

# **Exploring Game Transfer Phenomena:**

A multimodal research approach for investigating  
video games' effects

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I declare that the work presented in this thesis is, to the best of my knowledge and belief, original and my own work, except as acknowledged in the text. The material (presented as my own) has not been submitted previously, in whole or in part, for a degree at any other institution.

### **Statement of Contribution of Others**

In those cases where the material of this thesis has been published in collaboration, I declare that my contribution was substantial and prominent, involving the development of original ideas, as well as the definition and implementation of subsequent work. Detailed information about my contribution to published work part of this thesis is outlined in Appendix I, and abstract of the published papers on which individual chapters are based are presented in Appendix II.

## **Dedication**

This work is dedicated to all video game players, and those that believe that dreams can be built little by little with patience, perseverance and passion.

## Acknowledgements

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Critical inquiry and research on the psychosocial implications of technologies has been my professional passion since undergraduate school, more than fourteen years ago, where I completed my thesis on Internet addiction. Since then, I have been committed to better understanding the impact that our interaction with new technologies is having on us, both for

maximizing its benefit while reducing any potential associated risk. My search for new perspectives that contribute to the comprehension of human behaviour has finally started to benefit the gaming population in demystifying their GTP experiences and that is the most important accomplishment of this doctoral research.

*“It is nice to see that all those weird things which have happened to me, when it feels that my gaming experiences are sort of bleeding into my reality, actually has a name [Game Transfer Phenomena], and it wasn't just me :P”*

(Participant in the online survey in this thesis)

*Oh and here was me thinking, my seeing and hearing things that weren't real was just a symptom of my severe bipolar depression. Turns out I have just been gaming too hard. Phew! That's a relief”*

(Participant in the online survey in this thesis)

Thanks to all, that in one way or another have participated and contributed to my research. Gamers’ comments, critics, videos, cartoons, news and poetry enriched my days as a PhD student and strengthen my commitment to contribute to society through my research. Thanks to all of you who have made it possible for me to build up a new path for exploring my professional passion.

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## Abstract

Video games are evolving and are becoming ever more immersive. Consequently, it is necessary to understand their effects on gamers' psychological wellbeing. The impact on cognition, affect and behaviour has mostly been investigated separately and sometimes from narrow approaches that limit the understanding of the video games' effects. This thesis investigates the effects of playing video games from a novel, multimodal and broad research approach that is termed "Game Transfer Phenomena" (GTP). The Game Transfer Phenomena framework examines the influence of video games on gamers' sensorial perception, cognitions, and behaviours directly related to video games' structural characteristic, game content and, in-game activities.

A theoretically eclectic approach is taken to explain the interplay of physiological, perceptual, and cognitive mechanisms involved in GTP, mainly informed by socio-cognitive and behavioural theories. Mixed-methods were used in the empirical research. The three qualitative studies presented here were analysed by content and thematic analysis methodologies (n=1,244), and the quantitative online survey using appropriate statistical testing (n=2,362). The specific aims of the thesis were: (i) identify, classify and explain GTP experiences collected in online video game forums divided in three empirical studies, and (ii) investigate the characteristics of GTP, and factors associated with GTP in a cross-cultural online survey with a total sample of English and Spanish Speaking gamers.

The results suggest that gamers experience a variety of non-volitional phenomena when not playing. (i) Experiencing thoughts, urges, images, sounds, tactile and kinaesthetic perceptions and sensations associated with the game, (ii) perceiving distorted physical stimuli due to the video game features, (iii) confusing physical stimuli with video game elements, (iv) responding to certain physical stimuli as in the game, and (v) experiencing involuntary body movements and behaviours directly related with the video game. In summary: (i) different gamers reported similar GTP in the same video games, (ii) GTP are in the continuum between normal and pathological phenomena, and appear to reflect failures in cognitive and control inhibition, and neural adaptations, (iii) age and occupation, having a medical condition, gamer type, session length, playing for escape, immersion, exploring, customization and rules and mechanics were significantly associated with GTP, and (iv) the appraisal of GTP were either positive or negative (with one in five players experiencing distress or dysfunction due to their GTP

experiences). Findings suggest that resemblances between virtual and physical objects facilitate GTP and these may be strengthened with more advanced technologies. Knowing about particular video game features and their effect on gamers may contribute to taking more informed decisions regarding the psychological, cognitive, physiological and social effects of video games and the technologies that are still to come.



## Part I. Introduction

### Chapter 1 - The Effects of Video Game Playing: Cognition, Affect, Behaviour and psychophysiology

There is a long history of us humans trying to enhance and alter our senses. This has been done in many different ways. For instance, walking through a crowd wearing headphones can enhance the panoramic view with our favourite music (Ortiz de Gortari & Griffiths, 2012a). Video games are one of the most immersive technologies today and also one of the most popular ways to enhance the senses and induce altered states of consciousness (Ortiz de Gortari & Griffiths, 2012a; Wood, Griffiths, & Parke, 2007). As video games become more realistic and immersive, the more important it becomes to understand the challenges the human mind faces in light of the new technologies that are still to come.

Video game playing has been the subject of an increasing amount of empirical research. This research has typically polarized the potential positive and negative effects of playing video games, and so far the results are mixed. Some researchers have even argued that there are very limited or no positive or negative effects of video games (Ferguson, 2007a; Sherry, 2007; Valadez & Ferguson, 2012). A few scholars have suggested different approaches to examine video games' effects without the need to dichotomize the effects. For instance, Gentile (2011) suggested four dimensions to investigate the effects without focusing on a positive or negative side. These are: (i) amount of play, (ii) content of play and game context, (iii) structure of the game, and (iv) mechanism of game play. The *amount of play* is understood as the time spent playing and gaming habits. *Content of play* refers to the message and topic delivered by the video game. The *structure of the game* refers to how the game content is presented to the player, the *mechanism of game play* refers to the input-output devices used, which means what interfaces are used for interacting with the game. Other researchers refer to direct and indirect effects of the exposure to virtual environments. According to Virre and Bush (2002), direct effects are the ones that affect at tissue level such as photic seizures, migraines, damage of visual or auditory system, and injures, whereas indirect effects refer to effects at a high functional level such as modification of behaviour, eyestrain, modification of stereoscopic vision, visual acuity, modification of perception and motion sickness and, psychological implications (Virre & Bush, 2002, p. 581). Other studies have focused on understanding

transfer of cognition, perceptions, emotions, and/or behaviour from virtual experiences to real life contexts (Bigl, April, 2009; Fritz, 2005; Ortiz de Gortari, Aronsson, & Griffiths, 2011c; Poels, Ijsselstein, & de Kort, 2014; Wesener, 2004; Witting, 2007) or how media exposure modifies the perception of real life contexts by cultivating attitudes and beliefs about the real world (Beullens, Roe, & Van den Bulck, 2011, 2012; Chong, Teng, Siew, & Skoric, 2012; Van Mierlo & Van den Bulck, 2004; Williams, 2006).

The effects of video game playing have been investigated by (i) experimental studies where the participants are assigned to different treatment and control conditions for further comparisons between the groups, (ii) cross-section correlation or correlational studies that measure the relation between independent and dependent variables that explore the relationship between different factors, where causality is not possible to establish, and (iii) longitudinal studies that examine the effects of video game playing over a period of time by measuring independent and dependent variables at different points in time. Also, meta-analytical reviews and a variety of qualitative approaches have been carried out to understand the dimensions of the game experience. Since the Game Transfer Phenomena (GTP) framework examines the interplay of cognitive, physiological and behaviour mechanisms involved in gamers' experiences the overview in this chapter includes studies in each of these areas.

Research into video game effects is a relatively new area of research. Therefore, the aim of this chapter is to map the broad dimensions where research into video games' effects has been carried out in terms of cognitions, affects, behaviours and physiological effects, rather than engaging in the discussions of the findings of the studies included in this overview. Therefore papers were searched in respect to the dimension of cognitions (e.g., thoughts, intrusive thoughts or obsessions, cognitive bias, daydreams, dreams, etc.). This was done to identify in which areas more research about video game effects is required, and to identify the areas of opportunity for the further development of new approaches to investigate video game effects. This chapter also reviews health factors influenced by video game playing. Moreover, since a variety of tools and tasks have been used for assessing the effects of gaming, the limitations and areas that have not been assessed typically in research about the effects of video games are discussed. This chapter is organized as follows: (i) controversies of research about video games' effects, (ii) effects of playing video games on cognitions, affective states and, behaviours, (iii) physiological and psychophysiological effects of playing games, (iv) health effects, video game habits and consequences of excessive gaming, and (v) instruments typically used for assessing video games' effects.

## **Controversies of Research about Video Games' Effects**

Some of the most controversial issues concerning research into video games' effects include (i) the length of the exposure to the game in experimental studies, (ii) the actual duration of the video games' effects over time, and (iii) the actual transfer of video games' content to real life behaviours. On one side, concerning the length of exposure to the game, in research studies focusing on the improvement of cognitive skills by playing games, participants tend to play for longer periods of time (e.g., days, weeks or months), as a "training schedule", while in experimental research examining the negative effects of video games have often used participants playing only once or for very short periods of time (e.g. 5 to 75 minutes). This fact raises even more concern about the ecological validity of the outcomes measured in laboratory settings. Extreme outcomes and measures may merely be the result of overreaction to novel stimuli and activities.

On the other hand, little attention has been paid to measuring the temporal stability of the effects after playing or has taken into consideration the duration of the effects in cognition, affect, or behaviour over time. Only a few studies have used "lag designs" that consist of "increasing the distance between manipulating the independent variable and measuring the dependent variable" (Fischer et al., 2009, p. 1398). Distances between the measures may potentially reduce the possibilities that video game playing outcomes are pure habituation (Bradley, Lang, & Cuthbert, 1993), neural adaptation (Liang, Kern, & Egelhaaf, 2008), or short-term priming (Berkowitz & Rogers, 1986).

Research that has taken into consideration the deleterious effects of video game playing suggests that when video game outcomes are assessed with a delay, the expected influence of the video game decrease or disappear. For instance, Sestir and Bartholow (2010) found that when the outcomes were measured immediately after playing, those who played violent video games were more likely to have aggressive thoughts, and hostile affect, but when the outcomes were assessed 15 minutes after playing the game, there were no effects found, whereas in those who played the nonviolent video game the aggressive outcomes increased. Also, studies have found differences between the duration of changes on cognitions, behaviours and arousal after stopping playing a video game. In the study conducted by Barlett and colleagues (2009a) aggressive feelings and thoughts lasted less than four minutes, while higher heart rate and aggressive behaviour lasted four to nine minutes. Bushman and Gibson (2011) examined the

role of ruminating about video game content after playing. They found that participants who were instructed to ruminate behaved more aggressively 24 hours later when competing in a reaction time task by providing a blasting noise to the loser. Similarly, other research focusing on the effects of racing games (2009) found that the effect of playing a racing game (*Burnout*) on risk-taking remained even one day later when participants come back to the laboratory and engaged in simulated road traffic situations (Schuhfried, 2006).

An increasing (but still limited) number of studies have assessed the long-term effects of video game playing that are explained by the repetitive exposure to certain video game content and that facilitates the settling down of scripts, the strengthening of associations, which facilitate the activation of scripts (Anderson & Dill, 2000; Carnagey & Anderson, 2005) according to the General Learning Theory (Anderson & Dill, 2000).

Longitudinal designs usually comprise a series of cross-sectional measures that are taken at different periods of time (i.e., per week, month, or year) or studies where participants played a game more than one time during and experiment. Some studies have reported an increase of negative effects related to risky driving or higher levels of aggression over time (Hull, Draghici, & Sargent, 2012; Willoughby, Adachi, & Good, 2012) but the results are mixed (Ferguson, San Miguel, Garza, & Jerabeck, 2012). Bushman and Huesmann (2006) argue (based on the cognitive associative network) that temporary short-term changes in behaviour tend to be more pronounced in adults because they occur via the priming of already encoded scripts, schemas, or beliefs, which are already settled down in memory and that required to be replaced, modified, or reorganized. Since children have less experiences and less coded information that needs to be overwritten, games may facilitate them to learn quicker or encode new scripts, schemas or beliefs faster via observational learning (that sometimes result in imitation of actions and conduct).

### **Video Games' Effects on Cognitions**

This section includes an overview of research concerning video games into enhancement of cognitive skills and failures of cognitive control, prosocial cognitions, stereotypes, cognitions and intention related to risk behaviours, pervasive thoughts, daydreaming, dreams, and nightmares.

### **Enhancement of cognitive skills and failures of cognitive control associated with gaming**

On one hand, studies suggest that video game playing is capable of enhancing cognitive abilities beyond those tasks specific to the game (Boot, Blakely, & Simons, 2011b) and suggests that training using video games can be used for therapy and learning means, even when the games have not actually been developed for such purposes. More specifically, “serious games” or “good games” have been used successfully for therapeutic purposes (e.g., rehabilitate veterans suffering from brain injuries) (Jean, 2010) or learning (e.g., to learn about diabetes) (Brown et al., 1997). On the other hand, commercial video games which aim to purely entertain have been associated with positive outcomes such as improving cognitive, perceptual and, visuomotor skills (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Green & Bavelier, 2003), enhancing top down-attentional control that moderate attentional failures due to bottom-up attention (Chisholm, Hickey, Theeuwes, & Kingstone, 2010) and reducing flashback memories (Holmes, James, Coode-Bate, & Deeprose, 2009). On the other hand, research has found limited or no differences between gamers and non-gamers relating to positive cognitive effects (Boot, et al., 2008; Irons, Remington, & McLean, 2011). Also, studies have found relationships between the exposure to media violence and poor executive control, especially in adolescents with history of aggressive disrupted behaviours (Kronenberger et al., 2005).

Research concerning sustaining attention rather than measuring changes on attention (e.g., Boots, et al., 2011, Green & Bavelier, 2003) has investigated individuals’ capacity to focus on a task at hand and inhibit irrelevant and impulsive responses. Studies in this area have found correlations between attention deficits and media exposure (e.g., television, video games) (Chan & Rabinowitz, 2006; Gentile, Swing, Lim, & Khoo, 2012; Kronenberger, et al., 2005; Swing & Gentile, 2010). It has been argued that video games’ fast pace, continual positive reinforcement, and rapid changes in shifts in attention required to track different stimuli in the games make the relationship between video game playing and deficits in sustaining the attention plausible (Barlett, Anderson, & Swing, 2009; Swing & Gentile, 2010). Bailey, West and Anderson (2010) investigated the effect of video game experiences on reactive and proactive cognitive control and found that reactive cognitive control, the ability to solve conflicts when ambiguity or incongruence arise, appears not to be affected by the gaming experience, but the efficiency of proactive cognitive control, which is the ability to sustain the attention on a current task was reduced among frequent gamers.

### **Prosocial, aggressive, stereotypical and risky-related cognitions**

In terms of prosocial cognitions, participants in gaming experiments have shown (i) greater accessibility to prosocial cognition in lexical decision task (Greitemeyer & Osswald, 2011), (ii) decreases in aggressive cognitions such as less aggressive expectations, decreased accessibility of antisocial thoughts (Greitemeyer & Osswald, 2009); (iii) empathy when thinking about donating a great amount of money (Jin, 2011b), and (iv) increases in interpersonal empathy, and decreases in pleasure at another person's misfortune (Greitemeyer, Osswald, & Brauer, 2010).

According to Gentile and colleagues (2014), aggressive cognitions are better mediators for aggressive behaviour than other factors such as age and gender. Aggressive thoughts after playing a video game lasted less than four minutes (Barlett, Branch, et al., 2009a). For instance research has found that violent video games lead to: (i) increase of the accessibility of aggressive cognition (Barlett, Branch, Rodeheffer, & Harris, 2009b); (ii) hostile expectations bias (Bushman & Anderson, 2002; Hasan, Bègue, & Bushman, 2012; Kirsh, 1998; Krahe & Möller, 2004); (iii) faster identification or selective attention toward aggression-related words (Anderson & Dill, 2000; Kirsh, Olczak, & Mounts, 2005); (iv) association of the self with aggressive traits and actions (Uhlmann & Swanson, 2004); identification with violent video game characters making gamers more aggressive (Konijn, Nije Bijvank, & Bushman, 2007) and when playing a role of a violent police officer, less punitive attitudes and judgments toward real life police who have committed crimes in comparison to other criminals (Lee, Peng, & Klein, 2010); (v) playing a first-person shooter game resulting in automatic associations of military-related concepts and the self, while playing a racing game lead to racing-related concepts (Klimmt, Hefner, Vorderer, Roth, & Blake, 2010); (vi) perception of the real world as dangerous, mostly by females (Anderson & Dill, 2000); higher estimates of the number of crimes (Van Mierlo & Van den Bulck, 2004); and (vii) higher estimation of the proportion of policemen in the total workforce (Van Mierlo & Van den Bulck, 2004). On the other hand, other research studies have found no effects of violent video games on cognition (e.g., Ivory & Kalyanaraman, 2007; Williams & Skoric, 2005).

In terms of research into stereotypes, it has been found that: (i) adopting the role of an antiterrorist leads to displaying more anti-Arabic attitudes (Saleem & Anderson, 2013), (ii) females adopting the role of a sexualized heroine character leads to a reduction of their self-efficacy (Behm-Morawitz & Mastro, 2009); perception of females as sexual objects and

tendencies to behave inappropriately toward females in social contexts after playing a video game with explicit sexual content (Yao, Mahood, & Linz, 2010); (iii) females that embody a sexualized avatar either with a photograph of themselves or someone else unknown resulted in experiencing more body concern thoughts (Fox, Bailenson, & Tricase, 2013); and (iv) men who were exposed to sexually stereotypical characters were more tolerant towards sexual harassment in real life and significant correlations were found between violent video game playing and tolerance toward sexual harassment and greater endorsement of myths about rape (Dill, Brown, & Collins, 2008). Results in these experiments may be explained that by using a specific avatar, the participants internalized these representations and their beliefs and attitudes about themselves were influenced. In fact, Peña, Hancock, and Merola (2009) found priming effects in those who simply used a black cloaked avatar, which led to greater aggressive attitudes and intentions, and less group cohesion than those using a white cloaked avatar.

In terms of video game research into simulated driving has indicated that those who played a racing game show: (i) higher accessibility of risk-promoting cognitions (Fischer, Kubitzki, Guter, & Frey, 2007), (ii) positive attitudes toward risky driving when playing ‘drive’em up’ street-racing games, but not when playing “circuit” racing games (Vingilis et al., 2013), (iii) a self-perception as a risky driver when playing street-racing games (Fischer, et al., 2009), and (iv) beliefs that a larger prevalence of people died in a car accident or from drug overdose within the past year after they played a racing game (Chong, et al., 2012). Another study showed that after playing *Grand Theft Auto*, participants showed permissive attitudes toward consuming alcohol and marijuana (Brady & Matthews, 2006).

### **Pervasive thoughts and cognitive bias about the game**

Little scientific attention has been paid to the content of video gamers’ thoughts, but research into intrusive thoughts related to virtual immersion and cognitive bias toward game-related stimuli and/or to the game activity has been carried out. This research is briefly outlined below.

(i) **Cognitive preoccupation or obsession** for gaming implies spending a substantial amount of time thinking about playing while not doing it (Petry et al., 2014). It is a fundamental symptom included in the diagnostic criteria for assessing gaming disorder when gaming becomes the most salient and predominant activity in the life of the individual (Griffiths, 2000; Griffiths, 2008; Kuss, 2013). This has been assessed in different ways such as “become

preoccupied for gaming when not gaming, feel bad for being unable to play games or think obsessively about playing when not being playing” (Haagsma, Caplan, Peters, & Pieterse, 2013), not being able to concentrate on other things because of preoccupation with gaming (Demetrovics et al., 2012), continually thinking about past video game sessions, reliving the previous session or anticipating the next session (Tejeiro Salguero & Morán, 2002), and fantasizing about games (e.g., daydreaming about gaming) (Demetrovics, et al., 2012; Huang, Wang, Qian, Zhong, & Tao, 2007).

(ii) **Cognitive bias related to the video game.** Different dimensions concerning cognitive bias related to the video game have been investigated. This includes when gamers overreact to certain stimuli associated with the game. This has typically been investigated in laboratory where gamers in the ‘Go/No Go’ switching task (i.e., Internet game-shifting task) showed attentional bias by paying more attention to gaming-related cues than other cues presented, as well as executive functioning deficits when responding to distractors for not being able to discriminate between targets and distractors in the task (Lorenz et al., 2013; Metcalf & Pammer, 2011; Zhou, Yuan, & Yao, 2012). These findings have also been reported among individuals with gaming disorder, since attentional bias and response inhibition are characteristics of addiction (Van Holst et al., 2012).

Other studies have used interpretations of ambiguous stories after playing a violent game and have found that playing violent video games increases the hostile interpretation of social ambiguous events (Bushman & Anderson, 2002). Moreover, expressions of happy faces tend to be recognized more quickly than angry expressions, however, some evidence has shown that after playing a violent video game, happy faces are recognized more slowly which suggests that the game primes a negative processing bias (Kirsh & Mounts, 2007).

Research studies based on self-report measures have also found cognitive bias toward stimuli associated with the video game. For instance, Poels, et al., (2014) investigated cognitive bias when stimuli in real life (objects and sounds) trigger thoughts and imagery related to video games. Furthermore, Ortiz de Gortari, et al., (2010, 2011) found that objects or events associated with the video game triggered not only game-related thoughts but the thoughts also manifested themselves as urges to do something as in the game (e.g., climb buildings) and sometimes as behaviours when short periods of lack of awareness ended up in gamers doing something as in the game (e.g., approaching a bicycle and thinking about stealing it as in the video game), and/or jumping to conclusions or false expectations (e.g., walk on a certain side



of the road to avoid being attacked by a monster). Moreover, similarities between real life events and objects and the video game resulted in altered visual perceptions when gamers saw video game images superimposed onto real life objects (e.g., health bars above peoples' heads).

Another area of research has investigated maladaptive cognitions developed toward gaming which contribute to the development and maintenance of gaming addiction (Davis, 2001). Here, cognitive bias about the self (e.g., “worthless offline, but in the online game world I am someone”) and the real life world (e.g., “nobody loves me offline”, “the online game world is the only place that I am respected”) (Liu & Peng, 2009) results in excessive and problematic gaming.

Moreover, experimental studies conducted with non-clinical populations have found that virtual reality can elicit paranoid ideations in neutral environments with realistic cues in some individuals even with an exposure of just four minutes (Freeman et al., 2005; Freeman et al., 2008). Those individuals who experienced a higher degree of presence in the virtual environment and had a higher trait of paranoia experienced persecutory ideations (Freeman, et al., 2005). In Freeman et al., (2008) those who reported experiencing paranoid thoughts were twice as likely to have experienced persecutory thoughts in the virtual reality condition compared to those who do not typically have paranoid thoughts. Another experimental study found that among individuals at risk of mental disorders tend to attribute mental states to virtual reality characters (Valmaggia et al., 2007). Moreover, the virtual immersion with neutral characters have been used in clinical assessments and has effectively predicted paranoid thinking 6 months later and Post Traumatic Stress Symptoms due to having been assaulted (Freeman et al., 2014).

### **Daydreaming and video games**

Little research has investigated daydreams in the context of video games. Dauphin and Heller (2010) found that video game engagement was associated with “positive-constructive daydreaming”, while social/economical interference of gaming was correlated with guilt, and fear of failure daydreaming. Negative consequence of gaming such as neglect responsibilities was related to poor attentional control. Moreover, in an interview study about Game Transfer Phenomena (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c), gamers reported daydreaming about the game when they were at school, travelling, and/or when they were bored. The most common fantasies were about having superpowers or living in the video game

environment but also violent and criminal content were reported (Ortiz de Gortari, 2010). Sometimes, participants mixed elements found in their real life context enhanced their daydreams. Also, Poels (2010) in a focus group found that participants daydream about their favourite game, in terms of tactics or social interactions. In another study, Poels and colleagues also reported that *World of Warcraft* gamers daydreamt and fantasized about computer games when being bored (Poels, et al., 2014).

### **Dreams and nightmares**

The incorporation of video game content in dreams has been reported in different studies (Murzyn, 2012; Ortiz de Gortari, et al., 2011c; Ortiz de Gortari, Aronsson, & Griffiths, 2011d; Poels, et al., 2014; Stickgold, Malia, Maguire, Roddenberry, & O'Connor, 2000). For instance, Callaway (2009) reported dream incorporation after playing the *Doom* game one hour before sleeping in a laboratory settings, and later the performance in the game improved (which suggests there are learning effects of dreaming). Murzyn (2012) analysed 900 dreams of *World of Warcraft* players and found that the number of dreams was correlated with the average time spent playing *World of Warcraft*, with the number of game-related activities in real world and the time gamers spent on thinking about the game.

