.
	"I was thinking of cooking something but wasn't sure about whether I could make it taste nice, and then the voice 'even better than Mama' played in my head which was from the game series cooking mama, it was something she would say when you get a gold medal in your cooking" **This experience was related to the video game "Cooking mama"**
Altered Perceptions	*"I was walking (skipping) and out of nowhere I swear I heard the Yoshi sound"* **This experience was related to the video game "Mario Kart"**
	"*I was inside my house, I was standing up and suddenly I watched a plant that is in the main door of my house, but the way I watched that plant was like if I was inside the game Hell blade. In this game you have to focus the vision in particular objects, and I felt like that.* **This experience was related to the video game "Hell blade Senua's Sacrifice"**
Behaviours and Actions	*"I was sorting my desk and tried putting documents into my pockets as if I was in Animal Crossing putting stuff into my pockets"* **This experience was related to the video game *"Animal Crossing Horizons"***
	"I was finishing a difficult task and a phone call came in and I pressed the up arrow on the keyboard and was frustrated it didn't answer the phone as it does in game" **This experience was related to the video game "Grand Theft Auto V".**

3.5 Results

Results are presented in five main sections examining (1) participants' compliance with the diary method, (2) the frequency and types of recorded GTP experiences, (3) conditions in which GTP were experienced, (4) long-term priming hypothesis, (5) ratings of

GTP characteristics, and (6) correlations between the number of recorded GTP and scores on GTP scale and other questionnaires. In most sections, non-parametric tests such as goodness-of-fit chi square, were used to compare actual response frequencies to frequencies based on random distribution across response categories of interest.

3.3.2 Diary compliance

All 38 participants who reported keeping a diary for seven days, completed the diary compliance questionnaire at the end of the study. Across all questions, participants reported good levels of compliance. Thus, 97% of participants indicated that they had access to the digital diary at all times during the study. Participants also reported that it was easy to keep their digital diary (e.g., phone, laptop, etc.) with them most of the time (67% reported it being very easy, and 23% - somewhat easy). Only 10% of participants indicated that it was somewhat difficult. Most importantly, participants reported that they were able to record and acknowledge 89% of their GTP experiences in the diary over the 7-day period. In addition, most of the GTP (60%) were recorded within one hour after their occurrence (29% immediately, 8% within 10-15 minutes, and 23% within 15-60 minutes). Only 26% of GPT were reported as being recorded after more than one hour and 14% on the following day.

3.5.2 Number and types of recorded GTP experiences

Out of all 38 participants who kept a diary for one week, the majority recorded at least one GTP, while eight participants reported that they did not experience any GTP during the week even though they kept monitoring for their occurrence. After excluding one non-valid GTP description, in total, 62 entries were fully recorded by 30 participants (M = 1.79, SD = 0.76; range 1-4), and 25 GTP were simply "Acknowledged" as being experienced without filling in the GTP questionnaire (M = .65, SD = .94; range 0-4). The 62 valid descriptions of GTP experiences fell into three main categories (for examples see Table 3-2). The majority of entries (59.7%) referred to automatic mental processes (n = 37, M = 1.19, SD = .98), 19 entries (30.6%) were coded as altered perceptions (M = .61, SD = .88), while GTP referring to behaviours and actions were reported on only six occasions constituting 9.7% of recorded GTP (M= .19, SD = .60). Results of Friedman's test on the number of recorded GTP with the type of GTP (automatic mental thoughts, altered perceptions, and behaviours and actions) as the independent variable showed a significant effect of type of GTP, χ^2 (2) = 19.00, p < .001. All post-hoc analysis with Wilcoxon signed-rank test conducted with Bonferroni correction were significant at p <. 001.

Out of 62 GTP experiences recorded in the diary, 38 of the entries (61%) were associated with immersive video games with more realistic 3D graphics (e.g., *Call of Duty Warzone, the last of Us, p Grand Theft Auto V),* and more realistic *gameplay* mechanics such as first-third person shooters, driving and real-life simulators (e.g., *Animal Crossing New Horizons, Formula 1, 2022, Fortnite, etc.*). A total of 24 (39%) GTP entries were categorised into non-immersive video games (e.g., Tetris*, Mario Kart, Cooking Mama, etc.*). A chi-square goodness-of fit test was conducted to determine whether immersive and non-immersive video games were equally prevalent in participants' descriptions of their GTP experiences. Results showed that there was a marginally significant trend towards reporting more immersive than non-immersive games, χ^2 (1, N = 62) = 3.16, p = .075.

3.5.3 Type of trigger, ongoing activity, and concentration ratings

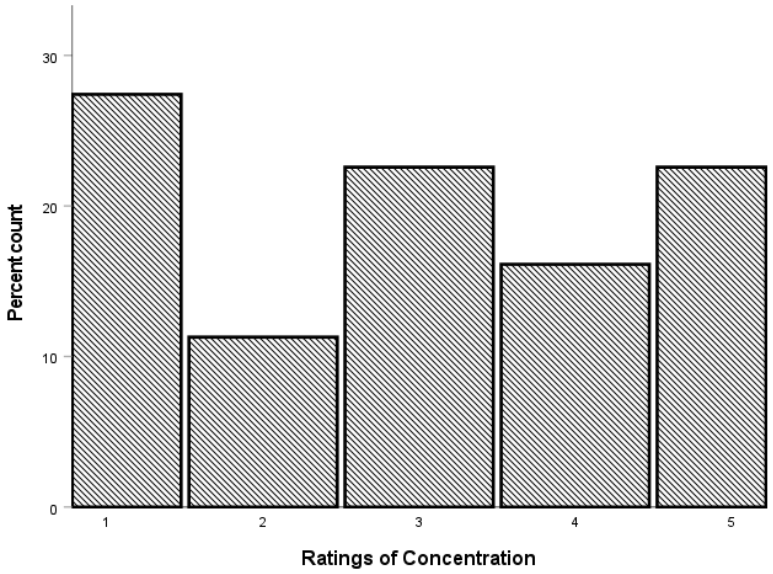
The circumstances in which participants reported their GTP experiences were examined in terms of the triggers that might have elicited the GTP and activities that participants were engaged in at the time. Although the type of triggers was self-reported by participants through a multiple-choice question, there were some discrepancies between the type of trigger selected and the descriptions of triggers provided by some participants in a follow up question. For example, some participants self-reported that the trigger of their GTP was in their "thoughts", however, in the next question about trigger description, (e.g., *"Walking through tall grass like you would in the game while on my daily exercise walk in a field")* it was noticed that the trigger of the GTP was in the "environment" and not in the "thoughts" as previously indicated. Therefore, participants' trigger descriptions were independently coded by JLA and LK into the 'internal', 'external', and 'no trigger' categories. Agreement between the coders was high (Cohen's *Kappa* = .70, *SE* = .08) and disagreements were solved by discussion. The results of this coding showed that the majority of recorded triggers referred to stimuli in the external environment (56%) than to one's internal thoughts (18%), and 'no triggers' were reported on 26% of occasions. A goodness-of-fit chi-square test was conducted to identify if every type of trigger was reported with equal frequency. Results showed that external triggers were more prevalent than other types of triggers, χ^2 (2, N = 62) = 15.51, p = .001.

Furthermore, participants' descriptions of what they were doing at the time of experiencing the GTP, were coded by JLA and LK into two main categories of automatic and controlled activities (see Kvavilashvili & Mandler, 2004). Activities were coded as automatic

or habitual if they did not demand too much attention and allowed the participant to think about matters unrelated to the activity (e.g., doing laundry, driving, cooking, or waiting in a queue). By contrast, all those activities that required high levels of attention and concentration to carry out the task were coded as controlled (e.g., working on Matlab, studying for an exam, reading a book for assessment, or planning a business meeting). There was excellent agreement between the coders (K = .86, SE = .07), and disagreements were solved by discussion. Most of the GTP reported in the diary occurred while participants were performing easy and routine daily activities (61.3%) compared to controlled activities requiring focused attention (38.7%). A goodness-of fit chi-square test showed that there was a non-significant trend towards automatic activities being reported more frequently than controlled activities, χ^2 (2, N = 62) = 3.16, p = .075.

Figure 3-1

Percentages of Concentration Ratings on a 5-point scale (1 = not at all, 5 = fully concentrated) for 62 GTPs Recorded by Participants

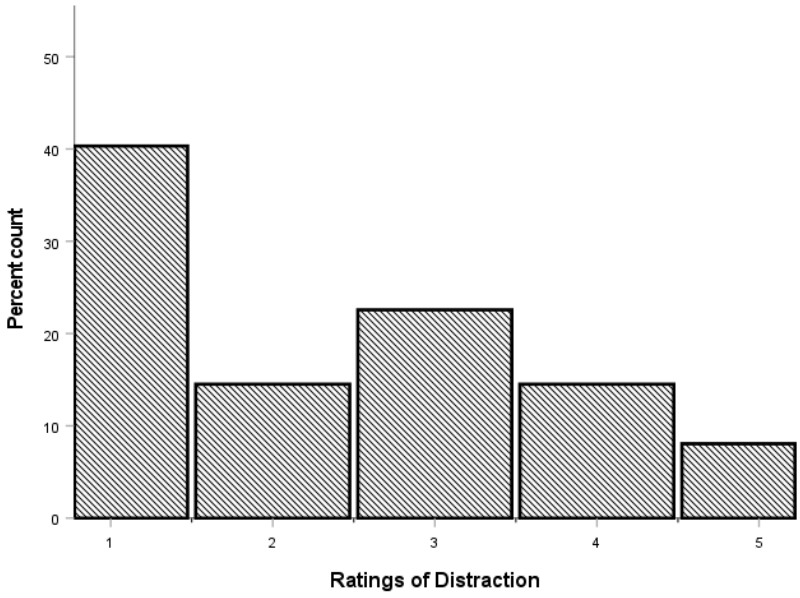


Moreover, participants' self-reported concentration levels on the activity at the time of having the GTP indicated that most GTP experiences were reported as having occurred under low to medium level of concentration (M = 2.9, SD = .15), see Figure 3-1 for percentages of GTPs for each rating on a scale. It is also interesting that, on the majority of occasions (63.2%), participants reported that they did not get distracted at all or were only

slightly distracted (ratings 1 and 2) from their ongoing activities when experiencing the GTP (M = 2.33, SD = 1.35) (see Figure 3-2 for percentages for each rating).

Figure 3-2

Percentages of ratings of distraction on a 5-point scale (1 = not distracted, 5 = fully distracted) for 62 GTPs recorded by participants



3.5.4 Prevalence of a prime for the reported GTP

To test the priming hypothesis, gamers were asked to indicate the last encounter with the video game related (i.e., the last time they played) to their GTP experience. Participants' answers were categorised into five different categories: the GTP-related game being last encountered or played "less than 24 hours", "within 1-6 days", "within 1-3 weeks", "within 1-12 months" and "more than one year" ago. Most of the diary recordings made by participants (57%) indicated that the contents of GTP experience had been encountered in identical (e.g., the game itself) or altered (e.g., stimulus associated to the game) form very recently (i.e., within last 24 hours). For example, *"I played fortune street the day before for about five hours non-stop".* On 16% of occasions, the GTP-related game was encountered 1 to 6 days earlier (e.g., *"I played the game 3 days ago", "I played that game about 3 days ago (little nightmares)".* On 8% of occasions, the game was encountered between 1 and 3 weeks before having the GTP (*"I played the game last week on Thursday for 2 hours at night", "I played the game about 2-3 weeks ago"),* and further 11% of the encounters occurred within 1

to 12 months earlier (e.g., *"I had last played Eurotruck simulator last month with my dad"*, *"Played Danganronpa V3 about six months ago").* Finally, 8% of the GTP were experienced more than after 1 year of having been exposed to the relevant game (e.g., *"Haven't played this game for over a year, been playing other games", "I played the game many years ago, I think maybe between 5-8 years ago")* (see Table 3-3).

Table 3-3

Frequency and percentage of last encounter with the game related to the GTP as a function of priming

Variable Last encounter with the game related to the GTP	Number of entries	Percentage
Less than 24 hours	35	57%
Within 1- 6 days	10	16%
Within 1- 3 weeks	5	8%
Within 1-12 months	7	11%
More than 1 year ago	5	8%

3.5.5 Ratings of Vividness, pleasantness, and mood

Each participant rated several characteristics of recorded GTP. Vividness was rated on a 7-point scale, and emotional valence and mood before and after GTP were rated on 5-point rating scales. For each participant, mean ratings for these dimensions were calculated and their averages across 30 participants who experienced at least one GTP are presented in Table 3-4 (if a participant recorded only one GTP then the ratings of this GTP rather than the average was used to calculate the mean across participants). Also, means presented in Table 3-4 indicate that recorded GTP were rated as having an average level of vividness, and that they were predominantly rated as being neutral to positive in terms of pleasantness and mood before and after the GTP. However, results of a paired sample t-test performed on 30 participants' self-reported mood ratings before (M = 3.21, SD = .765) and after (M = 3.43, SD = .756) the GTP was significant, t (29) = -2.42, p = .018, indicating a slight increase in mood rating after having the GTP experience.

Table 3-4

Mean (standard deviation), and Likert scale range including minimum and maximum of self-reported vividness, pleasantness, mood before, and after ratings

N=62	Mean	SD	Likert scale range Minimum	Likert scale range Maximum
Vividness	4.19	1.45	(1) "Very vague"	(7) Extremely vivid
Pleasantness	3.38	.70	(1) "Very unpleasant"	(5) "Very pleasant"
Mood before	3.21	.76	(1) "Very negative "	(5) "Very positive"
Mood after	3.43	.75	(1) "Very negative"	(5) "Very positive"

3.5.6 GTP associations with psychopathology variables and other involuntary phenomena

Bivariate Spearman rank correlations were conducted to explore the associations between the number of GTP experiences reported in GTP diary over a 1-week period with the total score on the GTP scale, and several other gaming and psychopathology related variables[3]

(see Table 3-5). The number of recorded GTP had significant and positive correlations with positive schizotypy, negative schizotypy, and anxiety. In line with the results of Study 1, the participants' self-reported frequency of GTP on the GTP scale correlated positively with IGD, positive schizotypy, disorganised schizotypy, mind popping, daydreaming, anxiety, stress, and depression. Most importantly, there was a moderate correlation between the number of recorded GTPs in the diary and participants' total scores on the GTP scale (r = .38).

A post-hoc power analysis was conducted using G-power (Faul et al., 2007) (G-power for Mac version 3.1.9.6) to assess the statistical power of this analysis. The correlation coefficients above r = 0.30, with an alpha error probability set at 0.05., and based on a total sample size of 38 participants revealed that the statistical power obtained was 0.584.

Table 3-5

Spearman Rank Correlation Coefficients Between Number of Diary-Recorded and other variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	GTP Diary (frequency)	1													
2.	GTPS Total Score	.380*	1												
3.	IGD	.078	.495**	1											
4.	Schizotypy positive	.477**	.657**	.325*	1										
5.	Schizotypy disorganised	.217	.441**	.550**	.524**	1									
6.	Schizotypy negative	.383*	-.008	.121	.183	.250	1								
7.	Mind popping	.037	.505**	.400*	.335*	.423**	-077	1							
8.	Day dreaming	.123	.473**	.221	.467**	.376*	.108	.580**	1						
9.	Anxiety	.333*	.497**	.496**	.453**	.572**	.030	.542**	.590**	1					
10.	Depression	.081	.330*	.410*	.365*	.632**	.172	.385*	.298	.526**	1				
11.	Stress	.043	.565**	.588**	.392*	.563**	-.210	.524**	.386*	.647**	.666**	1			
12.	M-IMP	.129	.269	-.103	.189	-.134	-.104	.091	.032	-.072	.118	.198	1		
13.	A-IMP	-137	.208	.266*	.238	.106	.059	.231	.187	.220	.219	.249	.284	1	
14.	NP-IMP	-.009	-.267	-.166	-.331*	-.273	-.129	-.199	-.330*	-.228	-.251	-.296	-.598**	-.560**	1

*Note * p< .05, ** p< .001, IGD= internet gaming disorder, M-IMP= motor impulsivity, A-IMP= attention impulsivity, NP-IMP= non-planning impulsivity.*

3.6 Discussion

This study used, for the first time, a structured diary method to investigate the frequency and nature of GTP in everyday life. Several novel findings emerged. In line with hypotheses, results showed important similarities between GTP and other involuntary cognitive phenomena such as mind-pops and daydreaming. For example, it was found that the majority of participants (82%) experienced at least one GTP during a 7-day period independently of their total score on the GTP scale. The GTPs classed as automatic mental processes were recorded with the highest frequency (58%) compared to the other types of GTP. In addition, participants who recorded more than one GTP, usually reported different sub-types of GTP rather than one particular GTP only. The frequency of GTP experiences (M= 1.79) was very similar to the frequency of mind-pops (*M* = 1.29) reported by a sample of undergraduate students by Kvavilashvili and Mandler (2004, Study 4), but less frequent than the number of IAMs (*M* = 6.31) recorded by the same participants during another 7-day period (see also Roberts et al., 1994; Schlagman et al., 2007). In addition, in terms of the contents of recorded GTP, the descriptions of GTP were more similar to mind-pops (*e.g., "The music of gris came to my mind when I was packing my colours"*) than IAMs (*e.g., "Listening to the radio and where's your head at came on, I used to sing the chorus line when I scored a headshot in Borderlands 2 and their head exploded, took me back to the game"*)

Another important finding was that triggers (both external and internal) were identified by participants on majority of occasions (74%). This finding is in line with previous studies on GTP reporting that GTP tend to be elicited by game-relate cues (Ortiz de Gortari & Griffiths, 2014 a, b; Ortiz de Gortari & Griffiths, 2016). However, it contradicts findings on studies of involuntary semantic memories or mind-pops where the percentage of cases with reported triggers varied between 20% to 37% (Kvavilashvili & Mandler, 2004b). Thus, it appears that the high percentage of identified triggers for GTP experiences is more in line with those obtained for IAMs (80%) in Study 4 by Kvavilashvili and Mandler (2004), and by Roberts et al. (1994, 93%), and by Berntsen (1996, 94%). These findings could be seen as contradictory, it is quite evident, that GTP experiences have a key feature that ordinary mind-pops do not have, which is the video game element. It appears that detecting game-related cues is much easier for gamers than detecting cues for non-game related mind-pops.

Previous studies on GTP have reported that GTP tend to occur when engaging in automatic activities such as cooking, walking, etc. (Ortiz de Gortari & Griffiths, 2014a, 2014b, 2014c; Ortiz de Gortari & Griffiths, 2016), similar to IAMs and mind-pops

(Kvavilashvili & Mandler, 2004; Berntsen, 1996). The current study confirmed that most of the GTP experiences recorded in the diary were reported to have occurred under low to medium levels of concentration (61.3%), and while performing automatic activities (61%).

These results are in line with majority of studies on spontaneous cognitive phenomena such as mind-wandering, prospective memory, IAMs and mind-pops, to name the few. For example, in an earlier laboratory study of mind-wandering (Giambra, 1995), it was found that the frequency of task-unrelated thoughts was higher when the difficulty of the task was low, and the target stimuli occurred infrequently. By contrast, when the ongoing vigilance was attentionally more demanding due to increased number of target stimuli that participants had to detect, the frequency of task-unrelated thoughts decreased (Giambra, 1995) (for similar findings see Vannucci, Pelagatti, Hanczakowski & Chiorri, 2019). Thus, vast majority of studies using diary, experience sampling and laboratory methods show that the number of involuntary phenomena is increased when people are in relaxed states of mind or when they are performing activities that are not cognitively demanding (Mandler, 1994).

Regarding the underlying priming mechanisms in GTP, a previous study on GTP reported that 47-54% of players experienced GTP seconds to hours after stopping playing, and 17% experienced it for days after (Ortiz de Gortari & Griffiths, 2016). In the current study, most participants reported having had a recent encounter with the game related to the GTP. Specifically, GTP occurred in the preceding 24 hrs (54%), with further 16% reported to have occurred one to six days after exposure with the game earlier. These findings are in line with laboratory studies by Mace and colleagues which demonstrated semantic to autobiographical memory priming over a one week-long period (Mace & Hidalgo, 2022; see also Mace 2005) and the diary study by Kvavilashvili and Mandler (2004) on mind-pops.

Furthermore, and in line with the hypothesis on the video game genres, most of the GTP experiences, reported in the diary, were associated with more immersive and realistic video games such as first-person shooters, horror, and role play games, and were mostly described as vivid (67.8%). Although some form of GTP experiences can result from playing non-immersive games, such as seeing images from puzzle games, these initial findings suggest that realistic video games may be more likely to elicit GTP than less realistic games. For example, previous studies have explored the effect of highly immersive first-person horror games using virtual reality technology (VR) to induce vivid in-game experiences, this phenomenon has been referred to as "*presence"*. It has been defined as a subjective sensation of being inside the game while playing, in other words, a subjective sensation where the reality of real-life merges with the video game environment (Terkildsen & Makransky, 2019).

Even though there are no studies inducing GTP under laboratory conditions using realistic games, future studies should consider the use of more realistic video games in combination with more realistic technology such as VR to induce GTP.

Finally, findings of the present study showed that even though the mood improved significantly after experiencing GTP, it remained within the range of neutrality, most of the experiences were perceived as neutral in terms of the mood. In addition, the emotional valance related to the level of pleasantness caused by GTP experiences were reported mostly as neutral (54.7%) in most participants, followed by pleasant (38.8%), and only (6.5%) as unpleasant suggesting that GTP does not significantly alter the emotional state in gamers (either pleasant or unpleasant). These findings are broadly in line with earlier studies that showed that gamers do not perceive GTP as disruptive or worrisome (Ortiz de Gortari & Diseth, 2022), nor particularly pleasant (Ortiz de Gortari & Griffiths, 2016; Ortiz de Gortari, 2023).

3.6.1 Differences between GTP scale and Diary method

Interesting results were also obtained from correlational analysis examining the associations between the GTP frequency as measured by the GTP scale (Ortiz de Gortari et al., 2015) and the diary method during a 7-day period used in this study. The results showed that there was a statistically significant positive correlation between the number of recorded GTP in the diary and participants' scores on the GTP scale. This provides strong independent support for the validity of the GTP scale. However, the correlation coefficient was moderate in size (r = .38). Moreover, discrepant patterns of correlations were obtained for the diary recorded GTP and GTP scale scores. Indeed, in replication with findings of Study 1 described in Chapter 2, the frequency of GTP measured by the scale was highly correlated with all the variables identified in Study 1 on the entire sample of 363 participants, such as IGD, positive and disorganised schizotypy, mind-pops, daydreaming, anxiety, stress, and depression. However, positive schizotypy and anxiety were the only two variables that were associated with the frequency of GTP as measured by the diary method. Although this finding provides further support for a strong link between positive schizotypal traits and spontaneous cognitive phenomena including GTP, the obtained pattern was unexpected and difficult to interpret. One possibility is that discrepant patterns of correlations occurred due to differences in the timeframe in which GTP was measured by the questionnaire (over the past 12 months) and the diary (over the 7 days of diary recording). The mean GTP scores are usually in the low to

medium range (Ortiz de Gortari, 2019). The results obtained with the diary method along with previous studies (Kvavilashvili & Mandler, 2004) shows that GTP experiences may be less frequent than previously assumed in the GTP literature. Given that the number of recorded GTP in diaries was so low with a small range, it is perhaps not surprising that there was not enough variability in the number of recorded GTP to result in significant correlations with most of the variables that were assessed.

3.6.2 Limitations

The current study presents some limitations that must be noted. Although most of the diary studies that have been conducted so far have included similar size samples (n = 38), it is important to replicate these findings with larger and more representative samples in terms of gender, age, education, and gaming experience. Moreover, due to the COVID-19 pandemic restrictions, this study had to be completed completely online, therefore, the scores for all the scales and questionnaires were collected online. Nonetheless, results from Study 1 did not find significant differences in the GTPS total scores as well as all the predictor variables obtained in online and face to face testing. Third, and again due to the lockdown restrictions, participants had to complete the diary online rather than using a paper diary. A previous study by Laughland and Kvavilashvili (2018) compared the frequency of recorded involuntary memories between a traditional paper-based and online diaries using participants' smartphones, and found that across three different studies, participants made significantly fewer diary entries in the digital diary in comparison with the traditional paper-based diaries, even though compliance rates with keeping the digital diary were significantly better than for paper diaries (Laughland & Kvavilashvili, 2018). In the present study, all participants completed a diary compliance questionnaire, and those participants who reported non-compliance were excluded from the final sample. In addition, to increase the number of entries in the online (electronic) diaries, participants received several reminders about their participation in the study during the 7-day period (see also Niedźwieńska & Kvavilashvili, 2019).

Finally, although all participants reported in a post-diary questionnaire that their mood and average gaming hours did not change significantly due to the pandemic restrictions at the time of keeping the diary, it is evident that being under lockdown restrictions could affect the mindset (way of thinking or general outlook on life) of some participants, and therefore future studies should replicate the present findings under more ordinary (non-lockdown)

conditions using a paper rather than online diaries to maximise the number of recorded GTP over a one week period.

3.7 Conclusions

This study has demonstrated that diary method is a suitable and reliable tool to measure GTP frequency in gamers' everyday life. The results showed that GTP experiences were similar to mind-pops in terms of their frequency and nature (e.g., contents, etc.). Thus, out of the three main dimensions of GTP, automatic mental processes were the most prevalent form of GTP recorded in diaries. Additionally, the results emphasize the importance of positive schizotypal traits in daily experience of GTP. Finally, results also provided preliminary support for the existence of long-term priming mechanism in the occurrence of GTP in everyday life. To explore this further, Chapter 5 will describe an online study using an implicit memory task to measure priming effects, as well as two measures of creativity as predictors of GTP.

Chapter 4: The role of priming and creativity in the frequency of Game Transfer Phenomena (Study 3)

4. Introduction

The results from Study 2 (Chapter 3) have demonstrated the relevance and utility of the diary method to study GTP by confirming that such experiences are similar to involuntary semantic memories or mind-pops (Kvavilashvili & Mandler, 2004). In addition, GTP shared similar characteristics with IAMs in terms of the higher prevalence of external cues reported by participants (Kvavilashvili & Mandler, 2004). Furthermore, and similar to both types of involuntary memories, most of GTP, recorded in the diary, occurred while participants were engaged in non-demanding and routine automatic activities, which supports the idea that such experiences are more likely to occur during diffused states of attention and periods of mind-wandering. In other words, this finding indicates that mind-wandering (daydreaming) states might facilitate the occurrence of spontaneous phenomena such as GTP experiences. In addition, one of the main aims of this thesis is to investigate possible underlying mechanisms of GTP. Study 2 showed that most of the participants, who reported their GTP experiences in a diary, were able to identify the last encounter in the recent past with the game as well as the trigger related to their GTP. These results confirm that the substantial proportion of recorded GTP experiences was potentially primed by a recent exposure to a game related to the contents of reported GTP (for similar findings in previous qualitative studies using retrospective designs, see Ortiz de Gortari, Aronsson, Griffiths, 2012; Ortiz de Gortari & Griffiths, 2015). Overall, results of Study 2 provide initial support for the long-term priming hypothesis as a possible underlying mechanism of this non-volitional phenomenon.