Nightmares involving video game content have also been reported (Bertolini & Nissim, 2002; Van den Bulck, 2004). For instance, Gackenbach, Kuruvilla and Dopko (2009) found that gamers tend to have more dreams with dead and imaginary characters, and have more bizarre dreams. However, it has been found that playing video games leads to a higher frequency of lucid dreams, observer dreams<sup>1</sup> where the individual controls and directs the dream experience (Gackenbach, 2006). In addition, soldiers who played war games had less threatening dreams and less dreams with war content compared with a control group (Gackenbach, Darlington, Ferguson, & Boyes, 2013).

### **Summary of the influences of video game playing on cognitions**

Research has mostly demonstrated the enhancement of cognitive, perceptual and, visuomotor skills by playing games (e.g., fast identification of targets, fast switching between tasks) (Boot, et al., 2008; Chisholm, et al., 2010; Green & Bavelier, 2003) and only a few studies have contradicted such findings (Boot, et al., 2008; Irons, et al., 2011), while another

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<sup>1</sup> Observer dreams refer to those dreams where the dreamer is not a participant rather than observing the events.

small number of research studies have investigated and showed cognitive failures when sustaining the attention in particular tasks, attributed to the shift of attention trained in the game (Bailey, et al., 2010; Barlett, Anderson, et al., 2009; Swing & Gentile, 2010).

In terms of psychosocial effects, a large number of studies have been carried out experimentally and have focused on investigating the accessibility to aggressive cognitions and hostile expectations that are explained by priming mechanisms induced experimentally by playing violent video games (Barlett, Branch, et al., 2009a; Bushman & Anderson, 2002; Hasan, et al., 2012; Kirsh, 1998; Krahe & Möller, 2004), and some evidence suggests that aggressive cognitions are short lived (e.g., last less than four minutes after stopping playing) (Barlett, Branch, et al., 2009a). Aggressive cognitions have been found to be mediator for aggressive behaviour, and rumination about the game led to increased aggression, at least in laboratory settings. Moreover, short-time priming of violent content has resulted in selective attention toward violent-related cues (Anderson & Dill, 2000; Kirsh, et al., 2005), self-identification with aggressive traits (Uhlmann & Swanson, 2004), hostile cognitive bias (Bushman & Anderson, 2002; Hasan, et al., 2012; Kirsh, 1998; Krahe & Möller, 2004) and perceiving the world as dangerous (Anderson & Dill, 2000; Van Mierlo & Van den Bulck, 2004).

Less attention has been paid to embodying stereotypical virtual representations. This research has shown the short-term effects on self-perception (e.g., reduction in self-efficacy when females embodied a sexualized character) and perception of certain groups (e.g., racist attitudes, perceiving females as sexual objects) and gender (Behm-Morawitz & Mastro, 2009; Fox & Bailenson, 2009b; Yao, et al., 2010) and less punitive attitudes toward crimes in similar circumstances as in the video game (Lee, et al., 2010). Moreover, another small area of research includes playing risk behaviour games such as racing games that promotes positive attitudes toward risk driving mostly in 'drive'em up' street racing games (Vingilis, et al., 2013) and higher expectations of people dying in car accidents and overdosing on drugs (Chong, et al., 2012).

Research has also investigated the pervasiveness of thoughts related to the game considered as a preoccupation for gaming when the video game has become the most salient activity (Griffiths, 2000; Griffiths, 2008; Kuss, 2013). However, there is a poor understanding of the content of thoughts and biased reasoning processes that may contribute to the development and the maintenance of dysfunctional gaming patterns (Davis, 2001; King &

Delfabbro, 2014; LaRose, Lin, & Eastin, 2003; Ortiz de Gortari, 2007). Moreover, some research has not made a clear distinction between high engagement in playing the game and gaming disorder contributing to overestimating gaming as problematic (Charlton & Danforth, 2007). Very little attention has been paid to unconscious cognitions and the incorporation of video games content into dreams as a way to explore video games' impact in the gamers' psyche. Additionally, only few studies have investigated irrational thoughts developed after the virtual immersion (e.g., paranoid ideation as a response to virtual characters) (Freeman, et al., 2005).

### **Influence of Affective States after Playing Video Games**

Affects are “cognitively accessible elements of a current mood, an emotional reaction, or an anticipated emotional reaction” (Västfjäll, Friman, Gärling, & Kleiner, 2002, p. 2) and include dimensions such as valence, the positive or negative evaluation of a subjective experience and state, motivational intensity, the strength of the urge to move toward or away from a stimulus, and the activation of the sympathetic system that results in arousal (Harmon-Jones, Gable, & Price, 2013, p. 301). Positive affects lead to open-mind perceptions, while negative affects lead to narrow-minded perceptions (Harmon-Jones, et al., 2013).

Research has reported positive mood state such as reduction of depression and hostile feelings by modifying mood states when playing violent video games after a frustration task (Ferguson & Rueda, 2010) suggesting that the game was cathartic. Also, playing video games has been used as a distractor task for reducing preoperative anxiety in children (Patel et al., 2006). Playing video games can also be used to relieve feelings of depression and to obtain incentives (LaRose, et al., 2003), (e.g., “I have gone online to contact others when I was feeling isolated”, “I have gone online to make myself feel better when I was down or anxious”) (Caplan, 2002). However, research has also found that video games with violent content can lead to hyper vigilant mood states (Bertolini & Nissim, 2002; Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011). Problematic gaming has been correlated with depressive mood and social anxiety (Van Rooij, Kuss, Shorter, Schoenmakers, & Van de Mheen, 2014).

In research concerning gaming disorder, mood modification such as irritability and anxiety has been reported when not being able to play a game (i.e., withdrawal symptoms) (Griffiths, 2005). Using the video game for escaping real life situations and modifying negative mood states has also been found (Kwon, Chung, & Lee, 2011) and this is one of the main

motivations to play among individuals considered as having a gaming disorder (King & Delfabbro, 2009) and playing as an escape from problems in the real world has been found to be a predictor for problematic gaming (Caplan, 2002; Kuss, Louws, & Wiers, 2012).

In terms of video game content, research has found that playing a video game with violent content leads to: (i) decrease in empathy (Anderson, Gentile, & Buckley, 2007) , (ii) greater anxiety, depression, anger as measures of negative affect (Brady & Matthews, 2006), (iii) increased hostility and anger in adolescents (Arriaga, Esteves, Carneiro, & Monteiro, 2008; Barlett, Branch, et al., 2009a). Other types of research study have been interested in how the game is used to modify mood states and how they are used as a form of mood regulation.

### **Summary of the influence of playing video games on affective states**

In most cases, research has assessed affective states or mood states as an additional variable rather than focusing on understanding mood states influenced by video game playing. Affective states have mostly been considered in research concerning violent video games in addition to some in the area of excessive gaming. Video games have shown to be capable of modifying mood states such as enhance positive mood states, reduce anxiety, reduce depression and hostile feelings but also lead to hyper-vigilant mood states while playing and that are prevalent after stopping playing (Ferguson & Rueda, 2010; Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c; Ortiz de Gortari, et al., 2011d). Irritability and anxiety when not being able to play has been extensively reported in research concerning gaming disorder (Griffiths, 2005), as well as research showing that video games can modify negative mood states and act as escape mechanism (Kwon, et al., 2011; Ortiz de Gortari, 2010). Also, short-term effects of playing violent video games have shown decreases in empathy (Anderson, et al., 2007) and increases in hostility and anger (Arriaga, et al., 2008; Barlett, Branch, et al., 2009a). Even though it is well known that video games are capable of modifying mood states and are used for these purposes, there is a very little understanding about the temporal and long-term consequences of changes of mood states in gamers' actual behaviours and lives.

### **Behavioural Effects of Video Games**

This section includes a review of behavioural modification – at least temporarily – due to virtual immersion. Studies identified were in the following areas: (i) engaging in prosocial

behaviour, (ii) change of behaviour due to virtual embodiment of avatar, (iii) engaging in aggressive behaviour after playing a violent video game, (iv) willingness to engage in risk behaviours, (v) criminal/illegal behaviour, and (vi) compulsive gaming.

### **Engaging in prosocial behaviour**

In terms of prosocial behaviour, participants in gaming experiments have shown (i) willingness to help after a mishap (Greitemeyer & Osswald, 2011), particularly when playing in cooperative mode versus competitive but only when using customized avatars and playing in teams (Dolgov, Graves, Nearents, Schwark, & Brooks Volkman, 2014), (ii) more willingness to help in other experiments, and more likely to intervene in a harassment situation (Greitemeyer & Osswald, 2011), and (iii) fewer aggressive responses (Greitemeyer & Osswald, 2009).

### **Change of behaviours due to virtual embodiment of avatar**

It has been argued that the virtual embodiment can potentially change attitudes and behaviours, since the virtual embodiment allows observation of a virtual self-performing a behaviour (Klimmt, Hefner, & Vorderer, 2009). Some have regarded virtual representation that resemble the user as looking at oneself in the mirror (Nass, Kim, & Lee, 1998; Ortiz de Gortari, July, 2007). Virtual environments with a specific purpose have been designed and have been used effectively to modify and promote changes on behaviours in therapeutic settings (Griffiths, Kuss, & Ortiz de Gortari, 2012). For instance, the effects of observing and modelling behaviours, attitudes, and emotional reactions have been posited by Bandura's social cognitive theory (Bandura & Bryant, 2002). Also, functional neuroimaging studies have shown that by simply imagining or observing someone else performing a movement activated the mirror-neuro system as a representation of those movements or as intention to reproduce such action (Hägner et al., 2008). This has even been demonstrated among individuals in vegetative states when they imagine playing tennis (Monti et al., 2010), and gives us an idea of the neural effects that are probably triggered by the embodying of simulations of movements and activities in virtual environments.

Changes of behaviour in the short-term reported after embodying virtual entities include: (i) exercising more and eating more healthily when watching an avatar that looked like

the observer losing weight (Fox & Bailenson, 2009a); (ii) exercising significantly more 24 hours after the experiment when being exposed to an avatar that resembled themselves running on a treadmill loitering (Fox & Bailenson, 2009a); (iii) engaging in pro-environmental behaviour when participants used significantly less non-recycled toilet paper after cutting a virtual tree in comparison to those who simply imagined cutting the tree (Ahn, 2011); (iv) negotiating more aggressively when being in the virtual world, and in subsequent interaction in a factual context (Yee & Bailenson, 2007) when using an attractive and tall avatar in *World of Warcraft*; and (v) comparing the effects of adopting the role of hero as *Superman* versus the villain as *The Joker*. Those who played *Superman* role showed more prosocial behaviour than those who played *The Joker* role (Happ, Melzer, & Steffgen, 2013).

### **Engaging in aggressive behaviour after playing a violent video game**

Short-term effects of the exposure to violent content has resulted in aggressive-related behaviours, and according to a study conducted by Barlett et al., (2009a), this occurred independently if the outcomes are measured with 0, 5 or 10 minutes of delay. They found that aggressive behaviours lasted four to nine minutes. For instance, changes in behaviours by playing violent video games assessed in laboratories include (i) delivering a significantly longer noise blast after losing trials to the other competitor (Anderson & Dill, 2000), and has been observed even 24 hours after participants played a violent game when they ruminated about the game (Bushman & Gibson, 2011), (ii) behaving less courteous (Cicchirillo & Chory-Assad, 2005) or being less likely to cooperate in a situation at the laboratory (Sheese & Graziano, 2005) or were more likely to behave uncooperatively in a competitive or cooperative task (Brady & Matthews, 2006), as well as taking longer time to assist someone injured due to a fight, not hearing the incident, or considering the incident less serious (Bushman & Anderson, 2009), and lowered prosocial behaviour toward strangers (Fraser, Padilla-Walker, Coyne, Nelson, & Stockdale, 2012). Also, playing violent video games has been correlated with reports of aggressive behaviours in day-to-day contexts. This includes: (i) significant increases in irritability (Anderson & Dill, 2000), (ii) higher levels of aggression over time (Willoughby, et al., 2012), (iii) getting into arguments with teachers more frequently (Gentile, Lynch, Linder, & Walsh, 2004), and (iv) participate in physical fights (Gentile, et al., 2004).

### **Willingness to engage in risk behaviours**

Games that reward traffic violations (mostly racing games such as *Formula 1* games) have been associated with risk behaviours (Fischer, et al., 2009). Willingness to engage in risk behaviour after playing racing games has been measured using driving simulations. Those who played the street racing game were shown to be more inclined to take risks; risk taking inclinations remained prevalent even one day after the participants played the racing game (Fischer, et al., 2009). Also self-report measures have been used and gamers have admitted taking risks in traffic at least occasionally (Begg & Langley, 2004; Beullens, Roe, & Van den Bulck, 2008; Fischer, et al., 2007) (e.g., speeding, tailgating, driving after the consumption of alcohol, being stopped by the police, being involved in traffic accidents, competitive road traffic behaviour, being less cautious) (Begg & Langley, 2004; Fischer, et al., 2007; Hull, et al., 2012; Vingilis, et al., 2013). Similarly, Beullens and colleagues (2011) conducted a longitudinal panel survey concerning driving games and found that playing racing games and drive'em up games two years earlier was positively correlated with self-reports of driving behaviour such as speeding and fun riding, but not driving while being under the influence of alcohol which are mostly absent in video game narratives or stories. Similarly, results related to risk driving behaviours were reported in another longitudinal study conducted by Hull et al., (2012). Gamers have also reported risky driving related to video games or intention to engage in such behaviours (Ortiz de Gortari, 2010). Other risk behaviours suggested by research include drug use and drinking alcohol or more permissive attitudes toward young adults engaging in it (Brady & Matthews, 2006; Padilla-Walker, Nelson, Carroll, & Jensen, 2010), sensation seeking, rebellious attitudes toward deviant behaviour (alcohol use, cigarette smoking, aggression, delinquency and risky sex), and affiliation with deviant peers over the time when playing 'mature' glorifying risk games (Hull, Brunelle, Prescott, & Sargent, 2014).

### **Criminal/illegal behaviours associated with video games**

In terms of criminal/illegal behaviour associated with video games, no cause effects of playing the games can be established but criminal cases involving gaming have been correlated with criminal activity. Research on violent video games have found self-reports of higher levels of nonaggressive delinquency (Anderson & Dill, 2000) and delinquency (Hasan, Bègue, Scharrow, & Bushman, 2013) in players that play violent video games. Also, criminal behaviour such as stealing money or forging cheques during the time of arcade gaming



machines has been reported (Fisher, 1994; Griffiths & Hunt, 1998; Keepers, 1990). Virtual crimes in online games have been related to account theft (Teng, Tseng, Chen, & Wu, 2012), and avatar identity theft (Chen et al., 2005). Other cases have been reported in media. For instance, in 2005 a Chinese gamer was stabbed by another gamer because the victim sold his sword; in 2007, a Dutch teenager were arrested for stealing furniture in the game *Habo Hotel* worth thousands of Euros. Other cases from the game *Habo Hotel* have been investigated by the Finnish police (Chen, et al., 2005) and some individuals have been persecuted and convicted due to online criminal activity related to video games (Telegraph, 2014, July 29; U.S. Department of Justice, n.d.).

### **Problematic gaming**

Problematic gaming involves deficient self-regulation where the gamer loses control of their gaming and is associated with negative consequences of gaming (LaRose, et al., 2003; Liu & Peng, 2009; Seay & Kraut, 2007). Problematic gaming has been assessed by diagnostic criteria such as unsuccessful attempts to stop or reduce engagement in gaming (Griffiths, 2005) or uncontrolled impulses to engage in gaming. Other factors that manifest as problematic behaviour include relapse when after being away from the game for a while the dysfunctional gaming patterns are reverted (Griffiths, 2005). In general, problematic gaming (i.e., gaming addiction) has been associated with large amounts of time being invested in gaming, particularly online gaming (Allison, von Wahlde, Shockley, & Gabbard, 2006). Other symptoms that indicate ‘behavioural salience’ (Petry, et al., 2014) include hostile behaviours (Chiu, Lee, & Huang, 2004), loss of interest in other activities or hobbies to the degree to actually neglecting responsibilities, and relationships with negative consequences (Griffiths, 2005). Negative consequences due to excessive gaming are considered a prerequisite in considering gaming dysfunctional patterns as gaming addiction (Griffiths, 2008).

### **Summary of video games’ effects on behaviours**

Short-term effects on behaviour have been measured by laboratory tasks but self-reports have also been used to measure current or retrospective behaviour in day-to-day contexts. The use of virtual environment design with specific purposes has been effectively used for inducing and modifying behaviour therapeutically (Griffiths, et al., 2012). Numerous changes of behaviour have effectively been induced experimentally at least temporarily. Changes of

behaviour have been influenced by the type of activity performed in the virtual environment or by aspects of the character or the avatar that is embodied. For instance embodying a more attractive avatar lead to behaving more confidently after exposure (Yee & Bailenson, 2007). Change of behaviour due to playing video games not designed for therapeutic purposes has typically been dichotomized into positive and negative behaviours. Positive behaviours include pro-social behaviours, and engaging in pro-environmental behaviours (Ahn, 2011). In terms of violent content, experiments have found that those who play violent video games have a more aggressive behaviour for example when punishing the other competitor in a fiercer way (Bushman & Gibson, 2011), taking longer time to those in need (Bushman & Anderson, 2009), or taking more risk in driving simulators (Fischer, et al., 2009).

Self-reports that have measured retrospective behaviours have found correlation (rather than causation) between playing violent video games, risk behaviour games and engagement in aggressive behaviours (e.g., physical fights, nonaggressive delinquency) (Anderson & Dill, 2000; Gentile, et al., 2004) and risk behaviours in day-to-day context respectively (e.g., having been stopped by the police and being drunk while driving, drug use, traffic accidents). Also, longitudinal research has found higher levels of aggression over time (Willoughby, et al., 2012) and risky driving (Beullens, et al., 2011; Hull, et al., 2012). Furthermore, playing video games excessively has been associated and correlated with failures in control regulation and dysfunctional patterns of gaming behaviour, conflicts and neglect of responsibilities (e.g., neglecting school or work, conflicts with family, lies).

### **Physiological and Psychophysiological Effects of Playing Video Games**

In general, research carried out on the physiological and psychophysiological effects of playing has either quantified gamers' states during the video game session or have assessed outcomes after stopping playing. Physiological measures have also been used to support findings concerning the effect of video game playing (Kivikangas et al., 2011). The advantage of physiological responses is that they provide outcomes that are not contaminated by the individual subjectivity (Kivikangas, et al., 2011). Physiological and psychophysiological effects of gaming in this section are divided into: (i) epilepsy seizures induced by playing video games, (ii) sleep disturbances and video game habits, (iii) neural adaptations induced by virtual immersion, (iii) changes in the cardiovascular, nervous and endocrine system measured when playing video games, (iv) brain activity related to playing video games, and (v) withdrawal and

tolerance symptoms for playing video games. Also in this section, body injuries from playing video games are reviewed.

### **Epileptic seizures induced by playing video games**

Photosensitive individuals with previous and non-previous seizure history have suffered seizures in response to specific stimuli in video games (e.g., flashing lights, colours alternating red and blue) (Bureau, Hirsch, & Vigeveno, 2004; Kasteleijn-Nolst Trenite et al., 2002). However, other factors that play important roles in epileptic seizures while playing video games have also been identified. These include: cognitive activities (e.g., decision-making, spatial tasks or rapid hand manipulation), emotional factors (e.g., emotional excitement, stress), sleep deprivation and fatigue, and prolonged play (Bureau, et al., 2004; Chuang, 2006). For instance complex reflex epilepsy can take place due the involvement in higher mental activities (e.g., arithmetic, writing, drawing, playing cards or chess) and spatial tasks required to play the tile game Mah-Jong either as a table game or in a computer version (Chang, Cheung, Ho, & Mak, 2007).

The seizures usually occur during the first 30 minutes of playing video games, although in some cases it took longer time, while in other cases it occurred during the first few seconds of play. The seizures that occur while playing tend to be considered as having been precipitated by the game. However, when the seizures occur more than a few minutes after discontinuing playing, the relationship may be questionable (Fisher, Harding, Erba, Barkley, & Wilkins, 2005).

Warning signs of possible seizures mentioned by the epilepsy foundation (Schacter & Shafer, 2013) include: (i) odd feelings, often indescribable; (ii) experiencing unusual smells, taste or feelings, unusual experience out of body sensations, feeling detached, body looking or feeling different, situations or people looking unexpectedly familiar or strange; (iii) feeling spacey, fuzzy or confused, (iv) experiencing periods of forgetfulness or memory lapses; (v) daydreaming episodes; (vi) jerking movements of an arm, leg or body; (vii) falling, (viii) tingling, numbness or feeling of electricity in part of the body; (ix) having headaches; and (x) experiencing unexplained confusion, sleepiness, and/or weakness.

### **Sleep disturbance and video game habits**

Sleep disturbances have been reported when engaging in prolonged cognitive tasks before going to bed (Takahashi & Arito, 1994). Studies have also found delayed bed time and shorter overall sleep time in association with electronic media (Cain & Gradisar, 2010). Disturbance in sleep quality and alterations in sleep physiology have been related with the exposure of bright screens in the evening or before going to sleep (Higuchi, Motohashi, Liu, Ahara, & Kaneko, 2003) and affects in the circadian rhythm (Zeitler, Dijk, Kronauer, Brown, & Czeisler, 2000). However, the results found in terms of the effects of bright screens have been inconsistent (Higuchi, Motohashi, Liu, & Maeda, 2005).

Other studies have reported sleep alteration due to increases in arousal by playing video games before sleep (Higuchi, et al., 2005; Ivarsson, Anderson, Åkerstedt, & Lindblad, 2013; King et al., 2013). The effects include: (i) reduced amount of slow wave sleep (i.e., deep sleep), and (ii) prolonged sleep-onset latency (Dworak, Schierl, Bruns, & Strüder, 2007). Particularly prolonged sessions of playing violent video games before going to bed resulted in decreased sleep efficiency, and total sleep time and reduction in REM sleep (King et al., 2012). Additionally, research has reported higher sympathetic activation of the nervous system and signs of lower sleep quality when playing violent video game compared to non-violent video games among players with a low experience of violent video games. Variations in heart rate such as higher heart rate and low and high frequency ratio while sleeping was found in participants who played violent video games with little previous experience with such games, while those with more experience showed a reverse effect. These results were explained by the authors as being due to the desensitization effect of playing violent video games (Ivarsson, et al., 2013).

### **Neural adaptations induced by virtual immersion**

The physiological and perceptual side-effects of virtual immersion due to neural adaptive mechanisms have mainly been investigated using virtual simulators and highly immersive virtual environments in the military or aerospace domain. However, motion sickness or cyber-sickness (Merhi, Faugloire, Flanagan, & Stoffregen, 2007; Stoffregen, Faugloire, Yoshida, Flanagan, & Merhi, 2008) have been found in commercial video games played via a head-mounted display, mainly when playing standing-up (Merhi, et al., 2007). The prolonged exposure to virtual stimuli can provoke neural adaptations to the virtual environment

(Champney et al., 2007). Prolonged exposure can result in increased degrees of presence in the virtual world that tend to become more familiar over time (Stanney, Kingdon, Graeber, & Kennedy, 2002), while decreasing the sense of presence in objective reality leading to depersonalization and derealisation-like sensations in susceptible individuals (Aardema, O'Connor, Côté, & Taillon, 2010). The recovery after the exposure is proportional to the exposure time (Champney, et al., 2007) and research has found that longer immersion induces higher levels of postural instability and symptoms of motion sickness (Murata, 2004).

Neural adaptations in virtual environments include: (i) drowsiness, nausea, fatigue, (ii) general discomfort, (iii) visual symptoms such as eyestrain, headache, blurred vision, difficulty in focusing and perceived inversion of the visual field and disrupted motor control have been reported (Kuze & Ukai, 2008), (iv) disorientation, postural instability (disequilibrium) and, illusory kinaesthetic sensations (e.g., feeling like you were climbing or moving) (Barrett, 2003; Kennedy, Fowlkes, Berbaum, & Lilienthal 1992), proprioceptive errors (Stanney, Kennedy, Drexler, & Harm, 1999), lack of motor flexibility (ataxia), uncoordinated and jerky movements, and dyskinesia (Cobb, 1999). Furthermore, visual motion after-effects experienced when seeing movement stimuli have been reported in music and dance video games (Dyson, 2010). Also, visualization of video game images have been experienced as a post-effect of video game playing when induced in laboratory settings – mainly in sleep onset (Kusse, Shaffii-Le Bourdieu, Schrouff, Matarazzo, & Maquet, 2012; Stickgold, et al., 2000; Wamsley, Perry, Djonlagic, Reaven, & Stickgold, 2010). (Further details about studies related to visual experiences are found in Chapter 4).

### **Changes in the cardiovascular, nervous and endocrine systems measured when playing video games**

In general, video game playing has been associated with increases of metabolic and physiological variables (e.g., heart rate, systolic and diastolic blood pressure, respiratory rate, oxygen consumption, and energy expenditure) although when the game is controlled by a gamepad, the increases cannot be compared to physical exercise (Penko & Barkley, 2010; Wang & Perry, 2006). However, in games where the player moves to control the game – such as *Wii* boxing or dance games (e.g., *Dance Dance Revolution*) – they can at least be equivalent to moderate-intensity walking (Graf, Pratt, Hester, & Short, 2009).

Since video games are capable of eliciting emotional responses that can result in physiological changes, studies investigating cardiovascular measures have been taken into account (Baldaro et al., 2004). Studies examining cardiovascular changes such as heart rate and blood pressure that indicate arousal have been carried out (Fischer, et al., 2009). One of the downsides is that increases in blood pressure under stress can (in extreme cases) lead to hypertension (Matthews et al., 2004). For instance, increases in systolic blood pressure have been recorded while playing a violent video game and decreases in the diastolic blood pressure were found after stopping playing, while playing a puzzle game resulted only in decreases in diastolic blood pressure after the playing session (Baldaro, et al., 2004). Similarly, higher levels of systolic pressure have been found after playing a racing game (Fischer, et al., 2009) or after playing a violent video game, but increases in diastolic blood pressure were found only when playing a violent video game and having antecedents of exposure to a violent environment (Brady & Matthews, 2006).

Taffalla (2007) found that when playing a violent video game with an audio soundtrack men's heart rates were significantly greater (suggesting arousal), whereas females showed significantly greater systolic and diastolic blood pressure (suggesting stress). However, more meticulous examination of levels of arousal while playing video games has shown that the arousal is not constant throughout the video game session. Weber, Ritterfeld and Mathiak (2006) found that participants show higher arousal levels at beginning of the game and that it decreases during exposure to the game. Increases in arousal were found when the ammunition ran out and when the player needed to run, being uncertain about where the enemies were. The arousal levels were low when gamers observed other gamers or used the menu, and when they located the enemy. Moreover, it has found that playing first-person shooter games with techno music leads to elevated levels of cortisol (Hebert, Beland, Dionne-Fournelle, Crete, & Lupien, 2005).

Additionally, research has investigated physiological responses to stimulating material (e.g., pictures, films) after playing violent video games. Findings show either weaker reactions (desensitization) to aversive stimuli (Ivarsson, et al., 2013; Staude-Müller, Bliesener, & Luthman, 2008) or stronger reactions (sensitization) to aggressive cues. Desensitization manifest as physiologically decreases in blood pressure after repetitive exposure to violent video game (Ballard, Hamby, Panee, & Nivens, 2006), lower heart rate (HR) and galvanic skin response (GSR) when viewing a film of real violence (Carnagey, Anderson, & Bushman, 2007).

Other lines of research have shown similar emotional responses to virtual avatars compared to real people when measuring facial Electromyography (EMG) reactions to emotional expressions of avatars using eye tracking measures (Mojzisch et al., 2006; Weyers, Mühlberger, Hefele, & Pauli, 2006). For instance, arousal measured by pupil size were observed in relation to the gender of the virtual character (Mojzisch, et al., 2006). Moreover, Jeon and Biocca explored the relation between brand memory and arousal by measuring GSR. They found an increase in recollection of brands logos embedded in the first-person shooter *Counter Strike 2* when the gamer experienced medium levels of arousal. However, no significant differences between medium and higher levels of arousal and brand memory were found. Familiarity with the brand had positive relationship with levels of arousal (Jeong & Biocca, 2012).

### **Brain activity related to playing video games**

Neuroimaging studies that have examined brain activity during video game playing and have found that: (i) activation of brain regions are associated with the reward system and increases in dopamine when playing games (Koepp et al., 1998); (ii) there is greater activation and functional connectivity in the mesocorticolimbic system in males compares to females (Hoefl, Watson, Kesler, Bettinger, & Reiss, 2008); (iii) there is activation of the same brain areas typically activated in aggressive cognition and behaviour (e.g., active suppression of affective areas such as the rostral anterior cingulate cortex (rACC)<sup>2</sup> and the amygdala and increase activity in the Dorsal anterior cingulate cortex (dACC)<sup>3</sup> when playing an aggressive video game). Changes in anterior cingulate cortex (ACC)<sup>4</sup> has been suggested as being indicative of suppression of positive emotions such as empathy that allow to play the game without remorse (Weber, et al., 2006), and (iv) activations of brain areas such as the frontal lobe and amygdala while being exposed to media violence which are correlated with aggressive behaviour and impulsivity (Kronenberger, et al., 2005).

Other studies have measured outcomes after playing video games and have found: (i) decreases of the P300 wave<sup>5</sup> when exposed to violence-related stimuli after playing violent

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<sup>2</sup> Activation of the rostral anterior cingulate cortex has been associated with the processing of emotional conflict (Etkin, Egner, Peraza, Kandel, & Hirsch, 2006).

<sup>3</sup> Dorsal anterior cingulate cortex is a brain region that sub-serves cognition and motor control.

<sup>4</sup> Activation in the anterior cingulate cortex has been associated with decision-making, socially-driven interactions, empathy related responses, impulse control, rational cognitive functions (Lavin et al., 2013).

<sup>5</sup> The P300 wave is considered to be involved in the process of evaluation of stimuli or categorization process.

video games or due to the experience with violent video games that indicate desensitization (Bowen & Spaniol, 2011; Engelhardt, Bartholow, Kerr, & Bushman, 2011), (ii) lower frontal activation when exposed to violence interpreted as desensitization or disinhibition to violence (Montag et al., 2012). According to Ferguson and Dyck (2012), this simply can indicate boredom; (iii) comparison between areas activated when observing real life vs. fantasy violence after playing a violent game showed that the brain activations were different. In fact, there were more neural overlaps among those that did not typically play and suggests that they were the ones having hard time distinguishing the differences. (Regenbogen, Herrmann, & Fehr, 2010); This makes sense since gamers are more habituated to confront virtual scenes and they may be better distinguishing virtual scenes from those that are not; (iv) brain changes over time, such as changes in the prefrontal-lobe activity, particularly the orbitofrontal (OFC)<sup>6</sup> and the anterior cingulate cortex (ACC) after the period of playing for six weeks in gamers that reported craving for playing, similar to the one observed in those who suffer from substance dependence (Han, Kim, Lee, Min, & Renshaw, 2010). Other research has indicated that playing *Super Mario 64* on the portable *Nintendo DS* for two months for at least 30 minutes per day resulted in increases in grey matter in brain regions involved in spatial orientation, memory formation, strategy planning and fine motor skills (Kühn, Gleich, Lorenz, Lindenberger, & Gallinat, 2014). Moreover, other positive effects of brain activation by playing video games include reduction of food intake in children that played *Angry Birds*. This was explained by video game playing activated the brain glucose which may have reduced the cravings for food (Branton et al., 2014). Also, playing *Tetris* has been associated with reducing cravings for food since visuospatial working memory activities are thought to interfere with the formation of craving imagery automatic elicited in the presence of food-related cues (Skorka-Brown, Andrade, & May, 2014).

In terms comparing brain activation and brain structures in gaming addicts and healthy controls, research studies have demonstrated that gaming addiction shares the same neurobiological mechanics as substance addictions, and that there are differences between the brain of gaming addicts and healthy individuals (Ko et al., 2009; Kuss & Griffiths, 2012a). Findings have shown that: (i) cues associated with the game (i.e., gaming pictures) result in brain activation of areas that control cravings and urges in individuals with gaming addiction but not in controls (Ko, et al., 2009); (ii) comparison of regional grey matter volume between

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<sup>6</sup> Pre-frontal cortex region in the frontal lobe is used for decision-making processes (Bechara, Damasio, & Damasio, 2000)



clinical patients with gaming addiction and gamers that play intensively such as professional gamers shows that clinical individuals display increases in impulsiveness, preservative errors, and increased grey matter volumes of the left thalamus, while the professional gamers display increases in grey matter volumes of the left cingulate gyrus (which are negatively correlated with impulsivity and perseverative errors). The authors argued that the differences between gamers that develop gaming disorder and professional games may be in the ability to control executive functioning and sustain attention (Han, Lyoo, & Renshaw, 2012); (iii) gaming/internet addiction is characterized by failures in the reward system that lead to deficiencies in the production of dopamine, and that this explains the individual seeking rewarding behaviours as compensation for producing dopamine (Kuss & Griffiths, 2012a; Park et al., 2010); and (iv) gaming/internet addiction is associated with neuroadaptive and structural changes due to the prolonged activation of brain areas related with addiction (Yuan et al., 2013; Yuan et al., 2011).

### **Withdrawal and tolerance symptoms after playing video games**

Withdrawal and tolerance are considered signs of physiological dependency (Petry, et al., 2014) and have important psychological components particularly in behavioural addictions. Withdrawal symptoms identified in gaming can manifest themselves as irritability, anxiety, and mood changes rather than physical signs observed in addiction by consumption of psychoactive substances (Griffiths, 2005). However, some evidence suggests a relationship between excessive gaming and visualization of images from the video game and involuntary movements of limbs (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011). Tolerance symptoms manifest as tendency to increase the amount of time playing in order to obtain the desired effects (Griffiths, 2005). Cravings for gaming or psychoactive substances have been measured experimentally when participants identified with gaming disorder are exposed to stimuli related to the game (i.e., a cue-reactivity task that leads to an emotional state or a strong desire to play since a stimulus has been associated with rewards obtained by gaming) (Franken, 2003).

### **Musculoskeletal injuries from playing video games**

Musculoskeletal injuries from playing video games have been reported including physical pain (Zapata, Moraes, Leone, Doria-Filho, & Silva, 2006) and repetitive strain injury after the use

of gamepads (Macgregor, 2000; Rubin, 2010). There have also been injuries associated with the use of motion tracking controls such as the *Wii* motion sensor control (e.g., hand laceration and/or bruise periorbital haematoma, tooth avulsion, patellar dislocation, infraspinatus tendonitis, severe thumb bone injury, etc.) (Bonis, 2007; Galanopoulos, Garlapati, Ashwood, & Kitsis, 2012; Hirpara & Abouazza, 2008; Sparks, Chase, & Coughlin, 2009).

### **Summary of the physiological and psychophysiological effects and musculoskeletal injuries in video game playing**

Physiological effects related to video game playing include: (i) cardiovascular changes as increases in systolic and diastolic blood pressure indicate arousal and stress; (ii) endocrine (secretion cortisol) as response to stress; (iii) sleep deficits such as sleep latency, shorter total sleep, sleep disturbances, lower quality of sleep, suppression of melatonin due to exposure to bright screens; (iv) neural activation of the reward system; (v) activation of the same neural areas when playing a violent video game than when being exposed to a real life violence, but no diminished capacity to distinguish between real and fantasy violence; (vi) reduction of craving for food after playing, (vii) activation of areas that control craving and emotions when being exposed to stimuli associated with the game particularly among individuals with gaming disorder, but also decreases in neural responses due to playing violent video games explained by desensitization to violence; (viii) epileptic seizures particularly in photosensitive individuals; and (ix) signs of dependency to gaming (e.g., withdraw and tolerance) manifesting mostly as irritability, anxiety, mood changes and need to increase the time invested playing to obtain satisfaction.

Even though at present there is not enough evidence concerning neural adaptation when playing video games, the incidences of these effects are expected to increase due to the advance in new technologies. Video game playing via heads-up displays and virtual simulators has led to side-effects such as motion sickness symptoms, postural instability, proprioceptive errors, lack of motor flexibility, uncoordinated and jerky movements, etc. Motion after-effects have been reported in association with music dance games and visualization of images as side-effects of playing such games. Finally, health issues such as sedentary behaviour, leading to obesity and body injuries and physical pain (such as repetitive strain injury provoked by the use of motion tracking controls) have been reported.

## **Instruments to Assess Effects of Video Game Playing**

A large variety of tools and tasks have been used to assess the effects of playing video games on cognition, affect, and behaviour. Most tools have been borrowed from other areas of psychology or items have been adapted from instruments that measure similar behaviours (e.g., developing instruments to measure gaming addiction that adapt items from gambling and alcohol addiction). However, there are many limitations and areas that could be improved in the most common tools used to assess the influence of video game playing on cognitions. These are now discussed below.

### **Instruments used to assess cognitions influenced by video games**

Cognitions have been typically measured by computer tasks in laboratory or self-report measures. Computer tasks have been used to assess cognitive skills and to assess emotional responses such as selective attention toward emotional stimuli or stimuli related to the game. Short-term priming effects have been measured by allowing participants to complete ambiguous stories and words; pairing words with positive or negative concepts, writing one's own thoughts, and drawing tasks. Self-report instruments have assessed beliefs about the perception of the world, expectations and estimations of danger, attitudes, stereotypes and prejudice, and influences in self-concept due to the embodiment of virtual entities. Also, self-report instruments have been used as a complement to assess cognition after playing a video game in a laboratory setting, and instruments have been developed to assess gaming disorder including items related to preoccupation for gaming.

**Assessing the influence of cognitions by playing video games in experiments does not support actual changes in cognitions that translate into social behaviour.** Studies in this area only show the capacity of video games to temporarily modify cognitions. Although, supporters of the General Aggression model have pointed out that even the short-term effects of video game playing on cognition are very important because it enables the rehearsal of behavioural scripts by activating aggressive related nodes of information which have the potential to modify expectations and intentions relevant in social behaviours (Anderson & Bushman, 2001). Some examples of tasks to assess violent related cognitions include the *homonymous decision task* that assesses risk-related cognitions. Typically, participants receive a list of ten words that have two possible meanings (e.g., 'kick' that can be related to kick a

football or kick due to excitement in risky behaviour by fast driving) that need to be defined (Fischer, et al., 2009), or are asked to *complete ambiguous stories* to measure attribution bias in hypothetical conflict situations which indicate expectation of aggression.

**The majority of the self-report instruments have focused on assessing explicit thoughts and intentions to engage in behaviours.** The construction of items in many of these instruments are based on real life situations where to a certain degree it is logical to perceive risk (e.g., walking alone in the darkness) rather than assess broad cognitive bias and selective attention toward stimuli and events simulated in the game that do not follow the logic from the real world (e.g., feeling fear or overreacting to sounds that resemble something in the video game, getting scared when seeing the colour red, water fountains, or churches, etc.). This constrains the full understanding of video games' effects on cognition that act at unconscious level as has been demonstrated in research concerning GTP (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c). For instance, modification of perception of the real life world due to video game playing has been measured with instruments such as *The World View Scale* which assesses criminal likelihood (e.g., "What do you think the chances are that any one person will be robbed by someone with a weapon in their lifetime?"), and safety feelings (e.g., "How safe would you feel walking alone at night in an average suburban setting?") (Anderson & Dill, 2000). Also, instruments have used first-order cultivation measures that assess either perceptions of probability of situations or prevalence of certain circumstances ("As a percentage of the total crime rate within the past year, what is the proportion of serious crime, e.g., rape, murder, assault, robbery", "How likely do you think you will be of a victim of crime within the following year?") (Chong, et al., 2012), or judgments that reveal beliefs and attitudes toward particular situations as second order measures of cultivation (e.g., "most men are cheating behind their wives' back" or "Judges should punish criminals more severely." "Cars parked out in the open are likely to be stolen" and "It is easy to steal a car."), or drug problems ("Drugs are one of the main problems of crime") (Chong, et al., 2012).

**Assessing thoughts after playing video games based on items concerning gambling and/or alcohol addiction do not provide a deep understanding of cognitions in gaming disorder.** Many instruments are useful tools in evaluating gaming related problems, however, they only determine the presence or frequency of thoughts related to gaming as a preoccupation for gaming (e.g., "Do you think about previous gaming activity or anticipate the next gaming

session?” (American Psychiatric Association, 2013). “I usually think about my next gaming session when I am not playing” (Pontes, Király, Demetrovics, & Griffiths, 2014), “When I have not been playing games for some time, I become preoccupied with the thought of gaming”, “I think obsessively about playing games when I am not playing” (Haagsma, et al., 2013)). However, such items do not allow a deep understanding of the nature or the content of the thoughts (King & Delfabbro, 2014); and neither do they assess what type of cognitions they are (e.g., daydreams or fantasies, dreams, associative thoughts, flashback from the game, etc.) or the role of biased reasoning process (e.g., attentional bias toward gaming related cues) crucial in the development and maintenance of dysfunctional internet use/gaming patterns (Davis, 2001). Only a few instruments actually include items that distinguish between thoughts, daydreams and/or dreams related to gaming (Demetrovics, et al., 2012). Moreover, retrospective thoughts and ruminating about the game has been assessed in experimental settings for example by using *spoken or written listing assessment* (Bushman & Gibson, 2011; Calvert & Tan, 1994).

### **Instruments used to assess behaviours influenced by video games**

Researchers have used a variety of tools and tasks that evaluate actual and/or retrospective behaviours. Particular behavioural tasks have been used in laboratories and self-report measures to assess retrospective behaviours or habits in day-to-day settings.

**Laboratory tasks developed to observe the influence of video game playing on participants’ behaviours do not necessary imply that such behaviours are executed in real life contexts.** Outcomes in these tasks are explained by priming-related mechanisms and lack ecological validity (Ferguson, 2007b). For instance, positive correlations between trait hostility and trait aggression and aggression in laboratory tasks have been found in some studies (Anderson et al., 2004). Repetitive exposure to certain content may be required to evaluate the actual effects. Some examples of tasks used in laboratory to measure aggressive behaviour include the assessment of hostile or aggressive behaviour in a competitive reaction time task such as the *Taylor Competitive Reaction Time (CRT)* that assesses the level of hostility based on the intensity or the aversive nature of the punishment provided to the opponent (e.g., aversive noise blasts, hot sauce) (Barlett, Branch, et al., 2009a; Hasan, et al., 2012). Another task used to measure empathic and prosocial behaviour is the *Pen-drop test* where apparently

by accident, the experimenter drops some pens on the floor, and if the participant helps to collect at least one pen it is interpreted as unrequested assistance and as an indication of empathy or prosocial behaviour (Greitemeyer & Osswald, 2010; Tear & Nielsen, 2013). Another task commonly used for measuring risky driving behaviour in laboratory is *the Vienna Test System for risk-taking (WRBTV)* that consists of a short sequence of films where the participants need to decide to continue driving or to press some keys on the keyboard to leave the situation (Schuhfried, 2006).

**Self-reports instruments have constrained their focus on items that measure video games' effects generally, rather than focusing on content specifics in the video game.**

Numerous instruments have been developed that borrow from other areas of psychology to assess the effect of video games on subsequent behaviour. These types of instrument have been applied based on spread activation theories that argue playing violent video games ends up in increased aggressive behaviour over time since playing them activates and strengthens violent-related nodes of information (Anderson, et al., 2007). Some examples of these instruments include: *Buss-Durkee Hostility Inventory* which assesses hostility affection (e.g., “When frustrated, I let my irritation show”), expressive hostility behaviour (e.g., “If somebody hits me, I hit back”), and suppressive hostility behaviour (e.g., “I boil inside”) (Buss & Durkee, 1957) or the *Buss-Perry Aggression Questionnaire (AQ)* (Buss & Perry, 1992), Likert Scale about aggressive tendencies such as verbal aggressiveness (e.g., “I can't help getting into arguments when people disagree with me”).

Certainly, spread activation via associations and semantic associations can occur, but studies conducted using the framework of transfer of effects from the virtual world to the real life (e.g., Fritz, 2005; Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011d) have found that transfer of video game effects tend to be content specific, since transfers only or mostly occur in situations closely related to or very similar to the content of the game. This position is also supported by studies conducted based on cultivation theory in video games (Beullens, et al., 2011). For instance, gamers in the first ever study concerning GTP conducted by the author of this thesis (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011) reported that while being in a traffic situation they had experienced sudden mind-pops wanting to hi-jack a car as they had done in the video game, or wanting to throw themselves in front of car as in the video game to get money from an insurance company.

**Instruments that assess deliberative behaviours do not identify impulsive and automatic behaviour particularly influenced by experiences in the video game and that are executed without intention to harm, commit a crime or deliberately engage in risky behaviours** (e.g., approach a bicycle thinking to take it but then realize this is not possible because it is not the game) (Ortiz de Gortari, 2010; Ortiz de Gortari et al., 2011). For example, instruments that measure criminal behaviour include *The Delinquency Scale* (Elliott, Ageton, Huizinga, Knowles, & Canter, 1983) that is used to estimate the prevalence and incidence of delinquent behaviour, such as how many times in the past year someone has engaged in aggressive behaviours (e.g., "purposely damaged or destroyed property belonging to a school", "attacked someone with the idea of seriously hurting or killing him/her"), none aggressive delinquency (e.g., "stolen [or tried to steal] a motor vehicle, such as a car or motorcycle"). Moreover, the instruments that assess risky behaviours and attitudes do not evaluate automatic mental processes when gamers drive as in the game without conscious awareness (Ortiz de Gortari, 2010; Ortiz de Gortari et al., 2011). For instances, *The Risky Driving Scale* that assesses risky driving behaviour (Begg & Langley, 2004) or the *Competitive Attitude Toward Driving* (Patil, Shope, Raghunathan, & Bingham, 2006) (e.g., "It's fun to beat other drivers when the light changes"; "it's a thrill to out-manoeuvre other drivers"; "it's really satisfying to pass other cars on the highway"; "it is fun to weave through slower traffic"; and, "taking risks in traffic makes driving more fun"); or other risk-taking attitudes (e.g., attitudes towards joyriding (fun riding), speeding and drinking and driving) (Beullens, et al., 2011); or the *Self-perception as a Reckless Driver Questionnaire* (based on (Trimpop & Kirkcaldy, 1997) (e.g., "I like to compare my driving skills with other drivers on the street", "I like to be admired for risky overtaking manoeuvres", "I like to impress people with my reckless driving skills") (Fischer, et al., 2009). In sum, none of these instruments have measured modification of behaviours influenced by cognitive bias or irrational and sometimes delusional ideas directly related to experiences in the game (as identified in the studies about GTP) such as avoiding certain objects or events due to experiences in the video game (e.g., walking on a certain side of the road to avoid being attacked by monsters). Neither have they assessed the elicitation of urges to do something as in the game due to encountering stimuli associated with the game (e.g., feeling the urge to climb buildings, urges when want to steal cars or urges to harvest plants) (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011).

**Instruments developed to measure gaming disorder have focused on measuring cognitions and behaviours but the criteria have neglected physiological signs and symptoms of gaming disorder** such as altered sensorial perceptions due to the exposure to visual and auditory stimuli and the virtual embodiment of repetitive movements. Episodic or recurrent intrusions with thoughts, images or sounds from the game, or involuntary movements of limbs related with the repetitive movements (e.g., typing, pushing buttons in the game pad, or engaging in the embodiment of simulation of repetitive movements) have been found in GTP studies (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011) and these experiences may well be withdrawal symptoms of gaming disorder and craving for playing. At the same time, they may contribute to the prevalence of dysfunctional gaming and in certain cases in the detriment of the psychological stability of the gamers. Interestingly, altered sensorial perceptions and hallucinations sometimes accompany withdrawal symptoms involving psychoactive substances. For instance, Hallucinogen Persisting Perception Disorder (HPPD) occurs once the effects of the hallucinogens (e.g., LSD) have passed away and share strong similarities with seeing images from the video game in the back of the eyelids as gamers have reported in previous studies (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c) and in Chapter 4 in this thesis. Interestingly, dysregulation of dopaminergic transmission has been associated with hallucinations in Parkinson's disease (Fénelon, Mahieux, Huon, & Ziégler, 2000) and in schizophrenia (Abi-Dargham et al., 2000), as well as among individuals engaging in excessive video game playing (Han et al., 2007).

In summary, it is important to point out that there are several different instruments to assess the effects of video games and some of the instruments may complement each other providing more reliable results. However, some limitations are observed in terms of individual instruments typically used to assess video games' effects: (i) instruments and tasks used for assessing cognitions and behaviours in laboratory settings demonstrate how playing video games can modify cognitions and behaviours temporarily, but these assessments cannot ensure that activation of how (for example) aggressive cognitions translate into aggressive behaviours, or how aggressive behaviours observed in the laboratory end up in aggressive behaviours in real life settings; (ii) self-report questionnaires in the most cases have explicitly assessed thoughts and deliberative intentions of engaging in behaviours even sometimes with the deliberative purpose to damage or harm, but have not typically assessed unconscious thoughts or impulsive behaviours guided by cognitive biases as a result of conditioning mechanisms to stimuli and events that are simulated in the game. Also, different self-report instruments tend



to assess aggressive behaviours based on the premise of spread activation of video game content (i.e., playing first person shooters will lead to perceiving the world as dangerous) instead of directly evaluating the effect of particular content that activate cognitions and lead to actual behaviours in a day-to-day context; (iii) instruments developed for assessing gaming disorder have focused on measuring cognitions and behaviours after playing, but have done so in a superficial way, which do not allow us to get a clear picture of the gamers' cognitions that contribute to the prevalence of dysfunctional gaming patterns (e.g., attentional bias toward gaming related cues) and the criteria have neglected physiological signs and symptoms of gaming disorder manifesting as altered sensorial perceptions and involuntary movements of limbs.