As discussed in Chapter 1, the priming hypothesis proposed by Kvavilashvili and Mandler (2004) suggests that exposure to certain stimuli or cues can unconsciously activate a multitude of related mental representations in one's semantic memory, leading to the subsequent occurrence of involuntary mind-pops in the form of words, images or music involving different priming mechanisms such as repetition priming or phonological or associative priming as discussed and described by Kvavilashvili and Mandler (2004). However, more recent research on so called semantic to autobiographical memory priming by Mace and colleagues has also shown that not only does a word or image activate related nodes in ones' semantic memory but that the activation also spreads to one's autobiographical memory representations some of which can be later recalled in response to some accidental but relevant triggers in one's environment or inner thoughts (Mace et al., 2019; Mace & Petersen, 2020; Mace & Hidalgo, 2022). Given that GTP are construed as primarily non-volitional experiences, it is important to elucidate if similar priming

mechanism is also in operation in GTP. This is mainly to explain why some gamers do not experience GTP, or experience them very rarely, despite being exposed to games to the same extent and having similar gaming habits to those who report high levels of GTP. One possible explanation of this observation is that there may be individual differences in the susceptibility to priming effects in gamers who do and do not experience GTP. In other words, it is possible that gamers with higher self-reported GTP may get more easily primed by the exposure to stimuli in the game than those with low frequencies of GTP or those who report no GTP at all. Thus, the constant exposure to video game content can be construed as primes for subsequent occurrence of the GTP in response to immediate cues in one's environment or thoughts. For example, participants who have reported experiencing GTP associated with the video game Tetris, have also reported playing the game in the recent past, or seen random stimuli in their thoughts or environment (e.g., shapes similar as Tetris blocks) that were associated with the game and therefore triggered their experience.

4.1 Brief overview of research on implicit memory and priming

Implicit memory refers to a type of long-term memory that operates without conscious awareness (Graf & Mandler, 1984; Graf & Schacter, 1985). It involves the retention and influence of previously encountered information and experiences on current thoughts, behaviours, or performance, without individuals intentionally trying to retrieve that information (Tulving et al., 1982). Implicit memory contrasts with explicit memory where information is consciously recalled. An essential consideration in this field is the potential dissociation (independence) between implicit and explicit memory forms (for a review see McDermott & Roediger, 1994). In other words, implicit memory seems to be less susceptible to interference manipulations that typically diminish retention in explicit memory tasks (Graf & Schacter, 1985).

Research on implicit memory to assess priming was at its height in the 90s. The term priming refers to a cognitive process in which previous experience increases the general accessibility of a perceptual or conceptual information and involves activating mental associations affecting cognitive processes or behaviours (Roediger et al., 1994; Schacter & Buckner, 1998). Initially, several studies investigated perceptual and conceptual aspects of implicit memory (Roediger & McDermott, 1993). For instance, perceptual priming studies examined visual and auditory priming, where the presentation of a visual or auditory stimulus affected the processing of similar stimuli presented later (Graf & Schacter, 1985). Perceptual priming has been traditionally measured with tasks like word fragment completion and word

stem completion, where participants performance on these tasks were unconsciously influenced by prior exposure to words acting as solutions to the word stems or word fragments, respectively (Roediger et al., 1993). For example, in a word fragment completion task, participants complete word fragments after being exposed to words earlier. Priming is measured by comparing the completion of fragments for words seen earlier (studied words) with fragments for words not seen earlier (non-studied words) (Rajaram & Roediger, 1993).

Similarly, conceptual priming was also a significant area of investigation with most studies examining how the activation of concepts or ideas could influence subsequent cognitive processing (for a review, see Roediger & McDermott, 1993). In particular, in semantic priming tasks, researchers investigated how exposure to a word (i.e., a prime stimulus) could facilitate or speed up the processing of semantically related target words presented later within a lexical decision task (Chandler, 1993; Connor et al., 1992; Dannenbring & Briand, 1982). Other tasks that have been used to measure conceptual priming include word association and category instance generation tasks (Shirriamura & Squire, 1984; Srinivas & Roediger, 1990). For example, in a category generation task participants are asked to process words from different categories (e.g., *animals*, *fruits*, or *furniture)* in the study phase, and in the test phase after a delay, they complete a category fluency task in which they have to list items belonging to different categories (usually 12 seconds per category). For example, if the category is *"animals"* participants are asked to generate as many names of specific animals as possible (Srinivas & Roediger, 1990). The priming effect is manifested by participants' tendency to generate more items for a given category that they were exposed to during the study phase compared to the items that they were not exposed to. This type of task is valuable for understanding how people organize and retrieve information from memory, exploring semantic networks, and examining the impact of priming on the recall of specific category instances.

Despite considerable progress made in research on priming and implicit memory, most of this research has been conducted in the laboratory and over short time delays between study and test phases. There are very few studies that have investigated possible long-term priming effects that may be occurring outside laboratory contexts. For example, Coane and Balota (2009) used a lexical decision task (LTD) to investigate the extent to which the activations of semantic concepts (e.g., reindeer, or skeleton) naturally occurring across a year in response to specific holidays and festivities (e.g., Christmas, Halloween, etc.) can be captured and measured in the laboratory. In this study, undergraduate students ($N = 204$) were tested throughout the year where testing times were scheduled as close as possible to

major holidays and festivities in the US (e.g., Thanksgiving, Easter, Christmas, etc.). The LDT involved non-words, and critical targets associated to different festivities and holidays (e.g., 'pilgrims' for Thanksgiving, 'haunted' for Halloween, 'bunny' for Easter, etc.). Also, to explore further possible individual differences due to academic performance, 30% of the critical targets were associated to academic concepts (e.g., study, exam, etc.).

In each LDT, participants were exposed to two conditions, the congruent condition in which the time of testing and the content of the stimulus matched (e.g., 'haunted' or 'skeleton' in late-October coinciding with Halloween), and the incongruous condition in which the time of testing and the content did not match (the same words related to Halloween presented in early-June). After the LDT, participants completed a post-test questionnaire to evaluate individual differences in participants' concerns about academic performance and how important the studied holidays and festivities were for them personally. Finally, participants completed an unexpected free recall test involving the items previously seen in the LDT. Results showed significant influences of seasonal events on the accessibility of concepts in the LDT and free recall task. For example, congruent targets were recognized faster and more accurately than incongruent targets, and more congruent targets were recalled than incongruent targets. Additionally, results from the post-test questionnaire showed that participants, regardless of congruency at the test phase, tended to respond faster to words associated with their most preferred holiday (Coane & Balota, 2009). Overall, these results demonstrated persistent changes in the accessibility of concepts in everyday life as a function of time of the year and the dependence of priming effects on individual differences variables such as preferred holidays or academic performance (Coane & Balota, 2009). Similarly, GTP experiences might be easily primed for some participants due to pre-existing activations of certain game related representations due to having played a video game in the past.

Research in cognitive psychology has primarily focused on understanding general principles by manipulating experimental conditions and comparing mean scores across conditions (Goodhew, 2020). However, more recent research in cognitive psychology has started to focus also on investigating individual differences in cognitive abilities (Boogert et al., 2018; Goodhew, 2020). This research is usually addressing two distinct issues: individual differences in the capacity to carry out cognitive tasks (e.g., working memory capacity) and individual differences in how one approaches cognitive tasks (e.g., individual differences in types of strategies used when completing a particular cognitive task). For example, research on participants' capacity to carry out cognitive tasks has focused on diverse cognitive phenomena such as working memory (Dale & Arnell, 2015; for a review, see Unsworth,

2016; Unsworth & Engle, 2005), or inhibitory control in the context of involuntary thoughts (Barzykowski et al., 2022; Barzykowski & Niedźwieńska, 2018). Although initial research in cognitive psychology assumed that participants' performance in these basic cognitive tasks would be fairly similar (reflected in small SDs), the latest research has demonstrated that there are often large and stable individual differences in both participants' abilities and use of strategies when they complete different cognitive tasks. For example, research on the attentional blink has shown that some participants do not experience this phenomenon at all and can be considered as "non-blinkers' (Enns et al., 2017; Martens & Wyble, 2010).

In line with this newly emerging research, the key premise of the present study was that there may be strong individual differences in participants' susceptibility to priming effects in terms of levels and spread of semantic activations in response to incidental primes encountered in one's recent past. To the best of our knowledge, no previous research on GTP has explored individual differences in participants' implicit memory and examined its relation to levels of self-report GTP frequency. Examining possible individual differences in priming and implicit memory and other associated factors to GTP will help to extend current knowledge of possible underlying mechanism of GTP.

4.1.1 Implicit memory tasks for studying priming

Traditionally, priming in implicit memory tasks has been measured by engaging participants in three phases (study, delay, and test) whereby memory retention is examined indirectly. For instance, participants are usually asked to perform different tasks that seem to be independent and not related. Thus, the first task works as a study phase which is indirectly linked to a second task as a test phase after a particular delay period (Graf & Schacter, 1985). During the study phase, participants are usually exposed to different stimuli (e.g., visual, or auditory), and are requested to perform a task that does not involve memory encoding. Instead, participants are usually instructed to rate levels of pleasantness or familiarity of a list of words presented to them. Once this task (or priming phase) is completed, participants must go through a delay phase. In most studies, researchers use different personality questionnaires, filler tasks or other cognitive tasks that measure variables of interest, that are not related at all with the list of words previously seen. The duration of the delay phase may vary across different studies (e.g., 10, 30, 60 mins, etc.) (see Rajaram & Roediger, 1993).

Finally, during the test phase, participants are asked to complete a second task that includes the items seen during the study phase plus new items not seen participants in the study phase, with both old and new items being presented in a random order. One premise of

implicit memory tasks is that participants should be able to identify previously seen words more easily than unseen (control) words, because of previous exposure to them even though they had not been instructed to remember the words (Rajaram & Roediger, 1993). Thus, there is a priming effect when the amount of retention on studied items is higher than associated items not seen during the study phase.

Overall, there are different types of implicit memory tasks that have been used for measuring priming (e.g., word stem completion, anagram solution, word identification, and word-fragment completion). For the present study, a word-fragment completion task was selected not only because it is one of the most often used tasks to study priming, but also because the reported consistency in measuring priming effects over longer periods of time. For instance, previous studies have reported that the priming effects using the word stem completion task usually disappear after two hours (Graf & Mandler, 1984). In contrast, priming effects for seen words can last over a week when using the word-fragment completion task (Roediger & Blaxton, 1987; Tulving et al., 1982). In this task, at the test phase, participants are presented with incomplete words in the form of fragments with some missing letters, and the main goal of participants is to identify and complete each fragment with the first word that comes to mind and is the correct solution. For example, the fragment T_ _E S _ _ P _ would be correctly completed as T E L E S C O P E. Participants are not informed that some of the test items were the previously seen (studied) words, they simply are told that they need to solve the word puzzles as best as possible (Roediger, 1990). Additionally, participants are clearly instructed about a time limit (12 seconds in most studies) to complete each fragment, and they will not be able to work ahead or return to any previous uncompleted fragments (Roediger et al., 1993; Soler et al., 2015). Furthermore, another important aspect that most researchers are very clear about, is the fact that participants are not informed at any point of the test about previously seen words and its relation to the test phase (Graf & Schater, 1985). Finally, priming effects are usually obtained by subtracting the proportion of correctly completed fragments for non-studied new words from the proportion of correctly completed fragments for previously seen (studied) words (Rajaram & Roediger, 1993; Soler & Ruiz, 2007).

In addition to this, priming experiments involve several considerations that researchers need to be aware of. For example, sensitivity to experimental conditions is a crucial factor; priming effects can be highly responsive to subtle changes in conditions such as the timing of the priming stimulus during the study phase, the duration of the interval between the prime and the target task (retention interval), manipulation of instructions, and

the nature of the interference or filler task, to name a few (Roediger & McDermott, 1993). Overall, minimal variations can lead to different results. Apart from these considerations, there are some others that have not been properly investigated such as possible individual differences and physiological states that might influence the priming effects.

Furthermore, the word-fragment completion task was chosen to assess priming because it is less contaminated by possible conscious influences. Indeed, research has shown that priming exists even for words that participants do not consciously remember having seen before (Roediger & McDermott, 1993). In addition, the inclusion of a filler task further minimizes contamination from explicit memory or conscious recollection of seen words while completing the word fragment task (Roediger & McDermott, 1993). In conclusion, the word fragment completion task is a reliable method for studying priming as it taps into implicit memory, reveals the unconscious influences of prior exposure, and offers insights into automatic memory activation making it a valuable tool in the investigation of priming effects.

4.1.2 Creativity and its association with other spontaneous phenomena

As discussed in Chapter 1, another variable associated with mind-wandering and priming effects, that might be linked with the frequency of GTP, is creativity (Agnoli et al., 2018). Creative thinking involves cognitive processes that are similar to mind-wandering, which often involves generating thoughts that are unrelated to the task at hand but can be prompted by stimuli in one's environment. It has been suggested that, like in creative processing, mind-wandering may sometimes involve a spontaneous generation stage followed by a more deliberate stage where thoughts are evaluated, guided, and reflected upon (Fox & Beaty, 2019). For instance, several studies have found significant associations between diverse measures of creativity and retrospective measures of daydreaming as a measure of mind-wandering (Baird et al., 2012; Agnoli et al., 2018). However, more recent studies have shown mixed results concerning the associations between creativity and mind-wandering (for a review, see Vannucci & Agnoli, 2019). While some studies have indeed found that participants had more creative ideas during states of mind-wandering than when actively engaged in directed thinking (Godwin et al., 2017; Mooneyham & Schooler, 2013), other studies did not find significant associations between mind-wandering and measures of creativity suggesting that mind-wandering could also diminish creativity due to lack of focus in the generation of unique ideas (Murray et al., 2021; Smeekens & Kane, 2016).

Regarding GTP, some of the content of GTP reported by participants in previous studies might be associated to creative processes in the context of being novel, useful and could also occur under a combination of spontaneous and executive processes. For example, solving problems: *"Need for Speed 2 helped me through a bad slice on ice. When I hit the ice, my brain went into gaming mode. It felt like I was with the controller in my hand…. I ended up off the slide"* (cited in Ortiz de Gortari, 2018). Another example might be the spontaneous mental representation of knowledge previously learned in a video game that might be useful in real life, such as a new word, new concept, historical fact, etc. *"I get different answering options as a picture in my head from Dragon Age. My sister insulted me (verbally), and I thought 'What am I going to answer?', 'Right back at you!', I see it as options in my head… the game triggered it, I feel organized"* (cited in Ortiz de Gortari, 2018).

Studies 1 and 2 found that there was an association between frequency of GTP and frequency of mind-wandering (daydreaming), which might lead to more streams of thoughts that eventually might be linked with game-related associations triggering GTP experiences. It is then important to investigate the relationship between GTP and implicit memory for priming effects using more systematic method, as well as the role of creativity.

4.1.3 Alternate uses task for studying creativity

The alternate uses task (AUT) (Guilford, 1970) has been widely used in creativity research. Guilford (1950) proposed a model of creativity that emphasized divergent thinking as a key component of creativity that involved the ability to generate multiple solutions or ideas in response to a given task or stimulus. The AUT aligns with this theoretical framework by providing a structured method to measure an individual's divergent thinking skills and assess their creative potential.

Some studies have validated the AUT as a reliable tool for assessing creativity. For instance, Beaty et al. (2014) conducted a meta-analysis of studies employing the AUT and found a positive correlation between AUT performance and other measures of creativity that include originality and creative achievement. These findings highlight the validity of the AUT in capturing important aspects of creative thinking. Moreover, another study explored a potential of AUT to enhance creative thinking by investigating its effects on creativity over a period of several weeks. Results showed that constant practice in the AUT led to improved creative performance on a subsequent creative task, indicating that regular engagement with

the AUT can enhance divergent thinking and creative abilities (Storm & Patel, 2014). Finally, neuroscientific research has also supported the link between the AUT and creativity. For example, the fMRI study by Benedek et al. (2014) investigated brain's neural activity while participants performed the AUT and found that high AUT performers exhibited increased activation in brain regions associated with creative cognition, such as the prefrontal cortex and the default mode network.

In the standard AUT, participants are presented with a piece of paper with the name of a common object (e.g., brick, bucket, pencil, etc.), and are asked to generate and write down as many alternative and novel uses (creative ideas) as possible for the given item. Participants are given a fixed amount of time such as 1 minute, 2 minutes, etc. (3 minutes in the present study) to generate as many novel and different uses as they can think of for the given object. Responses are coded and later scored based on certain criteria, for example, uniqueness (the originality of such ideas in comparison with the rest of the tested sample (Milgram & Milgram, 1976), fluency, flexibility, and elaboration of the ideas generated. For the generation of novel and creative ideas, this study used the words *"newspaper"* and *"car tyre"*.

It is important to mention that for this study, two different creativity criteria for evaluating participants' output in the AUT were used. Firstly, a traditional uniqueness score was used. Uniqueness is usually assessed by examining the entire sample of novel uses listed by all participants and ascribing a score of '0' if a particular use has been listed by more than one participant and assigning a score of '1' for the use that has not been mentioned by any other participant in the study. However, important limitations using uniqueness scoring have been discussed. Silvia et al. (2008) highlighted three key limitations. The first limitation states that "uniqueness scoring cofounds fluency and creativity", which means that there is not a clear difference between quality and quantity in the number of unique responses with the total number of responses. Researchers have shown that the extent of this confounding is significant with very high correlations (r = >.85) between unique responses and fluency scores (Silvia et al., 2008). It is then not possible to reliably determine if uniqueness scores account for any variation beyond mere fluency scores. Therefore, the cofounding between creativity and fluency is unavoidable because the probability of providing a unique response simply increases when the number of responses increases. The second limitation states that "statistical rarity is ambiguous", in other words, a response or many unique responses that are not actually creative, can easily break the objective scoring system just by simply being unique in the sample, without a proper suitability for the given task (Silvia et al., 2008).

Finally, the third main limitation of this scoring method is that "uniqueness scoring penalizes large samples". For instance, in large samples, creative responses will depend on the total number of entries among participants, therefore, the probabilities to obtain more unique responses will be higher in smaller samples with fewer entries (1 in 100) than large samples with substantial responses (1 in 100,000) (Silvia et al., 2008). For example, the probability that a response reporting that a newspaper can be used to slap flies is being higher to be scored as creative in a sample of 5 than in a sample of 50 participants.

To control for these possible limitations, it was decided to include a second scoring criteria which involved a usability criterion for creative responses. For instance, unique and creative (original) responses were given a score of '1' if they also referred to real-world usability. For example, a participant might generate a unique response for the item *"car tyre"* with the following answer: *"use a car tyre as a finger ring for a giant"*. However, there are no giants in real-life, therefore, despite the uniqueness of this particular response, it does not have a realistic use, and hence it would be scored with 0 points. In contrast, a creative response with a unique and real-world use would be scored with 1 point, for example, the unique idea *"use a car tyre as a practice range for knife-throwing"*, includes a real use that can actually be done with a *"car tyre"*. Moreover, recent studies have highlighted the challenge for participants to successfully generate unique and useful responses in this type of task. For example, idea generation requires search and retrieval of memory, individuals usually tend to rely too much on easy, accessible, and familiar information during idea generation (George & Wiley, 2019). These constant tendencies result in a high rate of obvious and unoriginal responses since the most accessible information to retrieve is visibly the least creative and unique.

To address this, recent studies have focused on investigating the effects of using specific examples and instructions on the generation of creative and novel ideas using the AUT (George & Wiley, 2020). Results have shown that participants who are previously exposed with multiple unoriginal examples and are explicitly instructed to "AVOID" such type of responses can enhance original and distinctive responses. To address this, this study followed George and Wiley's (2020) recommended instructions to enhance the probability of obtaining more creative and unique responses in the tested sample.

4.1.4 Forward flow for studying creativity

Apart from the traditional AUT to measure creativity, this study also employed a free association task using a more recent measure that has been reported to predict creativity (Gray et al., 2019). One of the most reliable tasks to measure streams of thoughts that have been shown as a good predictor of creativity is the free association task. This task has been designed to elicit spontaneous cognitive processes by asking participants to verbalize or write their stream of thoughts with just one single cue word used as a starting point (Marron & Faust, 2018). Instructions to participants are usually given without restrictions, individuals are simply asked to report every word that comes to their mind after they are presented with an initial cue-word (e.g., candle). Moreover, this task has been also used to evaluate multiple types of spontaneous processes such as fluency and flexibility (e.g., ability to switch between different sematic categories while producing the word associates) (Marron et al., 2018). Results have shown that chains of thoughts, based on unconstrained associative thinking, are correlated with creative performance, because such free associations are accompanied by reduced control over thought processes that are ideal for creative idea generation (Marron et al., 2018).

Recently, however, Gray et al. (2018) have suggested that free association tasks need to be improved to assess creativity more accurately. For instance, one of the key issues raised by Gray et al. (2018) is how to quantify more precisely the streams of thought in the free association task and to what extent such streams of thought can predict other psychological phenomena. Gray et al. (2018) suggested that both questions can be addressed by using a new metric in free association tasks which they have referred to as "forward flow". Forward flow allows to quantify streams of thoughts using "latent semantic analysis", which evaluates the semantic similarity or evolution of thoughts over time (Deerwester et al., 1990). In other words, how much current thoughts diverge from the initial word concept that was used as a starting point in the free association task. This measure calculates semantic similarity, and/or the distance between two words taking in consideration the frequency of their co-occurrence within some corpora of text (Gray et al., 2013). For example, the close association between the words *'garden'* and *'green'* would be a good example of a small semantic distance. If an online search is conducted, such words will usually appear together in multiple conversations and types of texts (e.g., books, essays, magazines, journals, etc.). However, if we use the words '*garden*' and '*radiator*' in the search, both words would rarely appear together obtaining a much larger semantic distance.

To test the forward flow metric, Gray et al. (2018) conducted six studies to evaluate its efficacy using a traditional free association task. Apart from this task, participants completed other creativity tasks measuring divergent thinking such as the AUT, (Guilford, 1957), graduate record examination (GRE) verbal intelligence, cognitive capacity, and convergent thinking as control measures. In general, their results showed that forward flow was a reliable tool to predict creativity among general and specific samples (N= 1397 divided into smaller samples) with specific demographic characteristics including undergraduate students, representative sample of Americans, professional workers (e.g., working professional actors and non-creative career-related professionals), and popular influencers of social media. Results showed that individuals involved in professional or daily activities linked to creative processes (actors, popular influencers, professional designers, etc.) had higher levels of forward flow scores as well as higher ratings of creativity measured by other creativity tasks in comparison with other professionals such as accountants, mechanical workers, students of drama, etc. (Gray et al., 2018). In addition, Gray and collaborators suggested that this new metric, based on the dynamics of unfolding and unconstrained thoughts approach, could be used beyond creativity research to predict mental illness, emotional experience, leadership ability, adaptability, group productivity, and other cultural process (Gray et al., 2018). Overall, the AUT and forward flow tasks encompass different ways of measuring creativity as a spontaneous cognitive phenomenon.

4.2 The present study

The main aim of this study was to investigate the association between priming scores and participants scores on GTP scale to assess if individual variability in the magnitude of priming effects is positively associated with self-reported rates of GTP frequency in everyday life. The second aim of this study was to examine empirically if GTP scores can be predicted by two different measures of creativity. Finally, the study aimed to replicate previous findings concerning the strongest of predictors of GTP such as the internet gaming disorder (IGD), frequency of mind-pops and daydreaming, and positive schizotypy.

To achieve these aims, participants in Study 3 completed several questionnaires online, psychological validated scales, and cognitive tasks. For example, to measure priming effects, individuals completed a word-fragment completion task. Regarding, creativity, participants completed the AUT, as well as a free association task. Finally, in order to replicate previous findings on IGD, mind-pops, daydreaming and positive schizotypy,

participants completed the same measures used on Studies 1, 2 and 3 (see Chapter 2 for full descriptions).

It was hypothesized that higher levels of GTP frequency would be associated with higher levels of priming effects as measured by the word-fragment completion task. Also, it was expected that higher frequency of GTP would be positively correlated with AUT scores, as well as the forward flow measure from the free association task. Additionally, and in line with Studies 1 and 2, it was expected that the same pattern of results would emerge between GTP scale scores and other predictors such as IGD, and scores on the mind-popping, daydreaming and schizotypal trait questionnaires. Finally, several previous studies (Ortiz de Gortari & Griffiths, 2016; Ortiz de Gortari & Panagiotidi, 2023) as well as Studies 1 and 2 of the present thesis have shown that IGD is a strong predictor of GTP. Therefore, a mediation analysis was conducted to explore the relationship of creativity as a moderator along with positive schizotypy to measure the effect of IGD as a predictor of GTP. It was hypothesized that IGD would be a good predictor of GTP mediated by positive schizotypy and creativity.

4.3 Method

4.3.1 Participants

A power analysis was performed using G-power (Faul et al., 2007) (G-power for Mac version 3.1.9.3), with a medium effect size of 0.15, power of 0.95 and 12 predictors. Based on these values, a minimum of 107 participants was required. A total of 120 participants were recruited for this study. In order to take part, all participants had to meet specific inclusion criteria. In particular, they had to be active gamers by having played any kind of video games for at least 4 hours per week on a regular basis for the past 12 months. Additionally, participants had to be 18 to 45 years old and have a minimum of 11 years of formal education. For non-native English speakers, it was necessary to have at least medium level of proficiency in English language (level 4 and above) on "The London School of English" 9-point scale. After data cleaning, a total of 35 participants were removed from the final data analyses: 15 participants did not complete the study, by dropping out at different stages; three participants were removed because they did not get any correct responses in the word-fragment completion task, 17 failed to complete the free association task in line with instructions. Out of these 17 participants, 6 participants failed to fill in any of the blanks, and 11 included non-allowed words such as commercial brands (e.g., *"Tesco", "Nike", "Savers"*), people's names (e.g., *"John"*, *"Marie"*, *"Jane"*) and multiple words (*"blue table", "ugly cat", "tall guy"*). The final sample consisted of 85 participants (53 males; M_{age}

= 24.89 years, *SD* = 5.87; age range: 18-43). Participants were recruited from several sources such as the University website and social media advertisements such as Facebook and Twitter (see Table 4-1 for demographic information).