### **Health Effects, Video Game Habits and Consequences of Excessive Gaming**

The possibility to play video games in different locations and in different platforms potentially facilitate frequent playing and increase the probability of engaging in prolonged and sometimes excessive video game playing sessions (Kuss & Griffiths, 2012b). Research has demonstrated that players tend to underestimate the time spent playing. For instance Tobin and Grodin (2009) compared how 116 adolescents estimated the duration of a reading task for eight minutes and of playing a video game (*Tetris*) for 24 minutes. They found that the playing time was underestimated more than the reading task, particularly by participants that typically play games. Moreover, shorter durations were overestimated and longer durations were underestimated. This is explained by the more attention a task needs to be completed, less attention is available to estimate the time investment in the activity. Losing track of time when playing a game occurs independently of gender, age, frequency of playing (Wood, et al., 2007) or of being a novice or expert gamer (Rau, Shu-Yun, & Chin-Chow, 2006). Positive and contra-productive effects of time loss have been suggested. Positive aspects include experiencing relaxation and temporal escape (Wood, et al., 2007). Negative aspects include sacrificing other things in their lives, guilty feelings about wasted time, and social conflict (Wood, et al., 2007).

Problems derive from video game playing have been suggested as the time invested in gaming reduce the time invested in other activities (Gentile, 2011).

Excessive video game playing has been associated with: (i) *neglecting obligations; poor school performance* (Gentile, et al., 2004), and *skipping school* (Charlton & Danforth, 2007; Chen, Weng, Su, Wu, & Yang, 2003; Keepers, 1990), (ii) *neglecting offline relationships*

(Charlton & Danforth, 2007), (iii) *unhealthy habits; sleep deprivation or fatigue* (Achab et al., 2011; Choi et al., 2009; Rehbein, Kleimann, & Mossle, 2010; Tazawa & Okada, 2001). For instances, gamers with problematic gaming habits tend to feel sleepy during the day (Achab, et al., 2011), (iv) *increased chance to experience altered perceptions or epileptic seizures* (Bigal, Lipton, Cohen, & Silberstein, 2003b) by continuing playing when feeling fatigued or being sleep deprived (Babkoff, Sing, Thorne, Genser, & Hegge, 1989; Liu & Peng, 2009; Mahowald, Woods, & Schenck, 1998) or skipping meals to carry on playing (Custers & Van den Bulck, 2010); (v) *adverse effects due to consumption of psychoactive substances to help prolong video game sessions* (Jonsson & Verhagen, 2011) might lead to anxiety, nervousness, insomnia, dehydration, and raised heart rates and blood pressure (Clauson, Shields, McQueen, & Persad, 2008). Research have found that the time spent on gaming resulted in higher consumption of caloric foods (i.e., sugared beverages, snacks) and lower consumption of healthy foods (i.e., fruits) (Santaliestra-Pasías et al., 2012) and obesity (Vandewater, Shim, & Caplovitz, 2004). Furthermore, the consumption of energy drinks has also been related to seizures, strokes, and mania (Calabrò, Italiano, Gervasi, & Bramanti, 2012; Iyadurai & Chung, 2007). Energy beverages contain high doses of caffeine, sugar, taurine and/or guarana, or herbal components such as ginseng and ginkgo, all of which have stimulant effects (Clauson, et al., 2008). Moreover, problematic gaming has also been associated with psychoactive substance use (Ream, Elliott, & Dunlap, 2011; Van Rooij, et al., 2014), and (vi) *deaths due to prolonged video game sessions*. According to media reports (Asian Once News, 2013, November 9; BBC News, 2005, August 10; Curran, 2013, September 9; TechnoBuffalo, 2013, January 18; UK, 2012, July 18) the combination of lack of movement, fatigue, and neglect of basic needs or symptoms of disease can lead to fatal heart failures and blood clots (Block, 2008).

### **Conclusions**

The effects of playing video games have been much debated and many aspects generate controversy. Research has typically dichotomized the effects as positive and negative. Either as the enhancement of cognitive and perceptual skills, promotion of prosocial and healthy behaviours, or have highlighted the detrimental psychosocial effects of playing games. The aim of this chapter was to identify factors that have been assessed in terms of cognition, affect, behaviour, and physiological effects, and other health factors related to playing video games.

A large number of studies has been conducted experimentally and have used cross-sectional designs that in the most of the cases have not measured the temporal stability of the effects, or the effects of gaming over the time on gamers' lives.

In terms of cognitive skills, there is a strong body of research that argues that even playing video games not designed with the purpose of learning are capable of enhancing cognitive and visual attention skills; particularly action games (Boot, et al., 2008; Green & Bavelier, 2003; Skorka-Brown, et al., 2014). However, this is not an area that escapes the debate and a few research studies have found that video games do not enhance spatial distribution attention (Murphy & Spencer, 2009). Moreover, other research studies argue that cognitive failures such as failure in sustaining attention have also been associated with gaming (Bailey, et al., 2010; Barlett, Anderson, et al., 2009; Swing & Gentile, 2010).

In terms of psychosocial effects of video games, for decades more attention has been paid to video game content particularly violent video games. It was not until recently that scholars started to move from this focus, and some have strongly criticised the research in this area arguing that it suffer from publication bias, and use of unreliable measures that increase the size of the effects (Ferguson, 2007a). Independently of the inconsistencies, research into violent video games has shown how video games are powerful in modifying (at least temporarily) cognitions and behaviours but the elicitation of aggressive cognitions does not necessarily translate into aggressive behaviour (Ferguson, 2007b).

Playing driving games is a virtual activity that directly resembles the activity in the real world (i.e., simulated driving). Therefore, it can offer interesting understanding of the actual effects of the video games but not much attention has been paid to this are. The physiological effects of gaming have not been paid much attention other than studies that take arousal in consideration. However, physiological measures have been progressively integrated into research designs about video games' effects and they are also being used to measure gamers' responses while playing a video game (e.g., cardiovascular, endocrinology, brain activations). Also, the physiological side effects of playing video games has for decades concentrated on epileptic seizures although not much attention has been given to this research area recently. Aspects that have been seldom investigated include neural adaptations (e.g., altered sensorial perceptions) when playing video games in on usual screens (e.g., monitor, television). It appears to have been assumed that only video games played using advanced technologies (e.g.,

heads-up displays) can provoke such effects, even though a small body of research has proved the contrary (Dyson, 2010; Ortiz de Gortari, 2010, Ortiz de Gortari, et al., 2011).

An area of gaming research that has grown recently is studies about the effects of video games on sleep. This research has examined the effects of exposure to bright screens, and the arousal provoked by gaming that result in deterioration of sleep quality (Ivarsson, et al., 2013; King, et al., 2013). A rapidly increasing body of research has been carried out about gaming addiction; particularly the effects of online video game playing have dragged the attention of researchers in the last 14-15 years.

Also, neuroimaging studies have found brain differences but it is not possible to determine if the brain differences are the cause of for example problematic gaming (Kuss & Griffiths, 2012a) or if brain changes are explained by the brain plasticity produced by playing video games (Kühn, et al., 2014).

Other health effects have been investigated for decades such as repetitive strain injury due to the repetitive movements when pushing buttons or typing. Newer areas of research have started to appear focusing on musculoskeletal injuries due to the recent introduction to the market of motion tracking controls (e.g., *Wii* control, *Kinect*). Other health consequences relying on habits associated with playing video games (mainly excessively) include sleep deprivation (Achab, et al., 2011; Choi, et al., 2009; Rehbein, et al., 2010; Tazawa & Okada, 2001) and unhealthy diet (Santaliestra-Pasías, et al., 2012), sedentary (Brodersen, Steptoe, Boniface, & Wardle, 2007). Other consequences include neglect of work and/or educational obligations and offline relationships (Charlton & Danforth, 2007; Chen, et al., 2003; Keepers, 1990).

In terms of instruments, there are many that have been used to measure the effects of playing video games. Physiological measures have been used to support findings about the effect of video game playing or to understand gamers' responses while playing (Kivikangas, et al., 2011). However, in these cases the limitations also lie in the narrow scope that assesses cognitions, affective states or behaviours that do not necessarily translate into real life situations. There are also superficial understandings of the video games' effects on cognition focusing on conscious and premeditative behaviours, and no inclusion of signs and symptoms of excessive playing manifesting as altered perceptions, automatic behaviours and corporeal experience when experiencing involuntary movements associated with the gaming activity.

As this introductory overview has shown, video games' effects have been investigated taking in consideration different factors, cognitions, affects, behaviours and physiological and

psychophysiological effects. However, these factors in the majority of the cases have been addressed individually and sometimes from narrow approaches that limit the understanding of the video games' effects. This thesis intends to fill the gap by proposing a framework for understanding the effects of video games in a more integrative way.

## **Chapter 2 - Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena**

Virtual experiences have proven to be pervasive in gamers' lives (Ortiz de Gortari, 2011) and, for some, the significance of virtual events has become "a matter of emotional touch, evoking not just sensations but lasting emotive imprints, which hold for gamers many of the same characteristics as memorable real life experiences" (Ortiz de Gortari, 2007, p.3). However, people tend to believe that media messages have a greater impact on others but not on one self, this is known in media studies as the Third Person Effect (TPE) (Perloff, 1993). The aim of this chapter is to review studies that are closely related to Game Transfer Phenomena (GTP) and the most relevant factors for GTP focusing on video games' structural characteristics, perceived realism and virtual phenomena.

Different theories have been used to explain transfer processes between the virtual world and the real world. The most predominant theories include: (i) *Pavlovian conditioning* – where responses given to certain stimulus can be generalized to another stimulus if these responses are conditioned (Rescorla, 1976), (ii) *priming effect* – where the previous exposure to certain information or stimulus affecting the interpretation of a subsequent stimulus (Berkowitz & Rogers, 1986), (iii) *schema theory* – where prior knowledge schemas or templates are "activated on respond to environmental input which providing context for interpreting experience and assimilating new knowledge" (Derry, 1996) (iv) *the excitation transfer theory* – where the residual emotional response or excitation from one stimulus amplifies the excitatory response to another stimulus (Zillmann, Katcher, & Milavsky, 1972), (v) *the reflective impulse model* – where impulses in the long-term are associated in a network, and when encountering an object, a behaviour associated with this stimulus is activated (Frieze & Hofmann, 2009), (vi) *social learning/social cognitive theory* – where social behaviour is imitated and learned by watching the behaviour of another person (vicarious learning) (Bandura, 1977), (vii) *the neoassociation theory*– where "cues present during an aversive event become associated with the event and with the cognitive and emotional responses triggered by the event" (Anderson & Bushman, 2002, p. 30), (viii) *cultivation theory* – which posits that media constantly portray an unrealistic picture of the real world that over time influences the perception of the real world (Potter, 2012), and (ix) *the General Aggression Model (GAM)* – provides a framework for explaining aggression and violence and is built up through a

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena compound of some of the previous theories described above, argues that “human memory, thought and decision processes can be represented as a complex associative network of nodes representing cognitive concepts and emotions when total activations is sufficiently high, the knowledge structure is activated and used”, as a result of priming (Anderson, et al., 2007, p. 41).

In addition, transfer effect approaches have suggested that transfer of effects occur between the virtual and the real world but these are activated mostly when real life contexts resemble virtual simulations (Ortiz de Gortari, 2010; Ortiz de Gortari, Aronsson, & Griffiths, 2011a; Ortiz de Gortari, et al., 2011c) or are only pertinent to contexts without provoking failures in framing events (Fritz, 2005). The Game Transfer Phenomena (GTP) approach developed in this thesis is a multimodal and neural approach that examines the structural characteristics of the video games, video game content, and in-game activities in an attempt to understand how video games influence gamers' sensorial perceptions, cognitions, and behaviours.

### **Gamers' Transfer Experiences and Related Studies**

There is much anecdotal data about gamers' transfer of experiences available online. Gamers has typically referred to these experiences as *The Tetris Effect*, in honour of the game *Tetris*, which is a stereotypical tile-puzzle game that have been recurrently associated with the seeing of replays of images from the game, or with the continual thinking of wanting to arrange physical objects as puzzle pieces. The origin of the *Tetris Effect* is debatable. Some attribute the name to the a poem “Virus in digital dreams” by Neil Gaiman (1987). Others refer to Garth Kidd (1996) who described the *Tetris Effect* as “seeing afterimages of the game for up to days afterwards” and “a tendency to identify everything in the world as being made of four squares and attempt to determine where it fits in”. Goldsmith (1994) defines the *Tetris effect* as a:

*“Biochemical, reductionist metaphor, if you will, for curiosity, invention, the creative urge. To fit shapes together is to organize, to build, to make deals, to fix, to understand, to fold sheets. All of our mental activities are analogous, each as potentially addictive as the next” (para.13).*

The definition of the *Tetris Effect* (2012a) in *Wikipedia* notes:

*“When people devote sufficient time and attention to an activity that it begins to overshadow their thoughts, mental images, and dreams. It is named after the video game Tetris. Some of the Tetris effects include thinking about ways different shapes in the real world can fit*

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena together, such as boxes on a supermarket shelf or the buildings on a street. Also, dreams about Tetris pieces falling or see images of falling Tetris shapes at the edges of the player's visual fields or when they close their eyes" (para.1).

Despite the large amount of anecdotal data about gamers' subjective experiences, empirical research to understand and explain these side-effects of video game playing has been little researched. In the author's previous research when trying to find a way to refer to numerous and diverse gamers' sensorial experiences, thoughts, fantasies and dreams collected in interviews with 42 frequent Swedish gamers (15 to 21 years old) (Ortiz de Gortari, et al., 2011a; Ortiz de Gortari, et al., 2011c), the term Game Transfer Phenomenon (GTP) was coined by the author of this thesis. In this study, the GTP were defined as "phenomena that occurred by associations between real life elements<sup>7</sup> and video games elements<sup>1</sup> that triggered subsequent thoughts, sensations and/or behaviours in players" (Ortiz de Gortari, et al., 2011c, p. 17).

There are important reasons why not to use the *Tetris effect* term to refer to research about transfer of experiences. These reasons include: (i) the '*Tetris effect*' definition is very broad and does not emphasize the importance of the association between real life stimuli and video game elements as a trigger of some of the experiences, (ii) it does not make a clear distinction between sensorial modalities in the game transfer experiences or talk about the players' experiences across different sensorial modalities (e.g., hearing a sound and visualizing a video game element), and (iii) the name itself is inspired by one specific stereotypical puzzle game (i.e., *Tetris*). The name indicates that it is a repetition that triggers the transfer effects but there are clearly other factors involved in the experiences. Furthermore, modern video games use more than abstract shapes and offer more flexible scenarios compared to *Tetris* and similar games (Ortiz de Gortari & Griffiths, 2012a).

The main findings in the author's previous interview study prior to the start of the current research (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011a; Ortiz de Gortari, et al., 2011c) were that gamers reported responding automatically to real life stimuli similar to that in the video game (such as gamers feeling the urge to climb buildings as in the video game). Also, they reported seeing video game images superimposed in real life objects such as when gamers saw health bars or text boxes above peoples' heads. Additionally, gamers experienced visual after-effects such as seeing real life objects levitating directly after stopping playing a

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<sup>7</sup> Video game elements' are understood as whatever agents, characters or objects representations are located in the virtual world.



Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena game, as well as performing automatic actions as in the video games, and using video game content for amusement. More specifically, a variety of behaviours deliberately initiated by gamers with video game contents were found (e.g., using games in school projects, using game score system in real life events, telling jokes using content of the game, mimicking video game characters) and automatic and non-volitional phenomena (e.g., visual altered perceptions, earworms, dreams, intrusive memories). The remainder of this chapter collates research and case studies closely related to GTP. In the following section a short overview of each of these studies presented.

### **Research Examining GTP-like Phenomena**

To demonstrate the continuity between waking activities and sleep, Stickgold, Malia, Maguire, Roddenberry and O'Connor (2000) conducted an experiment to investigate "hypnagogic mentation", a type of mental imagery where individuals experience hallucinatory replays of novel physical or novel activities at sleep onset (Stickgold, et al., 2000, p. 350). Subsequent studies were conducted in this matter by Wamsley, Perry, Djonlagic, Reaven, & Stickgold (2010) and Kusse, et al., (2012). These are discussed in more detail in Chapter 4 that focuses on visual GTP experiences. Achor (2011) argued that the *Tetris effect* can be maladaptive when engaging in gaming unrelated tasks, but that it can be used to induce positive thinking. Achor used the findings concerning the *Tetris effect* to identify dysfunctional behaviours due to stereotypical ideas or narrow-minded perspective. He argued this encouraged positive thinking by rehearsing positive thoughts.

In the area of media studies, studies published in German (Bigl, April, 2009; Wesener, 2004; Witting, 2007) have examined transfer effects in video games from a learning perspective. Wesener (2004) focused on the technical possibilities of transfer of learning in computer and video games. Witting (2007) interviewed 80 gamers and analysed the transfer effects in terms of players' behaviour, and their ethical and moral attitudes. Fritz (2005), in a book chapter about transfer from the media world to the real world, argued that the transfer from computer games are mostly of a problem-solving nature (e.g., thinking about possible solutions to solve a problem in the game) that occurred consciously or as a routine. He argued that it is possible to transfer schemata (mostly scripts) from video games to a real life context, but it should be framing competence that allows the transfer of the scripts and the individual interest to actually exercise the transfer. He identified ten types of transfer based on his qualitative research: (i) problem-solving transfer (e.g., thinking about problems), (ii) emotional transfer (e.g., anxiety),

(iii) instrumental action-oriented transfer (e.g., training patterns of action), (iv) ethical-moral transfer (e.g., changing values), (v) associative transfer (e.g., the connection between different stimuli), (vi) reality-structuring transfer (e.g., acquisition of game experience), (vii) informational transfer, (viii) memory-related transfer (e.g., memory of specific game elements), (ix) time-experiencing transfer (related to the flow experience), and (x) transfer related to imaginative activity (Fritz, 2005).

Bigl (April, 2009) conducted research in online forums and then administered an online survey comprising 1,146 participants. He identified seven different types of transfer: (i) transfer of knowledge (experienced by 21.4% of the participants), (ii) transfer of dreams (30.8%), (iii) transfer of emotions (12%), (iv) transfer of actions patterns (1.6%), (v) transfer of analysis ability (9.2%), (vi) transfer of functions (4.14%), (vii) transfer of attention and visual orientation (6.3%). Only 13% of the participants had not experienced the transfer of the effects that he investigated.

A recent online survey conducted by Poels, Ijsselstein and de Kort (2014) comprising 511 players from the MMORPG *World of Warcraft* outlined some of the transfer phenomena described in previous studies about GTP (e.g., Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011). They investigated game biases perceptions or associations in five domains: (i) memories from the game triggered by physical objects, (ii) daydreams, (iii) nightly dreams, (iv) memories from the game triggered by sound and music, and (v) intentionally using words and expressions from the game. The results suggested that increased playing time (e.g., the number of hours played on an average day during the last three months) was positively related to game bias perceptions and experiences in all five domains. Involvement in the narrative of the game was positively related to associations with physical objects, sounds and music, and dreams but the relationships were weak. In addition, researchers and clinicians have reported isolated case studies about perceptions and behaviours influenced by video games. This includes:

- (i) A female who suffered from persecutory delusions and exhibited violent behaviour, and who also heard constant replays of the music from the *Super Mario Bros.* game. The author described this case as a “Nintendo hallucination”, an example of “an environment stimulus being recruited into the phenomenology of a psychotic illness” (Spence, 1993, p.98).
- (ii) A child that suffered from nightmares involving monsters and witches from a game and they were going to kill him; this lead the boy to carry a toy gun around with him for self-defence because he was afraid someone would attack him and try to hurt him

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena (Bertolini & Nissim, 2002). This particular anecdote share similarities with persecutory GTP reports (e.g., Ortiz de Gortari, et al., 2010).

- (iii) A man that under the influence of alcohol accidentally punched his wife in the face as he thought he was battling a dungeon boss in *Zelda: Twilight Princess* (Fysh & Thompson, 2009).
- (iv) An 18-year old teenage male obsessed with gaming who was afraid of the darkness and to walk outside alone because he feared that someone would "jump out at him" (Allison, et al., 2006).
- (v) A man that was admitted to a psychiatric clinic from prison because he thought he was in a video game and was trying to collect points while stealing motor vehicles and assaulting the owners with weapons. He has paranoid delusions and believed that someone was going to murder him. Additionally, he experienced auditory hallucinations persistently hearing an abusive and pejorative voice. He was subsequently diagnosed with paranoid schizophrenia (Forsyth, Harland, & Edwards, 2001)
- (vi) A man that was fanatical about flying an aircraft (and had a non-specific psychiatric history) hijacked a plane after becoming obsessed with playing a flying simulator (Ichimura, Nakajima, Sadiq, & Juzoji, 2007).
- (vii) An elderly man with no previous psychiatric history who developed acute psychosis induced by prolonged video game playing after playing the video game version of the card game Bridge (Mukaetova-Ladinska & Lawton, 1999). According to the authors, this behaviour was explained as due to an "extracellular dopamine in the brain tissue" (p. 1076).

There are also cases concerning afflictions with using wearable technologies that share similarities with gamers' experiences identified in studies about GTP (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011; see also Chapters 4 and 6 in this thesis) that have started to appear. For instance, the case of a 31-year old male alcoholic with underlying psychiatric conditions checked into the US Navy's Substance Abuse and Recovery program (Yung, Eickhoff, Davis, Klam, & Doan, 2015). However, when he was restricted from using his *Google Glass*, he showed signs of what is described by the medical staff as withdrawal symptoms. These included seeing dreams through the Google Glass and frequently involuntary lifting the hand toward the temple to control the device that was no longer present. He also exhibited frustration

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena and irritation at not being able to use the device, and he felt highly dependent on using the device to recall information. After the 35 days of treatment, the majority of the symptoms reduced, although he continued seeing his dreams through the device and his desire to use the device did not disappear (Yung, et al., 2015).

### **Video Games and Their Structural Characteristics**

Video games are developed based on a balance between skills and challenges, and are intrinsically rewarding (Csikszentmihalyi & Csikzentmihaly, 1991). Many activities in video games are directly rewarded with points, sounds effects, level progression, etc. Video games are designed in a sequence of events that provide schedule reinforcement and punishment to achieve goals in the game, establishing the perfect conditions for conditioning the gamers' behaviours (Dill & Dill, 1999). Video games typically use variable and fixed ratio reinforcement (Chumbley & Griffiths, 2006). A variable schedule of reinforcement where not every "try" is reinforced maintains the expectations for the next successful try and therefore it is powerful to maintain habits (Ferster & Skinner, 1957).

According to Chumbley and Griffiths (2006) the reinforcement characteristics influence gamers' affective states. For instance, increment in the ratio of negative to positive reinforcements resulted in participants experiencing more frustration and less excitement. They also found that positive reinforcement was associated with the probability to continue and the willingness to return to play. Carnagey and Anderson (2005) investigated the effects of rewards and punishment in terms of violence-related outcomes. They found that violent actions that were rewarded led to greater hostile emotions, aggressive thoughts and aggressive behaviours, while violent actions that were punished only resulted in hostile emotions but not aggressive thoughts or behaviour. Also, research has found that rewarding and punishing features (e.g., finding unusual game items, fast loading, and earning higher score) are considered the more pleasurable features of the game (2010b).

Little research has been carried out into video games' structural characteristics although some researchers have studied them to understand gamers' motivations, gaming patterns and problematic gaming. Structural characteristics are the core features within the video game that are created by the video game developers. Psychostructural characteristics are important in the decision to play, the development, and the prevalence of gaming patterns (King, Delfabbro, & Griffiths, 2010a) independently of the individual's psychological, physiological or socio-economic status (Wood, Griffiths, Chappell, & Davies, 2004). Some evidence suggest that

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena  
 psychostructural characteristics are stronger predictor of problematic gaming than socio-demographic factors such as gender and age, and time invested on playing. (King, et al., 2010b).

Certainly, preferences in video game structural characteristic may vary between each individual; however, different researchers have investigated what structural characteristics are more desirable to be included in a game. Wood and colleagues (2004) surveyed 382 gamers to investigate among others the preference for including features such as sounds, graphics background and settings, duration of game, humour, winning and losing features, etc. They found differences between genders in terms of preference for the video game structural characteristics. For instance males prefer games based on real events (e.g., battles or sports), multiplayer options, beating other players, multiplayer communications and establishing aliases which suggest that socializing in the game and competing is more important for males. Females preferred non-violent, less competitive, cartoon and fantasy style and less aggressive games. Overall, the participants considered the degree of realism (e.g., realistic sounds, graphics and settings) more important and that the game allowed a rapid absorption rate (i.e., how quickly a person could get into the game) was also important, and possibilities for customizing characters and multiplayer features.

King, Delfabbro and Griffiths (2010a) proposed a five-factor taxonomy of video games. The following table shows a summary of the five-feature models proposed by King, Delfabbro and Griffiths (2010a).

**Table 2. 1** Summary of the five-feature model of video games' structural characteristics (King, et al., 2010a, p. 93)

| <b>Feature type</b>               | <b>Sub-features</b>   | <b>Example</b>  |
|-----------------------------------|---|---|
| Social features                   | Social utility features<br>Social formation/institutional features<br>Leader board features<br>Support network features | In-game voice and text chat<br>Guilds/clans in MMORPGs<br>"Hall of fame" high score list<br>Internet forums, strategy guides                |
| Manipulation and control features | User input features<br>Save features<br>Player management features<br>Non-controllable features                         | User input features<br>"Combos", "hot keys"<br>Checkpoints, "quick-save"<br>Managing multiple resources<br>Scripted events, loading screens |

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|                                 |   |   |
|---------------------------------|---|---|
| Narrative and identity features | Avatar creation features<br>Storytelling device features<br>Theme and genre features  | Choice of sex, race, attributes<br>Cut-scenes, mission briefing<br>"Role-playing", "shooting"   |
| Reward and punishment features  | General reward type features<br>Punishment features<br>Meta-game reward features<br>Intermittent reward features<br>Negative reward features<br>Near miss features<br>Event frequency features<br>Event duration features<br>Payout interval features | Experience points, bonuses<br>Losing a life, restarting a level<br>Xbox 360 Achievement points<br>Increasing difficulty of levels<br>Gaining health, repairing items<br>Difficult "boss" at end of level<br>Unlimited replayability of game<br>MMORPGs have no endpoint<br>Rewarded instantly for playing |
| Presentation features           | Graphics and sound features<br>Franchise features<br>Explicit content features<br>In-game advertising features  | Realistic graphics, fast music<br>Trademarked names, e.g. Mario<br>Violence, drug use, nudity<br>Real-life brands, sponsors logos   |

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In a further study, King, Delfabbro and Griffiths (2010b) tested their proposed five-factor taxonomy of video games (See table 2.1) in a survey of 421 gamers to investigate what were the more enjoyable structural characteristics and the relationship between structural characteristics and problematic gaming. Gamers with gaming problems in comparison to those without problems reported following features more enjoyable: (i) adult content, (ii) finding rare game items, (iii) watching cut-scenes, (iv) the tactile sensation or "feel" of controlling the game (including force feedback, button mashing). The features that were considered more important for those in the problem group included: (i) managing in-game resources, (ii) earning points, (iii) getting hundred percent in the game, and mastering the game, features that required significant time investment. Furthermore, this group considered levelling up as highly important, earning meta-game rewards (e.g., achievements), and faster loading times. In sum,

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena rewards, social interaction and features related with manipulation and control are crucial in problematic gaming.

Additionally, identifying the psycho-structural characteristics of the video games has proved beneficial in identifying types of gamers based on their motivations. Westwood and Griffiths (2010) used a Q-sort methodology<sup>8</sup> to identify six different types of gamers based on 40 gamers. These were (i) story-driven solo gamers, (ii) social gamers, (iii) solo limited gamers, (iv) hard-core online gamers, (v) solo control/identify gamers, and (vi) casual gamers. This study showed how each type of gamer is driven by different motivations to play specific games and the relevance of sounds, graphics and game story which contribute to make the game more realistic and immersive.

### **Virtual Phenomena, Cognitive Absorption, Immersion and Presence**

Playing video games requires the interaction with synthetic stimuli (e.g., image, sound, etc.). Gamers embody and manipulate virtual representations while their physical body is left behind which may provoke some sort of cognitive dissonance (Murray & Sixsmith, 1999). Furthermore, some have argued that the individual's thoughts, feelings and objective judgment are suspended when the individual gets engaged and is persuaded by the virtual experience (Dill, 2009).

Virtual phenomena that have been extensively investigated include absorption, immersion, flow, presence and engagement. Distinctions between absorption and immersion have been established. On one side, cognitive absorption is related to the individual's beliefs and attitudes about technology that guide subsequent behaviours (Agarwal & Karahanna, 2000). It is also related to the trait dimension called absorption (Tellegen, 1982) and the state of flow (Csikszentmihalyi & Csikszentmihalyi, 1991). Cognitive absorption does not take into consideration the motivation for playing (e.g., curiosity) (Jennett et al., 2008). On the other side, immersion has been conceptualized in different ways. Some consider immersion as a description of how technology is capable to provide an immersive experiences (Slater & Wilbur, 1997), while others consider it a mix of technological capabilities and the individual capacity to shut out the external world and get immersed in the virtual world.

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<sup>8</sup> QM focus on study personal point of view and consist in participants sort a series of statements not normally arrange in a hierarchical order, then the way the statement are sort are analyse using a invert factor analysis (Westwood & Griffiths, 2010).

Immersion is characterized by: (i) lack of awareness of time, (ii) loss of awareness of the real world, (iii) involvement and a sense of being in the task environment (Jennett, et al., 2008). Ermi and Mäyrä (2005) proposed three dimensions of immersion: sensory immersion, challenge-based immersion, and imaginative immersion. Sensory immersion is related to the video games' audio-visual features (Ermi & Mäyrä, 2005). Becoming sensory immersed in a game implies getting cognitively involved, dissociating from the objective reality by losing track of time due to focusing on virtual tasks, and in some games feeling dislocated from the physical location, and feeling present in the game space (Jennett, et al., 2008). Imaginative immersion focuses on involvement in the story, and in the game world, role-playing and identifying with the game characters (Ermi & Mäyrä, 2005; Poels, et al., 2014; Yee, 2006). In narratives, individuals get transported into the fictional story, and the person's disbeliefs and critical evaluations are suspended (Dill, 2009). According to Brown and Cairns (2004) there is a progression of immersion, as follows: engagement, engrossment, and total immersion or presence.

Presence has been defined as the "state of consciousness, the (psychological) sense of being in the virtual environment" (Slater & Wilbur, 1997, p. 4). Experiencing a sense of presence requires interaction with the virtual surroundings as 'being there' is different to only looking at images on the screen (Slater & Wilbur, 1997). However, it has been argued that a full sense of presence can only be experienced in highly immersive environments such as VR (Persky & Blascovich, 2006; Pettey, Bracken, Rubenking, Buncher, & Gress, 2010; Tamborini & Bowman, 2010). In the following section perceived realism in association with some of the virtual phenomena previously described and in relation to video games' effects are reviewed.

### **Perceived Realism of Video Games and Their Effects**

Realistic sounds, graphics and settings are important for most gamers (Wood, Griffiths, Chappell, et al., 2004). Perceived realism implies perceiving media content as realistic when compared to real life or if the individual responds to it as thought to be real (Hall, 2006). Many modern video games use realistic representations of objects, referred to as sensory realism cues (Jeong, Biocca, & Bohil, 2012). Shapiro, Pena-Herborn, and Hancock (2006) argue that there are two fundamental elements for judging if a mass media scene is realistic or not. The first, is whether the media portrays actions, characters, and others elements that could actually take place in real life sceneries. The second is whether media content is enhanced by the use of high quality graphics that lead it to look more realistic. The effects of realism have been investigated



Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena in different dimensions: (i) matching between video game content and physical events, (ii) realistic video game cues and graphic quality, (iii) comparison of old versus new versions of video games, (iv) immersive virtual environments versus traditional platforms, (v) natural game controls versus traditional gamepads, and (iv) viewer perspective and embodiment of realistic virtual entities.

### **Matching between video game content with physical events**

Cultivation theory (one of the dominant theories in media studies and mostly used in studies about television) posits that media constantly portray an unrealistic picture of the real world that over time influences the perception of the real world in two ways (Potter, 2012). The first-order cultivation corresponds to the perception of the likelihood of an event and the incidence of certain issues (e.g., number of assaults in a city per year), while the second-order cultivation assesses individuals' beliefs, attitudes, and point of view about an event (e.g., feel afraid to be assaulted) (Chong, et al., 2012).

Research has been conducted using this theory to examine to what degree the content of the game influences evaluations, expectations, and judgments of events in the real world. For instance, Williams (2006) investigated the longitudinal effects (over one-month) of cultivation in the role-play game *Asheron's Call 2*. He found that gamers' perceptions of real world dangers were influenced by the game experiences, but only in relation to situations found in the game rather than occurring in a spread activation network posited by the cultivation theory. Lee, Peng and Klein (2010) examined how role-playing a violent character influenced gamers' attitudes towards violent crime and criminals, specifically, when the crimes were similar to the meta-narrative in the game. Participants who role-played a violent police officer and committed violent virtual crimes showed less punitive attitudes when judging comparable violent crimes committed by a real life police officer than crimes committed by other people.

Similarly, Chong, Teng, Siew and Skoric (2012) conducted an experiment where participants played *Grand Theft Auto (GTA) IV* for 12 hours spread across three weeks. They only found support for the effects of the first-order cultivation limited to the "meta-narrative" of the game. Gamers' overestimated the incidence of people dying in car accidents while driving in comparison to the control group. This is explicable since the gameplay involved situations such as driving at high speed, crashing other cars, and driving over other people where the player can be injured or die. However, the effects of second-order cultivation were

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena found but in a reverse direction. Even though car theft is very common in the game, the experimental control group was more likely to believe that stealing cars was difficult in real life in comparison to those who did not play the game. The authors explained this result by arguing that this occurred because the game portrayed an unrealistic picture that stealing cars was very easy, and that car robbery was very unlikely in Singapore (where the study was conducted).

Other areas of research that have demonstrated the relevance of the match between video game content and video game effects on cognition, attitudes, and behaviour have been conducted particularly with racing video games. Here, researchers have compared street racing games where gamers race through cities against others by violating traffic rules to win (e.g., crashing into other cars, driving on sidewalks) versus circuit race games where players compete against each other at fast velocities on F1 circuit without violations (Fischer, et al., 2009; Vingilis, et al., 2013). These studies have found that those who played the street-racing games are more likely to show effects on intention to engage in risky driving behaviours or have actually engaged in such behaviours (Beullens, et al., 2011; Fischer, et al., 2009).

### **Realistic cues and video game graphics quality**

In terms of the use of realistic cues and graphics in video games, different studies have manipulated video game features to examine the effects. In particular, features such as the use of blood have influenced the classification of video games according to game rating boards since unrealistic blood provokes less arousal and is less memorable (e.g., PEGI in Europe; Entertainment Software Rating Board (ESRB) in US). The access to video games with realistic depictions of blood is restricted to adults, and some games instead use unrealistic blood such as representations of blue or white blood or no blood at all (Jeong, et al., 2012). Research into this has found that playing games with a high blood condition in comparison to lower levels of blood or no blood have resulted in: perception of more gore and aggressive intentions, particularly when participants reported higher involvement and immersion (Farrar, Krcmar, & Nowak, 2006); increases in hostility and higher sense of presence (Barlett, Harris, & Bruey, 2008); and physiological arousal (Ballard & Weist, 1996; Barlett, Harris, et al., 2008; Jeong, Biocca, & Bohil, 2008). Also, the use of red blood and realistic screams of pain resulted in physiological arousal independent of the gamer's level of experience (Jeong, et al., 2012). Kojin, Nije Bijvank and Bushman compared the effects of fantasy and more realistic violent

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena video games. They found that more realistic violent games led to better identification with violent characters and the gamers felt more immersed (Konijn, et al., 2007).

### **Comparison of old versus newer video games**

The video game industry has grown dramatically since the appearance of the first commercial video games in the 1970s. The experience of playing contemporary video games substantially differs from engaging with previous video game incarnations. In the first wave of video games, players engaged in the manipulation of primitive objects, and the video games' graphics were simpler and hardly invoked the players' sense of presence in the game environment (Ortiz, 2007). In terms of comparison between old and new video games, research has found that newer video games (i.e., newer versions or newer games) of the video games have been associated with: (i) higher sense of presence and involvement (Ivory & Kalyanaraman, 2007; Krcmar, Farrar, & McGloin, 2011), (ii) increased cognitive processing such as attention and reaction (retain the modelled behaviour in memory) (Krcmar, et al., 2011), (iii) aggressive outcomes such as physical aggressive intentions (Krcmar, et al., 2011), and (iv) verbal aggression on those who experienced greater identification (Krcmar, et al., 2011). Although, other studies have found that aggressive cognitions (Barlett, Rodeheffer, Baldassaro, Hinkin, & Harris, 2008) and state of hostility (Barlett, Rodeheffer, et al., 2008; Ivory & Kalyanaraman, 2007) elicited by playing a violent video game were not moderated by the advancement in the technology (Ivory & Kalyanaraman, 2007).

### **Highly immersive virtual environments versus traditional gaming platforms**

To date, VR technologies have mostly confined to therapeutic (Baños et al., 2006; Parsons & Rizzo, 2008) or military or aerospace domains (Stanney & Salvendy, 1998; Viirre & Bush, 2002), where these technologies have been used with success for modifying or encouraging behaviours or training. The majority of research conducted in these areas has used video games particularly designed and developed for the purposes of the studies. This should be acknowledged when interpreting the results since results may not be generalized to video games developed for the purpose of pure entertainment. However, in general it has been argued that playing video games with VR systems results in more realistic experiences due to that the gamers feeling more presence, involvement, and immersion (Persky & Blascovich, 2006; Pettay, et al., 2010; Tamborini et al., 2001) that in turn strengthen the effects of the games

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena (Persky & Blascovich, 2008). For instance, higher degrees of presence and immersion (Ivory & Kalyanaraman, 2007; Persky & Blascovich, 2008) have been related to physiological responses and self-reports of arousal (Ivory & Kalyanaraman, 2007) and higher presence has also been related with better memory recall (Jeong, et al., 2008). Additionally, research into dreams has found a higher degree of dreams incorporation in comparison to traditional platforms, which suggests higher impact of the experience (Gackenbach, Rosie, Bown, & Sample, 2011).

Alternately, Persky and Blascovich (2008) found that playing violent video games in a VR condition increased presence, aggressive feelings and behaviour compared to playing under normal gaming conditions (e.g., a desktop platform). Similar results were found in another study conducted by the same authors (Persky & Blascovich, 2007). However, in this latter study, the researchers also compared the effects of a non-violent video game, and they did not find that using VR intensified artistic and creative feelings. These discrepancies show the complexity of factors involved when measuring video games' effects. Also, other studies have shown mixed results in terms of video game content. Arriaga, Esteves, Carneiro and Benedicta Monteiro (2008) did not find differences in state hostility and aggression when the video game was played with or without VR. Similarly, Tamborini and colleagues did not find that telepresence, which was expected to be enhanced by the virtual reality system, mediated hostile thoughts or aggressive behaviour effects (Tamborini et al., 2004). However, in this study the traditional platform resulted in higher levels of telepresence rather than the virtual reality system. In another study, they found greater hostile thoughts in participants that observed the game than those who played the game in the Immerse Virtual Environment (IVE) (Tamborini, et al., 2001). Some of the explanations of these unexpected results offered by the researchers include failures of the system to be good enough to provide presence to the degree of strength the effects, or factors associated with participants such as expectations about the technology (Petty, et al., 2010), distress during the experiment due to the novelty of the VR, and perhaps cyber-sickness related symptoms (Tamborini, et al., 2001).

### **Viewer perspective and embodiment of realistic virtual entities**

Another important dimension that is related to realism in video games is the gamers' viewing perspective. The first-person perspective (1PP) better resembles the natural way we see ourselves (and our surroundings). This viewing perspective takes the player directly into the game environment and it is typically used within action games (Spence & Feng, 2010). On

the other hand, the third-person perspective (3PP) – a “puppeteer’s viewer” (Schoorink & Toet, 2010, p. 727) – consists in embodying virtual representations. Research that has compared first-person versus third-person perspectives have found that the third-person point of view compared with the first person point of view results in a higher degree of presence (Jeong, et al., 2008), although Farrar, Krcmar and Nowak (2006) found that females were more focused and involved when playing using the third-perspective view in comparison than males. Several studies via synchronous multisensory stimulation have induced and demonstrated the “body ownership”, “the attribution of an artificial objects (e.g., rubber hand or a virtual hand) as being part of one’s own body” (Kiltner, Normand, Sanchez-Vives, & Slater, 2012, p. 1; Sanchez-Vives, Spanlang, Frisoli, Bergamasco, & Slater, 2010). Moreover, changes in body perception such as perceiving oneself as having a bigger belly has been demonstrated (Normand, Giannopoulos, Spanlang, & Slater, 2011), as well as enlargement of an arm (Kiltner, et al., 2012) and ownership of a child body (Banakou, Groten, & Slater, 2013). Interestingly, Banakou, Groten and Slater (2013) measured the effects of body ownership on perception and attitudes. Temporary changes in perception and cognitions were found. Those in the child condition overestimated the sizes of objects’, and responded faster when their body type was paired with child images using the Implicit Association Test (IAT). Moreover, human-like characters have been associated with more emphatic decision patterns (MacDorman, Coram, Ho, & Patel, 2010), more engagement, and user satisfaction (van Vugt, Konijn, Hoorn, Keur, & Eliëns, 2007). More human-like characters as a target (when compared with a non-human looking target) leads to more aggression, but this appears to be limited to less socially sanctioned forms of aggression after playing such as verbally aggressive intentions and violent cognitions (Farrar, Krcmar, & McGloin, 2013).

Customizing or playing with virtual representations that match the real or the ideal self may facilitate a synchrony between the physical body, the virtual body, and the mind’s representation of the self. The customization of character or avatar have proved to be relevant for enhancing the game experience by allowing gamers to create, choose, and modify their avatars (Bailey, Wise, & Bolls, 2009; Wood, Griffiths, Chappell, et al., 2004). Customization has also lead to increased arousal while playing violent video games and after playing (Fischer, Kastenmüller, & Greitemeyer, 2010), as well as experiencing a sense of presence (Bailey, et al., 2009). Matching the user characteristics with virtual representations (e.g., same gender, similar look) enhance presence (Ratan, Santa Cruz, & Vorderer, 2007), strengthen persuasion (Hoyt, Blascovich, & Swinth, 2003; Okita, Bailenson, & Schwartz, 2008), encourage intimacy

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena (Bailenson, Blascovich, & Guadagno, 2008), and lead to positive attitudes toward the avatar (e.g., affection, passion) (Kil-Soo, Hongki, & Eung Kyo, 2011).

### **Natural game controls and new trends versus traditional gamepads**

Playing a video game is becoming a multi-sensorial experience, and virtual objects are not any longer just controlled by repetitive movements of fingers when pushing buttons, but can also be played by body movements and voice commands (e.g., *Kinect*), and icons can be manipulated by touching display screens (e.g., tablets). For generations, video games have used tactile-user interfaces such as steering wheels, guns with force feedback or gloves<sup>9</sup> instead of gamepads trying to enhance the virtual experience. More recently, motion-capture technologies that record movements have been introduced in a variety of ways. Sport games on the *Wii* console can be played with the *Wii* remote controller that can be attached into a wheel control, baseball bat, golf club, tennis racket, and the game can be controlled by replicating movements such as steering a wheel or swinging the arms. Controls as the *Wii* remote and *PlayStation Move* can control content by pointing into the screen simulating touching the interface. Furthermore, motion-sensing technology has been introduced into different consoles (e.g., *Nintendo Wii*, *Microsoft Kinect*) allowing gamers to control the game by body moments, physical gestures, voice commands, and blowing into the gamepad.

A small but growing body of literature has investigated the effects of using natural controls and contrasted the game play using the latest technological advances versus previous technologies. For instances, Skalski, et al., (2011) investigated the impact of natural mapping by using different types of controls in video games (e.g., gamepad, *Nintendo Wii* control, steering wheel). Natural mapping applied to video games is understood as how well in-game actions match actions in real life environments (Tamborini & Bowman, 2010). The use of more natural controllers (e.g., steering wheel) is related to higher levels of sense of presence and game enjoyment (McGloin, Farrar, & Krcmar, 2011; Skalski, et al., 2011; Williams, 2014) and realistic perception of the graphics and sound (McGloin, Farrar, & Krcmar, 2013; McGloin, et al., 2011).

Although, discrepancies have been found in terms of aggression-related outcomes, some research has found that the use of natural controls led to hostility but not negative

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<sup>9</sup> The power glove was released by Nintendo in 1989 (Matulef, 2013, July 13). It was the first gesture based game controller and predecessor of the motion capture controls.

Game Transfer Phenomena Related Studies, Video Games' Structural Characteristics and Virtual Phenomena emotions (Melzer, Derks, Heydekorn, & Steffgen, 2010) and increases in aggressive cognition (McGloin, et al., 2013), while other studies have not found such links (Markey & Scherer, 2009) or have found lower cognitive aggression (Charles, Baker, Hartman, Easton, & Kreuzberger, 2013; Mahood & Cicchirillo, 2008) even when playing in a cooperative or competitive mode (Charles, et al., 2013). There is also some evidence which suggest that engagement in body movements by controlling the game with the Kinect instead of a mouse reduce pain induced in laboratory (Czub & Piskorz, October, 2014).

Another relevant aspect when it comes to playing video games in more natural and realistic setting including mixed reality environments (MREs) or augmented reality (AR) described by Drascic and Milgram (1996) is: “between the extremes of real life and virtual reality, in which views of the real world are combined in some proportion with views of a virtual environment” (Drascic & Milgram, 1996, p. 123). Some examples of mixed reality in video games include using physical objects (e.g., figurines located in a responsive surface that connect with the game in the game *Skylanders*) or including papers cards as in the *Nintendo 3DS*, or gamepads with embedded touch screens (e.g., the *Wii U* gamepad) where some events in the game can be controlled by blowing. Also, Augmented Reality Handles (HAR) have been developed by *Nintendo*'s 3DS or XL3DS where real life environments are used as background for playing the game (Yan et al., 2011). Future developments include the commercialization the gaming treadmill (e.g., *Virtuix Omni*) and haptic technology (e.g., the *Kor-fx* vest that allow explosions from the game to become a pulse that is felt in the chest<sup>10</sup>) and head-mounted displays (e.g., *Oculus Rift* or *Sony*'s VR headset project *Morpheus*) that can be used to experience higher degrees of immersion and mixed reality experiences. The commercialization of these technologies suggests that research into them should not delay more.

## Conclusions

Transfer effects appear to be have been addressed focusing on different factors (e.g., transfer of moral, emotions, strategies, learned patterns). Game Transfer Phenomena as a multimodal approach examines how gamers' sensorial perceptions, cognitions, and behaviours are affected by playing video games. This approach is different to other transfer approaches as

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<sup>10</sup> For instances, the game accessory Immerz KOR-Fx claim that “sounds are felt rather than heard and that it turns the body into a sub-woofer”

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it focuses on understanding non-volitional transfer of effects and the psychological and social effects of these transfers. Research about GTP suggests that similarities between video games' content and real life contexts facilitate associations that end up in transfer of experiences (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011a; Ortiz de Gortari, et al., 2011c). Realistic cues in the game appear to favour transfer of effects. Even though the first-person view is more natural than embodying virtual characters, the embodiment of virtual entities especially when they are able to be customized or looks like the user, appear to be powerful tools of persuasion. Studies concerning highly immerse environments and augmented technology are still limited since these platforms are not yet commercialized, but virtual heads-up displays and haptic accessories may change the player experience sooner than we thought. This is interesting because research has suggested that multisensory channels (e.g., tactile, olfactory, auditory, and visual sensory cues) leads to a higher sense of presence and memory of objects in the virtual environment (Dinh, Walker, Hodges, Song, & Kobayashi, 1999) which may strengthen video games' effects.



## **Aims of the Empirical Studies and Research Questions**

The effects of video game playing on cognitions, affect and behaviours has mostly been investigated separately and sometimes from narrow approaches that limit the understanding of the video games' effects. This thesis intends to fill the gap by proposing a holistic framework for understanding the effects of video game playing. The aim of this thesis is to examine the influence of video games on gamers' sensorial perception, cognitions and behaviours directly related to video games' structural characteristic, video game content and, in-game activities. Altered perceptions, mental processes, and behaviours that manifest during playing, directly after stopping playing, and some period after playing when triggered by automatic associations between real life stimuli and video game elements and experiences would be take in consideration. Particular attention will be paid to non-volitional phenomena related with gaming. This is done to develop a multimodal and neural approach to investigate the psychological and social effects of video games. Previous research has shown that some GTP experiences share similarities with symptoms of pathologies, and such experiences appear to have been misunderstood by gamers and/or by others, therefore, the goal of this thesis is to raise awareness, inform and demystify these experiences and explain them as non-pathological.

Given these aims and based on the literature already outlined in Chapters 1 and 2, the main research questions of the studies carried out are: (i) In what modalities (perceptions, thoughts or behaviours) do gamers' transfer experiences manifest and what are the most common ones? (ii) What are the characteristics (e.g., frequency, duration, circumstances of manifestation, etc.) of GTP and how can GTP be explained? (iii) What is the impact (e.g., positive, negative or neutral, emotional appraisal) of GTP on the gamers? (iv) What factors (e.g., socio-demographic factors, video game habits, clinical condition, influence of substance, motivation for playing, etc.) are associated with GTP?