Table 4-1

Demographic Information of a Final Sample of Participants Included in the Study (N=85)

Variables	Final sample
Demographics	
-Age (years), mean (SD)	24.89 (5.87)
Gender, n (%)	
- Male	53 (62.4)
-Female	31 (36.5)
-Prefer not to say	1 (1.2)
Years of education, mean (SD)	16.62 (3.02)
Occupation, n (%)	
-Student	77 (75.5)
-Employed	19 (18.6)
-Self-Employed	4 (3.9)
-Unemployed	1 (5.2)
-Homemaker	1 (.4)
Drug use n, (%)	
-Never	70 (82.4)
-Once or twice	11 (12.9)
-3 to 5 times	1 (1.2)
-6 to 10 times	1 (1.2)
-More than 10 times	1 (1.2)
-Daily	1 (1.1)
Curent mental illness diagnosis, n (%)	
-No	68 (80)
-Yes	17 (20)

All participants completed a questionnaire with several questions about their gaming habits (e.g., years of playing, gaming hours per week, gaming hours per session), and classified themselves in terms of the type of video game player they considered themselves to

be (casual/leisure gamer, mid-core gamer, hardcore gamer and professional gamer). Most gamers reported spending a substantial amount of time playing per week, and the majority of participants self-reported themselves as hard-core and mid-core gamers (see Table 4-2).

Table 4-2

Gaming Habits of Participants included in the Final Sample (N=85)

Variable	Total sample	Min, Max
Video Game Experience		
-Years of playing, mean (SD)	15.94. (7.71)	1, 33
-Gaming hours per week, mean (SD)	18.74 (12.64)	4, 75
-Gaming sessions in hours, mean (SD)	3.36 (1.65)	1, 10
Playing days per week, n (%)		
-1-2 days	14 (16.5)	
-3-5 days	32 (37.6)	
-6-7 days	39 (45.9)	
Type of video games player* = n (%)		
-Casual	12 (14.1)	
-Mid-core gamer	32 (37.6)	
-Hardcore gamer	39 (46.9)	
-Professional gamer	2 (2.4)	

*Note: Casual/leisure gamer (e.g., *I enjoy playing games, but my time/ interest is somewhat limited*); Mid-core gamer (e.g., *I play different kinds of games enthusiastically, but I do not play as long or as hard as a hardcore gamer*); Hardcore gamer (e.g., *I spend a huge amount of time playing games. I like to search the last news and updates in gaming. I have a good console/Pc made especially for gaming*) and Professional gamer (e.g., *I like to play video games constantly as a fulltime job to make profit by competing in official tournaments*).

4.4 Materials

4.4.1 Questionnaires

All questionnaires to measure mind-popping frequency, daydreaming, and schizotypal traits were the same as those used in Study 1 and 2 (see materials section in Chapter 2 for full description).

4.4.2 Cognitive Tasks

4.4.2.1 Word fragment completion task (WFC) (Roediger et al., 1992)

All words used in the word fragment completion task were taken from normative data of 192 single-solution word-fragments (Erickson Gaffney, & Heath, 1987) and were controlled in terms of difficulty and familiarity in a college students' sample (n = 80). Additionally, to avoid order effects, two-word lists were created and balanced in terms of difficulty and familiarity. Half of the participants were presented with list A during the study phase and list B during the test phase, while the other half of the participants were presented with list B for the study phase and list A for the test phase. Both lists were matched in terms of word length (number of letters): list A (M = 6.19, SD = .90), list B (M = 6.36, SD = 1.10); familiarity ratings: list A (M = 6.19, SD = .90), list B (M = 6.36, SD = 1.10) and proportion of fragment completion: list A (M = 0.12, SD= .90) list B (M = 0.16, SD = 0.14) (see Appendix XV for both lists).

4.4.2.2 Alternate uses task (AUT) (Guilford, 1957)

To measure participants' creativity, two versions of the AUT were used, the prompts for each AUT were *"car tyre"* and *"newspaper"*. The first one was chosen following George and Wiley methodology (2019, 2020), which demonstrated that providing obvious and repetitive examples of a given item *("car tyre"*) in the AUT prompted participants to avoid such ideas and come up with more original and unique ones. The word *"newspaper"* was used as another common object that was often used in initial studies using the AUT (Michael & Wright, 1989; Wallach & Kogan, 1965).

The present study used the uniqueness score when coding participants' responses to the two items. As described in the introduction, this scoring method focuses on how different and unique participants' responses to each item are. The classic index proposed by Wallach and Kogan (1965) was used. Participants received 1 point for each response that was unique in the sample (i.e., no other participant mentioned it) and 0 for each response that was given by at least one other person. The unique responses were summed to create the uniqueness score for each participant. Finally, to control the most common problems when scoring for uniqueness such as confounding between creativity and fluency, ambiguity in unique responses, and potential issues obtaining uncreative responses due to large sample size, a second criteria comprising usability was implemented (Silvia et al., 2008). Based on these criteria, responses that were unique but did not entail a real or useful use according to the two objects provided for this task *("newspaper and car tyre"*) were scored with 0-points (e.g.,

"making glasses for a giant with a car tyre or making a gun from newspaper to kill someone").

4.4.2.3 Free association task (Forward Flow)

In the free association task, participants are asked to describe their chain of word associations in response to a previous seeded word listed at the beginning of the chain. In the version of the task that was used in the present study, participants were requested to type in their responses into individual boxes, a chain of single-word associations that came to their mind, one by one. The seed words used for this study were *"bear"* and *"table"* and were chosen from Gray and collaborators (2019) previous study. To score participants' responses, a method proposed by Gray et al. (2018) was used (called Forward Flow). The forward flow has been used as an index to measure creativity; it quantifies the semantic distance (latent semantic analysis) between current thoughts from previous thoughts within the network of free associations produced. The more dissimilar streams of thoughts are in terms of semantic meaning of listed words, the higher the levels of forward flow would be obtained. For example, the words lollypop, sweet, candy, treat, would have a lower forward flow because previous and current thoughts are semantically similar in comparison to a chain of words such as lollypop, company, dolly, toy which are more semantically dissimilar (Gray et al., 2018). The semantic distance between pairs of words can range from 0 "minimal" distance to 1 "maximum distance".

Authors have highlighted that apart from the association between two consequent thoughts, forward flow is a more holistic measure that captures the dynamics of an overall sequence of thought regardless of length. Forward flow is the calculation between the average semantic distance from all preceding thoughts. Figure 4-1 displays the equation for calculating the forward flow index where *D* is the semantic distance between thoughts and *n* is the numerical location of a thought within a particular stream. The open-access website (www.forwardflow.org) provided by Gray et al. (2018) was used to calculate forward flow scores for each participant.

Figure 4-1

Equation to Calculate the Forward Flow Index

$$\frac{\sum_{i=1}^{n-1} D_{n,i}}{n-1}$$

4.5 Procedure

The participants who expressed interest in taking part in the study, received an information sheet via email explaining the details of the study (e.g., the purpose of the study, how long it would take, etc.). Those who agreed to take part, signed a digital consent form before starting the study. After this, an anonymity ID was created for each participant, and personalized website links to access the whole study were individually provided.

All questionnaires and tasks used were hosted on Qualtrics platform (Qualtrics, Provo, UT), and participants received written instructions about how to complete each questionnaire. After this, the following questionnaires and tasks were completed in the same order: (i) demographic questionnaire; (ii) video games experience questionnaire; (iii) free association task (forward flow task); (iv) GTP scale; (v) word rating task (study phase for the priming task); (vi) alternate uses task; (vii) multidimensional schizotypy scale-brief version (MSS-B); (viii) internet gaming disorder scale-brief version (IGD-9); (xi) mind-popping frequency questionnaire (MPQ-4); (x) day-dreaming frequency scale (DDFS); and (xi) word-fragment completion task (test-phase priming task).

After completing demographics and gaming experience questionnaires, participants completed the free association task. During this task, participants were explicitly informed that the purpose of the task was to measure how their thoughts naturally flow. They were instructed that they would be presented with a cue word, and their task was to type in the first word that came to their mind in relation to the given cue word (e.g., "bear"). Subsequently, the word they had just typed would become the new cue word for the next thought. This procedure had to be repeated for 19 thoughts.

The following verbatim instructions were provided: *"In this task, we want to assess how thoughts naturally follow each other in your mind. You will be given a cue word and*

have to type in the first word that comes to your mind in relation to this cue word. Once you type in this word, it then becomes the cue word for the next word that comes to your mind, and so on. It is very important that you complete this task in a relaxed state of mind by relying on words and thoughts that pop into your mind spontaneously without you trying to deliberately come up with a suitable word. There are no right or wrong answers, you have to type in a word that comes to your mind whether it seems suitable or not. If you are ready to start, please type in the word that comes to mind in response to the previous word typed in the boxes below". "Please use only single words and no proper nouns" (e.g., names of people, places, etc.). The first cue word in this chain of thoughts is the word "BEAR". Participants were not instructed to be creative, after reading instructions, participants were instructed to enter a single word into each of the numbered available empty boxes (19 in total) to represent their train of thoughts, they just had to type in the first word that naturally came to their mind. There was no time limit to complete the whole task.

After the free association task, all participants first completed the GTP scale, and then a word rating task which served as the study phase for the word-fragment completion task. During this task, participants were presented with a list of 20 words (e.g., *"Ambulance", "Lobster", "Telescope", "Violin", etc.)*, and they were asked to rate the level of pleasantness of each word on a 5-point Likert scale where 5 = *Very pleasant*, 4 = *Quite pleasant*, 3 = *Neutral*, 2 = *Quite unpleasant*, 1 = *Very unpleasant*. It is important to mention that in this online task, every word appeared for only 5 seconds on the screen, therefore, participants were instructed to respond as quickly as possible otherwise the screen would just move forward to the next word. Before beginning the actual task, all participants completed a practice trial to get familiar with the task.

In the delay phase, participants completed two versions of the AUT using the words *"car tyre"* and "*newspaper"* as prompts. In the AUT, participants were provided with the traditional AUT instructions. Additionally, individuals were explicitly instructed to avoid listing the typical uses of the given object with several examples of typical uses provided (e.g., with a newspaper *"read and get informed about the latest news"*). Also, to prompt participants to come up with more original ideas (e.g., making a wallet or a sculpture out of newspaper), they were instructed to also avoid listing well-known alternative uses of the named object, for example, using a newspaper as a flypaper or a gift wrap.

Verbatim instructions stated: *"This task measures your* ***ability to generate as many creative ideas as possible within a brief time period. You will be given a name of a common object and you will have to generate as many creative and unusual uses for that object as***

***you can think of while, at the same time**, **AVOIDING** standard or unoriginal uses of that object (e.g. if an object is 'a chair' and you generate 'sitting' or 'using it to reach for something on a shelf' will not be creative uses for that object). **You will have to complete this task twice for two different objects.** Each time, you will have only 2 minutes to complete the task, therefore please stay focussed. Once you click the NEXT button below the time will start running"* (parts of the text were provided in bold text to emphasise its importance).

Once participants read the instructions and clicked to begin the task, a new screen appeared providing the first common object word "*car tyre*" followed by 5 alternative but unoriginal uses for the mentioned item (e.g., *"Tie a rope to it and make a tire swing out of it", "Use it as a chair to sit on", "Use it as an exercise tool by lifting it up and down", "Get inside it and roll down a hill", "Plant flowers in it"*). Bellow these examples, a blank box was available for participants to type in their responses. Once the time was up, the screen was updated, and the next common object "*newspaper*" was presented together with 5 alternative but unoriginal uses for this item (e.g., *"To wrap something in it", "To clean something with it", "To make a paper mache", "To line or protect something", "To make clothes"*).

After AUT completion, participants completed four questionnaires about schizotypal traits and IGD, as well as mind-popping and day-dreaming frequency (see materials section in Chapter 2 for full description of each questionnaire). Altogether, the delay phase lasted approximately 25-30 minutes. Finally, after completing all questionnaires, participants were presented with the test phase for the implicit memory task. During this phase, they were instructed to complete a word puzzle task, in which they were presented with word fragments that they had to complete one by one, as best as they could, with the first correct solution that came to their mind. All participants were presented with 20 words that were seen and rated during the study phase, intermixed with 20 new words not seen before, for example, the fragment '_ N I _ _ R _ E' for 'universe'. Each fragment was presented for only 12 seconds. If participants completed the fragment before the end of trial, they could move forward to the next word, but if the time ran out, the screen automatically moved to the next fragment. The whole session took between 45 to 60 minutes to complete. Once participants completed all tasks and questionnaires, they were thanked and debriefed. As a thank you for their time and participation, all participants who completed the study received a ticket to take part in a raffle for a chance to win several £10 and £20 Amazon digital vouchers.

4.6 Results

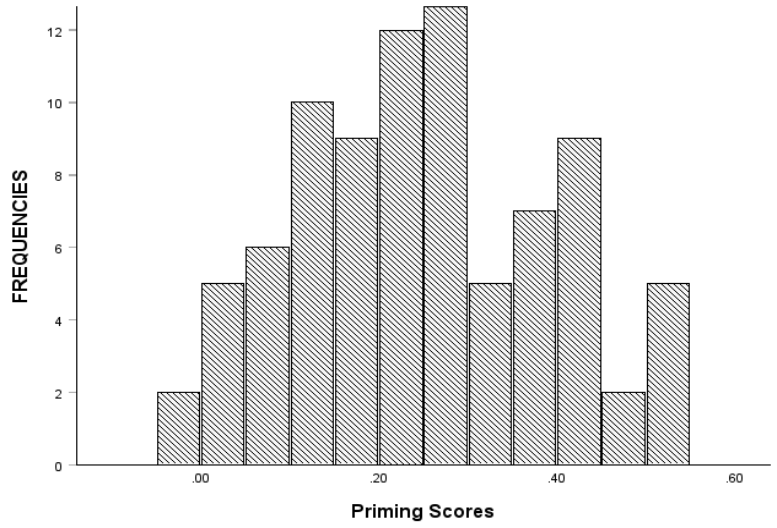
4.6.1 Priming Scores

The priming scores for each participant were calculated by subtracting the proportion of correctly completed word fragments for new words in the test phase from the proportion of correctly completed word fragments with the words encountered during the study phase. For example, if an individual was able to complete a total of 7 (.35) fragments for non-seen words and a total of 10 (.50) fragments for words encountered during the test phase, the total priming effect was 3 (.15).

A total of 78 participants (91.7%) showed positive priming effects in the word-fragment completion task (See figure 4-2 for distribution) (M = .225, SD = 142, minimum: -.05, maximum: .50, range .55. Only 5 participants showed no priming at all and only 2 showed a negative priming of -.05.

Figure 4-2

Frequency Distribution of Priming Scores



4.6.2 Scores on Alternate Uses Task (AUT)

A total of 776 alternate uses were listed by 85 participants for items '*car tyre*' and '*newspaper*': 362 for '*car tyre'* and 415 for '*newspaper'*. After coding the data applying the criteria of uniqueness and utility, there were a total of 158 unique and useful responses, 63 for car tyre (M = .74, SD = .92, range 0-4), and 95 for newspaper (M = 1.11, SD = 1.15, range 0-4). To calculate the AUT total score, the total numbers of unique and useful solutions for both

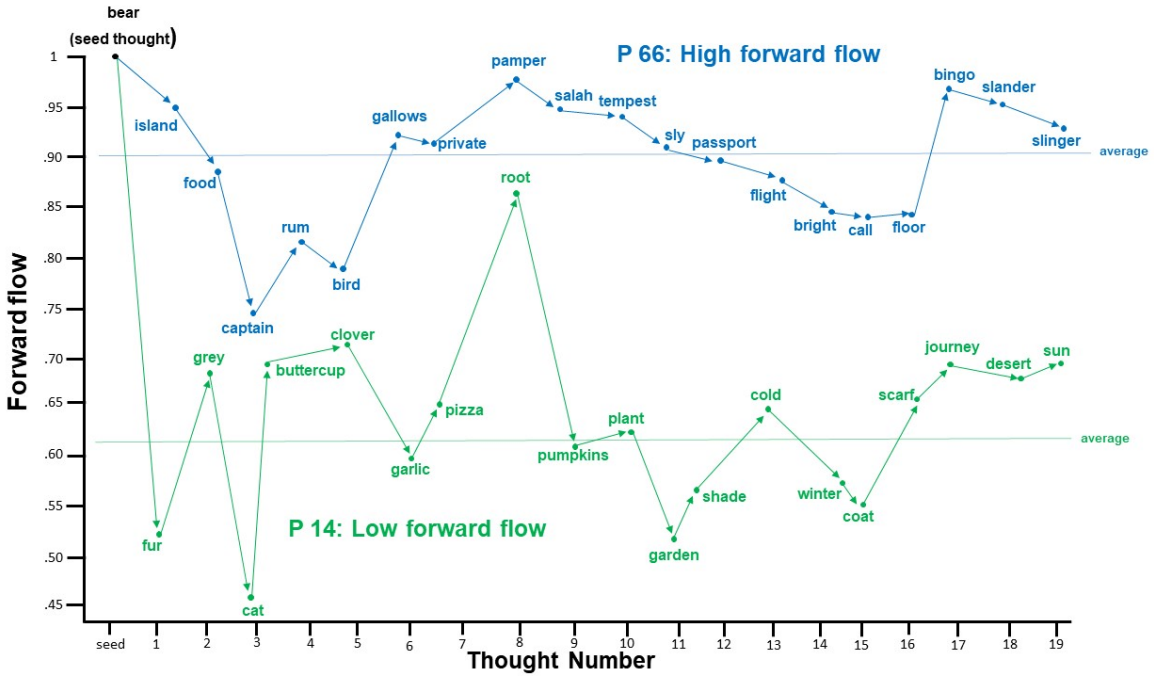
items were added up (M = 1.77, SD = 1.73, range 1-8). This AUT score was used in all further analyses reported below.

4.6.3. Forward Flow Index

Most participants obtained quite high forward flow indexes for both seeded words, '*Bear*' (M =.78, SD = .058, range .60-90), '*Table*' (M = .80, SD = .053, range .64-90). Figure 4-3 shows a contrast between thought plots of two participants with the highest (M =.90, SD = .071) and lowest (M = .63, SD= .12) indexes of forward flow in the sample.

Figure 4-3

Thought Plot Comparing Two Participants. Responses of Participant (P) 66 (Blue) Represent High Index of Forward Flow, while responses of Participant P 14 (Green) Represent Low Index of Forward Flow



4.6 Correlation results

All statistical analyses were performed with IBM SPSS statistics version 28. Bivariate Pearson correlation analyses were conducted to evaluate associations between the GTP frequency score and scores on all other variables of interest: hours played per week, and per session, years of playing, internet gaming addiction (IGD), mind-popping, daydreaming, positive schizotypy, negative schizotypy, disorganized schizotypy, and scores on the word

fragment completion (priming) task, AUT, and the forward flow task. There were significant positive correlations between GTP scores and hours played per week ($p< 0.05$), hours played per session, IGD, mind-popping, daydreaming, positive schizotypy, disorganized schizotypy, and AUT ($p < 0.01$). The variables years of playing, negative schizotypy, priming (PT) and forward flow (FF) showed no significant correlations with GTP scores. In addition, several significant associations emerged between spontaneous cognitive phenomena and schizotypy and AUT. In particular, there was a significant positive correlation between mind-popping scores and daydreaming frequency. Mind-popping scores also correlated positively with disorganised and positive schizotypy and creativity as measured by AUT, while daydreaming scores correlated positively with disorganized and positive schizotypy, but not with creativity scores (measured by AUT and the forward flow index) (see Table 4-3 for correlation coefficients).

4.6.5 Regression analysis

Before conducting the analyses, the assumptions of regression analysis were tested, and no violations were found. Overall, multicollinearity was low. To examine direct associations of GTP frequency with gaming-related variables, psychopathology, and cognitive variables, a multiple (4-block) hierarchical regression analysis was conducted with the GTP total score as the dependent variable. Gaming variables such as hours per week, hours per session, and IGD were entered in Block 1. Mind-popping and daydreaming scores were entered in Block 2. Disorganized and positive schizotypal traits were added in Block 3. Finally, the total score from the AUT as a measure of creativity was entered in Block 4.

In Block 1 of the hierarchical multiple regression, gaming hours per week, per session and IGD accounted for a significant 35.4% of the variance in GTP ($p<.001$). Hours per session and IGD were the significant predictors in Block 1. When mind-popping and daydreaming frequency scores were entered in Block 2, the variables accounted for an additional and significant 7.2% of variance in the total GTP frequency, $R^2= .454$, $\Delta R^2=.100$, $p <.001$. Hours played per session, IGD, and daydreaming frequency were the only significant predictors in this block. When the scores of disorganized and positive schizotypal traits were added as predictors in Block 3, they accounted for an additional and significant 9.28% of the variance in GTP frequency, $R^2= .560$, $\Delta R^2=.106$ $p <.001$. Hours per session, IGD, daydreaming, and positive schizotypy scores were the significant predictors in this block. In Block 4, when creativity was added as predictor, this accounted for an additional 2.1% of the

variance, $R^2 = .582$, $\Delta R^2 = .022$ p <.049. In this final block, only hours per session, IGD, daydreaming, positive schizotypy, and AUT were the significant predictors GTP.

The full hierarchical regression model explained a total of 58.2% in the variance of GTP frequency, $R^2 = .582$, $\Delta R^2 = .022$ p <.049. This 4-block hierarchical model revealed that the strongest predictors of GTP were again IGD, daydreaming frequency, and positive schizotypy as was found in Study 1, and in addition, new significant predictors that emerged in the present study were hours played per session and the AUT scores. The results of each step in the regression analysis and individual beta coefficients with associated significance are provided in Table 4-4

Further analyses were conducted to determinate if any specific dimension of GTP *(Altered Perceptions, Automatic Mental Processes or Behaviours and Actions)* was contributing to the pattern of results obtained in the analysis, several additional linear regression analyses were conducted using each dimension as an outcome variable. All comparisons showed significant differences at p <.001. Therefore, it was decided to use the whole score of GTP as the only outcome variable in the mediation analyses.

Table 4-3

Correlation Coefficients between GTP Frequency Scores and Other Variables

		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	GTP	1												
2.	HPW	.217*	1											
3.	HPS	.358**	.624**	1										
4.	YOP	-.051	.065	-.014	1									
5.	IGD	.552*	.305**	.295**	-.116	1								
6.	MP	.364*	.020	.055	.262*	.309*	1							
7.	DD	.499**	.125	.163	.182	.397**	.391**	1						
8.	DS	.350**	.104	.247*	.009	.437**	.381*	.502**	1					
9.	PS	.607**	-.011	.161	-.212	.377**	.392**	.428**	.383**	1				
10.	NS	0.11	.013	.226*	-.066	.148	-.001	.010	.192	.108	1			
11.	PT	.002	-.044	-.078	.000	.087	.027	-.074	-.012	-.048	-.011	1		
12.	AUT	.297**	-.121	-.036	.193	-020	.416**	.171	.090	.324**	-.043	.114	1	
13.	FF	.095	.133	.091	.136	.146	.026	.124	.168	.147	.015	.041	-.029	1

Note: Pearson correlation was conducted to measure the relation between outcome variable game transfer phenomena (GTP) and predictor variables: hours played per week (HPW), hours played per session (HPS), years of playing (YOP), internet gaming disorder (IGD), mind popping frequency (MP), day dreaming (DD), disorganised schizotypy (DS), positive schizotypy (PS), negative schizotypy (NS), priming totals (PT), alternate uses task (AUT), forward flow (FF) * = p< 0.05, ** = p< 0.

Table 4-4

Hierarchical Multiple Linear Regression for Variables Predicting the Outcome Variable of GTP Frequency (Four Blocks)

		Unstandardized coefficients		*Standardized coefficients*							
Block	*Predictors*	β	SE	β	*p-value*	R^2	*Adjusted* R^2	ΔR^2	*F*	*p-value*	*VIF*
1	Hours per week	-.110	.116	-.110	.343	.354	.330	.354	14.80	.001***	1.681
	Hours per session	2.128	.882	.278	.018*						1.670
	Internet gaming disorder	.887	.167	.504	.001***						1.125
2	Hours per week	-.088	.108	-.088	.420	.454	.419	.100	7.22	.001**	1.690
	Hours per session	1.960	.823	.256	.020*						1.677
	Internet gaming disorder	.620	.170	.352	.001**						1.358
	Mind-popping	.632	.433	.135	.147						1.230
	Daydreaming	.337	.117	.276	.005*						1.317
3	Hours per week	-.013	.101	-.013	.897	.560	.520	.106	9.28	.001***	1.825
	Hours per session	1.577	.771	.206	.044*						1.849
	Internet gaming disorder	.512	1.63	.291	.002**						1.455
	Mind-popping	.325	.411	.069	.431						1.302
	Daydreaming	.261	.115	.213	.027*						1.416
	Disorganised schizotypy	-.379	.332	-.109	.258						1.453
	Positive schizotypy	1.715	.405	.387	.001***						1.109

4	Hours per week	.000	.099	.000	.998	.582	.538	.022	4.00	.049*	1.833
	Hours per session	1.547	.757	.202	.044*						1.850
	Internet gaming disorder	.572	.163	.325	.001***						1.516
	Mind-popping	.004	.434	.001	.993						1.496
	Daydreaming	.253	1.13	.207	.028*						1.416
	Disorganised schizotypy	-.325	.327	-.093	.324						1.540
	Positive schizotypy	1.517	.409	.342	.001***						1.111
	Alternate Uses Task	1.247	.623	.172	.049*						1.343

*Note. N= 85; $\Delta R^2 = R^2$ Change, * = p< .05, ** = p<.01, *** = p<.001*

4.6.6 Mediation Analysis, IGD-GTP mediated by AUT, PST (Model 6)

Mediation analyses were conducted using model 6 of the PROCESS package, version 4.1 (Hayes, 2013). Before conducting the mediation analyses, the total effect of IGD on GTP without the presence of mediators was significant (c = 4579, p<. 001). The subsequent mediation analyses were conducted using GTP as an outcome variable and IGD as a predictor variable with the presence of creativity and positive schizotypal trait as mediators (see Figure 4-4). This model indicated that the effect of IGD on GTP remains and is partially mediated by AUT and positive schizotypy scores (c' = 3218, p<. 001), indicating that the effect of IGD in predicting GTP is influenced by AUT and positive schyzotypy as mediators. However, the indirect effects comparisons revealed that only positive schizotypy was a significant moderator (see Table 4-5). The indirect effects were assessed using 95% bias-corrected confidence interval based on 5,000 bootstrap samples and showed that the total of standardized indirect effects (.1214) were entirely above zero when holding the other mediator constant, however, only the path a2*b2 was positive (see Table 6 for all coefficients of the model 6 mediation analysis).