## **Chapter 3 - Review and Critique of Research Methodologies used**

In this thesis, a mixed-methods approach was used for examining how video games influenced gamers' perceptions, mental processes, and behaviours in daily contexts. The data were collected via online platforms, online forums, and by using an online questionnaire. This chapter addresses conceptual issues concerning the methodologies used, ethical issues, and outline the procedures used in the different studies, while discussing the reasoning behind the chosen methods.

### **General Issues about Conducting Online Research**

Computer-mediated communication has opened new possibilities to explore human behaviours and social interactions in asynchronous and synchronic modes. Patterns of communication and interesting online behaviours can be examined. Online research methods include: questionnaires, interviews, experiments, online tracking, participant and non-participant observation, analysis of texts, images and, videos can also be used (Griffiths, 2010; Griffiths, Lewis, Ortiz de Gortari, & Kuss, 2013; Wood, Griffiths, & Eatough, 2004) and research can be conducted through e-mails, chats, social networks, blogs, etc. (Griffiths, 2010; Griffiths, et al., 2013; Griffiths & Whitty, 2010).

In terms of access to participants and data, online research has many advantages: (i) the researcher can target specific populations and the ones that otherwise will not be able to participate in research (e.g., individuals with social phobia), (ii) it is possible to advertise the study in numerous outlets and information can easily be shared among individuals and groups, (iii) a large amount of participant data can effortlessly be gathered in a short time, (iv) participants usually come from different regions and can therefore facilitate cross-cultural comparison, (v) online interactions are saved and sometimes are perpetual, and allows access the archives independently of the time frame, contributing to a fuller picture of a phenomenon, and facilitating long-term research, (vi) data in most of the cases do not need to be transcribed that saves time and can easily be used for qualitative analysis (e.g., interpretative phenomenological analysis, discourse analysis), and (vii) information is interchanged in a variety of formats (e.g., texts, images, sounds, or videos) which can enhance the research (Griffiths, et al., 2013; Kraut et al., 2004; Wood, Griffiths, & Eatough, 2004). Online research also has important limitations and challenges. In general there are issues about the interaction

between the researcher and the participants. In general the researcher has less control over the participants: (i) the researcher cannot be sure if the participants are who they say they are and can affect validity (Griffiths, et al., 2013; Kraut, et al., 2004; Wood, Griffiths, & Eatough, 2004), (ii) the participants can easily disappear when the data collection is done in numerous sessions (e.g., experiments) since they may not consider their participation as serious as if it was face-to-face, (iii) the non-visibility and anonymity may facilitate misbehaviours and intent to sabotage to the research (Kraut, et al., 2004; Reips, 1996). There are also issues concerning sample bias due to the self-selecting and convenient nature of the data collected. The samples are also more diverse than the typical ones where participants are recruited face-to-face (Reips, 1996) but this can contribute to obtaining non-representativeness in a sample. Also, online research is restricted to the population that have internet accessibility (Wood, Griffiths, & Eatough, 2004).

In terms of the research interface, the online medium can facilitate the research process: (i) the participants can engage in research in the comfort of a familiar environment and usually at time of their convenience which can contribute to them feeling relaxed, and (ii) online communication tends to be more open, straightforward and interpersonal thanks to the disinhibition effect facilitated by the anonymity, invisibility, lack of eye contact, false sense of privacy, neutralization of status or more egalitarian participation across gender, age and social economic stratus and the relationship between researcher and participant (Suler, 2004). Disinhibition is related to deindividuation, the emergence of the true self (Barak & Gluck-Ofri, 2007) that may contribute to more honest responses and therefore to the validity of the research (Griffiths, 2010; Wood, Griffiths, & Eatough, 2004). Disinhibition also makes it easier to discuss sensitive and controversial issues and disclosure of behaviour (Barak & Gluck-Ofri, 2007; Griffiths, 2010). Self-disclosure and reciprocity are particularly important when discussing sensible and controversial topics such as discussing some aspects of video game playing (e.g., video game addiction). Self-disclosure includes communicated personal information, experiences, personal thoughts and, personal feelings. In fact, self-disclosure is accelerated by the communication mediated by a computer which is useful for establishing rapport with the participants and obtaining rich data (Barak & Gluck-Ofri, 2007; Suler, 2004).

### **The Mixed-Method Approach**

According to Leech and Onwuegbuzie (2009) “*once a study combines quantitative and qualitative techniques to any degree, the study no longer can be viewed as utilizing a mono-*

*method design*” (p. 267). Mixed methods “*involves collecting, analysing, and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon*” (Leech & Onwuegbuzie, 2009, p. 267).

Mixed-methods in research are widely utilized, but a consensual definition does not seem to exist. More than twenty definitions about mixed-methods provided by the leaders in the field were examined by Johnson, Onwuegbuzie and Turner (2007) to encourage further discussion. Some researchers, based on the epistemological understanding of research, argue that quantitative and qualitative are grounded in incompatible epistemological principles, while others argue that the combination of both methods can strengthen the research by facilitating corroboration, complementation and a wider perspective of phenomenon (Bryman, 2008).

According to Leech and Onwuegbuzie (2009) mixed-methods designs can be classified in three dimensions: (i) level of mixing (partially mixed versus fully mixed); (ii) time orientation (if the phases of the research occurred concurrently or sequential), and (iii) emphasis of approaches (whether or not both quantitative and qualitative phases had equal status or one phase had a dominant status). Several researchers have evaluated empirical research that has integrated quantitative and qualitative research to explore what the rationalizations are behind combining the both methods in practice. The purposes appear to be similar but not always coincide. Greene, Caracelli and Graham (1989) identified five different purposes found in the evaluation of 57 empirical studies. These were: Triangulation, complementary, development, initiation and expansion (see Table 1 details about each type).

**Table 3. 1** Purposes for mixed-method evaluation designs (Greene, Caracelli, & Graham, 1989, p. 259)

| <b>Type</b>          | <b>Purpose</b>  | <b>Rationale</b>   | <b>Key theoretical sources</b>  |
|----------------------|---|--|---|
| <b>Triangulation</b> | Seeks convergence, corroboration, correspondence of results from the different methods. | To increase the validity of constructs and inquiry results by counteracting or maximising the heterogeneity of irrelevant sources of variance attributable especially to inherent method bias but also to inquirer bias, bias of substantive theory, | Campbell & Fiske, 1959<br>Cook, 1985<br>Denzin, 1978<br>Shotland & Mark, 1987<br>Webb et al. 1966 |

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|                        |   |  |   |
|------------------------|---|--|---|
|                        |   | biases of inquiry context.   |   |
| <b>Complementarity</b> | Seeks elaboration, enhancement, illustration, clarification of the results from one method with the results from another method.  | To increase the interpretability, meaningfulness, and validity of constructs and inquiry results by both capitalizing on inherent method strengths and counteracting inherent biases in methods and other sources. | Greene, 1987<br>Greene & McClintock, 1985<br>Mark & Shotland, 1987<br>Rossmann & Wilson, 1985 |
| <b>Development</b>     | Seeks to use the results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions. | To increase the validity of constructs and inquiry results by capitalizing on inherent method strengths.   | Madey, 1982<br>Sieber, 1973   |
| <b>Initiation</b>      | Seeks the discovery of paradox and contradiction, new perspectives of frameworks, the recasting of questions or results from one method with questions or results from another method.                | To increase the breadth and depth of inquiry results and interpretations by analysing them from the different perspectives of different methods and paradigms.   | Kidder & Fine, 1987<br>Rossmann & Wilson, 1985  |
| <b>Expansion</b>       | Seeks to extend the breadth and range of inquiry by using different methods for different inquiry components.   | To increase the scope of inquiry by selecting the methods most appropriate for multiple inquiry components.  | Madey, 1982<br>Mark & Shotland, 1987<br>Sieber, 1973  |

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Bryman (2006) conducted a content analysis of 232 social science papers and concluded that *“the rationales that are given for employing a mixed-methods research approach and the ways it is used in practice indicates that the two do not always correspond”* (Bryman, 2006, p. 97). Based on this analysis, Bryman outlined a larger number of categories (more than ten) to capture in more detail the range of rationales used by researchers. These

categories show similarities with Greene et al., (1989) evaluation design (To see the full outline of rationales identify see Bryman, 2006, p. 105).

### **Outline of the Empirical Studies**

A broad overview of the methodological procedures used in each of the studies in this thesis (qualitative and quantitative) will be described in this chapter, but more specific details of each one of the studies will be addressed in the subsequent chapters. This thesis is considered as the second stage into the understanding of GTP (See Figure 3.1 for an overview of the GTP research conducted to date and potential future research about GTP derived from this thesis). Mixed-methods were used to investigate GTP in a series of studies. The qualitative and quantitative methods were not mixed within-study but were conducted sequentially. Although the qualitative analysis were not exhaustively concluded before initiating the questionnaire study due to the large amount of data collected and the time frame established for this PhD project. While the qualitative research provided the basis for conducting the quantitative study and a deeper understanding of GTP as phenomena, the quantitative study complemented the understanding of GTP by corroborating or contrasting the findings of the qualitative studies, and providing in-depth understanding of the prevalence of GTP among the population investigated, as well as examining factors associated with GTP.

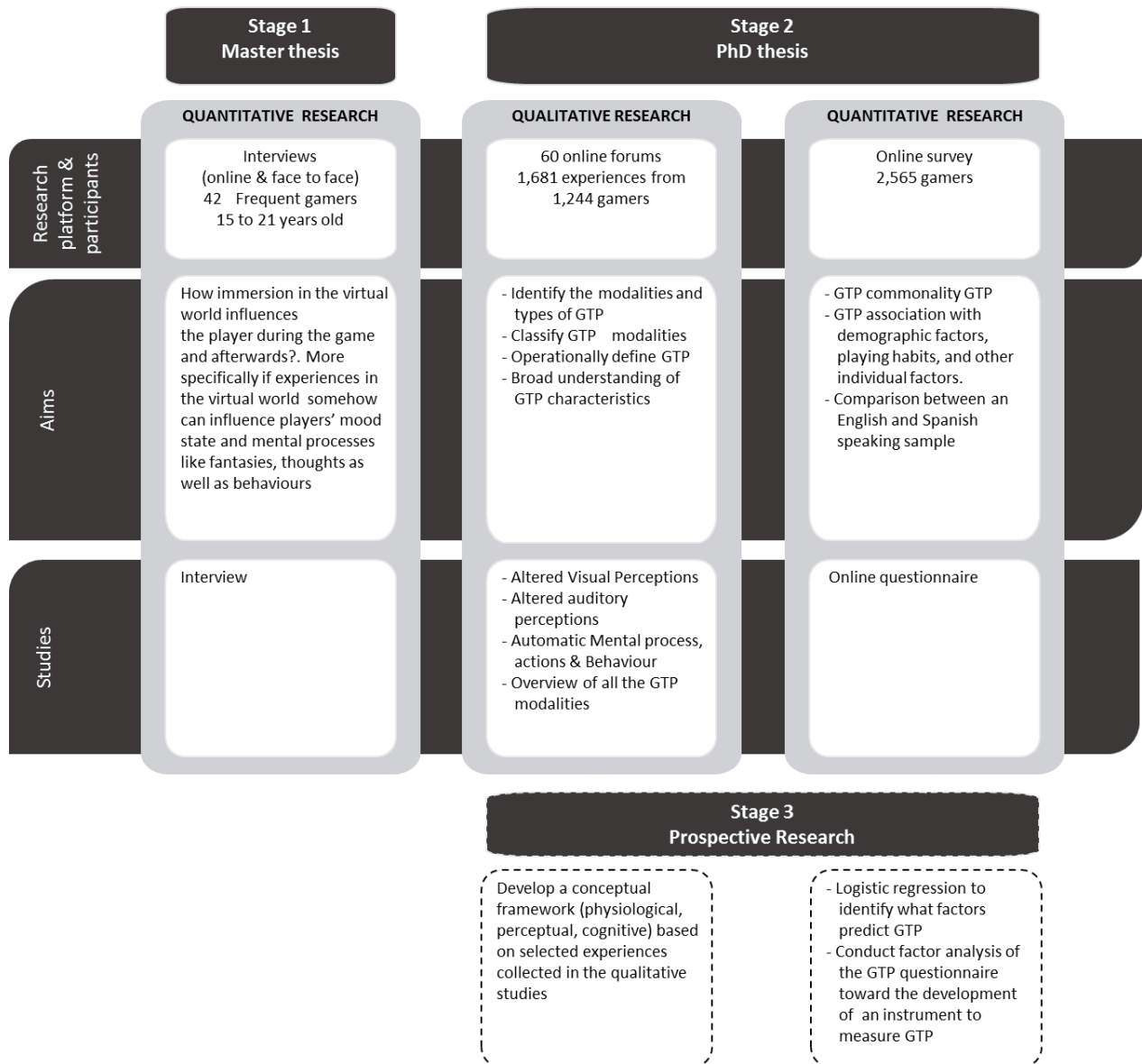


Figure 3. 1 Overview of the research about GTP conducted to date and the next research stage

### Qualitative Studies Conducted

Since the research about GTP is novel and in its infancy, the first stage of the empirical research consisted in a series of qualitative studies for (i) identifying, broader classifying, operationalised and explaining gamers' transfer of experiences extract from a self-selected sample of online posts. These resulted in three different qualitative studies: (i) altered visual perceptions and altered body perceptions, (ii) altered auditory perceptions, and (iii) automatic mental processes and behaviours. A total of 1,681 experiences from 1,244 gamers collected from 60 publicly available online video game forums took place. The qualitative studies are included in the chapters 4 to 6 of this thesis.

### **Method of data collection used in the qualitative studies**

Online gaming forums were used as outlets for data in three of the five studies conducted. Online forums are spaces where the gamers meet to discuss all kinds of video game related topics. The majority of the forums used for collecting the data in the studies were of narrative nature. Here, the gamers freely shared their game transfer related experiences, their opinions, and occasionally their feelings related to their gaming experiences. Interestingly, it was observed how gamers assured each other that they were not alone in experiencing these game transfer phenomena and occasionally they advised each other arguably in the same way that online support groups do.

More specifically, participants in online forums and chat rooms shared their experiences and received feedback – sometimes as judgmental statements, and other times as empathic comments where other participants acknowledged that they had gone through similar issues and self-disclosed information. One important aspect of self-disclosure is reciprocity that has been described as “*mutual effect*” (Barak & Gluck-Ofri, 2007; Derlega, Metts, Petronio, & Margulis, 1993, p. 408). This means that when someone discloses information the other person they also tend to disclose information. Online forums work efficiently as platforms where the exchange of information is negotiated between the parties. According to social exchange theory, human relationships are formed based on the subjective cost-benefit obtained (Barak & Gluck-Ofri, 2007; Derlega, et al., 1993). Interestingly, research has found that when researchers disclose more information about themselves, the participants also disclose more information (Joinson, 2001). It has also been found that communication mediated by a computer (e.g., online chat) leads to higher levels of intimate communication and self-disclosure even with strangers than with interactions face-to-face (Leung, 2002).

Reciprocity appears to be a crucial phenomenon in the collection of gamers’ experiences about GTP. It is probably the case that without reciprocity it would not had been possible to collect such rich information as that collected in the qualitative studies about GTP. The importance in reciprocity when discussing GTP was observed when conducting interviews online where by telling gamers about others’ experiences facilitated them in disclosing and sharing their own GTP experiences (Ortiz de Gortari, 2010, March, 2011). (See the poster “Using Online Interviews with young people” in appendix II for more details).

Similar effects have been observed in different online outlets (e.g., articles about GTP, *Twitter* messages); as soon as someone disclosed their GTP experiences other people replied



with their own experiences. However, self-disclosure has been found to be higher in online support groups compared to online discussion forums in general (Barak & Gluck-Ofri, 2007).

In online forums, individuals are typically seeking to discuss a topic. They either want to share something interesting to talk about or they are looking for support and self-assurance. A difference with face-to-face groups is that they tend to be formed by individuals from the same local community. Online groups are heterogeneous but at the same time with some interest in common, flexible and variable to accept different types of members (e.g., nationality, expertise about a topic) (Jin, 2011a). The group identification and dynamics emerges around an idea, task, or an activity (Squire & Johnson, 2000). Online forums can be considered communities of practice, that facilitate target certain groups for research, because they usually involve discussion of authentic issues, trying to resolve day to day issues and involve learning, and is different to practice fields that include activities such as simulation and role playing (Squire & Johnson, 2000).

Despite the numerous advantages of online forums, there are some issues that should be taken in consideration. For instance, (i) much of the data in online spheres is personal and raises concerns about transferability, although in general qualitative research cannot be equally generalized as quantitative research, (ii) potential misinterpretation of the posts as the researcher cannot always obtain the full picture of the context, and in case of passive research cannot approach participants to verify the information (and some posts may have been deleted not allowing to see the full conversations), (iii) the researcher has less control about the participants' behaviours as the communication between the participants could have taken place in private arenas (e.g., email) resulting in text that appear incomplete to the researcher, (iv) the researcher may not understand the online jargon and non-verbal cues (e.g., emoticons) to be able to identify emotions and expressions not explicitly included in words, (v) there are serious issues about the credibility of data (i.e., the truthfulness), (vi) there are theoretical limitations since with later data collection, theoretical saturation is not possible (as can be done more easily with real life data), and (vii) the researcher cannot clarify unclear comments or probe comments that required further explanation (Griffiths, et al., 2013; Sixsmith & Murray, 2001).

### **Method of data analysis used in the qualitative studies**

The analysis of qualitative data can be done in different ways according to the type of material and the purpose of the study. There is an overlap between qualitative content analysis and thematic analysis. The boundaries between both have not been clearly established and they

tend to be used interchangeably (Vaismoradi, Turunen, & Bondas, 2013) (See Table 3.1 which compare the processes for data analysis between content analysis and thematic analysis). Despite the similarities (e.g., cutting across data, searching for patterns and themes) the main difference is that content analysis works at micro level by focusing exclusively on frequency outcomes for further quantitative analyses (Braun & Clarke, 2006; Vaismoradi, et al., 2013). The data is coded and interpreted in a descriptive way (Down-ne Waboldt, 1992; Morgan 1993). While, thematic analysis provide a solely qualitative understanding of the data (Vaismoradi, et al., 2013), the units of the analysis are typically more than a word or phrase and the themes are not quantified (Braun & Clarke, 2006). Although, Boyatzis (Boyatzis, 1998) suggest the use of thematic analysis to transform qualitative data into quantitative form for further statistical analysis. Thematic analysis rely on the systematic analysis of content taking in consideration the analysis of the frequency codes but also the analysis of the meaning in contexts (Vaismoradi, et al., 2013). (For more detail about the similarities and differences between content analysis and thematic analysis see Vaismoradi, et al., 2013).

**Table 3. 2** *Processes of data analysis in thematic analysis and qualitative content analysis*

| <b>Content analysis</b><br><b>(Elo &amp; Kyngäs, 2008: 110)</b>   | <b>Thematic analysis</b><br><b>(Braun &amp; Clarke, 2006: 87)</b>   |
|---|---|
| <p><i>Preparation</i><br/>Being immersed in the data and obtaining the sense of the “whole”, selecting the unit of analysis, deciding on the analysis of manifest content or latent content.</p>                                      | <p><i>Familiarising with data</i><br/>Transcribing data, reading and rereading the data, noting down initial ideas.</p>   |
| <p><i>Organising</i><br/>Open coding and creating categories, grouping codes under higher order headings, formulating a general description of the research topic through generating categories and subcategories as abstracting.</p> | <p><i>Generating initial codes</i><br/>Coding interesting features of the data systematically across the entire data set, collating data relevant to each code.</p> |
|   | <p><i>Searching for themes</i><br/>Collating codes into potential themes, gathering all data relevant to each potential theme.</p>                                  |
|   | <p><i>Reviewing themes</i><br/>Checking if the themes work in relation to the coded extracts and the entire data set, generating a thematic map.</p>                |
|   | <p><i>Defining and naming themes</i></p>  |

---

|   |   |
|---|---|
|   | Ongoing analysis for refining the specifics of each theme and the overall story that the analysis tells, generating clear definitions and names for each theme.   |
| <i>Reporting</i><br>Reporting the analysing process and the results through models, conceptual systems, conceptual map or categories, and a story line. | <i>Producing the report</i><br>The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a report of the analysis. |

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Extracted from (Vaismoradi, et al., 2013, p. 402)

The themes or categories can be classified using two approaches: Deductive coding which is based on existing theoretical ideas or inductive coding which is directly obtained from the raw data itself. Deductive themes allow replication, refutes and expands the research while inductive themes are suitable for new areas of research (Joffe & Yardley, 2004). The biggest issue is to decide to what extent it is important to test a theory, or to explore new possibilities.

Three different approaches have been distinguished of qualitative content analysis based on inductive reasoning. The first is referred to as ‘conventional’ consisting in coding categories directly from the raw data. This is usually used in grounded theory. The second is referred to as ‘direct’ and consists in the direct analysis of content where coding is initiated having in mind a theory or previous research findings, then the researcher get in touch with the data, and new themes emerge. This approach intent to develop a conceptual framework or validate a theory. The third approach is referred to as ‘summative’ content analysis and involve counting the occurrence of words or manifestation of content followed by the counting the latent data for further interpretation of the underlying context (Hsieh & Shannon, 2005). In the following section I explain the reasoning behind the methods chosen and describe the steps for a better understanding of the procedures involved.

In this thesis, the way the qualitative data were coded was based on content analysis procedures. This was done due to the type of data, the amount of data and because the data analysed per post were approximately from 10 to 300 words, which is shorter than the data typically obtained using an interview schedule. The way the data were coded fit better with the “direct approach”, previously described. The way the data was interpreted and reported was according to thematic analysis. More specifically, on one hand, words rather than full sentences were coded and quantified, which is typically used in content analysis (Vaismoradi, et al., 2013). On the other hand, frequencies of the relevant categories, were reported but these were

not use for explaining the phenomena's actual "psychological content" but rather to describe the characteristics of the phenomena (e.g., when, where, how long, implications), neither the main conclusion were based on the frequency of the words but adjectives of frequency were used to show the prevalence of the data (e.g., many gamers, some gamers), as is done in thematic analysis but not in content analysis that report frequencies (Braun & Clarke, 2006). Also, GTP were exemplified by extracts of text from the gamers' experiences, which is always done in thematic analysis (See Table 3 for examples of how the data were coded and interpreted).

### **Criteria for collecting the data in the qualitative studies**

The criteria for whether or not collecting the data from the forums depended on if the gamers made any reference between their transfer experiences and playing video games in a direct (i.e., mentioning a video game name(s)) or indirect way (i.e., explaining their experience related to a video game).

The data was analysed focusing on identifying the different types of experiences gamers were reporting and classifying these experiences in different categories for explaining them later according to literature in each of the human sensorial channels, mental processes and behaviours. Understanding the characteristics of the phenomena such as how, when, where and for how long the phenomena had occurred was another focus of the analysis. A previous study about GTP (Ortiz de Gortari, 2010) suggested that gamers' transfer of experiences manifested in different modalities (e.g., perceptual) (See Figure 2 for the initial modalities of GTP identified in the interview study which is the base for this PhD project), therefore a large number of the gamers' experiences were analysed to extend and specify the sub-categories in each of the GTP modalities.

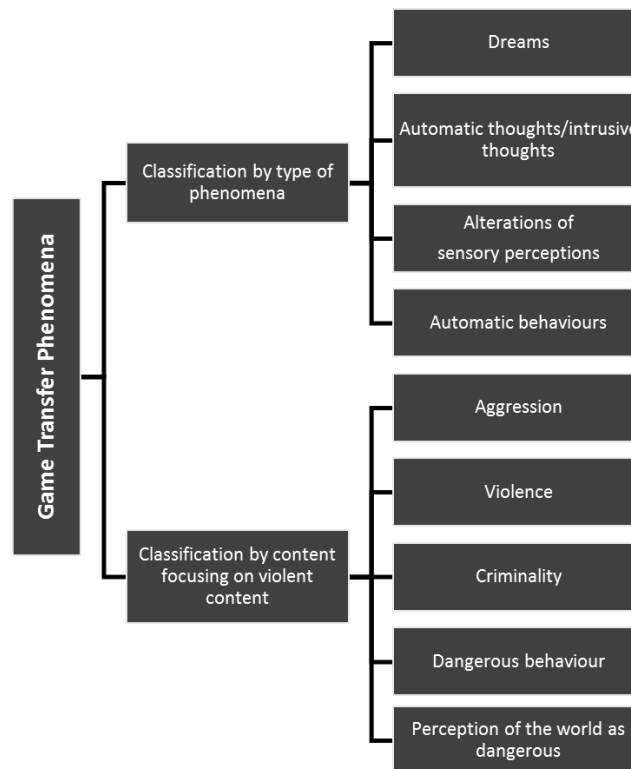


Figure 3. 2 Core categories of the gamers' experiences. (Figure extracted from (Ortiz de Gortari, 2010)).