Figure 4-4

Results of Mediation Analysis with 2 Mediators (model 6). Internet Gaming Disorder (IGD) as a Predictor of Game Transfer Phenomena (GTP) and Alternate uses task (AUT), and Positive Schizotypy (PS) as mediators

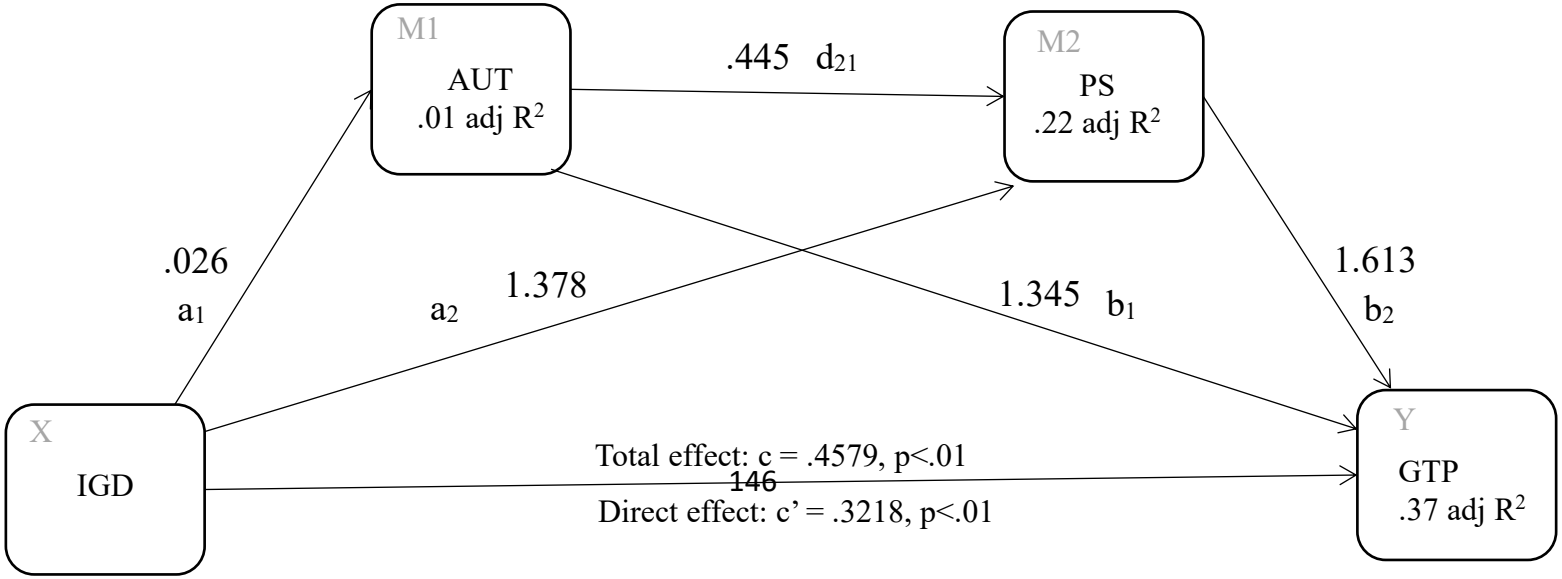


Table 4-5

Mediation analysis results for internet gaming addiction (IGD) to predict GTP mediated by alternate uses creativity and positive schizotypal trait

Path	Variable	Coefficient	SE	t	p	Adj. R^2	95% CI low	95% CI high
	Outcome: AUT	.0118				.0001		
a_1	IGD>AUT	.0261	.2219	.1176	.9066		-.4141	.4663
	Outcome: PS	.4770				.2275		
a_2	IGD>PS	1.3787	.3176	4.3417	<.001		.7486	2.0088
d_{21}	AUT>PS	.4522	.1431	3.1596	.0021		.1682	.7361
	Outcome: GTP	.6149				.3781		
b_1	AUT>GTP	1.3456	.6306	2.1337	.0354		.0941	2.5971
b_2	PS>GTP	1.6133	.4221	3.8219	.002		.0596	.1078
c’	Direct effect	.3218	1.4552	3.7025	.004		2.5000	8.2755
c	Total effect	.4579	1.4882	5.1513	<.001		4.7136	10.6188
Path	Indirect effects	Coefficients	SE	95% CI low	95% CI high			
$a_1 * b_1$	IGD>AUT>GTP	.0021	.0189	-.0360	.0444			
$a_2 * b_2$	IGD>PS>GTP	.1329	.0429	.0572	.2251			
$a_1 * d_{21} * b_2$	IGD>AUT>PS>GTP	.0071	.0037	-.0173	.0257			

Note. CI= confidence interval; IGD = Internet gaming disorder; PS = Positive schizotypy; GTP = Game transfer phenomena; AUT= Alternate uses task; se = standard error; Adj. R^2 = adjusted R-square (standardized)

4.7 Discussion

The present study explored, for the first time, a potential relationship between individual differences in priming, creativity and GTP scores, while at the same time attempting to replicate the findings obtained in Study 1 and 2 on most important predictors of GTP in hierarchical multiple regression analyses such as IGD, mind-popping and daydreaming frequency scores and positive schizotypal traits. Several important findings emerged. First, although the majority of participants showed positive priming in the implicit memory test, the predicted association between participants' priming scores and GTP frequency were not found. Second, out of two measures assessing participants' creativity (AUT and forward flow index), only AUT scores were significantly correlated with GTP scale scores, and AUT explained a significant amount of variance when added into the final Block 4 of the hierarchical multiple regression model after the effects of all other predictor variables were controlled for. In addition, the AUT scores partially mediated the effect of IGD on GTP along with positive schizotypy, further supporting the existence of possible links between creativity and GTP. Third, and in line with the results of Study 1 and 2 of this thesis, IGD, and positive schizotypy were the strongest predictors of GTP in a 4-block multiple hierarchical regression model. It is also interesting that hours played per session also came out as a significant predictor in this analysis (contrary to the results of Studies 1 and 2).

4.7.1 Association between priming scores and GTP frequency

Although majority of the participants (91%) showed a positive priming effect in the word-fragment completion task, there were no associations between the priming scores and self-reported GTP frequency on the GTP scale, which does not provide support for the idea that individual differences in priming scores may be associated with the frequency of GTP. This was an unexpected finding especially in the light of results from previous diary studies of mind-popping and autobiographical memories (Kvavilashvili & Mandler, 2004; Mace, 2005) suggesting the involvement of long-term priming mechanism in the occurrence of these involuntary memory phenomena in everyday life. These findings were also supported by the results of Study 2 of this thesis, which used a diary method and found that majority of participants (73%) reported the last encounter with the game associated to the GTP occurred within 24 hours (57%) or up to one week ago (16%). These findings provided the first indirect support for the idea that GTP experiences can be primed by recent exposure to certain stimuli or the video game itself. More recent laboratory studies of involuntary

autobiographical memories by Mace and colleagues have also provided ample evidence for the potential involvement of long-term priming mechanism in the experience of autobiographical memories under strictly controlled laboratory conditions providing further evidence for long-term priming hypothesis (Mace & Petersen, 2020; Mace & Hidalgo, 2022).

Nonetheless, it is important to mention that priming and GTP were measured separately from each other using the GTPS and an unrelated word-fragment completion task adopting a correlational and individual differences approach rather than manipulating the presence or absence of long-term primes as in the studies by Mace and colleagues. Future studies should focus on developing an experimental design, similar to the study by Coane and Balota (2009), that can measure GTP and priming in a more direct manner, for example, using the vigilance task with video game cue words associated with the video games currently played by the gamers. Another experimental approach that might facilitate a more direct exploration of GTP and priming could be using a lexical decision task that includes video game cue words encountered previously during a video game play. This approach was adopted in Study 4 that will be described in Chapter 5.

4.7.2 Creativity and GTP

Alternate uses task as a measure of creativity showed a significant positive correlation with frequency of GTP, as well as it turned out to be a good predictor in a multiple hierarchical regression model. Fantasizers tend to have higher scores on creativity and imagination (Lynn & Rhue, 1986). Previous studies on GTP have found a correlation between fantasy proneness and dream recalls (Ortiz de Gortari & Gackenbach, 2022 Ortiz de Gortari, Oldfield and Griffiths, 2016).

In addition, the results from a mediation analysis showed that while AUT was a mediator along with positive schizotypy and accounted for the total effect of IGD predicting GTPs, it did not interact directly with IGD and positive schizotypy in the tendency to experience GTP. This finding suggests an indirect relationship between GTP and creativity playing a role as a facilitator for the occurrence of this spontaneous phenomenon.

In line with Study 1, the strong link of IGD and positive schizotypal traits in predicting GTP was further supported in the mediation analyses confirming the associations between dysfunctional traits and GTP.

Overall, creativity itself, although predicted GTP when tested individually, and in the whole model including positive schizotypy as moderator, it might not seem to be directly

linked to GTP experiences as a mediator when other variables are predicting this nonvolitional phenomena. Nonetheless, these results suggest that participants with higher frequencies of GTP, also have more creative responses in the AUT task as measure of creativity. It is important to understand that the design implemented in this study cannot provide experimental evidence for a causal effect of creativity on GTP. It is necessary to conduct more systematic and empirical research on these variables to replicate and extend current findings.

Additionally, there was a positive correlation between the AUT scores and mind-popping frequency which supports previous findings on involuntary semantic memories and measures of creativity (Zhang et al., 2015). Moreover, as discussed in the introduction, the relationship between mind-wandering and creativity is contradictory. Results from this study did not find a significant association between AUT and measures of daydreaming which might have occurred due to individual differences, measurement challenges, contextual factors, and task dependency (Vannucci & Agnoli, 2019).

In addition to this, AUT also correlated with positive schizotypal traits. It has been suggested that creativity and schizotypy are manifestations of hyperactivation of unusual or remote semantic knowledge (e.g., concepts and words) (Son et al., 2015). The role of creativity and schizotypal traits have been investigated in several studies (for a review, see (Acar et al., 2018). However, results have been inconclusive possibly because different measures of creativity and scales of measuring symptoms of schizophrenia have been used in different studies. The inconsistency in results has been linked to the complex and multifaceted nature of creativity and challenges in distinguishing between schizotypal traits and adaptive creativity, understood as the ability to generate novel and valuable ideas that effectively address specific challenges or goals in the given context (Son et al., 2015).

Surprisingly, the forward flow index, calculated for the free association task, was not correlated at all with creativity, mind-wandering or any of the variables used in this study. This finding was unexpected since this index has been shown to be a good predictor of creativity, divergent thinking, and fluid intelligence (Gray et al., 2019; Beaty et al., 2021). The lack of association might have occurred due to several cofounding variables, for example, contamination from other measures before completing this task. Indeed, participants completed demographic and video game experience questionnaires before completing the free association task. Also, all the tasks in this study were administered online due to COVID-19. Although a lot of studies have shown significant validity and reliability when collecting online data on psychological scales and questionnaires (for a review, see (Walter et

al., 2019), free association tasks are usually administered under controlled laboratory conditions. Therefore, we did not have control over the environment participants were in that might have distracted or contaminated the nature of their responses. Future studies should take this into consideration and control these potential issues that might have impacted the results using this measure.

4.7.3 GTP predictors

All the variables that significantly correlated with GTP were entered into a four-block hierarchical regression model to explore potential predictors of GTP. Results showed that hours played per session, IGD, daydreaming, positive schizotypy and AUT were all significant predictors of GTP. Similar to results of Study 1 and 2, IGD and positive schizotypy were the strongest predictors of GTP confirming the importance of dysfunctional gaming habits and positive schizotypal traits in the frequency of self-reported GTP. Moreover, hours played per session was consistently a good predictor of GTP. Even though this variable was not significant in Study 1 and 2, gaming hours per session have been reported as a significant factor in previous studies (Ortiz de Gortari & Griffiths, 2015; Ortiz de Gortari & Panagiotidi, 2023). This finding suggests that the number of hours played per session along with dysfunctional gaming habits predict the frequency of GTP. Furthermore, daydreaming once more confirmed the importance of mind-wandering in the tendency to experience GTP, and this finding adds more support to our main hypothesis that GTP can be considered as part of spontaneous cognitive phenomena. Another important pattern of results came up from strong correlations between mind-pops and mind-wandering as measures of spontaneous cognitive phenomena with positive schizotypy. For instance, the association between mind-pops and positive schizotypy replicates previous findings reported by Elua and collaborators (Elua et al., 2012, 2015) and results reported in Chapters 2, and 3. Taken together, these consistent patterns demonstrate the interplay between spontaneous cognitive processes, creativity, and positive schizotypy.

4.7.4 Conclusions

The present study advances our understanding of the complex interplay between priming, creativity and GTP as well as other important variables such as IGD, positive schizotypy and mind-wandering. Although most gamers with different frequencies of GTP had positive priming effects, the results were inconclusive in terms of our hypothesis that

individual differences in priming scores would be positively related to GTP frequency scores. This non-significant finding emphasises the need for further exploration of these variables, particularly with refined and more systematic experimental designs in the laboratory to elucidate the nature of possible relationship between them. Additionally, this study for the first time, reported the association between GTP and creativity using the AUT, but it will be necessary to replicate this finding under more controlled conditions. Finally, replicating the findings on key predictors of GTP, reported in Studies 1 and 2, emphasises the importance of dysfunctional gaming habits, positive schizotypal traits, and spontaneous cognitions in the occurrence of GTP and sheds further light on possible mechanisms of GTP.

Chapter 5: Semantic priming, induced by a video game playing, and its relation with the frequency of Game Transfer Phenomena (Study 4)

5. *Introduction*

Study 3, reported in Chapter 4, investigated the role of priming using a word-fragment completion task, and two measures of creativity including AUT and forward flow as predictors of GTP. However, only AUT turned out to be a significant predictor of GTP. Although most participants showed a positive priming effect after completing an online word-fragment completion task, there were no associations with GTP in a correlational analysis. In contrast, the results from Study 2 using the diary method, showed that majority of participants reported a recent encounter with the video game associated to their experience suggesting the possibility that exposure to games could have activated game-related representations that acted as primes for subsequently experienced GTP. Moreover, two previous diary studies also reported the presence of priming in involuntary cognitive phenomena (Mace, 2005; Kvavilashvili & Mandler, 2004). There are, however, limitations to this method that some researchers have highlighted, for instance, there is a lack of experimental control in diary studies, and researchers cannot systematically manipulate variables that they are interested in (Vanucci et al., 2014).

On the other hand, priming effects in the generation of involuntary phenomena have also been demonstrated under laboratory conditions (Barzykowski et al., 2018; Mace et al., 2019; Mace & Unlu, 2020; Mace & Kruchten, 2023; Mace, Ostermeier, & Zhu, 2023). It is therefore important to further explore the priming hypothesis and its relationship with GTP by conducting experimental studies under more controlled laboratory conditions. To achieve this aim, a lexical decision task (LDT) was used with a list of cue words obtained from a video game that participants previously played for 30 mins. Before explaining the details of this experiment, I will first provide a brief overview of priming effects studied within separate literatures on video games and semantic priming effects using the lexical Decision Task (LDT).

5.1 Priming effects in research on video games

Research investigating the association between video games and priming effects began in the mid-90s. Most of these studies explored the relationship between exposure to violent games and subsequent aggressive behaviour (for a review, see Anderson et al., 2010; Anderson, 2004; Anderson & Morrow, 1995; Scott, 1995). Anderson and Murphy (2003) proposed a General Aggression Model (GAM), which proposed that the exposure to violent video games could lead to aggressive thoughts, feelings, and behaviours. It introduced the

concept of priming as part of the process through which media content influenced the activation of certain thoughts and behaviours. Similarly, gaming-related priming effects have been investigated in the context of general learning model (GLM), which assumes that when players are exposed to a concept from a game, it becomes temporarily activated or primed, and such activation can be observed for various aspects of gaming, including gameplay elements, narrative elements, character design, and environmental cues (Sternberg & Preiss, 2005). For example, a game level featuring abundant vegetation and a serene atmosphere may prime players to experience a calmer emotional state, while a level with intense action and suspenseful music may prime players for heightened vigilance and arousal (Sternberg & Preiss, 2005). Within the GLM, it is assumed that priming requires constant exposure to specific in-game concepts over longer periods of time to reinforce its effects on players' behaviours (Buckley & Anderson, 2006).

Several studies have expanded the focus beyond aggression to include other psychological and behavioral aspects. For instance, priming effects have been also reported with commercial video games featuring sexual content (Greitemeyer & Osswald, 2011; Yao et al., 2010), as well as in games with prosocial themes and cooperative gameplay mechanics that prime players (semantic priming) for increased empathy and altruistic behaviours. For example, in a study by Greitemeyer and Osswald (2011), participants were randomly assigned to either play for 10 minutes either "Tetris" or prosocial game "Lemmings". While in Tetris players organise geometrical shapes to match and make horizontal lines, in Lemmings they have to guide a group of small creatures (the Lemmings) through various obstacles and challenges to reach a designated endpoint. After the gameplay session, participants completed a lexical decision task that consisted of non-words, neutral words (e.g., *"run"*) and prosocial words (e.g., *"help"*). Results showed that participants exposed to the prosocial game responded significantly faster to prosocial words in comparison to non-words and neutral words, while participants exposed to Tetris (i.e., the neutral game) were faster in responding to neutral than prosocial words and non-words. Similar findings were also reported by Li and Zhang (2023) on a sample of children who responded faster to prosocial images in a picture decision task that were previously primed in a prosocial video game. Another study reported that a participant who played a relaxing game in comparison to neutral or violent showed less aggressive, more positive mood, and more proactive and helpful behaviours (Whitaker & Bushman, 2012). Similarly, other studies have shown that in-game advertising and microtransactions can also prime players to make specific purchasing choices and influence their attitudes toward brands (Chou & Singhal, 2017).

Recently, however, several authors have criticised the methods used in previous studies investigating priming effects on aggression after the game-play by suggesting that there were several cofounding variables that were not controlled for such as the difficulty and length of exposure to the game, competitiveness of players, and complexity of the controls that might have led to false positives and lack of external validity (Ferguson & Rueda, 2010; Valadez & Ferguson, 2012). Indeed, in most of these experiments, only selected video games were used to prime participants, which were fast-paced and quite difficult to play. The comparisons of these action games with other non-action games that are considered easier and slow-paced in terms of game mechanics may not be adequate. It is, therefore, not clear if the priming effects obtained in a subsequent laboratory task occurred due to the video game content itself or due to these non-controlled variables (Valadez & Ferguson, 2012). For example, it is possible that participants showed more aggression not because of the game content, but because they got angrier and frustrated due to the difficulty of the game (Adachi & Willoughby, 2011).

Taking into consideration and controlling these possible cofounding variables, Valadez and Ferguson (2012) investigated if violent video game exposure and time spent playing had any effects on hostile feelings, depression, and visuospatial cognition. They piloted and equated a violent ("Read dead redemption") and non-violent ("FIFA 10") video games in terms of their complexity, competitiveness, pace of action, and difficulty. In the main experiment, 100 participants were randomly assigned to play one of the three types of game: violent game, non-violent portion of the violent game, and non-violent game. Another independent variable was the time spent playing the video game (15 or 45 minutes), resulting in six experimental conditions: the violent game (Red Dead Redemption) played for 15 or 45 minutes, non-violent portion of the violent game (Red Dead Redemption) played for 15 or 45 minutes, and the non-violent game (FIFA 10) played for 15 or 45 minutes. Each participant also completed a visuospatial cognition task, a frustration task, and scales measuring hostility and depression before and after the gameplay session. Contrary to the initial hypotheses, results did not provide any evidence that exposure to violent games either increased or decreased aggressive affect, hostile feelings, depression, or visuospatial cognition. Overall, this study suggests that the causal link between violent video games and negative behaviours is nonexistent to weak when potential cofounding variables are controlled for (Valadez & Ferguson, 2012).

Additionally, it has been argued that most of the experimental conditions investigating the priming effects of video games have been conducted with different

commercial games, mainly selected due to their current popularity in the market at the time. Similarly to Valadez and Ferguson (2012), this lack of control might lead to false positives, resulting in the failure of many studies to effectively equate video game conditions. Although many of the games previously used across different studies belong to the same genre, they have different game mechanics, content design, in-game physics, and hence are quite different from each other (Barlett et al., 2007).

Similarly, several other studies that controlled for most of the mentioned confounding variables, and still did not find significant priming effects on aggressive thoughts (Charles et al., 2013; Tear & Nielsen, 2014) or prosocial behaviours (Kneer et al., 2018). More recently, (Zendle, Cairns, and Kudenko (2018) opted for an even more controlled design by using a laboratory-designed video game. These authors did not find positive priming effects using an image categorization task when differences between the gameplay conditions were equally controlled. In this study, the video game created in the laboratory comprised a maze-based video game, in the first condition, animals were featured, while vehicles were presented in the second condition of the same game. Results showed non positive priming effects, instead, a negative priming effect was found, which made the authors question if video games could elicit positive priming effects at all, suggesting that playing a video game can sometimes even inhibit reactions to in-game concepts (Zendle, Cairns, & Kudenko, 2018). Despite these findings, it is important to mention that priming has been argued to occur after repetitive, and constant exposure to target stimuli (Roediger, 1993; Ferguson & Rueda, 2010), and in the study by Zendle and collaborators (2018), participants played the maze game for only 200 seconds. Overall, understanding the mechanisms and implications of priming effects in video games have been challenging for researchers. The knowledge gained from this research can be leveraged to use games with specific characteristics or even design them in order to facilitate priming effects.

5.1.1 Lexical decision task for measuring semantic priming

The Lexical Decision Task (LDT) is a classic psycholinguistic paradigm used to explore how quickly and accurately individuals can distinguish between words and non-words. During this task, participants are presented with a series of letter strings, and their primary goal is to determine whether each string forms a real word or a non-word by pressing a designated response key (Paap et al., 1982). The LDT also assesses the speed and efficiency of lexical access and processing, providing valuable insights into how the brain recognizes

and retrieves lexical information. Overall, the LDT is a well-established and widely used cognitive tool for probing the efficiency and accuracy of lexical access and retrieval.

The study of cognitive processes underlying word recognition and language comprehension has been a central focus in cognitive psychology research. An essential goal of this investigation involves understanding priming effects, which occur when the presentation of one stimulus (the prime) influences the processing of a subsequent, related stimulus (the target). The LDT has emerged as a prevailing experimental paradigm for studying priming effects and shedding light on the complexities of word processing. This task engages processes associated with lexical activation, spreading activation, and semantic processing, making it an ideal instrument for investigating the facilitation or inhibition of word recognition through priming (Ratcliff, 2020).

Primed lexical decision paradigms within the LDT commonly utilize semantic and phonological primes. Semantic priming involves presenting a prime word that shares a related semantic meaning with the subsequent target word, leading to facilitated recognition of the word due to the activation of a shared semantic network. For instance, if the prime *"dog"* is presented, the target *"cat"* is recognized more quickly compared to an unrelated target word due to associative priming. Similarly, phonological priming involves prime-target pairs with phonologically related sounds, such as *"pear"* as the prime and *"pair"* as the target, resulting in faster recognition (Ratcliff & McKoon, 2020). By leveraging the LDT to explore priming effects, researchers gain valuable insights into cognitive mechanisms underpinning word recognition and language comprehension. Studies utilizing the LDT have provided evidence of the automatic and unconscious nature of priming effects, illustrating the activation of mental representations even in the absence of explicit awareness (Foster & Davis, 1984). Additionally, the LDT allows researchers to investigate the impact of various lexical factors, such as word frequency, word length, and orthographic characteristics on the modulation of priming effects (Hutchison, 2003).

Recent research utilizing the LDT has increased our understanding of priming effects and their underlying mechanisms. For example, it has been instrumental in demonstrating the automaticity and robustness of priming, revealing that even brief exposures to the prime can significantly impact subsequent word recognition (Ratcliff, 2020). Moreover, investigations using physiological measures during the LDT have provided valuable insights into the neural processes associated with priming effects, highlighting the involvement of specific brain regions and networks in semantic and phonological priming (Dambacher et al., 2013).

The flexibility and versatility of the LDT have allowed researchers to explore various dimensions of priming effects, for example, the influence of individual differences, such as age and cognitive abilities, on priming effects during the LDT (Wu et al., 2021). Additionally, the LDT has been employed to investigate the impact of contextual cues and linguistic factors on priming, including word frequency and orthographic characteristics (Yap et al., 2021).

5.2 The present study

Using empirical approach and face-to-face testing, this study aimed to investigate the association between the magnitude of semantic priming effects and the frequency of GTP in video game players. Furthermore, this study also investigated the prevalence of priming effects over a delay of 24 hours. Finally, the study aimed to further replicate findings on important predictors of GTP reported in Studies 1, 2, and 3 such as mind-pops, mind-wandering (daydreaming), IGD, and positive schizotypy.

To address these aims, participants, whose GTP frequency was assessed by the 20-item GTP scale, were asked to play a racing video game for 30 minutes. This was followed by completing the LDT that contained words and concepts encountered previously in the video game, control words and non-words. To explore long-term priming effects, all participants completed a second version of the LDT approximately 24 hours after playing the video game. Participants completed also the same validated scales and questionnaires, used in Studies 1, 2, and 3, to further examine the replicability of the findings concerning the significant predictors of GTP.

It was hypothesized that frequency of GTP would be predicted by participants' semantic priming scores, as reflected in shorter reaction times to game-related targets words in the LDT in comparison to non-target words. Also, it was anticipated that the semantic priming effects as well as its association with GTP frequency would remain over a delay of 24 hours. Finally, it was expected that the patterns of associations reported in previous studies between GTP frequency scores and the most important variables (e.g., IGD, mind-popping, daydreaming, positive schizotypy) would be replicated in the present study.

5.3 Method

5.3.1 Participants

A total of 42 participants were recruited for this study. In order to take part, all participants met the same inclusion criteria which consisted of being a constant gamer (playing video games for at least 4 hours per week), without having a current mental illness diagnosed, and English as the first language. After data cleaning, two participants were removed from the final data analyses due to inconsistencies following the instructions in the LDT. The final sample consisted of 40 participants with a mean age of 23.47 years (*SD* = 4.23) (see Table 5-1 for demographic information).

The information about participants gaming habits is presented in Table 5-2, which shows that most gamers reported spending a substantial amount of time playing per week and identified themselves as hard-core and mid-core gamers.

Participants were recruited from several sources including the university website, social gaming groups, flyers distributed on campus, and in the local area. All interested participants who met the inclusion criteria and agreed to take part were invited to complete two sessions in the researcher's office at the University of Hertfordshire with an approximate duration of 80 to 100 minutes in total (50-60 minutes for the first session, and 30-40 minutes for the second).

5.4 Materials

5.4.1 Arcade racing video game: Forza Horizon 5 (Priming study phase)

The decision to choose an arcade racing game as the main stimulus for the priming phase was due to its neutrality as a video game genre in terms of content and difficulty. This type of video game usually does not have controversial (violent, sexual, rude) content and the difficulty does not represent a challenge. Additionally, most of the video game players, regardless of their proficiency and years of experience at gaming, have usually played racing games even if this genre of video games is not their favourite. Although there are more popular genres of video games such as First Person Shooters (FPS) and Massive Multiplayer Online Role Play (MMORPGs), they usually involve more complex game-controls and could have controversial content that might cause frustration and distress in some participants who do not play such video games.