**The data analysis was conducted by the following steps:**

1. Read through the gamers' experiences to identify what type of information the post contained. Rather early it was noticed that the gamers' experiences were more or less homogenous on the type of information included (e.g., name of the game, hear, see, think, do, situations, feelings or emotions, circumstances, objects and events in the game and in real life contexts).
2. A large number of experiences were collected (larger in comparison to conventional practices in qualitative data analysis), therefore a Microsoft Access data-base was created to systematically categorize and later quantify the gamers' experiences. The categories were modified and re-arranged in several occasions along with the coding of each of the gamers' narrations. A total of three databases were designed for the different GTP modalities: altered perceptions was sub-divided in two databases altered visual, body and auditory perceptions. A third database consisted of thoughts, impulses, automatic actions and behaviours.
3. Basic definitions were developed along the analysis in each category and sub-categories were created to help with the coding.

4. Initially the names of the categories and subcategories were kept as descriptive as possible, but the parallel review of literature in each on the GTP modalities suggested re-arranging in the categories and sub-categories in some cases.
5. In many cases the classification of the data required knowledge about the games for understanding the gamers' experiences better, therefore while coding the data I watched some videos of gameplay, watched images from the games and even played some of the games.
6. A large variety of categories and sub-categories were obtained, described and explained in each of the GTP modalities/sub-modalities.
7. Finally, the gamers' experiences were quantified and frequencies were reported to get a general overview of the commonality of the types of the experiences but further quantitative analysis was not conducted.
8. The GTP were exemplified using extracts from the gamers' experiences (See chapter 4 to 6 for generalities in each of the GTP modalities/sub-modalities).

The advantages of conducting the qualitative analysis as I did, is that it could facilitate data analysis replication. The coding consisted in: (i) contextualize the GTP experiences: by asking simple questions such as what, when, where, how; (ii) certify the game transfer of effects: what video games elements were involved (e.g., objects, type of games, activities), what real life elements were involved and what was the connection between them; (iii) appraisal of the experiences: by looking for adjectives, emotional content; (iv) nature of GTP; voluntary or involuntary: paying attention to words such as “suddenly”, “awareness”, “control”, “by accident”, “wanted it”; (v) classification of GTP modalities/sub-modalities, categories and sub-categories: by distinguish between word such as “perceive”, “feel”, “believe”, “confuse”, “see”, “imagine”, “think”, “do”, “urge”, and looking at the operationalised definitions of GTP. Although I should recognize that even though the final categorization of the gamers' experiences took into account conceptual theories (e.g., sensorial phenomena, cognitive mental process, non-volitional phenomena)) for explaining the phenomena, the labelling and the way some gamers' experiences were interpreted may vary among coders. I consider the data analysis a first stage in the search for a more consensus classification. (Examples of how the data was coded are shown in table 3.3).

**Table 3. 3** *Examples of procedures used to analyse gamers' experiences.*

| Gamer's experience  | Modality<br>Category/<br>subcategory  | Contextualize in the video game<br>& in real life   |
|---|---|---|
| <p>"It was <i>scary</i> [impact of the experience] <i>because I would always worry</i> [reoccurrence] <i>that if I was tired or not paying attention</i> [physiological conditions] <i>I would by mistake switch over</i> [involuntary] <i>to Grand Theft Auto IV mode</i> [game name] <i>and drive</i> [activity IRL] <i>over cars and people</i> [content of the experience – risk behaviour]" (ChronosBob)</p>       | <p><b>Thoughts</b><br/><br/>Episodic Thoughts<br/><br/>- Worries to lose control</p>                                      | <ul style="list-style-type: none"> <li>▪ In Grand Theft Auto players can engage in illegal driving (and other activities) and drive over objects and pedestrians.</li> <li>▪ The gamer was worried that driving in the game interfered in his performance when driving a car in real life contexts.</li> <li>▪ Associative experience: driving in real life and driving in the game.</li> </ul> |
| <p>"I haven't played a <i>Zelda</i> [game name] <i>for 2 years...I was looking</i> [activity] <i>in the drawers</i> [object IRL] <i>When I found it without even realising</i> [involuntary experience triggered by association with the game] <i>I sang</i> [behaviour] <i>the open chest theme</i> [video game elements: chest and music]" (Twistmax)</p>   | <p><b>Behaviours</b><br/><br/>Carrying out automatic actions<br/><br/>- Verbal slips</p>                                  | <ul style="list-style-type: none"> <li>▪ In Zelda chests are precious and you need to search for them; every time that the gamer open a chest a special sound is played.</li> <li>▪ The gamer associated looking for chests in the game with looking for something in the drawers and then found himself singing out the sound.</li> </ul>  |
| <p>"The first time I got '<i>Meteos</i>' [game name], <i>I played it constantly for days</i> [frequent playing]. <i>It was not possible to sleep</i> [cause] <i>for a while</i> [duration] <i>after that because every time</i> [recurrence] <i>my eyes</i> [sensory organ] <i>were closed</i> [close], <i>I would see</i> [visual experience] <i>the Meteos pieces</i> [video game element] <i>falling. (Mars)</i></p> | <p><b>Altered perceptions</b><br/><br/>Digitally induced images<br/><br/>-Retinal sensations or recurrent afterimages</p> | <ul style="list-style-type: none"> <li>▪ Meteos is a tile-puzzle game; the gameplay is monotonous and the objects are simple and usually shiny. This experience was not associative but it manifested after stopping playing while trying to sleep.</li> <li>▪ Recurrent exposure to a stereotypical video game resulted in seeing images with the eyes closed while trying to sleep</li> </ul> |

### Quantitative Study Conducted

The second stage of the empirical research had the aim to corroborate and complement the findings from the qualitative studies, therefore quantitative methods were used and

2,362 gamers answered an online questionnaire in the English or Spanish language (the quantitative studies can be found in chapter 7 of this thesis).

### **Method of data collection used**

The participants were collected via online outlets with a convenience sample. Two self-administrated questionnaire were designed to investigate GTP, one was in English and the other in Spanish language (See Appendix III). The questionnaire comprised 30 questions; in some answers the respondents could include additional comments. A self-completion questionnaire should be easy to follow and easy to answer since there is no interviewer present during the answering time. In general, questionnaires are cheaper and quicker to administer in comparison to other data collection such as interviews (Bryman, 2008).

The questionnaires were administered online. The use of online questionnaires is an effective way to gain understanding of online communities and culture. There are typically two types of questionnaires – the ones that focus on understanding the aspects of online communities and culture, and the ones that deal with general topics not particularly related to phenomena online. Online questionnaires have been prominently used in research related to study the behaviour of video game players (Wood, Griffiths, & Eatough, 2004). Online questionnaires are ideal for conducting research about phenomena related to interactive media technologies particularly as gamers tend to like the technology, being proficient at using it and feel comfortable interacting thought it. Also, gamers are often curious and interested about research related to gaming and are motivated to take part in it (Wood, Griffiths, & Eatough, 2004). Furthermore, large groups of gamers tend to congregate in different online interfaces that are usually easy to target (Griffiths, 2010).

Web-based questionnaires have a number of advantages but also limitations. These include the advantage that:

- Online surveys are low cost and need much less effort than offline surveys. The target population is easy to identify and it is efficient to recruit a large number of participants in short time. Also, the data are quickly captured for the statistical analysis.
- Online surveys tend to have a faster response speed since it is easy to fill in and send it electronically.
- In online surveys, the researcher can have greater control over the format which contributes to producing more attractive questionnaires, combining different type of



questions, skipping questions, including images, sound, etc. Research have shown that using visualisations (e.g., images) result in higher response quality (Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004). Some software also allows participants to save their responses and continue at their convenience.

- Online surveys have good response rate in relation to the effort and time that it take to distribute the survey in relation to sending questionnaires by postal mail. There are evidence suggesting that online surveys tend to be completed with less unanswered questions than surveys in other modalities (Bryman, 2008; Stanton, 1998).
- Online surveys tend to include more response details to open questions in comparison to postal surveys (Bryman, 2008).
- Online surveys are particularly good for researching sensitive issues since participants do not need to worry about how they present themselves which can increase the level of honest responses (Griffiths, 2010).
- Although there are many advantages, online surveys also have limitations such as:
- There is usually there is not enough understanding about how the instrument's design affect the quality, the response rate and the response accuracy (Fricker & Schonlau, 2002).
- Some evidence suggests that there are lower response rates than questionnaire sent by postal mail (Bryman, 2008) but this is not always the case since it appears to be influenced by different factors (e.g., length of the survey, participant demography) (Sax, Gilmartin, & Bryant, 2003). However, research studies have shown that short questionnaires have a higher response rate and that long questionnaires also result in higher responses (Deutskens, et al., 2004).
- Participants may have concerns about confidentiality and the way their responses may be used which may discourage participation (Griffiths, 2010).
- Online surveys may lead to multiple responses. The researcher needs to check for identical IP addresses of responses and eliminate the repeated ones if such appear.
- The researcher cannot certify if the participants are who they say they are (Griffiths, 2010; Griffiths, et al., 2013; Wood, Griffiths, & Eatough, 2004).

### **Method of the Analysis used**

The aim of the online questionnaire was to explore the generalities about GTP and examine if socio-demographic factors, video game habits, motivations for playing and other

individual factors were associated with GTP. The answers from the questionnaire based on categorical data were coded and analysed using SPSS 21 (IBM, Armonk, NY, USA). Descriptive statistics such as frequencies and Pearson's Chi-square test, also referred to as chi-squared goodness of fit test or chi-square test for independence, were used to analyse the data as the first stage to understand GTP in a quantitative manner. The Pearson's Chi-square test is used to find out if there is a relationship between two categorical variables and consist in calculating for each cell in the table an expected frequency or value that is, one that would occur by pure chance (Bryman, 2008; Field, 2009). In this case, the tests were used to compare proportions between two groups; those who have experienced GTP and those who have never experienced GTP.

A first stages comprehend the analysis of the full population for identify what were the differences between those people who experience GTP and those who do not, looking for general predictors overall, for example, age, gamer type, etc. The second stage consisted in an analysis of each sample independently (The English speaking and the Spanish speaking) for a cross cultural analysis. According to Hantrais (1996) cross-cultural or cross-national research takes place:

*“when individuals or teams set out to examine particular issues or phenomena in two or more countries with the express intention of comparing their manifestation in different socio-cultural settings (institutions, customs, traditions, value systems, life style, language, thought patterns), using the same research instrument either to carry out secondary analysis of national data or to conduct new empirical work” (Hantrais (1996) cited in Bryman, 2008, p. 58).*

The aim of this type of research is to explain similarities or differences or get a better understanding of the social reality in different cultures. Generally they are conducted with primary data. Cross-cultural studies often include dissimilar groups that can differ in many background characteristics and only share in common some characteristics relevant for the research question (Van de Vijver & Leung, 1997).

## **Ethical Issues**

Conducting research online raises important ethical issues (Griffiths & Whitty, 2010). This include informed consent, private versus public space, confidentiality (Buchanan & Williams, 2010; Ess, 2002; Monica, 2008; Sixsmith & Murray, 2001), security of online data, procedures to ensure withdrawal rights and debriefing, levels of researcher control and

implications of the scientific contribution and the potential harm. The research can be reactive when the participants interact with the material, or non-reactive when the researcher gather information unobtrusively from subjects (analyses text in forums, blogs, websites, observation of online behaviours, etc.) (British Psychological Society, 2013). In this PhD thesis both approaches were used, reactive in the online questionnaires and non-reactive when collecting the data in online video game forums. Ethical approval for the study was granted by the researchers' University Research Ethics Committee.

### **Informed consent**

It should be ensured that the participants' involvement in the research is voluntarily and that they have understood the purpose and implications of their participation. Although, there are some cases where research may be carried out without consent, according to the British Psychology association (2013, p. 7). "Where it is reasonable to argue that there is likely no perception and/or expectation of privacy (or where scientific/social value and/or research validity considerations are deemed to justify undisclosed observation), use of research data without gaining valid consent may be justifiable". Possibilities for withdrawal should be provided. In the case of this PhD, the participants could choose a nick name which they could use in case they change their mind and want to withdraw their participation. One participant was removed from the data because he requested it. Participant consent was requested in the online survey; the qualitative studies used analysis of text in discussion forums and were done in non-reactive way where the data was collected unobtrusively. This raised uncertainty about the ethical way to proceed when collecting the data in forums, since boundaries between private and public places are difficult to define (British Psychological Society, 2013). Research in spaces that are considered private without allowance may be intrusive, unwelcome and inappropriate (British Psychological Society, 2013).

Wood and Griffiths (2007) who have used online outlets for investigating gambling and video gaming point out that since online forums are typically public domains, no usernames or passwords are needed to access the sites. Therefore online forum data can be collected without identifying oneself as a researcher or even acknowledging the researchers' presence. Disclosing the researcher's presence can damage the natural flow of the forum and change the dynamic between the participants by breaking the false sense of privacy typically experienced in the cyberspace (Griffiths, et al., 2013). This can interfere with the participants' desire to participate and potentially interferes with the validity of the data and in some cases even

contribute to the disappearing of pre-established forums (Griffiths, et al., 2013). The research needs to decide in what situations join a group without disclosure as a researcher it is appropriate for avoid to interfere in the groups dynamics (British Psychological Society, 2013).

Additionally, online forums can be online for years (as was the case of some of the forums used in the studies of this thesis) and efforts to contact participants after such long time may have unfruitful results. In this sense, posts in online forums can be considered as secondary data but at the same time it could be considered as primary data since the participants' post are first-hand naturalistic data about individual experiences (Griffiths, et al., 2013). It is the researcher's responsibility to decide in which cases it is necessary to ask for consent and protect the identity of the participants as much as possible. According to researchers that have conducted numerous research studies concerning gambling and gaming, this does not tend to be an issue with these particular groups (Griffiths, 2010; Griffiths, et al., 2013).

### **Confidentiality, anonymity**

Confidentiality and anonymity should be insured as far as possible, however, it is important to recognise that since the data is collected online, the researcher is not in control of the networks (British Psychological Society, 2013) and the systems can also be vulnerable to fraudulent attacks. IP addresses, names and, nick names can be tracked revealing information of the participant, for this reason IP addresses should not be tracked. Data encryption may be a solution to protect the data but it might not be enough; removing identifiers from the data is recommended. Some measures for protecting the participants in forums included removing identifiers (e.g., nicknames, names of the forums, etc.) that allow tracking or identification of the posts or blogs (British Psychological Society, 2013; Griffiths, et al., 2013). The researcher can paraphrase (British Psychological Society, 2013), slightly modify the texts used as examples in the research process by using synonyms, changing tense, and/or removing extraneous information (Griffiths, et al., 2013). (These strategies were used in the research conducted in online video game forums in the present studies). However, this can be challenging and not always lead to successfully avoiding identification of individuals or forums. "Serious consideration should be given to whether publishing traceable quotes require specific valid consent from the individual, and it should be avoided in any cases where possible consequential risk and harm to participants is non-trivial" (British Psychological Society, 2013, p. 18).

## **Debriefing**

It is important to bear in mind that since the researcher lack of control when conducting research in synchronic format, monitoring the participants' reactions and behaviours is impossible as well as to detect when participants have withdrawn and provided the appropriate debriefing information. The levels of the risks of provoked harm to the participants especially when dealing with sensible issues should weigh up. In this thesis debriefing information were provided automatically at the end of the online survey; debriefing information was provided after the participants clicked a button to submit the survey. (See appendix III).

## Part II. Empirical Studies

### Chapter 4 - Altered Visual Perceptions in Game Transfer Phenomena

“When players see, hear, feel or interpret the real world based on video games’ content, they are recreating, transforming, and aligning elements from the game into the real world ‘puzzle’”.

(Ortiz de Gortari, 2011)



Altered sensorial perceptions can be induced either by sensory deprivation (sensory isolation) or by the exposure to a monotonous stimulus (Sacks, 1970) (i.e., overload of sensory information). Playing a video game usually involves the interaction for extended periods of time of colourful, texturized stimuli in movement that can result in unintended altered perceptions and reactivations of a video game's content after stopping playing. However, little empirical work has been conducted to understand altered visual perceptions induced by video game playing, and besides a previous study about GTP (Ortiz de Gortari, Aronsson, & Griffiths, 2011b), any study has looked whether or not these experiences have psychological and social consequences. For this reason, extending our understanding of the effects of visual cues in games that result in altered perceptions is important.

The purpose of this study was to contribute to the understanding of the effects of video game playing by identifying, classifying, and explaining gamers' perceptual experiences referred to as Game Transfer Phenomena in the visual modality (GTP-V). More specifically, the study examined these altered perceptions associated with video game playing and examined what effects these gamers' experiences have in real life. This was done to encourage strategies that predict, prevent, and/or reduce certain post-video game playing effects and to promote safe and healthy gaming.

The literature review in this chapter is divided into two parts. The first part discusses the phenomenon of perceiving something in the absence of a visual stimulus that is relevant to understand gamers' visual experiences. The second part consists in an overview of studies concerning visual phenomena – with particular reference to studies reporting the use of virtual environments.

### **Research into Visual Phenomena Relevant to Gamers' Experiences**

This section consists of an overview of a broad range of visual phenomena. These include: (i) entopic phenomena, (ii) afterimages, (iii) illusion and visual after-effects, (iv) eidetic images, (v) hypnagogic and hypnopompic states, (vi) mind visualization and daydreaming, (vii) visual hallucinations and pseudo- hallucinations, (viii) across sensorial and multisensory experiences.

### **Entopic phenomena**

Entopic phenomena usually originate from “within the eye” and are transient. Among the most common entopic phenomena are floaters and phosphenes (Voke, 2010 ). Floaters are observed when staring at a bright background. They look shadowy and dark and usually appear as a cluster with a curved movement, usually downwards. Phosphenes are “sensation of flashes of light in the absence of visual stimulation” (Bokkon, 2008, p. 169). Phosphenes are fleeting and intense and can be white, yellow or blue and move in the visual field especially when someone is in darkness. They disappear soon afterwards (Voke, 2010, January 29) and can be induced artificially by mechanical, electrical, and/or magnetic stimulation of the retina (Bokkon, 2008). Evidence suggests that the main difference between complex hallucinations and phosphenes is in the cortex area. In simple experiences, basic visual areas are activated. In complex hallucinations, activation occurs in more advanced visual areas (Ffytche, Brammer, Woodruff and Williams, 2008).

### **Afterimages**

Afterimages come in two forms; either as negative (inverted colours) or positive (retaining original colour). In the positive images, the colour is almost the same as the object, whereas in the negative images the colours appear complementary. Seeing a very bright stimulus may prolong the perception of the afterimage but it is usually of short duration (Padgham, 1953). Usually, visual afterimages or burnt-in images are considered as appearing in the retina but they also show characteristics that suggest brain involvement (Urist, 1959). Negative afterimages are considered retinal but the mechanism behind positive after images is less understood. Bender and colleagues (1968) described how afterimages are expected to behave: (i) the duration of the retinal afterimage depends on the intensity and the exposure to the initial visual stimulus, (ii) afterimages may appear larger when visualized against a distant surface as compared with a close surface. The size of the afterimages is linearly related to the distance from the subject of the background on which it is visualized (Emmert's Law), (iii) they are seen as positive against a dark background and negative against a light background, (iv) they can reappear suddenly by blinking or a wave of the hand in front of the eyes, (v) they may form in both the central and peripheral field. Several afterimages may form concomitantly, and (vi) afterimages move in the direction of active eye movements. When the eyes move passively they remain stationary or appear to move in a direction opposite to the movement of the



environment. Experiments have induced visual afterimages using flickering lights (Allefeld, Pütz, Kastner, & Wackermann, 2011) or induced the Ganzfeld stimulation by staring at any featureless or monochrome field (i.e., the individual's perception changes and everything looks dark) (Milton & Wiseman, 1999).

### **Illusion and visual after-effects**

The visual system constantly adapts to the reception of new information. It is only noticed when it does not work as supposed. Illusions occur when an external stimuli change in shape, size, colour or texture (Elliott, Joyce, & Shorvon, 2009b). Several experimental studies have demonstrated that the prolonged exposure to specific visual patterns or visual effects provokes visual distortions (Carandini, 2000; Kohn & Movshon, 2003; Movshon & Lennie, 1979). For decades, psychologists have conducted experiments using optical devices such as glasses and mirrors that shift, reverse, and/or invert vision (Harris, 1965; Linden, Kallenbach, Heinecke, Singer, & Goebel, 1999). Stratton (1896) was the first one to carry out such experiments when he wore eyeglasses with prism lenses designed to optically invert the physical environment. Stratton wore the glasses for several hours a day over three consecutive days and adapted to function perceiving everything upside-down. Then when he took the prism glasses off at the end of the experiment, he experienced seeing the world upside-down. Furthermore, visual illusions have been induced by hypnosis (Barber, 1959; Brady & Levitt, 1966; Kosslyn, Thompson, Costantini-Ferrando, Alpert, & Spiegel, 2000). For instance, Kosslyn and colleagues (2000) wanted to investigate whether or not hypnosis could influence colour perception. The results showed that brain areas that regulated the perception of colour were activated when participants were actually shown the coloured stimulus or when they were instructed to see colour in the grey stimulus.

### **Eidetic imagery**

Eidetic imagery shares features with afterimages since an image of an object recently seen can be "seen" after it is projected against a grey background or in the back of the eyelid when the eyes are closed. However, eidetic images are considered to be more than afterimages, in fact they are considered slightly intensified afterimages (Jaensch & Oeser, 1970). Sometimes eidetic images are similar to afterimages but on other occasions they appear to be closer to memory images and are related to recalling visual information. Eidetic imagery has mainly

been reported in young children and it is believed that they tend to disappear with age and is rare among adults (Haber, 1969). While afterimages appear to float, eidetic images appear in a fixed physical location independently of the movements of the eye (Jaensch & Oeser, 1970). Eidetic images share similarities with hypnagogic images such as clearness and richness in detail, three-dimensionality, and colouration, externality of localization with eyes open or shut. However, eidetic images can be seen with eyes open in daytime whereas hypnagogic images typically manifest with closed eyes or in low light (Jaensch & Oeser, 1970).

### **Hypnagogic and hypnopompic states**

Hypnagogia and hypnopompia (Myers, 1992) are considered transitional states of drowsiness when going to sleep or waking up, respectively (Mavromatis, 2010; McCarthy-Jones et al., 2012). Hypnagogic visions are considered “subcortical in nature” (Mavromatis, 2010). Mavromatis (2010) argues that this visualization does not manifest in the absence of absorption and psychological withdrawal. “Concentration on a mental image would result in the latter becoming vivified and either leading to sleep or to the subject becoming fascinated, absorbed and kinaesthetically involved in the character of the image” (Mavromatis, 2010, p. 242). Hypnagogic experiences are more common than hypnopompic ones and both can manifest in all sensory channels (e.g., visual, auditory, olfactory, gustatory, tactile, kinaesthetic, somesthetic, synesthetic), and sometimes a single experience can include different sensory modalities (Brown, 1985; Mavromatis, 2010). Usually, the individual has no control over the visualization but occasionally hypnologists can control and prolong their hypnagogic imagery, and some can even induce it (Mavromatis, 2010).

The hypnagogic hallucinations are usually experienced passively, but there is evidence suggesting that it is possible to have different degrees of control. Colours are usually seen more vivid in hypnagogia and hypnopompia than in normal perception, and the images can be seen in detail. However, more abstract patterns can be seen like those in entopic phenomena. Commonly, they last seconds to a few minutes and can be recurrent. Also, some have suggested that giving attention to one’s hypnagogic vision increases the duration and the frequency in later experiences (Sartre, 1978). Studies suggest that hypnagogic experiences are quite common among normal populations (Collerton, Perry, & McKeith, 2005; Ohayon, 2000). In a UK study based on a large number of telephone interviews (n=4972), of people aged 15 to 100 years, 37% reported experiencing hypnagogic imagery and 12.5% reported hypnopompic

imagery. In both cases, the hypnagogic experiences were more common in people with symptoms of insomnia, excessive daytime sleepiness, or mental disorders (Ohayon, Priest, Caulet, & Guilleminault, 1996).

### **Daydreaming and Mind visualization**

Different perspectives from cognitive psychology to neuropsychology have debated the similarities and differences between sensorial perception and visual imaginary. On one hand, some argue that imagery takes place due to the activation of top-down perceptual representations that are activated automatically by an external stimulus during perception (Farah, 1998). On the other hand, others claim that even though the imagery uses similar visual representations as the ones used in perception and phenomenology, it is manifested as “seeing with the mind’s eye” and that these representations are different to actually seeing them (Farah, 1998). There is evidence that areas of the visual cortex play an important role in visual imagery (Roland & Friberg, 1985) but “when the imagined object is complex, the links are weaker” (Eysenck & Keane, 2005, p. 109). It can work as a mechanism to fill boring moments or as a mechanism to pass time during daily activities (Markman, Klein, & Suhr, 2009). Daydreaming is thus considered an altered state of consciousness (Vaitl et al., 2005).