Table 5-1

Demographic Information of Participants Included in the Study

Variables	Total sample (n = 40)
Demographics	
-Age (years), mean (SD)	23.47 (4.23)
Gender, n (%)	
- Male	29 (72.5)
-Female	10 (2.5)
-Non-binary/third gender	1 (2.9)
Years of formal education, mean (SD)	16.62 (3.02)
Occupation, n (%)	
-Student	32 (80)
-Employed	8 (20)
Drug use n, (%)	
-Never	32 (80)
-Once or twice	1 (2.5)
-3 to 5 times	3 (7.5)
-6 to 10 times	3 (7.5)
-Daily	1 (2.5)

Table 5-2

Gaming Habits of Participants Included in the Sample

Variable	Total sample (n=40)	Min, Max
Video Game Experience		
-Years of playing, mean (SD)	15.20 (4.82)	4, 24
-Gaming hours per week, mean (SD)	16.80 (8.33)	4, 40
-Gaming sessions in hours, mean (SD)	3.35 (1.45)	1, 9
Playing days per week, n (%)		
-1-2 days	25 (62.5%)	
-3-5 days	4 (10%)	
-6-7 days	11 (27.5%)	
Type of video game player* = n (%)		
-Casual	5 (12.5%)	
-Mid-core gamer	24 (60%)	
-Hardcore gamer	11 (27.5%)	

*Note: Casual/leisure gamer (e.g., *I enjoy playing games, but my time/ interest is somewhat limited*); Mid-core gamer (e.g., *I play different kinds of games enthusiastically, but I do not play as long or as hard as a hardcore gamer*); Hardcore gamer (e.g., *I spend a huge amount of time playing games. I like to search the last news and updates in gaming. I have a good console/Pc made especially for gaming*).

Furthermore, results in Study 2, using the diary method, showed that most of the GTP experiences reported during a 7-day period were related to immersive games (e.g., realistic high-definition graphics and gameplay mechanics). Forza Horizon 5 is the newest version from the Forza Horizon series, released in November 2021, developed by Playground games TM, and published by Microsoft studios. The Forza Horizon franchise is one of the most successful and popular in the video games industry, and the game was developed with motion capture technology which allows recording of real-life environments and movements of real cars digitally in 4k graphics (see Figure 5-1 for a representative image of the video game).

Figure 5-1

Representative gameplay screenshot from Forza Horizon 5, 2021.

5.4.2 Lexical decision task

This task was used to measure the semantic priming of concepts previously activated (primed) during the video game session. To measure priming effects over time, two versions of the same task were developed using the software Gorilla TM (list A and B). Each version of the LTD had a total of 108 trials, which were divided as follows: 8 practice trials, 40 non-targets, 20 target words and 40 non-words. Non-target words were words that did not appear in the video game session, such as *"brandy, duchess, orchestra"* (see Appendix XVI for a full list). These words were selected from a standardized pool of clusters of words that were rated for concreteness, familiarity, imagery, meaning, and pleasantness (Toglia & Battig, 1978). For this study, only concreteness and familiarity ratings above 4 were considered for the final list. Both lists of words were also selected and balanced in terms of the length and number of syllables in each word (see Appendix XVI for the full scores). Table 5-3 shows the mean characteristics of each word list used in the LTD.

Table 5-3

Means (Standard Deviations) for Ratings of Concreteness and Familiarity, and Number of Letters and Syllables for words in List A and B of the Lexical Decision Task

	List A		List B		Total	
	M	SD	M	SD	M	SD
Concreteness	5.55	0.62	5.39	0.69	5.47	0.65
Familiarity	5.79	0.44	5.84	0.47	5.82	0.45
Length	7.17	1.29	7.02	1.29	7.1	1.28
Syllables	2.3	0.51	2.3	0.56	2.3	0.53

Twenty target words referred to words and concepts encountered in the game that participants played at the start of the session (e.g., *"checkpoint, highway, traffic"*) (see Appendix XVII for full list). Each target word included in the LDT was selected from the video game "Forza Horizon 5" due to their frequent appearance during the first 30 minutes of gameplay. In addition, each participant was explicitly instructed to read all the text that appeared on the screen during the gaming session and encouraged to put attention to all details and surroundings on the screen. Finally, 40 non-words, used in the task, were created by interchanging the order of the syllables from proper words as well as adding extra letters to keep the essence of a real word (e.g., *"psyfon, jumple, crostic"*). All the target and non-targets words included in the task were balanced in terms of length and number of syllables.

5.5 Procedure

All interested participants were invited to attend a one-to-one laboratory session with the researcher at the University of Hertfordshire. In Session 1, the participant read the information sheet with all the details about the study and signed the consent form indicating their willingness to participate in the study. After completing the Game Transfer Phenomena Scale (GTPs), the participant was then asked to play an arcade racing game ("*Forza Horizon 5"*) on a 15-inch screen laptop using an Xbox controller for 30 minutes. None of the participants had played the game before except one participant who reported having played it around 12 months ago.

Before starting the game play, all participants were able to see on the screen all the gameplay controls and game mechanics. Besides, they were explicitly informed that their performance in the game would not be evaluated, they had to just follow the instructions on

the screen, try to relax, and enjoy the game. All participants started the game from the beginning. Therefore, they were exposed to the same stimuli during the gameplay session. Once the gaming session was over, a 10-minute break was granted, and then each participant was asked to complete the LDT, which lasted for 15 mins.

The LDT was introduced to participants as a comprehension task, which assessed the accuracy and speed with which participants could distinguish real words from non-words. They were told that on each trial, a string of letters would appear, and their task was to decide as quickly and accurately as possible whether the string was a meaningful English word or a non-word. Also, participants were informed that each trial would start with an empty screen with a cross (fixation cross) in the middle that would remain on the screen for a brief time period. To prevent participants from learning or anticipating the appearance of each trial, a stimulus onset asynchrony approach was used. In other words, the fixation cross remained on the screen for random time periods, for example, 250, 312, 375, 437, 500, 562, 625, 687, and 750 milliseconds (see (Smith, 2003). After this, the next string of letters appeared on the screen. Participants were instructed to press the "F" key if the string of letters on the screen corresponded to a non-word, and to press the "J" key if the string was a meaningful word. The following verbatim instructions were provided to each participant: *"The task that you will now have to complete is a simple language comprehension task, which assesses the accuracy and speed with which people can distinguish real words from non-words. On each trial, you will see a string of letters, and you will have to decide as quickly and accurate as possible whether it is a meaningful English word or a non-word. Each trial will start with an empty screen with a cross in the middle. It will stay there for a few milliseconds, and you will then see either a word, for example, "holiday" or a non-word, for example, "sonper". Press "F" if the stimulus is a NON-WORD, PRESS "J" if the stimulus is a WORD. To be able to press these keys as quickly as possible, please put your right and left middle or index finger on F and J keys, respectively. Remember that both, the accuracy, and the speed are equally important in this task. Do you have any questions? Before we start the main task, let's first complete some practice trials"*. The completion of Session 1 lasted approximately 50 to 60 minutes.

All participants who successfully completed the gaming session and the LDT in Session 1 were booked for Session 2, which took place approximately 24 hours after Session 1. The completion of Session 2 took approximately 30 to 40 minutes. At the beginning of Session 2, participants completed a second version of the LDT following the same instructions provided during Session 1. At the end of the session, they also completed several

questionnaires in the following order: (i) Internet gaming disorder short scale (IGDs); (ii) mind-popping questionnaire (MP-Q); (iii) Day-dreaming scale (DDFS), and (iv) multidimensional schizotypy scale (MSS) (see Chapter 2 for full descriptions). Finally, all participants were thanked and debriefed, and received a £10 voucher as a compensation for their time and effort.

5.6 Results

Semantic priming in the LDT is calculated by subtracting the mean reaction time (RT) for target words from the mean RT for non-target words. In the present study, semantic priming effects were calculated only for the means of correct response latencies, which were based on RT between 500 and 1500 msec. As a control measure to avoid extreme values and outliers, it was decided that all participants' individual RTs above or below 2.5 SDs of their own mean RT would be excluded from the analyses, which resulted in the exclusion of data from only 4.98% of trials.

5.6.1 Mean lexical decision latencies

Table 5-4 shows mean reaction times in milliseconds (msec) to target and non-target words in Sessions 1 and 2. A Wilcoxon-signed rank test was conducted because mean scores from target and non-target words did not assume normality. Results showed that in the first session, the mean reaction time was significantly longer for non-target words than target words (Z = -3.858, p <.001). Out of a total sample of 40 participants, 30 participants had shorter reaction times to target-words than non-target (control) words, and only 10 participants had higher reaction times to target than control words. This means that when participants were exposed to word stimuli during the game session, this influenced their responses in the LDT by speeding their reaction times to previously seen words. Similar patterns were found in the second session: the mean reaction time for non-target words was significantly longer than the mean reaction time for target-words (Z = -4.530, p <.001).

The semantic priming score was calculated by subtracting the mean reaction time for target words from the mean of the non-target words for each session. The magnitude of priming was 40.5 msec, and 60.18 msec for Sessions 1 and 2, respectively. Both values were significantly different from 0, which would indicate no priming. A paired sample t-test revealed a non-significant difference in priming scores obtained in Session 1 (M = 40.57, *SD*

= 69.70) and Session 2 (M = 60.17, SD = 107.79), $t(39) = -1.096$, $p = .280$. This means that semantic priming remained active across the two testing sessions over a 24 hour-delay period.

Table 5-4

Mean lexical decision times (in ms and mean semantic priming of the lexical decision task during sessions 1 and 2.

	Session 1		Session 2	
	M	SD	M	SD
Target words	676	104.35	660.40	169.87
Non-target words	716.60	203.73	720.58	179.92
Priming	40.50		60.18	

Note: M = mean, SD = standard deviation (priming effect is the difference between non-target words and target words).

5.6.3 Correlation analysis

Pearson bivariate correlations were conducted to examine the relationship between GTP and all the variables of interest (see Table 5-5 for correlations). The variables of internet gaming addiction (IGD), daydreaming (DD), and disorganised schizotypy (DS) had the strongest correlations with total GTP frequency (all $r_s > .50$, $p < 0.01$). Positive schizotypy (PS) was also significantly associated with GTP ($r = .39$, $p < 0.05$). There were no correlations between GTP scores and hours played per week (HPW), hours per session (HPS), years of playing (YOP), mind-popping (MP), negative schizotypy (NS), or priming scores in Session 1 (PS1), and priming scores in Session 2 (PS2).

Table 5-5

Correlation coefficients of GTP and associated variables

		1	2	3	4	5	6	7	8	9	10	11	12
1.	GTP	1											
2.	HPW	-.055	1										
3.	HPS	.190	.162	1									
4.	YOP	-186	-.068	-.079	1								
5.	IGD	544**	.156	.136	-.027	1							
6.	MP	.289	.029	-.020	-.306	.372*	1						
7.	DD	.547**	.149	.107	-.076	.604**	.362*	1					
8.	DS	.654**	.224	.335*	-.187	.613**	.152	.517**	1				
9.	PS	.394*	-.083	.082	-.365*	.494**	.336*	.350*	.381*	1			
10.	NS	.122	.160	.033	.066	.263	-.079	.106	.220	.067	1		
11.	PS1	-.129	-.074	-.077	-.010	-.026	-.004	.018	.091	-.113	-.089	1	
12.	PS2	-.080	-.045	-.105	-.138	-.050	.046	-.082	-.099	-.020	-.062	.244	1

Note: Pearson correlation was conducted to measure the relation between outcome variable game transfer phenomena (GTPs) and predictor variables: hours played per week (HPW), hours played per session (HPS), years of playing (YOP), internet gaming disorder (IGD), mind popping frequency (MP), day dreaming (DD), 168isorganized schizotypy (DS), positive schizotypy (PS), negative schizotypy (NS), priming session 1 (PS1), priming session 2 (PS2), * p< 0.05, ** p< 0.01

5.6.2 Priming scores as a predictor of GTP

To test the priming hypothesis, a linnear multiple regression analysis was conducted to examine priming effects obtained during session 1 and 2 as main predictors of the frequency of GTP as the only outcome variable. A post-hoc power analysis was performed using G-power (Faul et al., 2007) (G-power for Mac version 3.1.9.6) for F tests, linear multiple regression, fixed model, R^2 deviation from zero, with a medium effect size of 0.15, power of 0.95 and 2 predictors. Based on these values and the final sample of 40 participants, a statistical power of 0.547 was obtained. A multiple regression analysis was conducted to predict the frequency of GTP from priming scores obtained in Session 1 and Session 2. This resulted in a non-significant model, F (2, 37) = .594, p = .597, $R2$ = .031. The individual predictors were examined further and indicated that priming Session 1 (t = -9.46, p = .350) and priming Session 2 (t = -.295, p < .770) were non-significant predictors of the frequency of GTP.

5.7. Discussion

The present study investigated, for the first time, the effects of semantic priming under laboratory conditions as a function of time delay in video game players with different levels of self-reported GTP frequency. Several interesting findings were obtained. First, contrary to the main hypothesis, priming effects were not associated with participants' self-reported GTP levels. Second, and importantly, most participants (75%) showed positive priming effects with participants responding significantly faster to game-related target words in comparison to game-unrelated non-target words. In other words, recent exposure to the video game did influence participants´ semantic processing by activating game-related concepts in their semantic network, leading to facilitated recognition of previously seen game-related words in the LTD. Moreover, these effects remained active over two sessions in a timeframe of 24 hours, demonstrating the presence of long-term priming. Third, in line with findings from previous studies of this thesis, GTP scores were significantly and positively correlated with indices of IGD, daydreaming, and disorganized and positive schizotypy. Finally, informal feedback from participants indicated that the video game ("*Forza Horizon 5*") was appropriate for this experiment in terms of its levels of difficulty and enjoyment. Participants did not report any problems learning the controls (irrespective of their proficiency level), or discomfort or frustration throughout the session. However, future studies should assess the difficulty and enjoyment levels more directly via Likert style ratings scales.

5.8. Association between priming effects and GTP frequency

In line with the results of Study 3, which used an online word-fragment completion task to assess individual differences in priming, this study did not find any significant associations between priming scores and total frequency of GTP, when using the LDT to measure priming in laboratory conditions (see Table 5-5). This finding somewhat contradicts results obtained in diary Study 2 and previous diary studies of involuntary memories (Kvavilashvili & Mandler, 2004; Mace, 2005), which showed that the experiences of GTP and involuntary memories were often reported to be preceded by exposure to certain stimuli in one's environment or thoughts. They also contradict the findings of studies using cognitive tasks in the laboratory (Mace et al., 2019; Mace & Petersen, 2020; Mace & Hidalgo, 2022) that have consistently found priming effects in IAMs

However, this null result could be explained by several factors. For example, as discussed in Study 2, the GTP scale (Ortiz de Gortari et al., 2015) measures GTP frequency over a period of 12 months, which raises potential questions about the accuracy of participants' reports of GTP due to recall problems. This is supported by the results of Study 2 in which the correlation between diary recorded GTP frequency and scores on the GTPS, albeit statistically significant, was only medium in size (r = .38). It is therefore possible that different results would be obtained if participants completed the GTPS with a shorter time frame in mind (e.g., one month). It would be also interesting to use the new GTP-MDS scale (Ortiz de Gortari & Diseth, 2022), which was developed with the aim of obtaining a clearer classification of different types of GTP by distinguishing inner and outer based experiences, and scores on this new scale were significantly correlated with other involuntary phenomena without game content such as hallucinations and perceptual distortions (Ortiz de Gortari & Diseth, 2022). However, as with the original GTP scale, participants evaluate the frequency of their outer and inner GTPS experiences over a 12-month long period, which may involve a similar retrospective bias that needs to be assessed in future studies.

Another potential issue arising in relation to null results involves reliability of the priming task used in the present study. This has been a neglected topic in research on priming and implicit memory, but some previous studies have shown low reliability of several perceptual priming tasks when compared to explicit memory measures. This has been demonstrated by obtaining low test-retest, and parallel-test reliabilities, as well as low intercorrelations among different measurements of implicit memory (Meier & Perrig, 2000). These potential issues along with other unexplored variables such as the effect of context and associative learning will be discussed in more detail in the General discussion described in Chapter 6. In line with these findings, it has been suggested that priming may exhibit variability that would make it challenging to measure it as a consistent ability. Also, there remains the possibility that certain individuals may present very low or even no priming at all, that could be attributed to factors unrelated to the test itself (Meier & Perrig, 2000).

Overall, the lack of association between the magnitude of priming and different levels of GTP frequency could be influenced by the complexity and multifaceted nature of the processes involved in priming and GTP, suggesting that their relationship is not straightforward. As discussed, other possible reasons include the presence of confounding variables, methodological considerations, or the need for more nuanced analyses to uncover potential associations that might not be apparent at a surface level. Previous findings, obtained through diverse methodologies in the context of involuntary phenomena, highlight

the necessity for additional research and exploration controlling for a wider range of variables.

5.9 Priming effects on video game players

Although the main aim of the study was to investigate the association between priming scores and GTP frequency, it is important to highlight the presence of positive priming effects in the majority of gamers who took part in the study. It is interesting that the semantic priming effect was also observed in Session 2 which provides evidence supporting the long-term priming mechanism (at least over a 24-hour period assessed in the present study). If anything, the magnitude of priming effect was numerically higher in Session 2 than in Session 1 (although this difference between sessions was not statistically significant). This is in line with findings of some previous studies on semantic priming effects in visual word recognitions tasks (for a review see Neely, 2012), as well as the results of diary and laboratory studies of involuntary memories that have demonstrated the presence of priming effects over days, a week and even longer periods of time (e.g., Kvavilashvili & Mandler, 2004; Mace & Hidalgo, 2022). For example, the phenomenon of semantic-to-autobiographical memory priming suggests that when information about objects, individuals, or events is presented, this exposure activates related knowledge units (nodes), in one's semantic network and autobiographical knowledge base that may later result, in response to an appropriate trigger, in the experience of involuntary memory popping into one's mind (Kvavilashvili & Mandler, 2004). In line with this, the results of the present study clearly demonstrated that the exposure to verbal and pictorial stimuli within a racing game for 30 minutes in the laboratory, speeded up participants' responses to these words in the subsequent LDT, in comparison to control words, both after a short delay of few minutes and a delay of 24 hours.

Although these results provide significant evidence for priming effects in response to game-related stimuli in the context of game-play, it is important to note that current findings on priming effects in response to video game exposure are inconclusive. As discussed in the introduction of this chapter, some studies have reported positive priming effects on aggression and prosocial concepts (Anderson et al., 2010; Greitemeyer & Osswald, 2011), while others did not find significant effects of priming in tasks measuring the same variables (e.g., Tear & Nielsen, 2014; Zendle et al., 2018). Neither did these studies demonstrate long-term priming effects (for reviews see Drummond et al., 2020). Importantly, most of this research may have suffered from publication bias and methodological problems (e.g.,

cofounding variables) as demonstrated by null results in the study by Zendle et al. (2018) who controlled for most of the previously reported cofounding variables.

In addition, it is vitally important to distinguish between semantic priming of words and simple concepts measured in the laboratory with simple cognitive tasks (e.g., word-fragment completion task, lexical decision, anagram solution, etc.), as was the case in the present study, and more complex tasks measuring aggression, violence, and prosocial attitudes and behaviours. Finally, the type of video games used to elicit priming might also have impacted the results in previous studies. For example, in Tear and Nielsen (2014) study, although they controlled for the content of video games, most of the games used were action and first-person shooter video games, and their difficulty could have been a negative factor in those participants without experience. In addition, in Zendle et al. (2018) study, a laboratory designed video game with low-level graphics was used. In the present study, it was decided to use a video game with highly advanced graphics to enhance immersion among participants. This decision was based on the results of diary Study 2, which found that most of the GTP experiences reported by gamers involved more realistic and immersive video games. Subsequently, choosing a racing game was a good natural alternative, allowing more participants to be engaged in it despite their expertise in gaming.

5.10 GTP associations with previously reported predictors

The correlation analyses revealed that GTP frequency was positively correlated with several variables of interest such as IGD, daydreaming frequency, positive schizotypy, and disorganised schizotypy while the correlation between GTP scores and mind-popping frequency failed to reach conventional levels of statistical significance ($p = .071$). These correlations suggest that individuals who experience GTP are also more likely to experience certain gaming-related behaviours associated to gaming addiction, daydreaming states, and schizotypal traits. These results are in line with those reported and discussed in Studies 1, 2, and 3 and consistently provide support to our main hypothesis of GTP being associated with other spontaneous cognitive phenomena in terms of nature and underlying mechanisms across different samples of video game players.

Additionally, there were no significant correlations between GTP and gaming habits (e.g., hours played per week, years of playing, and hours per session). Thus, years of playing and the amount of gaming hours played per week did not have strong associations with the frequency of GTP. Only gaming hours per session has been associated with GTP in some

previous studies on GTP (Ortiz de Gortari et al., 2015; Ortiz de Gortari & Panagiotidi, 2023). This could mean that despite avid gamers usually investing a lot of time playing games on a weekly basis, those who play in a more intense manner (3-6 hours per session) (Ortiz de Gortari & Griffiths, 2014), might be more susceptible to experiencing GTP. Nonetheless, this association has not been consistently found across studies, and more systematic research controlling for other variables is needed to extend the current knowledge on the role of gaming hours per session.

5.11 Conclusions

This study highlights the importance of using experimental methods in investigating priming effects in the context of video games and involuntary phenomena. By conducting controlled experiments, researchers can gain valuable insights into how the exposure to specific game elements may influence subsequent cognitive processing. The LDT proved to be a useful tool for assessing semantic priming effects of game-related concepts in video-game players and their prevalence over a delay period of 24 hours. Although the study did not find a direct relationship between GTP frequency and priming effects, the findings emphasise the need for further exploration of mechanisms of GTP, especially in terms of the long-lasting effects of exposure to game elements and understanding the multifaceted interplay between gaming experiences and involuntary cognitive processes.

Chapter 6: General Discussion

6.1 Main Aims of the Thesis

This thesis consisted of four studies using questionnaire, diary, and experimental methods with a total sample size of 526 participants. The overall objective of research, presented in the thesis, was to make a major advance in the study of GTP by examining the idea that GTP can be considered as part of a broader class of involuntary cognitions such as mind-wandering, IAMs, mind-pops, and earworms. Despite similarities between GTP and these phenomena, documented by Ortiz de Gortari and colleagues (Ortiz de Gortari 2011; Ortiz de Gortari & Griffiths, 2012), research on GTP and involuntary cognitions has been, so far, conducted separately from each other. It is, therefore, important to start investigating possible associations between GTP and some of these involuntary phenomena as well as other variables that have been associated with a broader class of involuntary cognitions.

To address this overall goal, the first aim of the thesis was to examine the associations between GTP, as rated on the GTPS, and two different self-report measures of spontaneous cognitions such as mind-wandering or daydreaming (Stawarczyk et al., 2012), and involuntary semantic memories or mind-pops (Kvavilashvili & Mandler, 2004). The second and related aim was to examine correlations between GTP and variables associated with spontaneous cognitive phenomena, such as schizotypal traits, creativity, and working memory capacity. For example, positive associations have been reported between schizotypal traits, mind-pops (Elua et al., 2015) and IAMs (Allé et al., 2020), as well as between schizotypy and creativity (for a review, see Acar, Chen, & Cayirdag, 2018). Creativity has also been associated with mind-wandering states, when individuals let their minds wander and allow involuntary thoughts and associations to surface (Fox & Beaty, 2019; Sun et al., 2021). Lastly, previous research on mind-wandering has reported small but negative correlations between working memory capacity and mind-wandering (McVay & Kane, 2009; 2010; Robinson & Unsworth, 2017). It was therefore important to examine if similar patterns could also be obtained for GTP in terms of its association with schizotypal traits, creativity and working memory capacity. To assess these variables, participants completed a questionnaire measuring schizotypal traits (Studies 1 to 4), and two different cognitive tasks assessing working memory capacity (Study 1). Creativity was assessed by the Alternate Uses Task (AUT) and free association task.

The third aim of the thesis was to provide new evidence about the nature and frequency of GTP in everyday life by using a diary method to capture and record GTP. Several studies have used the diary method to investigate the nature of involuntary cognitions

in more naturalistic daily life settings (Kvavilashvili & Mandler, 2004; Berntsen, 2008; Schlagman & Kvavilashvili, 2008; Mace & Atkinson, 2009; Rasmussen, Ramsgaard & Berntsen 2015). Similar to involuntary cognitions, experiences of GTP are often prompted by incidental triggers (words, images, sounds) in the environment or thoughts, making the diary method a suitable approach to explore the nature of GTP in everyday life. To achieve this aim, a digital diary of GTP was developed using the format that had been used previously in diaries for recording involuntary memories (Laughland & Kvavilashvili, 2018). This method allowed to gain a more direct understanding of all the possible circumstances of GTP occurrence in everyday life.

The fourth aim of the thesis was to test, for the first-time, a priming hypothesis as a possible underlying mechanism of GTP. This was based on findings from previous research on involuntary semantic mind-pops (Kvavilashvili & Mandler, 2004), on the one hand, and research by Mace and colleagues on the so called semantic to autobiographical priming when recalling autobiographical memories (Mace & Unlu, 2020; Mace & Hidalgo, 2022). For example, mind-pops in the form of words, images, or music, have been suggested to be primed by previous encounters with these stimuli (e.g., repetition priming) or by previous encounters with stimuli that were associated (e.g., semantically, phonologically, etc.) with these words, images or music (Kvavilashvili & Mandler, 2004). It has also been suggested that the activations produced by words, images, concepts, etc. in one's network of semantic knowledge and memories do not disappear immediately after the encounter, and instead appear to persist in the mind for minutes, hours or even days and weeks (Kvavilashvili & Mandler, 2004). In diary studies, the priming hypothesis can be tested if participants are able to remember the occasion in their recent past when they encountered the stimuli related to the experience recorded in the diary (Kvavilashvili & Mandler, 2004). To test the hypothesis that GTP experiences are primed in a similar way as mind-pops, a diary method was used (Chapter 3) in which participants recorded instances of GTP and indicated if the contents of GTP had been encountered via prior exposure to the game or game-related stimuli. The priming hypothesis was further assessed in the online Study 3 (Chapter 4) by correlating participants' scores on the implicit memory test and the GPT scale, and in the laboratory Study 4 (Chapter 5) by exposing participants to a racing game and measuring priming of words and concepts from this game in a subsequent lexical decision task after a short (10 minutes) and a longer, 24-hour long delay.

The final aim of the present thesis was to replicate and extend previous research on factors associated with GTP by examining its correlations not only with variables that had

been examined by previous research (e.g., gaming-related variables such as hours played per session, etc.), but also several new emotion and psychopathology-related variables that had not been investigated before. For example, IGD has consistently been found to be related to higher GTP prevalence in gamers across several GTP studies (Ortiz de Gortari et al., 2016; Ortiz de Gortari & Panagiotidi, 2023). However, a few studies that examined a link between GTP and the presence of a pre-existing mental illness resulted in contradictory findings: while Ortiz de Gortari and Griffiths (2015) reported a positive link, other studies did not find an association between the two variables (Ortiz de Gortari & Laroi, 2018; Ortiz de Gortari & Panagiotidi, 2023). In addition, initial studies on GTP investigated mental illness as a categorical variable (YES or NO). Therefore, a more targeted approach was adopted by using several validated scales assessing different aspects of mental distress (e.g., depression, anxiety, and stress; Henry & Crawford, 2005) as well as behavioural impulsivity (Spinella, 2009). Impulsivity was assessed because some GTP can manifest as impulsive actions or urges, suggesting poor cognitive control (Ortiz de Gortari & Griffiths, 2014; Ortiz de Gortari & Panagiotidi, 2023). Finally, given that previous studies consistently reported IGD as the strongest predictor of GTP, this thesis also explored if IGD and other gaming-related variables (e.g., the number of hours played per week, length of gaming sessions, etc.) remained as important predictors of GTP when entering all the other variables of interest into a hierarchical multiple regression model.

6.2 Main findings

6.2.1 GTP as part of a family of spontaneous cognitive phenomena

Despite the progress achieved in the study of GTP and its associated factors over the past decade, this is still a relatively new area of research with some gaps in the knowledge about the nature of GTP in everyday life and its underlying cognitive, physiological, and emotional mechanisms. All the empirical studies conducted as part of this thesis (described in Chapters 2 to 5), were the first comprehensive studies examining possible associations between GTP and other spontaneous cognitive phenomena such as mind-wandering or daydreaming and involuntary semantic memories or mind-pops. First, results of a multiple hierarchical regression analyses, conducted in Study 1 (Chapter 2) on a large sample of participants (N=363), showed that GTP frequency was significantly predicted by frequencies of mind-popping and daydreaming, when other variables of interest (e.g., IGD, positive schizotypy, anxiety) were controlled for, and this finding was replicated in a smaller sample

of participants (N=38) in a diary Study 2, reported in Chapter 3. In addition, the results of the diary study showed that the number of GTP recorded (*M* = 1.79) in a 1-week diary was very similar to the frequency of mind-pops previously recorded by a sample of 50 undergraduate students over a similar 1-week period (M= 1.29) (Kvavilashvili & Mandler, 2004).

Additionally, GTP was consistently predicted by positive schizotypal traits in Studies 1 and 2, similarly to studies on involuntary mind pops (Elua et al., 2012; 2015) and IAMs (Allé, et al., 2020). These novel findings were also replicated in Studies 3 and 4 (Chapters 4 and 5, respectively), in new samples of participants who completed the same questionnaires measuring GTP, mind-popping, daydreaming, and schizotypy in addition to experimental tasks assessing implicit memory and priming. Thus, in line with findings on other spontaneous cognitive phenomena, GTP experiences appear to be consistently associated with positive schizotypal traits.

In terms of creativity, results from Study 3 (in Chapter 4) showed that GTP was significantly associated and predicted by creativity scores as measured by the Alternate Uses Task (AUT), which used improved instructions to increase the generation of original uses for a given item (Silvia et al., 2008). However, no relation was found between GTP, and creativity scores as measured by the free association task. This result could have occurred due to the online administration of the task, leading to possible interference with external sources at the moment of completing the task. Overall, these results could suggest that participants with higher tendency to experience GTP might also have higher tendency to generate more novel and creative ideas in the context of problem solving with clear instructions to avoid unoriginal ideas.

It is also important to note that the creativity scores, as measured by the AUT, were significantly correlated with the frequency of mind-popping, in line with previous findings by Zhang et al. (2015). In addition, they were correlated with positive schizotypal traits, which is also in line with findings reported in the literature on creativity (for a review, see Acar, Chen & Cayirdag, 2018). These findings provide additional validity to the data obtained in the present study on GTP correlates with these and other important variables and call for further, more targeted, research of precise mechanisms of GTP and their relation to spontaneous cognitive phenomena.

Finally, contrary to the expectations, there was no association between GTP and working memory capacity (WMC), which has been linked to different instances of mind wandering states (McVay & Kane, 2012; Rummel & Boywitt, 2014). However, other studies have failed to show a clear link between WMC and mind-wandering suggesting that the

relationship might be dependent on other cognitive processes, mainly attentional ones, and the link is not as straightforward as suggested in earlier studies (McVay, et al., 2013; Robinson & Unsworth, 2017; Robinson & Brewer, 2020). The lack of association with GTP frequency could also be potentially explained by methodological issues with the online administration of working memory tasks which require high levels of attention over a considerable time period and hence, slightest disruptions such as mobile phone buzzing could affect performance (Barzykowski et al., 2022). Additionally, it is advisable to consider potential technical issues (e.g., compatibility software issues affecting the pacing of the task) and address experimental and psychological challenges. For instance, cheating is difficult to track and prove, and users must be trusted not to multitask with other computer web applications, among other factors (Leidheiser et al., 2015).

In summary, the results from the four empirical studies, across different samples and methodologies (Chapters 2 to 5), consistently provided support for the main hypothesis, proposed in this thesis, that GTP can be part of a broader family of spontaneous cognitive phenomena, which opens up interesting avenues for further research (see below).

6.2.2 Studying the nature and frequency of GTP with a diary method

Evidence concerning the nature and characteristics of GTP has been mostly based on initial qualitative studies of GTP (Ortiz de Gortari, 2011; Ortiz de Gortari & Griffiths, 2014 a, 2014b), while the frequency of GTP has been measured with retrospective questionnaires (Ortiz de Gortari & Griffiths, 2015; Ortiz de Gortari & Diseth, 2022). In contrast to all previous research on GTP, Study 2 used a structured diary method to study the nature and frequency of GTP avoiding retrospective biases characteristic of questionnaires and interview methods. Results showed that GTP share multiple similarities with other spontaneous cognitive phenomena such as mind-wandering, mind-pops, and IAMs. For example, out of the three the main types of GTP assessed by the GTP scale (i.e., altered perceptions, automatic mental processes, and automatic behaviours and actions), the instances of GTP, recorded in the diary, were mostly involuntary mental processes in the form of mind-pops, earworms, and IAMs experienced by participants as inner mental phenomena rather than occurring outside one's head (e.g., altered perceptions or hallucination like experiences). This is in line with recent findings using retrospective questionnaire where it was found that most of the GTP reported in the GTP-MDS were internal mental experiences (Ortiz de Gortari & Diseth, 2022).

Moreover, most of the GTP, recorded in the diary, occurred while participants were carrying out non-demanding (automatic) activities, with low levels of concentration as observed in previous qualitative studies (Ortiz de Gortari & Griffiths, 2014 a, 2014b,). This finding is in line with studies exploring task-unrelated thoughts during periods of mind-wandering (Giambra, 1995; Vanucci, et al., 2019), IAMs, and mind-pops (Berntsen, 1996; Kvavilashvili & Mandler, 2004). Another important finding concerned the prevalence of cueing, with majority of participants being able to identify stimuli that acted as triggers for their GTP, and this finding again aligns with rates of triggers previously reported for IAMs (Kvavilashvili & Mandler, 2004; Roberts et al., 1994; Berntsen, 1996). Finally, and in line with previous studies, most instances of recorded GTP were perceived as neutral and non-disturbing (Ortiz de Gortari & Griffiths, 2016), which means that having GTP does not necessarily distract gamers from their current activities, nor does it significantly affect their mood before and after experiencing GTP. Taken together, these novel findings provide strong evidence to support the idea that GTP occur under very similar circumstances to a variety of spontaneous phenomena studied by researchers in other areas of cognitive psychology.

Furthermore, important findings emerged in this thesis in relation to the frequency of GTP. Over the past decade, the prevalence of GTP has been mostly assessed with the GTP scale (Ortiz de Gortari & Griffiths, 2015), and more recently the GTP-MDS (Ortiz de Gortari & Diseth, 2022). GTP frequency has been assessed in large participant samples with different ethnic and cultural backgrounds including American, Swedish, Polish, Norwegian, Mexican, Turkish, and British samples (Ortiz de Gortari, 2019; Dindar & Ortiz de Gortari, 2017; Ortiz de Gortari & Diseth, 2022; Cudo et al., 2021);Ortiz de Gortari & Cudo, 2023). As discussed in Chapter 1, the overall total scores, obtained in these studies, have ranged from low to medium when using the GTP scale. Similar low scores were obtained in all four studies reported in this thesis with the mean GTP scores ranging from 18.11 to 27.67. Most gamers have experienced some type of GTP over the past 12 months, however, the daily occurrence of GTP appears to be less frequent than previously reported because participants in the diary study (Chapter 3) recorded, on average, only 1.79 (*SD* = 0.76) GTP over a 7-day period.

Importantly, results also showed that GTP frequency, reported in the diary, was positively correlated with participants' total GTP scores on the GTP scale, which provides additional independent evidence of the scale's external validity. Nevertheless, this correlation was only modest in size, which indicates that GTP frequency estimates, obtained with the diary and questionnaire, do not align with each other completely. For example, several participants who obtained more than 40 points on the GTP scale, which could be considered

as experiencing frequent GTP, only reported having one or no GTP during the 7-day diary-keeping period (*cf.* Kvavilashvili & Mandler, 2004, Study 4). In addition, another unexpected finding was that the number of GTP, recorded in the diary, was not associated with almost any of the variables (IGD, mind-popping and daydreaming) that the total GTPS scores were significantly associated with in all other studies of the thesis.

As discussed in Chapter 3, this unexpected result could have occurred due to differences in the timeframe in which the GTP frequency was assessed: over the past 12 months in the GTP scale and just seven days of recording GTP in the diary. It is also interesting that this finding appears to bear some resemblance to the results of a recent study that investigated correlations of PTSD symptoms with both self-reported prospective memory errors *("forgetting to make a phone call", "to buy a birthday card", etc.*) and prospective memory performance measured in the laboratory (Swain & Takarangi, 2023). Results showed that self-reported failures, but not lab-based prospective memory performance were associated with more severe PTSD symptoms (Swain & Takarangi, 2023). The authors suggest that self-report scales and lab-based tasks of prospective memory might represent different components of prospective memory. The lack of correlation between self-reported prospective memory and the actual performance scores in the laboratory might be due to pre-existing negative beliefs during self-report assessments generating consistent biases in participants' responses. There is, of course, the possibility that lab-based prospective memory does not truly reflect people's prospective memory performance in everyday life (Swain & Takarangi, 2023). In the context of GTP, all the validated scales and questionnaires used are based on retrospective reporting that may be subject to various biases. On the other hand, it is possible that recording GTP over a period of only seven days does not provide a reliable estimate of true GTP frequency in everyday life. Lastly, it is also possible that significant correlations between diary recorded GTP and other variables of interest would be obtained if larger samples of participants were tested.

In summary, findings using the diary method showed that this tool could be quite valuable and reliable for assessing GTP as a spontaneous phenomenon in everyday life by providing new evidence on the nature and frequency of GTP and the circumstances under which they occur in everyday life. However, findings showing the lack of correlation between the number of diary-recorded GTP and several variables of interest that had positive associations with the total scores on the GTP scale (e.g., daydreaming and mind-popping frequency) requires further investigation. For example, if experiences of GTP are fairly infrequent, then it may be necessary to record GTP in shorter 2- or 3-day diaries several times

over a longer period of time to obtain a more reliable assessment of GTP frequency in everyday life.

6.1.3 Long-term priming as a potential underlying mechanism of GTP

The results from Study 2 (Chapter 3), using the diary method, showed that, in line with the priming hypothesis in this thesis, the content of most GTP experiences, recorded in the diary, could be associated with a recent encounter with either the identical (e.g., the game itself) or altered (e.g., related to the game) stimuli, usually within a timeframe of 24 hours. This finding provided support for the existence of long-term priming mechanisms in the occurrence of GTP and is in line with laboratory studies demonstrating the presence of semantic priming in IAMs (Mace, 2005; Mace & Hidalgo, 2022), as well as findings using a diary method with mind-pops (Kvavilashvili & Mandler, 2004).

By contrast, results of Study 3, using a word-fragment completion task to measure individual differences in perceptual priming, showed that although most gamers experienced positive priming effects, there was no association between the frequency of GTP and priming scores. The non-significant results obtained in this study may have occurred due to several reasons. For example, the lack of association between priming and GTP could be due to low reliability of implicit memory tasks as demonstrated by Meier and Perrig (2000). In this study, young and old participants (N = 335) completed two different measures of perceptual implicit memory (a picture clarification and word stem completion task) and several different measures of explicit memory (free recall, recognition, and cued recall). Results showed that the reliability of implicit memory tasks was significantly lower than the reliability of explicit memory tasks. The intercorrelations between explicit memory tasks were also higher than between the implicit memory tests, which suggests that caution is needed when using implicit memory tasks to measure stable individual differences in this cognitive variable.

It is also possible that using the word fragment completion task, which measures perceptual priming, was not an optimal task to assess the long-term priming hypothesis, which assumes the existence of semantic or conceptual rather than perceptual priming as the key mechanism involved in the occurrence of involuntary mind-pops and spontaneous GTP experiences. In retrospect, it appears that using a conceptual implicit memory task such as a category instance generation task would have been a better choice to measure participants' implicit memory, and future research should use several conceptual priming tasks to examine the relationship between GTP scores and the priming index derived from these implicit memory tasks.

In Study 4 (Chapter 5), all participants were tested face to face under laboratory conditions. After playing a racing game for 30-minutes, all participants completed a lexical decision task in which the magnitude of priming for (target) words encountered during the video game was assessed by subtracting reaction times to target words from reaction times to control words not encountered in the game. Results of Study 4 showed that the majority of participants displayed positive semantic priming effects in the lexical decision task in response to the words previously encountered in the video game. Importantly, this priming effect was also observed in Session 2, approximately 24 hours after playing the game, providing evidence of long-term priming in the context of video-game playing. However, contrary to expectations, the magnitude of priming effects over two sessions was not a significantly associated with the frequency of GTP. Individual differences in current concerns and motivation and extra experimental influences might explain the lack of association obtained in Study 4. As discussed in Chapter 4, Coane and Balota (2009) investigated how individual differences in recent experiences outside the laboratory can influence priming of concepts, related to different festivities, in the laboratory. Their results showed that when presenting target words associated to different festivities and holidays in the lexical decision task, participants who were tested around the time of a specific holiday *(e.g.,* in December for Christmas), or those who previously reported their preference for a specific festivity (e.g., Christmas) responded significantly faster to words related to this festivity (tree, present, etc.) than words related to other festivities. It is, therefore, possible that Study 4 could not control for this extra noise in participants' response to non-target (control) words, some of which could have been already activated via exposure in daily life before coming to the experiment.

Furthermore, it is important to acknowledge that the results of Study 2 supporting a priming hypothesis, might not be comparable with the findings obtained in Studies 3 and 4. For instance, the assessment of priming in the diary study involved conscious explicit processing whereby participants were consciously retrieving the last time they had an interaction with the video game associated to their GTP. By contrast, the experimental priming tasks with the word-fragment completion task and the lexical decision task used in Studies 3 and 4 involved implicit, unconscious cognitive processing.

Another cognitive process that might be consistent with the proposal of priming as an important variable for the occurrence of GTP is associative learning. One of the key features of associative learning (also referred as classic conditioning) is that it takes place in the presence of cues, and in a particular context and surroundings (Rosas et al., 2013). Consistent with this viewpoint, other studies investigating memory and availability-biased metacognitive

illusions found similar results in terms of context as those described by Coane and Balota (2009) (see Chapter 5). For instance, participants tested in early July were more confident remembering features of the American flag in comparison to those tested in early August (Blake & Castel, 2019). Overall, it has been suggested that context can encompass the setting or equipment where associative learning occurs (Bouton et al., 2010; Fanselow, 2007). Therefore, associative learning could offer an alternative compelling explanation for the occurrence of some GTP, as it emphasizes the role of repeated exposure to cues within the gaming environment and their subsequent association with specific experiences or responses. Through this process, several cues such as visual, auditory, or tactile stimuli become strongly linked to actions, emotions, or states of mind experienced during gaming, forming enduring associations in the brain. When encountering similar cues in real-life contexts, these associations can be triggered involuntarily, leading to experiences reminiscent of gaming. Thus, the principles of associative learning could provide a framework for understanding how GTP occurs through the transfer of gaming-related associations to non-gaming situations and further studies should investigate this cognitive process and its association with priming and GTP.

Another possible explanation for not finding an association between priming scores of participants and frequency of GTP over two sessions could be a small sample size used in Study 4 (N=40). Future studies will benefit from using larger samples. This is a relevant strategy to use in the initial stages of research to establish the presence of the predicted effect or a relationship, which can then be followed up with a correlational approach to estimate the magnitude of the effect (see Preacher et al., 2005). In addition, future studies may benefit from using the recently developed GTP-MD scale (Ortiz de Gortari & Diseth, 2022) as the improved measure of GTP frequency. It is possible that a clearer distinction between endogenous and exogenous GTP experiences, allowed by this scale, will ensure that significant results will be obtained when using larger samples and conceptual priming tasks under controlled laboratory conditions.

6.1.4 Associations of GTP with measures of negative affect and psychopathology

One of the most important variables that was consistently associated with self-rated GTP frequency on the GTP scale, across all four studies of the thesis, was the internet gaming disorder (IGD). In addition, it predicted GTP in the multiple hierarchical regressions and mediation analyses conducted in Studies 1 and 3. These findings replicate and extend the

results of previous studies where IGD was shown to be a strong predictor of GTP (Ortiz de Gortari & Gackenbach, 2021; Ortiz de Gortari & Panagiotidi, 2023). By contrast, findings concerning the association between GTP and gaming-related variables has been inconsistent. For example, in Studies 1 and 3, gaming-related habits such as gaming hours per week, and years of playing did not predict GTP, the only variable that come out as significant in the multiple hierarchical regression analyses was gaming hours per session, but this was found only in Study 3. This finding was in line with the results of previous studies that had reported the association between the length of gaming sessions and GTP frequency (Dindar & Ortiz de Gortari, 2017; Ortiz de Gortari et al., 2016).

Apart from the undeniable relevance of IGD, the tendency to experience GTP may depend also on other variables measuring negative affect and psychopathology in this thesis. First, results from Studies 1 and 2, using a validated scale of depression, anxiety, and stress showed significant associations of these measures with GTP. These findings are in line with a previous study that measured the association of having a medical condition with a "Yes or No" question (Ortiz de Gortari, Oldfield, & Griffiths, 2016), and provide new insight about which particular aspects of negative affect are linked specifically with GTP frequency. Indeed, the additional hierarchical regression analyses revealed that only levels of anxiety significantly predicted GTP, which is in line with players' reports of experiencing GTP under conditions of anxiety (Ortiz de Gortari, Aronsson & Griffiths, 2012). The findings therefore suggest that anxiety might be a more important variable than depression in predicting GTP. This conclusion is further supported by the results from studies on involuntary cognitions which have reported significant positive associations between anxiety and mind-wandering (Ottaviani & Couyoumdjian, 2013b), IAMs (del Palacio-Gonzalez & Berntsen, 2020), and earworms (Reuman et al., 2020b), while the links of these phenomena with depression have been non consistent (Figueiredo et al., 2020). The association of anxiety and GTP could be also explained in the context of increased levels of IGD, given that several features of IGD, for example, preoccupation with gaming, and withdrawal symptoms when not gaming, have been observed in the form of increased irritability and anxiety (American Psychiatric Association, 2013).

It is interesting that in all four studies, disorganised schizotypy also correlated significantly with GTP in addition to positive schizotypal traits. This is perhaps not surprising given that in the continuum of schizotypy, individuals with disorganised traits present abundant but abnormal thoughts (Kane et al., 2016), while in the context of GTP, the experiences involving automatic mental processes are the most prevalent type of GTP (Ortiz

de Gortari & Diseth, 2022). In addition, using multiple validated assessments of schizotypal traits, Kane et al. (2016) showed that mind-wandering modestly predicted disorganised schizotypy. However, it is important to note that the association between GTP frequency and disorganised schizotypy was not found in the multiple hierarchical analyses, which suggests that the association between these variables disappears when controlling for other factors such as positive schizotypy, IGD and involuntary cognitive phenomena. Overall, it is also important to acknowledge the role of individual differences in schizotypal traits, and how these might influence the susceptibility to experience GTP. For instance, variations among individuals associated with the multi-dimensional schizophrenia spectrum encompass a broad range of cognitive, perceptual, and interpersonal characteristics that resemble to varying degrees the symptoms of schizophrenia, but to a lesser extent and without reaching clinical significance (Esterberg & Compton, 2009). For example, several studies with non-clinical participants have suggested that psychotic like thoughts can be considered common experiences in the general population due to their widespread occurrence, and that these experiences cannot merely reflect pathological functioning. For instance, several studies have shown that non-clinical individuals with high positive schizotypal traits can even display some beneficial functioning associated with personal wellbeing such as more flexible and unconventional thinking that leads to higher creative thinking (for a review, see (Mohr & Claridge, 2015).

Regarding GTP, these individual differences in schizotypal traits can influence how some individuals perceive and interact with their environment, including their engagement with video games, leading to more or even less susceptibility to experience GTP. For example, Individuals high in positive schizotypy might be more susceptible to experience altered sensory perceptions and cognitive biases such as vivid imagery or hallucinations, which could lead to more intense and immersive experiences with video game content. This heightened perceptual and cognitive sensitivity may contribute to the occurrence of some GTP, where game related stimuli are integrated into the individual´s perception of reality.

Moreover, impulsiveness is another variable that has been suggested to account for the occurrence of GTP, especially in terms of lack of inhibitory control when suppressing or controlling various automatic cognitive and behavioural resulting from the game-play (Ortiz de Gortari, Oldfield, & Griffiths, 2016). This was supported by findings of Study 1, which showed that motor and non-planning impulsivity were significantly correlated with GTP. However, only motor impulsivity predicted GTP in the multiple hierarchical regression analyses. This finding aligns with a recent study showing that self-reports of cognitive

failures, assessed by a validated scale, significantly predicted frequency of GTP in a multiple hierarchical regression analysis (Cudo, Kopis-Posej, Shcehelska, 2022; Ortiz de Gortari & Panagiotidi, 2023). Taken together, these findings suggest that individuals who exhibit more impulsive personality tendencies, especially motor impulsivity, are more susceptible to experiencing GTP involving automatic behaviours and actions.

In general, the findings presented in this thesis about the association of GTP with different indices of psychopathology, extend the current knowledge and provide new insights into the complex nature of this phenomenon. For example, the consistent association of GTP with IGD and positive schizotypy could explain why some gamers with very similar gaming habits (e.g., similar years of experience, hours played per week and per session) may not experience GTP with the same frequency or even not at all. It is also important to mention that apart from IGD and positive schizotypy, there were other variables predicting the tendency to experience GTP such as disorganised schizotypy, anxiety, and motor impulsivity as well as frequency of involuntary cognitions. Overall, the converging evidence from the studies of this thesis underscore the potential association of GTP with mental health and warrants more in-depth exploration in the future.

6.1.5 Methodological Implications

This thesis has made several methodological contributions to studying GTP. To date, the majority of research on GTP has been conducted online (Ortiz de Gortari et al 2009). Therefore, the first important contribution of this thesis was made in Study 1 where it was found that scores on the GTP scale and several other scales and questionnaires that were initially administered under laboratory conditions, produced comparable results when the same questionnaires and scales were administered online. This finding further supports robustness of the GTP scale as a valid tool to measure GTP experiences both in the laboratory and online.

Another significant methodological contribution of the present thesis is the development of a structured diary method for studying GTP experiences in everyday life. Moreover, this method demonstrated that the contents of most GTP experiences, recorded in the diary, were very similar to other spontaneous cognitive phenomena in the form of mind-pops, earworms, IAMs, and instances of mind-wandering. Importantly, findings from diary Study 2 also suggest that the self-reported GTP frequency, as assessed by the GTP scale, may

be overestimated by participants due to biases in retrospective recall spanning across the past 12 months.

Several studies have compared findings obtained across the diary method and recall-based (retrospective) questionnaires, by comparing reports from the diary, averaged over a certain time period, with measures of recall-based questionnaires during the same timeframe (for review see Shiffman, Stone & Hufford, 2008). Often, these studies have demonstrated that recall-based methods produce higher estimates of frequency or intensity in comparison to the diary method (Carnet et al., 1998; Litt et al., 2000). This overestimation has been shown in many areas of research. For example, the frequency, intensity and the duration of medical symptoms is reported to be significantly higher with retrospective questionnaires than when recording symptoms with the diary method (Broderic et al., 2006, Houtveen & Oei, 2008, Shiffman, 2007; Shiffman et al., 2006; for a review, see Van den Brink et al., 2001). Similarly, the frequency of certain frequent events or behaviours is also often overestimated in recall-based questionnaires (Homma et al., 2002, Shiffman & Paty, 2003).

Moreover, other studies have shown significant discrepancies in findings when the diary and questionnaire methods have been administered to the same participants. For example, negative correlations were obtained between participants' retrospective reports of alcohol consumption and diary recorded instances of the same behaviour (Carney et al., 1998; Searles et al., 2000). This means that even when recall-based reports appear to be adequate to characterize the aggregate experience of the to-be-studied phenomenon or behaviour, it may not be adequate to characterize day-to day changes in cognitions and behaviours of interest, which are typically the focus of diary studies. This highlights one of the unique contributions of diary method to the study of spontaneous cognitive processes that occur over time under specific circumstances. Overall, these discrepancies might occur due to influence of more salient experiences in recall, for example, intense pain is more salient than no or dull pain, migraine headaches are more salient than non-migraine headaches, and so on, leading to possible overestimation of clinical symptoms in questionnaire studies. Based on these considerations, in relation to GTP frequency, it is possible that the frequency scores on the GTP scale potentially overestimate the actual GTP frequency in daily life due to recall bias or social desirability. In diary research, the use of daily reminders and clear instructions about how to keep the diary and identify target events may generate more objective entries from participants (for review see Shiffman, Stone & Hufford, 2008; Laughland & Kvavilashvili, 2018).

Lastly, another important methodological contribution of this thesis was the use of immersive video games to investigate priming effects. Results from Studies 2 and 4 highlight the potential methodological importance of using more immersive and realistic video games, and longer exposure to the priming stimuli when attempting to generate priming effects. This is very important given that the recent research on gaming has cast some doubts in the existence of priming by exposure to video games (Charles et al., 2013; Tear & Nielsen, 2014; Zendle et al., 2018). In Study 2, participants showed that most of the experiences reported in the diary were associated to more immersive and realistic video games, whilst findings in Study 4 provided further support for this idea. The use of a highly graphic video game in terms of realism, coupled with the content focused on neutrality, resulted in a reliable method to elicit and assess semantic priming via the lexical decision task in the majority of gamers both after a brief delay (15 minutes) and after 24 hours.

6.1.6 Theoretical Implications

The results of the present thesis have theoretical implications for the understanding of GTP, by supporting the hypotheses about the involuntary nature of GTP and types of GTP. The results from four studies provided consistent evidence to support the descriptive model of GTP, presented at the end of Chapter 1, that considers GTP as part of a broader family of involuntary cognitive phenomena. For instance, GTP was predicted by scores on daydreaming and mind-popping questionnaires in the hierarchical multiple regression analyses. In addition, the results of the diary Study 2 showed that the most common GTP were fairly benign involuntary thoughts and memories, experienced as inner mental phenomena rather than perceptual experiences located in the external world. This method also showed that the content of most GTP consisted of game-related involuntary autobiographical/semantic memories, and musical mind-pops or earworms. The circumstances of GTP occurrence were also very similar to other involuntary phenomena. For instance, the majority of GTP were reported by participants as being prompted by external triggers in the environment while performing non-demanding activities that required low levels of concentration.

Further support for the model comes from the finding that the frequency of GTP, as measured by the GTP scale, was consistently predicted by positive schizotypy in all the analyses reported in the thesis. This is very important considering the close association of this trait with other spontaneous cognitive phenomena. Indeed, research with clinical samples has

shown a close association between schizophrenia and the tendency to experience IAMs (Allé, Berna, Danion & Berntsen, 2020), mind-pops (Elua et al., 2012, 2015) and mind-wandering (Shin et al., 2015). More importantly, the same patterns of results has been obtained in studies with non-clinical samples, which have reported significant correlations between positive schizotypal traits and higher tendency to experience IAMs (Jones & Steel, 2012), intrusive memories (Holmes & Steel, 2004), mind-wandering (Seeman, 2016; Welhaf et al., 2020) and involuntary musical imagery or earworms (Cotter et al., 2016). Overall, these results indicate that positive schizotypal traits may be a key variable in the frequency of GTP as well as other spontaneous cognitive phenomena.

Another important aspect to consider in relation to the GTP frequency and positive schizotypal traits, is the possible brain mechanisms involved in GTP. There is a large body of evidence from fMRI studies of mind-wandering and other forms of spontaneous cognitions that their frequency and occurrence is linked to increased activity in the Brain's Default Mode Network (DMN) (for a review see Kvavilashvili et al., 2020). As discussed in Chapter 1, DMN is a set of interconnected nodes or hubs in the brain (most notably Medial Prefrontal Cortex, Posterior Cingulate Cortex, and Inferior Parietal Lobe) that show increased activations when individuals are focussed on their inner train of thoughts and decreased activations when focusing on external stimuli during cognitively demanding tasks and activities. However, there is also a growing body of research showing that patients with schizophrenia and individuals at risk of schizophrenia (e.g., first degree relatives) show increased hyperactivity within the key hubs of the DMN as well as hyperconnectivity between the hubs and these processes have been associated with disturbances of thought and hallucinations in schizophrenia and the risk of illness(for a review, see Whitfield-Gabrieli & Ford, 2012). Based on this research, it can be proposed that experiences of GTP will also be linked with activations in specific hubs of the DMN, most notably in Posterior Cingulate Cortex, and future studies will need to directly investigate possible relation between GTP and DMN in gamers high and low in positive schizotypal traits.

A final set of results, that may have important theoretical implications for understanding the underlying cognitive mechanisms of GTP, refer to long-term priming effects that have been studied in research on involuntary semantic mind-pops and autobiographical memories. For example, it has been suggested that these memories can occur as a result of long-lasting spread of activation in the representational network of semantic and autobiographical knowledge in response to previous encounters with incidental stimuli in the environment (Kvavilashvili & Mandler, 2004). Few minutes, hours or even days later, encountering related

stimuli or cues in the environment may further re-activate the already activated concepts and memories resulting in a sudden and unexpected experience of an involuntary mind-pop, musical earworm or an IAM (Kvavilashvili & Mandler, 2004; Mace et al., 2018, Experiment 2). Building on this perspective, such long lasting activations, emanating from stimuli and concepts encountered in daily life, can also be captured in the laboratory tasks measuring priming (e.g., see Coane & Balota, 2009). The findings from Study 2 provided support for this hypothesis. Participants' reports in the diary revealed that a significant portion of GTP experiences was linked to recent exposure to the video game content, which were mostly prompted by external cues, associated with the GTP content, in the current situation.

However, the hypothesis about a possible association between individual differences in the magnitude of priming effects and GTP was not supported in Studies 3 and 4. Despite this null result, it is important to note that almost every participant in both studies displayed positive priming effects with two different experimental designs and priming tasks, and it is particularly noteworthy that in Study 4 participants consistently reacted faster to words and concepts previously encountered in the video game session after short and long delays (15 minutes versus 24 hours). Taken together, these are theoretically important findings especially in the light of recent studies arguing that priming effects by previous exposure to video games may not actually exist (Zendle, Cairns, & Kudenko, 2018), and merit further investigation in future research on GTP.

6.1.7 Limitations and Future Directions

The findings of this thesis are subject to some limitations, but also suggest some new and novel future directions. First, it is important to note that Studies 2 and 3 had to be completed entirely online due to the COVID-19 lockdown restrictions. Therefore, the scores for all the cognitive tasks (e.g., implicit memory, AUT, etc.) were collected online losing control over participants' performance. In addition, it is worth noting, that the tasks measuring working memory capacity in Study 1, were also mostly completed by participants online. Although the comparison of findings obtained between participants tested face-to-face and under online testing conditions in Study 1 were not significant, it is obvious that more caution may be needed when assessing participants' cognitive abilities under online testing condition. For example, a recent study compared the reliability of online working memory capacity scores in participants who were remotely supervised or not supervised. While both conditions presented adequate reliability, higher reliability for the working memory task was

found in remotely supervised than unsupervised participants (Gonzalez et al., 2023). Therefore, future online studies that use cognitive tasks involving fast processing pace and reaction times should consider adopting procedures such as remote supervision to ensure increased control over participants' performance.

Moreover, the same measures were used to asses' spontaneous cognitions across four different studies. Future research should replicate and extend present findings by including several additional measures of spontaneous cognition. For example, the frequency of IAMs and involuntary future thoughts could be measured by the Involuntary Autobiographical Memory Inventory (IAMI; Berntsen, Rubin & Selgado 2015). In addition, instead of Daydreaming Frequency Scale (DDFS), one can use more recent scales such the Mind-Wandering Questionnaire (MWQ; Mrazek, Phillips, Franklin, Broadway, and Schooler, 2013) or a questionnaire developed by Carriere, Seli and Smilek (2013;Studies 2 and 3) that distinguishes unintentional (spontaneous) mind-wandering from intentional mind-wandering. Considering strong links of GTP with IGD and other variables linked to psychopathology (see below), it would be also interesting to include in future studies of GTP measures assessing more clinically relevant spontaneous cognitions such as intrusive thoughts, rumination, and hallucination proneness. Future research can also use other scales of GTP such as a newly developed 38-item GTP Multiple Dimensions Scale (GTP-MDS; Ortiz de Gortari & Diseth, 2022) that has improved item structure and 12 items that specifically measure internal involuntary cognitions represented by three sub-scales of intrusive thoughts, involuntary mental imagery and involuntary auditory imagery.

Moreover, as mentioned in Chapter 3, the diary method was used completely online, but previous studies have shown higher number of entries in paper-based diaries compared to online app-based diaries (Laughland & Kvavilashvili, 2018). It is then of vital importance that future studies replicate findings obtained with the online diary method using a paper-based diary. Another potential limitation to consider might be a small sample size using the diary method and a lexical decision task in Studies 2 and 4, respectively. Future studies should replicate these findings with bigger and more representative samples considering other variables such as gender, age, education, as well as more controlled and strict measures of proficiency at gaming.

Moreover, considering all the findings related to psychopathology variables, future studies should use more controlled measures of mental illness among participants. In this thesis, most of the studies asked participants to report if they had a current diagnosis of a

mental illness. However, only Study 4 asked participants to describe the diagnosis if the participant responded affirmatively to this question.

Lastly, it is important to note that all the studies conducted in this thesis measured the frequency of GTP using retrospective questionnaire as well as the diary method. Future studies should also attempt to measure GTP frequency under controlled settings in the laboratory. This could be achieved by creating adapted versions of vigilance tasks, which include irrelevant stimuli with video game content instead of cue phrases used to study involuntary memories and future thinking (Cole et al., 2016; Schlagman & Kvavilashvili, 2008). Experimental designs could compare the prevalence of GTP between participants with different scores on GTP scale (high versus low). Subsequent studies should also investigate GTP elicited in controlled laboratory conditions, using physiological measures like EEG and fMRI. This will enable the extension of the findings presented in this thesis by examining brain and neural correlates of GTP.

6.1.8 Conclusions

The studies conducted as part of this thesis have significantly advanced the current knowledge on GTP by providing new evidence in support of the idea that GTP can be considered as part of other spontaneous cognitive phenomena in terms of their frequency, characteristics and underlying mechanisms. Results from multiple hierarchical and mediation analyses consistently demonstrated the importance of psychopathology variables such as the IGD and positive schizotypy in the frequency of GTP as assessed by the GTP scale scores. The link of GTP with these variables can potentially explain why some gamers may not experience this phenomenon despite their gaming habits (e.g., prolonged exposure to games). The thesis also demonstrated that the diary method is a reliable tool for studying the nature and frequency of GTP in everyday life. The results obtained with this method, confirmed the crucial role of external and internal cues in triggering different types of GTP. Importantly, they also demonstrated that spontaneous inner mental representations (thoughts, memories, music, etc.) were the most prevalent and common experiences among gamers, which confirms recent findings obtained with the newly developed GTP questionnaire by Ortiz de Gortari and Diseth (2022).

Additionally, the findings from this thesis demonstrated, for the first time, the links between GTP and creative thinking, using the Alternative Uses Task, and the potential role of long-term priming effects in GTP using both the diary and experimental methods. However,

inconclusive results suggest that the association between these variables and GTP is more complex than initially thought**,** and more research is needed.

Collectively, the novel findings presented in this thesis offer the first systematic support for the central proposition of the current investigation that GTP represents a specific form of spontaneous cognition. This idea has been overlooked in cognitive psychology and warrants more detailed examination to enhance the understanding of involuntary cognitive phenomena in general, and GTP in particular.

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Appendix I: Demographics, medical conditions (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

1. What is your gender?
2. What is your age?
3. What is your current occupation?
    a) Student
    b) Employed
    c) Self-employed
    d) Unemployed
    e) Unable to work
    f) Homemaker
    g) Retired

4. Which is your current country of residency?
5. How many years of formal education have you completed successfully? (e.g., If you are first year university student in UK, and started your education at 5 years of age, you would have 13 years of formal education).
6. Do you currently have a psychiatric or mental illness?
    a) Yes
    b) No
7. Are you currently taking any prescribed medication for the diagnosed condition mentioned above?
    a) Yes
    b) No
8. How often do you use recreational drugs or psychoactive substances other than alcohol?
        a) Never
        b) Once or twice
        c) to 5 times
        d) 6 to 10 times
        e) More than 10 times
        f) Daily
        g) More than once a day

Appendix II: Gaming Habits questionnaire (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

On what platform(s) do you usually play video games?

- Console (e.g., Xbox One, PS4, Nintendo Switch, etc.)
- Computer
- Mobile phone
- Handheld (e.g., N3DS, Nintendo Switch, Ps vita, etc)

Do you play video games online?

a) Never
b) Rarely
c) Sometimes
d) Often
e) Very Often

On average how many days do you play video games per week? <0-7 days>

On average, how many hours per day do you play video games? <0-24>

On average, how long (in hours) are your gaming sessions (e.g., how long do you play video games in one session/ one sitting)? <0-24>

In a normal and routine week which days do you usually play the most?

For how many years have you been playing video games?

How often do you sleep less because you have been awake playing video games?

a) Very often
b) Often
c) Sometimes
d) Rarely
e) Never

How often do you play video games right before bedtime?

a) Very often
b) Often
c) Sometimes
d) Rarely
e) Never

How often do you keep playing a game when you feel very tired?

a) Very often
b) Often
c) Sometimes
d) Rarely
e) Never

What kind of gamer do you think you are? Please select the option that you think describes you the MOST.

a) Casual/Leisure Gamer (e.g., I enjoy playing games, but my time/interest is somewhat limited).
b) Mid-core Gamer (e.g., I play different kinds of games enthusiastically, but I do not play as long or as hard as a hardcore gamer).
c) Hardcore Gamer (e.g., I spend a huge amount of time playing games. I like to search the last news and updates in gaming. I have a good console/PC made especially for gaming).
d) Professional Gamer (e.g., I like to play video games constantly as a fulltime job to make money and to participate in official tournaments).

Please rank (as 1,2,3) the video game genres you have played "most" during the last "12 months". Drag to the top "1" the genre you have played the most, "2" for the second most frequently played genre, and "3" for the third most. Choose only THREE (3).

a) First person shooter
b) Multiplayer online battle arena (MOBA)
c) Real-time strategy
d) Massive multiplayer online role play games (MMORPG)
e) Action-adventure game

f) Adventure puzzle game
g) Music-dance games
h) Simulation games
i) Sports games
j) Circuit racing games
k) Drive'em up street racing games
l) Tile puzzle games
m) Brain games
n) Turn-based strategy games
o) Roleplaying games (RPG)
p) Shoot'em ups
q) Open world/ sandbox
r) Other

Which are the last three video games that you have played the MOST in the last 6 months?

Which game are you playing the most at the moment?

Appendix III: Game Transfer Phenomena Scale (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

The following questions will ask you about experiences in various sensory modalities (e.g., visual, auditory, tactile) that you may have had in association with your gaming activity.
***please only report experiences you had when NOT been under the effect of some psychoactive substance (e.g., alcohol, cannabis, ecstasy, etc.)
Please report how frequently the following experiences have happened to you during the last **12 months** when you **WERE NOT** playing, use the following 4-point scale.

0 Never
1. Once or twice
2. A few times
3. Several times
4. Many times

1. I have visualized video game images (e.g., imagined icons above people's heads).
2. I have seen images with closed eyes when I was not playing (e.g., seen images static or in movement when I close my eyes).
3. I have misperceived a real-life object as something from a video game (e.g., seeing a plane and thinking that it was something from Call of Duty.
4. I have experienced bodily sensations of movement as if I was in a video game (e.g., lying in bed but feeling like your body or some part of your body is moving).
5. I have felt a tactile (touch) sensation associated with a game when I was not playing (e.g., felt the sensation of pushing buttons on the gamepad under my fingers).
6. I have perceived that time or velocity are influenced by a feature or activity in a video game (e.g., felt as if I was walking or driving slower or faster than usual).
7. I have perceived my body feeling differently after playing a game (e.g., felt bigger or shorter than I actually am).
8. I have heard the music from a game when I was not playing.
9. I have heard sound effects from a game when I was not playing.
10. I have heard a character's voice from a game when I was not playing.
11. I have misinterpreted a sound in real life as something from a video game.

12. I have wanted or felt the urge to do something in real life after seeing something that remind me of the video game (e.g., seeing red doors and wanting to break through after playing Mirror's Edge or feeling the urge to climb buildings after playing Assassin's Creed).
13. I have experienced still being mindset of a game after I have stopped playing (e.g., trying to align and match real life objects or constantly thinking about where the best place is to put portals after paying the game Portal).
14. I have found myself thinking about using something from a video game in real life (e.g., wanting to use the scope zoom to see faraway objects).
15. I have momentarily mixed-up video game events with actual real-life events (e.g., wondering if the door is locked so that the monsters can't come in).
16. I have sang, shouted or said something from a video game in real life without intending to do so.
17. I have experienced a reflex body reaction associated with my video game playing (e.g., moving my arms or fingers to look for game pads as a reflex reaction without thinking about it).
18. I have acted out a behaviour or performed an activity influenced by a video game (e.g., climbed to the top of a roof after playing Mirror's Edge).
19. I have acted differently in real life situations because something I have experienced in a game without intending to do so (e.g., avoid fountains after playing Fallout, or ducking when noticing a security camera).
20. How often do you experience any kind of Game Transfer Phenomena/ post-play experiences?

Appendix IV: Daydreaming frequency (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

Instructions to participants on Qualtrics:

Daydreaming or 'mind-wandering' is a temporary detachment from reality during which people tend to fantasize different thoughts, goals, ambitions all of which are encountered while awake (Klinger, 1987). There is no 'official' definition for daydreams but thinking about something completely random and unrelated to the task you are working on is called daydreaming. There are 12 items in this Daydreaming Frequency Scale. Each item has five alternative response options corresponding to one of the letters A to E. For each item, please choose the response option, which is most true or appropriate for you.

1. I daydream

A. Infrequently

B. Once a week

C. Once a day

D. A few times during the day

E. Many different times during the day

2. Daydreams or fantasies make up

A. No part of my waking thoughts

B. Less than 10% of my waking thoughts

C. At least 10% of my waking thoughts

D. At least 25% of my waking thoughts

E. At least 50% of my waking thoughts

3. As regards daydreaming, I would characterize myself as someone who

A. Never daydreams

B. Very rarely engages in daydreaming

C. Tends towards occasional daydreaming

D. Tends towards moderate daydreaming

E. Is a habitual daydreamer

4. I recall or think over my daydreams

A. Infrequently

B. Once a week

C. Once a day

D. A few times during the day

E. Many different times during the day

5. When I am not paying close attention to some job, book or TV, I tend to be daydreaming

A. 0% of the time

B. 10% of the time

C. 25% of the time

D. 50% of the time

E. 75% of the time

6. Instead of noticing people and events in the world around me, I will spend approximately

A. 0% of my time lost in thought

B. Less than 10% of my time lost in thought

C. 10% of my time lost in thought

D. 25% of my time lost in thought

E. 50% of my time lost in thought

7. I daydream at work (or school)

A. Infrequently

B. Once a week

C. Once a day

D. A few times during the day

E. Many different times during the day

8. Recalling things from the past, thinking of the future, or imagining unusual kinds of events occupies

A. 0% of my waking day

B. Less than 10% of my waking day

C. 10% of my waking day

D. 25% of my waking day

E. 50% of my waking day

9. I lose myself in active daydreaming

A. Infrequently

B. Once a week

C. Once a day

D. A few times during the day

E. Many different times during the day

10. Whenever I have time on my hands I daydream

A. Never

B. Rarely

C. Sometimes

D. Frequently

E. Always

11. When I am at a meeting or show that is not very interesting, I daydream rather than pay attention

A. Never

B. Rarely

C. Sometimes

D. Frequently

E. Always

12. On a long bus, train, or airplane ride I daydream

A. Never

B. Rarely

C. Occasionally

D. Frequently

E. A great deal of time

Appendix V: Mind Popping Questionnaire (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

Mind-popping refers to involuntary occurrence of certain contents (e.g., words, images, melodies, etc.) in one's mind mostly without any apparent external or internal trigger. For example, you may be doing washing up in the kitchen, and thinking about your upcoming trip to Paris when, all of a sudden, something comes to your mind quite clearly: a single word "Nicorette", a phrase "Midsummer night's dream", or a familiar tune from a TV advert. You are amazed because what popped into your mind has nothing to do with your current activity and/or thoughts. This clearly differs from occasions when certain cues bring back memories of past events, for example, when a particular smell reminds you of lunchtimes at school or a dog in the street reminds you a friend's dog you played with last week. If the difference between these two phenomena is clear to you, then you could proceed with the questionnaire:

QUESTION 1:

Have you ever experienced the phenomenon of involuntary mind-popping? (Please, bear in mind that there are big individual differences among people in this respect as some claim to have never experienced the mind pops whereas others seem to have them every day).

☐ **YES**

☐ **NO**

NB. If your answer to this question is "**NO**", you do not need to answer the remaining questions.

QUESTION 2:

If your answer to Question 1 was "**Yes**", how often do you have these mind-pops? Please, read carefully all the options listed below and tick the one which most accurately reflects the frequency of their occurrence:

☐ Only a few times in my entire life

☐ Once or twice a year

☐ Once or twice per 6 months

☐ Once or twice a month

☐ Once or twice a week

☐ Three or four times a week

☐ Once or twice a day

☐ Three or more times a day

QUESTION 3:

Below are listed the possible contents of involuntary mind pops. Please, put a tick along those contents which you think you have experienced at least once in your life. You can tick as many options as you. feel appropriate.

☐ A word in your native language

☐ A phrase or a sentence in your native language

☐ A proper name (of a person, town, street, TV programme, etc.)

- ☐ A word in a foreign language - and you know its meaning.
- ☐ A word in a foreign language - and you don't know or have forgotten its meaning.
- ☐ A visual image (of a building, place, etc.)
- ☐ A sound
- ☐ A melody
- ☐ Other (please, specify)

QUESTION 4(optional): If you can, please, give one or two examples of mind popping as you have experienced it.

Appendix VI: Internet Gaming Disorder Scale-short-form (IGDS9-SF) (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

Instructions to participants on Qualtrics:

These questions will ask you about your gaming activity during the past year (i.e., last 12 months). By gaming activity, we understand any gaming-related activity that has been played either from a computer/laptop or from a gaming console or any other kind of device (e.g., mobile phone, tablet, etc.) both online and/or offline.

	Never	Rarely	Sometimes	Often	Very Often
1. Do you feel preoccupied with your gaming behavior? (Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?)	○	○	○	○	○
2. Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?	○	○	○	○	○
3. Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?	○	○	○	○	○
4. Do you systematically fail when trying to control or cease your gaming activity?	○	○	○	○	○
5. Have you lost interests in previous hobbies and other entertainment activities as a result of your engagement with the game?	○	○	○	○	○
6. Have you continued your gaming activity despite knowing it was causing problems between you and other people?	○	○	○	○	○
7. Have you deceived any of your family members, therapists or others because the amount of your gaming activity?	○	○	○	○	○
8. Do you play in order to temporarily escape or relieve a negative mood (e.g., helplessness, guilt, anxiety)?	○	○	○	○	○
9. Have you jeopardized or lost an important relationship, job or an educational or career opportunity because of your gaming activity?	○	○	○	○	○

Appendix VII: The multidimensional schizotypy scale brief (MSS-B) (Studies 1, 2, 3, 4, Chapters 2, 3, 4, 5)

Instructions to Participants on Qualtrics:

The following items inquire about a broad range of attitudes, experiences, and beliefs that people have. Please answer each item in the way that best describes you. Please note that there are no right or wrong answers – just answer in the way that is most like you.

Item			
1	Yes	No	Throughout my life I have noticed that I rarely feel strong positive or negative emotions.
2	Yes	No	I have sometimes felt that strangers were reading my mind.
3	Yes	No	My thoughts and behaviours are almost always disorganized.
4	Yes	No	In general, it is important for me to have close relationships with other people.
5	Yes	No	I often think that I hear people talking only to discover that there was no one there.
6	Yes	No	Most of the time I find it is very difficult to get my thoughts in order.
7	Yes	No	I have always preferred to be disconnected from the world.
8	Yes	No	I have felt that there were messages for me in the way things were arranged, like furniture in a room.
9	Yes	No	I often have difficulty following what someone is saying to me.
10	Yes	No	If given the choice, I would much rather be with another person than alone.
11	Yes	No	I believe that dreams have magical properties.
12	Yes	No	I often feel so mixed up that I have difficulty functioning.
13	Yes	No	Throughout my life, very few things have been exciting or interesting to me.
14	Yes	No	I sometimes wonder if there is a small group of people who can control everyone else's behaviour.
15	Yes	No	My thoughts are so hazy and unclear that I wish that I could just reach up and put them into place.
16	Yes	No	Having close friends is not as important as people say.
17	Yes	No	I have had the momentary feeling that someone's place has been taken by a look-alike.
18	Yes	No	My thoughts and behaviours feel random and unfocused.
19	Yes	No	Generally, I do not have many thoughts or emotions.

20	Yes	No	There are times when it feels like someone is touching me when no one is actually there.
21	Yes	No	No matter how hard I try, I can't organize my thoughts.
22	Yes	No	Throughout my life, I have had little interest in dating or being in a romantic relationship.
23	Yes	No	I have had experiences with seeing the future, ESP or a sixth sense.
24	Yes	No	I find that I am very often confused about what is going on around me.
25	Yes	No	Most of the time I feel a desire to be connected with other people.
26	Yes	No	I often worry that other people are out to get me.
27	Yes	No	People find my conversations to be confusing or hard to follow.
28	Yes	No	There are just not many things that I have ever really enjoyed doing.
29	Yes	No	Some people can make me aware of them just by thinking about me.
30	Yes	No	My thoughts are almost always hard to follow.
31	Yes	No	I generally am not interested in being emotionally close with others.
32	Yes	No	I believe that there are secret signs in the world if you just know how to look for them.
33	Yes	No	I often have difficulty organizing what I am supposed to be doing.
34	Yes	No	My emotions have almost always seemed flat regardless of what is going on around me.
35	Yes	No	I often worry that someone or something is controlling my behaviour.
36	Yes	No	I have trouble following conversations with others.
37	Yes	No	Spending time with close friends and family is important to me.
38	Yes	No	At times I have wondered if my body was really my own.

Appendix VIII: The short-form version of the Depression, anxiety, stress scales (DASS-21) (Studies 1, 2, Chapters 2, 3)

Instructions to participants on Qualtrics:

Please read each statement and press a response that indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

		Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of time	Applied to me very much, or most of the time
1	I found it hard to wind down	**0**	**1**	**2**	**3**
2	I was aware of dryness of my mouth	**0**	**1**	**2**	**3**
3	I couldn't seem to experience any positive feeling at all	**0**	**1**	**2**	**3**
4	I experienced breathing difficulty (eg, excessively rapid breathing	**0**	**1**	**2**	**3**
5	I found it difficult to work up the initiative to do things	**0**	**1**	**2**	**3**
6	I tended to over-react to situations	**0**	**1**	**2**	**3**
7					

8	I experienced trembling (eg, in the hands)	**0**	**1**	**2**	**3**
9	I felt that I was using a lot of nervous energy	**0**	**1**	**2**	**3**
10	I was worried about situations in which I might panic and make a fool of myself	**0**	**1**	**2**	**3**
11	I felt that I had nothing to look forward to	**0**	**1**	**2**	**3**
12	I found myself getting agitated	**0**	**1**	**2**	**3**
13	I found it difficult to relax	**0**	**1**	**2**	**3**
14	I felt down-hearted and blue	**0**	**1**	**2**	**3**
15	I was intolerant of anything that kept me from getting on with what I was doing	**0**	**1**	**2**	**3**
16	I felt I was close to panic	**0**	**1**	**2**	**3**
	I was unable to become enthusiastic about anything	**0**	**1**	**2**	**3**

17	I felt I wasn't worth much as a person	**0**	**1**	**2**	**3**
18	I felt that I was rather touchy	**0**	**1**	**2**	**3**
19	I was aware of the action of my heart in the absence of physical exertion (eg,sense of heart rate increase, heart missing a beat)	**0**	**1**	**2**	**3**
20	I felt scared without any good reason	**0**	**1**	**2**	**3**
21	I felt that life was meaningless	**0**	**1**	**2**	**3**

Appendix IX: The short form of the Barrat impulsiveness scale (BIS-15) (Studies 1, 2, Chapters 2, 3)

Instructions to participants on Qualtrics:

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

1	2	3	4
Rarely/Never	Occasionally	Often	Almost Always/Always

1. I act on impulse
2. I act on the spur of the moment
3. I do things without thinking
4. I say things without thinking
5. I buy things on impulse
6. I plan for job security
7. I plan for the future
8. I save regularly
9. I plan tasks carefully
10. I am a careful thinker
11. I am restless at lectures or talks
12. I squirm at plays or lectures
13. I concentrate easily
14. I don’t pay attention
15. Easily bored solving thought problems

Appendix X: Working memory capacity; Automated symmetry task (Study 1, **Chapter 2)**

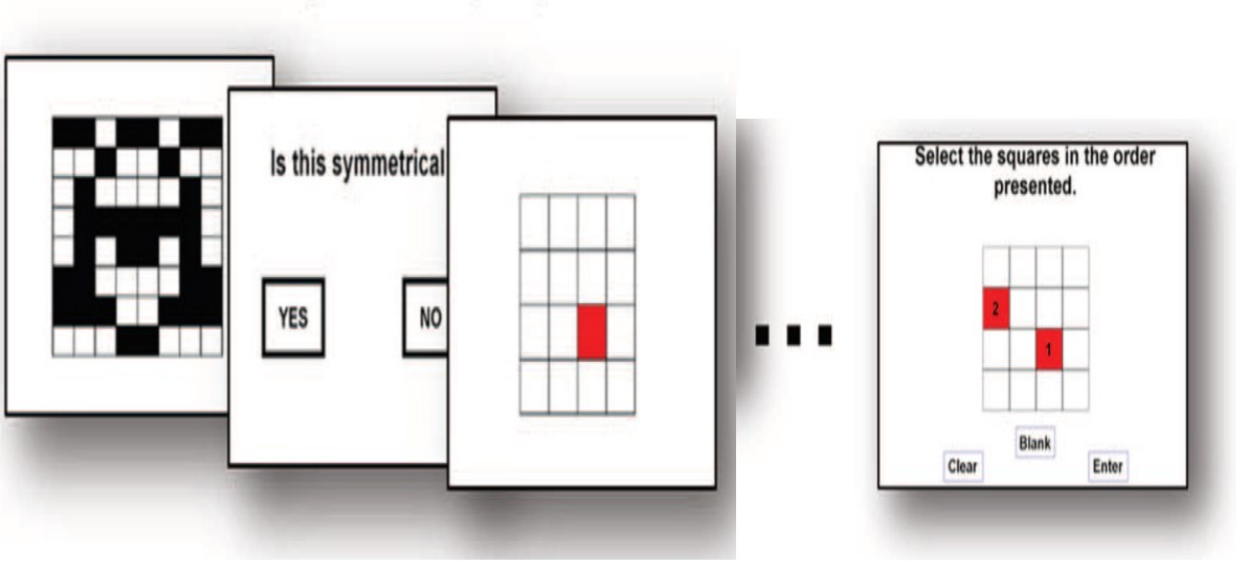
Instructions: In this task you will try to memorize the position of colored squares you see on the screen while you also make judgment about other pictures. In the next few minutes, you will have some practice to get you familiar with how the task works.

We will begin by practicing the square part of the task. For this practice set, squares will appear on the screen one at a time. Try to remember where each square was, in the order it was presented in. After 2-5 squares have been shown, you will see a grid of the 16 possible places the squares could have been. Your job is to select each square in the order presented. To do this, the squares you select will turn red. When you have selected all the squares, and they are in the correct order, hit the EXIT box at the bottom right of the screen. If you make a mistake, hit the CLEAR box to start over. If you forget one of the squares, click the BLANK box to mark the spot for the missing square. Remember, it is very important to get the squares in the same order you see them. If you forget one, use the BLANK box to mark the position.

Now you will practice doing the symmetry part of the task. A picture will appear on the screen, and you will have to decide if it is symmetrical. A picture is symmetrical if you can fold it in half vertically and the picture on the left lines up with the picture on the right (a perfect MATCH). Once you have decided if the picture shown is symmetrical, on the next screen a Yes and NO box will appear, then you will need to click either box according with your judgment. Once you decide, the computer will let you know if your decision was correct or not. It is very important that you get the pictures correct.

Now, you will practice doing both part of the task at the same time. You will be given one of the symmetry problems, once you decide, a square will appear on the screen. Try and remember the position of the square. In the precious section where you only decided about the picture symmetry, the computer computed your average time, the computer will automatically move you onto the square part, thus skipping the YES or NO part will count that problem as an error. Therefore, it is very important to solve the problems as quickly and as accurately as possible. After the square goes away, another symmetry picture will appear, and then another square. At the end of each set of pictures and squares, a recall screen will appear. Try your best to get the squares in the correct order. The real trials will look just like the practice trials you will complete. Some sets will have more problems than others. It is important that you do your best on both the symmetry and the square parts of this task. Thanks for your participation.

When you are ready to begin, click the START box.



Example of one complete trial (symmetry and square parts).

Appendix XI: Working memory capacity; reading task (Study 1, Chapter 2)

Instructions: In this experiment you will try to memorize letters you see on the screen while you also read sentences. In the next few minutes, you will have some practice to get you familiar with how the experiment works. We will begin by practicing the letter part of the experiment.

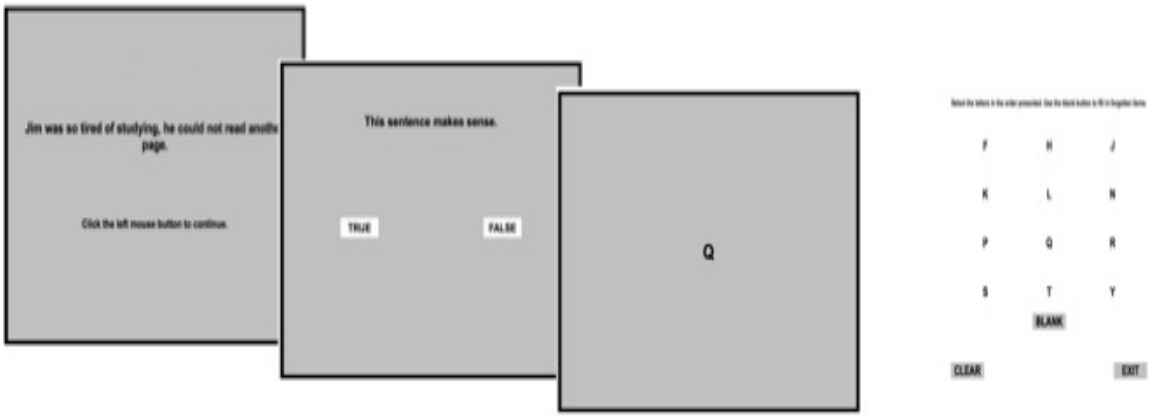
For this practice set, letters will appear on the screen one at a time. Try to remember each letter in the order presented. After 2-3 letter have been shown, you will see a screen listing 12 possible letters. Your job is to select each letter in the order presented. To do this, the letters you select will appear at the bottom of the screen. To continue, when you have selected all the letters, and they are in the correct order, hit the EXIT box at the bottom right of the screen. If you make a mistake, hit the CLEAR box to start over.
If you forget one of the letters, use the BLANK box to mark the spot for the missing letter. Remember, it is very important to get the letters in the same order as you see them. If you forget one, use the BLANK box to mark the position.

Now you will practice doing the sentence reading part of the experiment. A sentence will appear on the screen like this: “I like to run in the park” As soon as you see the sentence, you should read it and determine if it makes sense or not. The above sentence makes sense. An example of a sentence that does not make sense would be “I like to run in the sky” When you have read the sentence and determined whether it makes sense or not, please click either the TRUE or FALSE boxes on the screen. The computer will tell you if you make the right choice. It is very important that you answer the problems correctly, also that you try and read the sentences as quickly as you can.

Now you will do both parts simultaneously (the letters and the sentences), you will be given one sentence to read. Once you make your decision about the sentence, a letter will appear on the screen. Try and remember the letter. In the previous section where you only read the sentences, the computer computed your average time to read the sentences. If you take longer than your average time, the computer will automatically move you onto the next letter part, thus skipping the TRUE or FALSE part will count that problem as a sentence error. It is very important to read the sentences as quickly and as accurately as possible. After the letter goes away, another sentence will appear, and then another letter. At the end of each set of letters and sentences, a recall screen will appear. Use the mouse to select the letters you just saw. .
The real trials will look just like the practice trials you will complete. Some sets will have

more problems than others. It is important that you do your best on both the sentences and the letter parts of this task. Thanks for your participation.

When you are ready to begin, click the START box.



Example of one complete trial (sentence and letter parts).

Appendix XII: Diary Questionnaire of GTP (Study 2, Chapter 3)

1. Time and date of the GTP experience.
2. Time and of date when the record was made.
3. Please give a brief description of your experience, what exactly happened?

4. Was the experience of GTP triggered by something?
   (a) in your thoughts
   (b) in your environment
   (c) there was no trigger (if no trigger, move to Question 6)

5. Please describe what triggered your experience of GTP?

6. What were you doing immediately before the GTP experience?

7. How much were you concentrating on this activity?

1	2	3	4	5
Not at all				Fully concentrating

8. How demanding or difficult was the activity you were doing?

1	2	3	4	5
Not at all				Very Demanding

9. How pleasant or unpleasant was the GTP experience?

1	2	3	4	5
Very unpleasant	Unpleasant	Neutral	Pleasant	Very pleasant

10. What was your mood before the GTP experience? (Circle as appropriate. In this scale 4 is 'neutral.')

1	2	3	4	5	6	7
Very Negative			Neutral			Very Positive (happy)

11. Were you affected by alcohol or some drug when you had the GTP experience?
    □ Yes □ No

12. Have you ever had this GTP experience before?

1	2	3	4	5
Never	Once or twice	A few times	Several times	Many times

13. When was the last time you played the game which relates to the content of your GTP experience?

14. When was the date and duration of your last gaming session before your GTP experience, indicate the name of the game and for how long you played it?

Appendix XIII: Diary of Game transfer Phenomena (Instructions) (Study 2, Chapter 3)

Diary Instructions

You are asked to keep a diary of Game Transfer Phenomena (GTP). They can manifest as game related automatic thoughts, sensory perceptions or hallucinatory experiences (e.g., hearing or seeing things from the game), that come to mind spontaneously without deliberate intention to have them. They can also manifest as automatic motoric actions (e.g., repeating movements you made in the game). They can range from trivial experiences to important experiences, can be pleasant or unpleasant and can have a short or long duration. They may happen soon after you have finished a gaming session, however, they can also happen any other time after this. Sometimes, you know what triggered your experience and sometimes it seems to come out of blue (i.e., you can not detect any trigger in the environment or in your own thoughts). At the beginning of this recording period, you will receive an Email reminder to start recording your GTP experiences next morning from your skype meeting with the researcher.

In the diary booklet, there are 32 pages (one page per GTP experience). When you experience GTP, please complete the questionnaire on a diary page. We do not expect a minimum or maximum number of GTP recordings. You may have very few or many. If, for some time, you do not experience any GTP at all, that's fine, too. The most important thing is that you do record only genuinely GTP experiences. In other words, you should not try to consciously force them to occur even when you have not recorded any GTP experiences for some time.

It is essential that you carry this diary with you always during the following 7 days, so that you can record the experiences as immediately as possible after they occur. However, there are situations where it is clearly not possible to record GTP experiences, like when you are driving, in the middle of an important meeting, during class, etc. In such cases, record the event at the earliest opportunity after its occurrence. If by the time you can record the GTP experience, you have already forgotten some essential details, then you do not need to record it in the diary by filling in the questions. Instead, you can acknowledge the occurrence of this event by 'ticking' the box on a grid provided on the reverse side of the diary cover page.

There are 14 questions to answer on each page about each GTP experience recorded. Some are structured (you should tick the appropriate response), others are open ended (you describe something with your own words). Each question is explained in more detail below:

1. Write down the exact time and date when you had a GTP experience.

2. Write down the exact time and date when you recorded the experience.

3. Describe what exactly happened during your experience. Below are three examples given during a previous study:

(a) "The GTP experience was about wishing to make a portal like in the video game "Apex legends or Portal", triggered by the need to reach my coffee mug without standing up".

(b) "I remembered the famous scene of Gray Fox slaughtering a lot of soldiers in a big hall in Metal Gear Solid 1. I was walking on this empty and long hall at campus and suddenly I felt like I was in the game for a few seconds.

(c) I was playing "Xenua's Sacrifice", after 3 hours I was on my way to the grocery store and suddenly I started hearing voices as in the game, like if someone was whispering in my ears.

4. Was the experience of GTP triggered by something?
   Indicate if your experience was triggered by something in your thoughts, your surroundings or whether there was no easily identifiable trigger
   (d) in your thoughts
   (e) in your environment
   (f) there was no trigger

5. If you chose (a) or (b), please describe briefly what triggered your experience of GTP? For example:
   - In your thoughts (e.g., you were thinking about the song you were listening in a game and suddenly you started moving your fingers as you were playing it)

- In your environment (e.g., I saw a pile of boxes of different sizes in the supermarket, and I felt that I was playing Tetris trying to arrange every box in the proper order)

6. Describe exactly what were you doing when you had the GTP experience (e.g., trying to fall sleep, doing exercise, driving, cleaning the house, playing soccer, etc.)

7. Indicate how much were you concentrating on this activity where 'not at all concentrating' indicates that you were performing this activity automatically, and probably thinking about other unrelated things, while 'fully concentrating' means that you were entirely focused on the task, without thinking about anything else.

8. Indicate how demanding or difficult was the task you were performing where 'not at all' means that the task did not require any mental effort, and where 'very demanding' means the task did require a lot of mental effort to perform it properly.

9. Indicate if you were under the effects of alcohol or some drug when you had the GTP experience

10. Indicate how pleasant or unpleasant was your experience where 'very pleasant' means that you really enjoyed the experience and would like it to happen again, and where 'very unpleasant' means that you felt worried, stressed or anxious about the experience and did not wish it to happen again.

11. If you have experienced this event before Indicate how often it happened

12. Indicate how was your mood before the GTP experience where 'very happy' means you were very happy and in a quite positive mood, and 'very negative' means you were very sad or distressed.

13. Describe when exactly you played for the last time the game related with your experience, mention the name of the video game and for how long you played, for example:

    (a) I was playing "Fortnite" 2 days ago for about 4 hours

(b) I was playing “Overwatch” 30 minutes ago for about 2 hours

(c) I was playing “Smash Bros Ultimate” 5 hours ago for about 6 hours

14. Describe, as accurately as possible, the time and date of your last gaming session, also mention the name of the game, and for how long you played it.
PS: If your last gaming session match with the GTP experience you just describe above, just write “Same as question 12” otherwise please specify.

Appendix XIV: The Post-Diary Questionnaire of GTP (Study 2, Chapter 3)

Below is a list of questions that relate to your experiences of keeping a diary of GTP experiences for a required period. For each question, please tick the answer that best applies to you. Some of the questions may seem to repeat sections of your diary entries. Please, still provide an answer as the purpose of this questionnaire is to find out whether the use of a diary method worked well or not and if you felt this was a useful or interesting experience.
There are no right, or wrong answers so please answer honestly:

1. Did you keep a diary with you all the time during the requested period?

❍ Yes ❍ No

2. If you did NOT keep your diary with you all the time, was there a reason for this and if so please write what the reason was?

3. How did you find keeping your diary with you at all time or most of the time?

❍ Very easy ❍ Somewhat easy ❍ Somewhat difficult ❍ Very difficult

4. Did you occasionally deliberately remind yourself of the task?

❍ Yes ❍ No

If *Yes*, how often? And how?

5. Did things in the environment remind you of the diary task of recording GTP experiences?

❍ Yes ❍ No

If *Yes*, what were things that reminded you were on the task/study?

6. What percentage of GTP experiences that you had during the recording period do you think you were able to record and acknowledge in your diary?

_____%

7. How did you find recording your GTP experiences using the diary provided?

❍ Very easy ❍ Somewhat easy ❍ Somewhat difficult ❍ Very difficult

If you found it difficult, what made it difficult for you?

8. Any other comments?

Appendix XV: Word Fragment Completion task- LIST A and B (Study 3, Chapter 4)

Buffer words study phase: clock, snake, heart, peanut, doorknob, snowman, pencil, banana, swing, knife

Instructions *study phase.*

In this task, you will see a list of words, one by one, and you will have to rate each word for pleasantness. You should think about the real object, depicted by the word, and then rate each one for pleasantness on a scale of 1 (Very unpleasant) to 5 (Very pleasant) with 3 being Neutral (neither pleasant nor unpleasant).

People with different personality types differ in how they perceive the pleasantness of common words, the same word (e.g., school or grass) will be rated differently by different people. **It is important that you rely on your first impression of the word's pleasantness rather than overthinking and running out of time.**

You will have up to 6 seconds to rate each word. If, by the end of 6 seconds, you have not provided your rating, the next word will come up, but if you respond earlier, that is completely fine, just wait until the next word appears.

Instructions *test phase.*

In this task, which is the last task that you have to complete, you will have to solve 46 word puzzles.

You will see word fragments with missing letters one by one, and your task is to type in the correct word that successfully completes the blanks.

This task requires your full attention, because some fragments are quite challenging, please try your best to complete them! You will have only **12 seconds** to complete each fragment. If you complete a word fragment sooner, please click on the arrow button to move to the next word fragment.

All the fragments you will find in the task are **"singular nouns"** please avoid words such as people names or brands.

Please carefully check the following examples that have been already completed:

a p _ l _ (apple)

o_ e _ (open)

m o _ e _ u l _ (molecule)

Practice words test phase:

pineapple = p _ n e _ p p l e

potato = p _ t _ t o

bottle = b o _ t l_

cigarette = c i _ a r e t t _

waterfall = w a t _ r _ a l l

button = b u t _ o _

Buffer words study pase:

Clock, snake, heart, peanut, doorknob, knife, swing, banana, pencil, snowman

	List A words	*List A fragment*	*List B words*	*List B fragment*
1	*avocado*	*_ v _ _ a d _*	*cinnamon*	*_ i _ _ a m o _*
2	*flamingo*	*_ l _ m I _ g _*	*insomnia*	*_ n _ _ m n _ a*
3	*delirium*	*d_ l _ _ I u _*	*horizon*	*h o _ _ _ o n*
4	*monogram*	*m o _ o _ _ _ m*	*cholera*	*c _ o _ _ r a*
5	*espresso*	*_ s _ r _ _ s o*	*pendulum*	*_ e _ d _ l _ m*
6	*bladder*	*b _ _ d d e _*	*gazelle*	*_ a z _ l _ e*
7	*ladybug*	*l a _ y _ _ g*	*antenna*	*_ n _ _ n n a*
8	*asbestos*	*_ s b _ _ _ o _*	*migraine*	*_ i g r _ _ n _*
9	*verandah*	*v _ _ a _ d _ h*	*universe*	*_ n I _ _ r _ e*
10	*ideology*	*_ d e o _ o _ _*	*democrat*	*_ _ m _ c _ a t*
11	*ellipse*	*_ l l _ p _ e*	*assassin*	*a _ _ a _ _ i n*
12	*rhubarb*	*_ h u _ _ _ b*	*coconut*	*_ o _ o _ u t*
13	*dinosaur*	*d _ n _ s a _ _*	*plankton*	*_ _ _ n k _ o n*
14	*spatula*	*_ p _ t u _ a*	*clarinet*	*_ l _ r _ _ e t _ _*
15	*cavalry*	*c _ v a _ _ y*	*membrane*	*m _ b _ _ n e*
16	*bandanna*	*_ a _ d _ n n a*	*mistery*	*_ y s _ _ r y*
17	*leprosy*	*_ e _ _ o s y*	*menthol*	*m _ _ t _ o l*
18	*sheriff*	*s _ _ _ _ f f*	*chipmunk*	*c h _ _ _ _ n k*
19	*gangrene*	*g _ _ g r _ _ e*	*conifer*	*c_ n I f _ _*
20	*borough*	*_ o _ _ u g h*	*surgeon*	*s u _ g _ _ n*

Appendix XVI: Lexical Decision Task (Non-target words) (Study 4, Chapter 5)

List A and B of words (non-targets) including length, number of syllables, level of concreteness and familiarity (above 4 points).

List A	Words (Non-targets)	Length	syllables	concreteness	familiarity	List B	Words (Non-targets)	Length	syllables	concreteness	familiarity
1	Relic	5	2	5.24	5.44	1	adult	5	2	4.88	6.64
2	Baton	5	2	4.34	5.62	2	canon	5	2	5.37	4.98
3	Temple	6	2	5.52	5.34	3	ferry	5	2	5.72	5.4
4	Barrel	6	2	5.77	6.12	4	inhale	6	2	4.13	5.9
5	Gutter	6	2	4.94	5.41	5	lesson	6	2	4.19	6.34
6	Puddle	6	2	6	5.95	6	nation	6	2	4.17	5.3
7	Riddle	6	2	4	5.63	7	valley	6	2	5.76	6.28
8	Wallet	6	2	5.8	6.09	8	tripod	6	2	5.66	5
9	Loafer	6	2	4.13	5.53	9	sodium	6	2	5.07	4.77
10	Carbon	6	2	5.07	5.44	10	resort	6	2	4.95	5.97
11	Walnut	6	2	6.38	6.12	11	dollar	6	2	5.76	6.83
12	Circus	6	2	5.31	5.78	12	collar	6	2	6.18	5.83
13	Dancer	6	2	5.54	6.09	13	brandy	6	2	5.91	6.16
14	Bouquet	7	2	5.97	6.59	14	father	6	2	5	6.65
15	Antique	7	2	4.78	5.72	15	oxygen	6	3	4.73	6.12
16	Lantern	7	2	6.26	5.64	16	pudding	7	2	6.13	6.25
17	Platter	7	2	5.89	5.52	17	dresser	7	2	5.56	6
18	Rowboat	7	2	5.49	5.59	18	boulder	7	2	5.97	6.59
19	Tarnish	7	2	4.39	5.29	19	glutton	7	2	4.78	5.64
20	Croquet	7	2	5.55	4.92	20	hallway	7	2	5.71	6.16
21	Quarter2	7	2	5.9	6.21	21	incense	7	2	4.95	5.78
22	Alcohol	7	3	6.45	6.27	22	drizzle	7	2	5.54	5.9
23	Fingers	7	2	6.4	6.67	23	duchess	7	2	5.64	4.9
24	Academy	7	4	4.95	5.83	24	fertile	7	2	4.26	5.76
25	Hamster	7	2	5.95	5.41	25	harness	7	2	5.33	5.63
26	Bourbon	7	2	5.66	6.05	26	phantom	7	2	4.24	5.39
27	Stadium	7	3	5.65	6	27	whisker	7	2	5.56	5.9
28	Cocktail	8	2	5.72	5.85	28	parcel	7	2	5.21	5.77
29	Shoulder	8	2	5.67	6.02	29	earrings	8	2	6	6.39

30	Chestnut	8	2	5.96	5.97	30	raincoat	8	2	6.25	5.69
31	Dandruff	8	2	5.42	5.69	31	mortgage	8	2	4.18	5.8
32	Princess	8	2	5.64	5.76	32	islander	8	3	5	5.48
33	Granular	8	3	4.46	4.97	33	lemonade	8	3	6.36	5.92
34	Canary	8	3	5.73	4.85	34	elephant	8	3	6.53	5.73
35	Cigarette	9	3	6.03	6.47	35	magazine	8	3	5.91	6.15
36	Saxophone	9	3	6.18	5.92	36	aluminium	8	4	5.19	5.68
37	Hurricane	9	3	5.84	6.1	37	orchestra	9	3	5.87	5.97
38	submarine	9	3	6.62	6.18	38	jellyfish	9	3	6.04	5.53
39	Commercial	10	3	4.76	6.33	39	penicillin	10	4	5.86	5.68
40	Screwdriver	11	3	5.7	6.18	40	marshmallow	11	3	6.43	5.86

Appendix XVII: Lexical Decision Task. Target words and Non-Words (Study 4, Chapter 5)

List A and B of Target words.

List A	Words Game-related (Target words)	Number of syllables	Length	List B	Words Game-related (Target words)	Number of syllables	Length
1	progress	2	8	1	wreckage	2	8
2	rewind	2	6	2	redeem	2	6
3	position	3	8	3	kangaroo	3	8
4	finished	2	8	4	steering	2	8
5	accolade	3	10	5	objective	3	9
6	checkpoint	2	8	6	campaign	2	8
7	festival	3	6	7	discover	3	8
8	winner	2	7	8	event	2	5
9	circuit	2	7	9	garage	2	6
10	horizon	3	8	10	upgrade	2	7
11	flamingo	3	6	11	parachute	3	9
12	outrun	2	7	12	jungle	2	6
13	traffic	2	7	13	pyramid	2	7
14	cactus	2	6	14	driver	2	6
15	competition	4	11	15	celebration	4	11
16	volcano	3	7	16	culture	2	7
17	spanish	2	7	17	airplane	2	8
18	motor	2	5	18	rainy	2	5
19	highway	2	7	19	meadow	2	7
20	drifting	2	7	20	desert	2	6

List A and B of non-words including length and number of syllables.

List A	Non-words	Length	syllables	List B	Non-words	Length	syllables
1	intex	5	2	1	bremo	5	2
2	tikto	5	2	2	yemers	6	2
3	visie	5	2	3	alibes	5	2
4	anklus	6	2	4	astumed	6	2
5	chonza	6	2	5	othate	6	2
6	chuted	6	2	6	niktep	6	2
7	teblin	6	2	7	jumple	6	2
8	brodly	6	2	8	pratoh	6	2
9	kontab	6	2	9	oralfe	6	2
10	tiabre	6	2	10	mechal	6	2
11	autumes	7	2	11	psyfon	6	2
12	werlic	6	2	12	shadol	6	2
13	ayates	6	2	13	faumir	6	2
14	napblin	6	2	14	phachi	6	2
15	acadle	6	3	15	pifola	6	3
16	neagued	7	2	16	milodue	7	3
17	zoartech	7	2	17	clietes	7	2
18	wheisty	7	2	18	floutos	7	2
19	shotbul	7	2	19	nulizem	7	3
20	twinted	7	2	20	roatblek	7	2
21	esplonch	7	2	21	zoncled	7	2
22	waitled	7	2	22	clemans	7	2
23	lemmeds	7	2	23	metetch	7	2
24	crostic	7	2	24	milrent	7	2
25	fainble	7	2	25	squando	7	2
26	alighnt	7	2	26	flyclin	7	2
27	guettes	7	2	27	werefek	7	3
28	acleque	7	3	28	sharblek	7	2
29	spoolink	8	2	29	rockleps	8	2
30	palenged	8	2	30	prighwai	8	2
31	whamuled	8	2	31	gamblent	8	2
32	fleligde	8	2	32	hovarlow	8	3
33	bloomero	8	3	33	pelgulid	8	3
34	phyrechos	8	3	34	wrogongo	8	3
35	phounemu	8	3	35	sckincle	8	2
36	elebimum	8	4	36	acabently	8	4
37	acapunte	9	3	37	torolimed	9	3
38	dreameglo	9	3	38	tictatung	9	3
39	blenecivly	10	4	39	cartesticly	10	4
40	platunstra	11	3	40	shoroutleck	11	3