There are two types of thoughts that are classically called daydreaming, i.e., thoughts that are predominantly undirected (spontaneous, respondent thoughts such as mind wandering) and thoughts that are at least partially fanciful. It is estimated that individuals experience approximately 2,000 daydream segments per day (Markman, et al., 2009). Daydreaming can be defined:

*“As nonworking thought that is either spontaneous or fanciful. This includes mind wandering – a paradigm of spontaneous thought when it is unrelated to an ongoing activity – and also instances when people decide to daydream about something and then let their minds run undirected into whatever fanciful directions occur to them”* ( [no page] ).

### **Visual hallucinations and pseudo-hallucinations**

Hallucinations have been defined as:

*“A sensory experience which occurs in the absence of corresponding external stimulation of the relevant sensory organ, has sufficient sense of reality resemble a*

*veridical perception, over which the subject does not feel direct and voluntary control, and which occurs in the awake state”(Elliott, Joyce, & Shorvon, 2009a, p. 164).*

However, it is debatable to call any visual perception without external stimulation a hallucination, since hallucinations with delusion have serious psychiatric implications. Here, the individual is convinced that the hallucinations are real (Cummings & Miller, 1987). Some authors have suggested using the term ”pseudo-hallucinations” in these the individual are able to recognize the unreality of the hallucination (Cummings & Miller, 1987).

Hallucinations can manifest in all sensorial areas. They can, for example, be visual, appear with smell or taste; they can be hallucinations of the general sensibility, multi-sensorial hallucinations, and psychomotor hallucinations (David, 2004). There is a large variation in the content of hallucinations. They can range from simple images such as flashing or steady spots (unformed hallucinations) and coloured lines and shapes (geometric hallucinations), to vivid objects (formed hallucinations). Formed hallucinations can be induced by (i) hypnagogic visions, (ii) Charles Bonnet Syndrome<sup>11</sup> (iii) psychiatric disorders, and (iv) toxic metabolism (Cummings & Miller, 1987).

There is evidence that suggest hallucinations are relatively common and that not all hallucinations indicate pathology (Bentall, 1990). In fact, in some cultures they are highly valued (Bourguignon, 1970). A telephone survey conducted, with 13,057 participants (aged 15 years or older, in United Kingdom, Germany and Italy) investigated the experience of different types of hallucinations (e.g., visual, auditory, olfactory, haptic and gustatory hallucinations, out-of-body experiences, hypnagogic hallucinations) in the general population. In total, almost two-fifths of the sample (38.7%) reported hallucinatory experiences (Ohayon, 2000).

### **Multisensory and Cross-Sensorial Experiences**

Multisensory experiences occur when perception in one modality is accompanied by the perception of sensation in another sensory modality. Synaesthesia occurs when “stimulation of one sensory modality automatically triggers a perception in a second modality” (Weiss, Zilles, & Fink, 2005, p. 859). Only a few individuals are considered real synesthesiacs, however, multisensory experiences can be induced. The acquired types of synaesthesia are assumed to have a purely environmental trigger (Ward, 2010). Experimental studies have

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<sup>11</sup>Charles Bonnet Syndrome is a condition that causes patients with visual loss to have complex visual hallucinations. It usually reported in elderly people without cognitive defects or psychological disorders.

demonstrated that even people without synesthetic abilities can draw associations between sensations in different modalities (Goldstein, 2010; Marks, 1974). According to Hidaka, et al (2011) “perceptual systems can rapidly form a direct association between a sound without explicit spatiotemporal or motion information and visual motion information and that they can establish a new neural representation between auditory and visual modalities.” (p. 6). This has been demonstrated using a technique called “*cross-modality matching*” where a stimulus is present in one modality and a person is asked to adjust a stimulus in another modality to match it. For example, Hidaka and colleagues (2011) presented random dots moving right or left together with a distinctive auditory tone to the participants. They noticed that after three minutes of exposure, the participants’ perception of the dots started to be influenced by the tones. Also, colours have been paired with sounds in other experiments (Ward, 2010). In another experiment, Marks (1974) asked the participants to match squares of paper ranging from bright to grey with pure tones. The majority of the participants matched the brighter squares of papers with higher pitches. According to Mavromatis (2010), a common characteristic of hypnagogia is synaesthesia. Listening to music while becoming drowsy can sometimes trigger seeing hypnagogic images (Silberer, 1965 in Mavromatis, 2010).

### **Effects of Visual Features in Video Games**

The effects of visual cues in video games have not been investigated much except in relation to epileptic seizures. Epileptic seizures due to photo-sensitivity to visual stimuli have been reported (Chuang et al., 2006). The visual effects that have been identified as epileptogenic precipitators include flashing lights or images, scene changing, choice of colour (e.g. alternating red and blue), contrast, colour images in motion, geometric patterns with specific characteristics of luminance (e.g., stripes), sequences of images including bright red/blue frames, chromatic stimuli mainly red light (Bureau, et al., 2004; Kasteleijn-Nolst Trenite, et al., 2002). Programs with steady maximal brightness (SMB) >100 lux should be considered potentially dangerous; programs with SMB <50 lux may be relatively safe (Ricci & Vigevano, 1999) (For a comprehensive review of epileptogenic precipitators and visual stress see Wilkins, 1995). Seizures induced by video games manifest as generalized tonic-clonic seizures, myoclonic seizures, and absences (Chuang, 2006).

Wolfson and Case (2000) studied how background colour and sound level influenced players’ level of excitement and arousal. They found that when using a blue background, the

players progressed gradually in the game, but players using red background initially showed better performance but then it declined over time. Jeong, Biocca and Bohil (2012) investigated the effects of blood colour (red vs. blue). Red coloured blood was associated with an increase of arousal. Sounds and lights have been associated with enjoyment in gambling activities such as playing a video lottery terminal (Loba, Stewart, Klein, & Blackburn, 2001).

### **Visual After-Effects in Virtual Environments**

Perceptual adaptation can occur after short- or long-term exposure to a particular stimuli (Wade & Verstraten, 2002), but when the exposure is prolonged as usually happens with the use of virtual environments, the visual after-effects may be strengthened. Research about altered perceptions induced by virtual stimuli date back to 1984, when users of video display terminals with black backgrounds and green characters reported seeing white surfaces tinted with pink colour (Khan, Fitz, Psaltis, & Ide, 1984); this is known as the McCollough effect (Seaber, Fisher, Lockhead, & Wolbarsht, 1987). Few studies have investigated altered sensorial perceptions, particularly in video games. Dyson (2010) reported motion aftereffects, more specifically waterfall aftereffects in music video games such as *Guitar Hero* that occur after viewing a moving visual stimulus for a certain period. Supporting Dyson's findings was a qualitative interview study about GTP conducted with 42 gamers between 15 and 21 years of age (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c). Gamers reported that objects appeared to levitate when they stopped playing and looked away from the screen. In the online *Urban Dictionary*, gamers have defined this visual experience as "dizziness and wavy vision that can occur after playing *Guitar Hero*" (Urban Dictionary, 2011a).

Video games have showed the potential to induce cross-sensorial perceptions and inter-sensory illusions (Biocca, Inque, Lee, & Tang, 2002). In an experiment conducted by Biocca, Kim and Choi (2001) where only "visual feedback" was used, participants reported significant haptic sensation of resistances even though the experiment did not include haptic feedback that contributed to the sensation of spatial and sensory presence. Also, sound has been used to induce the self-motion illusion orvection in a virtual reality (Väljamäe, Larsson, Västfjäll, & Kleiner, 2008).

### **Pseudo-Hallucinations Associated with Virtual Environments**

Different studies have induced visualization of video game images during sleep onset. Experiences and tasks are replayed during REM phases of sleep and it is believed that this process contributes to the consolidations of memories (Jones, 2010). Therefore researchers interested in the understanding of the continuity between activities while being awake, dreams, and the consolidation of memories while sleeping have conducted experiments to monitor the pseudo-hallucinations experiences induced by visuomotor tasks such as playing video games. In general, these studies have shown the incorporation of stereotypical video game images and thoughts with video game content while falling asleep, in dreams, and when being awake.

Other studies have used the game Tetris that is related to classical tiling problems (Baccherini & Merlini, 2008) and playing imply engaging in an intense visual working memory activity since the player rotate geometric shapes at certain velocity to make them fill the gaps in the rows (Skorka-Brown, et al., 2014).

In fact, Holmes, James, Coode-Bate and Deeptose (2009) found that the practice of a visuospatial task such as playing video games during the time frame when the memory consolidation takes place interfered with the formation of unwanted and involuntary visual memories, reducing these memories to manifest as flashbacks. According to findings in their experiments where a traumatic experience was simulated by watching a movie with real traumatic scenes of injury and death, participants who after the break of 30 minutes played the *Tetris* video game for ten minutes reported fewer flashbacks from the movie one week after, although deliberative recalls from the scenes of the movie were intact.

Stickgold and colleagues (2000) conducted another experiment using the *Tetris* video game with normal and amnesic participants. They demonstrated that seeing video game images during sleep onset was subcortical in nature, better controlled by implicit memory, and not necessarily mediated by declarative memory systems (Stickgold, et al., 2000). In their experiment, even amnesic participants reported seeing *Tetris* shapes, even though they did not remember having played the game. However, participants who were not amnesic and who had played *Tetris* earlier reported seeing images of previous versions of *Tetris* played one to five years ago. This suggests that the incorporation of remote memories into recent visuospatial experiences is possible when appropriated. More specifically, 17 of the 27 participants (63%) that played *Tetris* for seven hours during a three-day period reported seeing *Tetris* pieces falling as they fell asleep, along with a few reports that this also occurred while waking up. Reports from the participants were obtained during the first hour of trying to sleep. Participants were

woken up on different occasions. A larger number of reports with video game content were obtained during the second night. The time of manifestation of the images appear to be similar as in the incorporation of waking experiences into dreams during the first or second day (Nielsen, Kuiken, Alain, Stenstrom, & Powell, 2004).

Wamsley and colleagues (2010) extended the work done by Stickgold and colleagues (Stickgold, et al., 2000) and examined the integration of video game elements at different sleep phases by conducting three different experiments. Participants played an arcade ski video game called *Alpine Racer II*<sup>12</sup> for one or more days. A total of 43 healthy, college students participated in the experiments. None had played the game before but some participants had previously skied downhill in real life. They were woken up at different phases of their sleep cycle (e.g., pre-sleep, wakefulness) and asked to give their verbal reports using a *Nightcap* recorder device. Additionally, dreams or other thoughts related to the *Alpine Race* gamer were collected. In this study more than a quarter (30%) reported video game content in sleep onset. The reports mainly contained sensory imagery such flashes, as well as kinaesthetic related imagery, and fewer thoughts. The quality of the reports about video games' content was influenced by increasing sleep time. However, while longer duration of sleep decreased the presence of direct imagery with game content, indirect imagery such as thoughts with video game content increased with longer sleep durations. Not many dreams were reported by the participants. Interestingly, the frequency of reports of any type of video game content per participant decreased across the three nights. The authors argued that engaging in a multi-sensorial experience by playing a video game in a sky simulator enhanced the experiences. However, both control participants (who only observed others playing) and participants who played the game reported the same rate of reports with video game content, which indicated that the motor activity in this particular task was not relevant.

In another experimental study where verbal reports were collected in combination with behavioural and electroencephalography (EEG) measures conducted by Kusse, et al., (2012) found participants' reporting images from the game during hypnagogic trance states (i.e., the transition between being awake and falling asleep). A total of 43 participants were placed into three different groups. The experimental group played two hours of *Tetris* every day for three days. Participants in the two control groups played the game after sleeping or did not play any

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<sup>12</sup> *Alpine Racer II* is a simulation game where the player controls the avatar skiing downhill using its arms and legs.



game at all. The participants were repetitively awakened during different stages of sleep. The tendency to recall content from the video game did not significantly change during the three days; however, the recollections mostly occurred during hypnagogic trance states. The group that played *Tetris* and then slept was the one that reported more *Tetris*-related reports compared to the group that slept and then played the game. Participants reported visual and auditory hallucinations, as well as mnemonic associations with content from the game integrated into novel contexts. This is similar to the findings of both Wamsley (2010) and Stickgold (2000).

Two of the three experimental studies described above used the puzzle video game *Tetris* as experimental game to induce hypnagogic experiences. Playing *Tetris* is repetitive and stereotypical. However, Wamsley et al., (2010) used a ski simulator game that is controlled by moving the legs, but is also a game that involves repetitive and stereotypical gameplay. It may be that the stereotypical gameplay and the simplicity of the games facilitate the reactivation of the games' content in the participants. The studies reported similar and stereotypical visual, auditory and kinaesthetic sensory imagery and thoughts as reminiscences of the game elements. Among gamers' reports they found direct incorporations of video game content, but also mnemonic associations with content of the game that were integrated into novel contexts. The researchers found almost no emotional content among gamers' experiences which they argued showed the absence of participation of cerebral structures such as the amygdale and the reward system (Kusse, et al., 2012). This suggests that video game images reported in the studies differ from flashbacks that are unwanted recalls of traumatic and stressful events (Mineka & Oehlberg, 2008). Interestingly, the studies found similarities between the participants' reports, but none of the participants' reports included elements such as the screen or game controls, not even in the game *Alpine Racer II* where the participants controlled the game by moving their body. It appears that the mentation with video game content focused on the more salient elements and activities in the video game.

Furthermore, in the qualitative interview study about GTP, gamers reported seeing video game images while trying to sleep, but they also saw projected video game images that were triggered by associations between real life stimuli and events and video games elements (Ortiz de Gortari, Aronsson, & Griffiths, 2011). For example, one gamer saw health bars from *World of Warcraft* above other gamers' heads while playing a football game. Another gamer saw *Guitar Hero* frets in front of her eyes when her teacher said the word *guitar*. Visualizations of video game elements, or involuntary replay of the game after playing, are popularly known among gamers as the *Tetris Effect*. Some of the *Tetris Effects* include "thinking about ways

different shapes in the real world can fit together. Other effects include having dreams about *Tetris* pieces falling, or seeing images of falling *Tetris* shapes at the edges of the gamers' visual fields or when they close their eyes" (Wikipedia, 2012a). Other visual experiences associated with particular video games are defined in the online *Urban Dictionary*. For example, the *Call of Duty Effect* was defined as "a condition experienced after long nights of playing *Call of Duty 4*. [This *Call of Duty Effect*] causes dreams to consist of bright environments with shadows popping up everywhere. In the waking hours, [the] *COD Effect* causes severe reactions to fleeting images in the afflicted person's peripherals" (Urban Dictionary, 2012). Also, *Minecraft Sickness* has been defined in different ways. For example: "When you wake up and *Minecraft* tries to make you think it's real by appearing in full blown vividness while your eyes are closed. When you start seeing pixels hexagons and square themed shapes in everything" (Urban Dictionary, 2011b).

## Method

### Sample

A total of 656 experiences in the visual modality from 483 gamers were collected from publicly available online forums. Only 78 gamers reported their age ranging from 13 to 68 years ( $M = 20.86$ ,  $SD = 6.90$ ). Some gamers reported more than one GTP experience; therefore, there are a larger number of experiences than number of participants. A total of 181 different video game titles were associated with GTP-V, the experiences ranging from tile-matching puzzle games to massively multiplayer online role-playing games.

### Data collection

Initially, a total of 2,000 gamer's experiences were collected from the online video game forums. However, later on some data were eliminated because some self-reports did not contain enough information and/or were ambiguous. This resulted in a total of 1,681 usable gamers' experiences identified as GTP in one or more modalities and sub-modalities (e.g., visual or auditory altered perceptions, thoughts and, behaviours). These were collected from 60 publicly available online video game discussion forums<sup>13</sup> over a seven-month period. GTP experiences identified as "altered visual perception GTP" (GTP-V) were found in 54 of the

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<sup>13</sup> Online video game forums included comments to articles on websites, as these are considered discussion platforms.

online gaming forums. Some of the forums were frequented by players of specific online games (e.g., *Guitar Hero*), whereas others were frequented by online gamers more generally. Most of the forums had thousands of members and/or visitors although the specific size and characteristics of each forum were not recorded. Video game gamers' forums were searched with the *Google* search engine using the keywords "Tetris Effect," "Game Transfer Phenomena," "bleeding effect AND video games," "hallucinations video games," "video games AND/OR real life/reality." The gamers' experiences were included for analysis when their self-reports contained explicit information, and when the self-reports established clear references or cited previous posts to explain their own experiences.

### **Data analysis**

A mix of content analysis (Hsieh & Shannon, 2005) and thematic analysis (Boyatzis, 1998) was used to code and analyse the data. First, the gamers' visual experiences were extracted from the forums and recorded in a table. The following step was to systematically record gamers' experiences in a database for systematic coding and quantification. Categories and variables in the database were modified until all gamers' experiences were coded under a specific category (e.g., misperceptions). Other information that was coded (if provided) included: (i) gamers' profile (nickname, age, gender), (ii) GTP-V characteristics (e.g., frequency of occurrence, duration), (iii) playing habits (e.g., frequency of play, length of playing sessions), (iv) gamers' perception of their GTP-V experiences (e.g., positive, neutral, negative). The data analysis was informed by a rigorous literature review concerning altered perceptions process. In addition to this, some video games identified in the posts were played. This was to gain a clearer idea of the mechanisms and concepts described by the gamers. This was also supplemented by the watching of gameplay videos that also provided further insight into what gamers were describing. The gamers' self-reports (below) were paraphrased – where possible – to reduce the possibility of individual gamers being tracked, and to protect gamers' online identity. This was challenging due to the risk of losing the context of the experiences. This included using synonyms, changing tenses, and/or removing extraneous information. Gamers' pseudonyms were also modified.

## Results

The results were divided in two main sections: (i) general characteristics, (ii) types of identified GTP.

### General Characteristics of GTP-V

Only a few posts included information to explain the general characteristics of GTP-V.

#### Duration of the GTP-V experiences (n=75)

In relation to the length of the experience, a larger number of the gamers' posts specified that the experiences lasted only a few seconds or minutes (e.g., "split second", "didn't last for long", "seconds or so", "minutes", "short time") but a significant number also mentioned that their experience lasted hours (e.g., "the whole night", "a few hours"). Fewer posts mentioned that the experience lasted for days (e.g., "all day", "two days", "days after"), weeks (e.g., "at least a week", "for weeks") or a month or more (e.g., "for a good month", "for ages").

#### Frequency of the GTP-V occurrence (n=656)

The majority of the gamers in the total sample mentioned that the experience happened only once or they only reported one experience, but there were also gamers that experienced GTP-V on several occasions.

#### Hours played per session when experiencing GTP-V (n=192)

In most of the cases, the posts included details indicating that the gamers played long sessions (e.g., 3½ hours) or very long sessions (e.g., "all the day", "17 hours straight"). Also some of the gamers' posts explicitly indicated that they were playing excessively (e.g., "too long", "hard-core", "far too much", "a lot", "addictive", "like mad men"). Only a few posts mentioned that the experience happened after short or very short sessions (e.g., minutes to 2 hours).

#### When the GTP-V occurred (n=50)

Some gamers' experienced GTP-V after playing the game for the first time, but for others it also occurred after a few days, weeks or more of playing a particular game.

### **Activities associated with GTP-V (n=199)**

A larger number of posts mentioned that GTP-V happened when they were trying to sleep, but in general the experiences occurred while doing daily activities. The activities that were mentioned by the gamers when they experienced GTP-V were: driving, staring or spacing out, listening to music, waking up, being in a lecture or sitting, walking or being outside, talking, watching TV/movies, training or dancing, packing, reading, rushing and, cooking.

### **Physiological conditions (n=25)**

Only a few posts mentioned under what physiological conditions the gamers were when they experienced GTP-V but the few who reported it said it occurred when they were sick, fatigued, sleep deprived, drunk, dizzy and/or under the influence of drugs.

### **Gamers' perception about their experiences (n=143)**

There were a larger number of gamers' posts that included negative expressions (e.g., "scary", "annoying", "freak me out", "sign of madness") than the ones that considered GTP-V as normal (e.g., "it is not unpleasant", "no big deal") or positive (e.g., "entertainment", "fun", "creative"). Some gamers qualified GTP-V as "strange", "crazy" and, "trippy"; descriptions that could arguably be perceived as either positive or negative.

## **Types of GTP-V Identified**

A large variety of GTP-V experiences were reported (Table 1). The largest numbers of experiences reported were when the gamers either visualized or saw video games images, this was referred to as "digitally-induced images". The second most predominant category was perceptual distortions where objects and environments were perceived distorted, followed by misperceptions where real life objects were confused by elements from the video game or video game contents were seen in ambiguous shapes. Only 21% of the total GTP in the visual modality occurred by association between real life (RL) stimuli and video game elements.

Game Transfer Phenomena in the visual sub-modality (GTP-V) were defined as misperceptions and visual distortions of real life objects and environments, and stereotypical visual experiences that arise from mind visualization, and pseudo-hallucinatory phenomena where video game images were visualized or seen with close or open eyes. These phenomena can also manifest as cross-sensorial or multisensory phenomena, and can be triggered by automatic associations between real life stimuli and events, and video game elements.

**Table 4. 1** *GTP-V categories and sub-categories*

| Type of GTP-V   | Number of GTP | GTP-V type (%) | GTP-V category (%) |
|---|---------------|----------------|--------------------|
| <b>Perceptual Distortions</b>   |               |                |                    |
| Seeing real life environments distorted   |               |                |                    |
| Coloured altered perception   | 10            | 8              |                    |
| Textural after-effects  | 3             |                |                    |
| Grid vision   | 3             |                |                    |
| Perceive things smaller   | 1             |                |                    |
| Ambiguous perceptual distortions  | 4             |                |                    |
| Seeing particular objects distorted   | 16            |                |                    |
| Changes in shapes   | 9             | 7              |                    |
| Patterns (e.g., grid, pixelated) vision   | 4             | 3              |                    |
| Objects float and spin  | 2             | 2              |                    |
| 3D - depth  | 1             | 1              |                    |
| Altered perceptions/sensations movement and time                                |               |                |                    |
| Visual Motion after-effect  | 75            | 6              |                    |
| Slow motion/time perception   | 7             | 6              |                    |
| Motion sickness   | 3             | 2              |                    |
| <b>Subtotal</b>   | <b>122</b>    |                | <b>19</b>          |
| <b>Visual Misperceptions</b>  |               |                |                    |
| See video game elements in ambiguous RL stimuli                                 | 8             | 19             |                    |
| Confuse RL stimuli with video game elements                                     | 8             | 19             |                    |
| Thought to have seen a video game element in RL                                 | 5             | 11             |                    |
| Make analogies between RL stimuli and video game experiences                    | 7             | 16             |                    |
| See things as blocks  | 15            | 35             |                    |
| <b>Subtotal</b>   | <b>43</b>     |                | <b>7</b>           |
| <b>Digitally Induced Images</b>   |               |                |                    |
| Mind visualizations   |               |                |                    |
| Recurrent mind visualizations   | 112           | 23             |                    |
| Picture video game elements   | 24            | 5              |                    |
| Seeing video game images  |               |                |                    |
| Seeing video game images with closed eyes or as retinal sensations              | 140           | 30             |                    |
| Seeing video game images with open eyes or seeing video game elements projected | 131           | 28             |                    |

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|  |            |   |           |
|--|------------|---|-----------|
| See video game elements unspecified<br>(open/closed eyes)  | 16         | 3 |           |
| Multisensory experiences   | 10         | 2 |           |
| Cross-sensorial modalities   | 14         | 3 |           |
| Seeing /visualizing video game elements<br>(unspecified)   | 27         | 5 |           |
| <b>Subtotal</b>  | <b>474</b> |   | <b>72</b> |
| <b>Unspecified GTP-V</b>   | 14         |   | 2         |
| <b>Visual experiences not directly associated<br/>with a specific video game's visual effect</b> (e.g.,<br>sleep paralysis, prodrome-epilepsy) | 3          |   | <1        |
| <b>Total</b>   | <b>656</b> |   |           |

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### **Perceptual distortions of object or environments (n=125)**

In this main category, the gamers reported perceiving objects and environments distorted in accordance with the visual effects perceived in the game. In most of the cases, the perceptual distortions appear to be explained by sensorial adaptations that result in visual after-effects immediately after stopping playing. However, in some cases, these experiences were triggered by automatic association between real life stimuli and video game elements, and suggest the interplay of cognitive process. Furthermore, in some cases, physiological conditions due to sleep deprivation, sensory deprivation and the consumption of psychoactive substances appear to have played important roles. Additionally, in a few cases, the gamers indicated that they could induce the phenomena. The gamers either (i) saw full real life environments distorted, or (ii) particular objects distorted.

#### ***Seeing real life environments distorted (n=21)***

Some of these experiences were fairly abstract and gamers reported seeing real life environments as in the game. This occurred after playing, but could also occur while playing. The gamers' experiences were further sub-divided into: (i) coloured altered perceptions, (ii) textural after-effects, (iii) grid vision, (iv) perceive things smaller, (v) ambiguous altered perceptions.

*Coloured altered perceptions (n=10)*

Here the gamers perceived real life environments distorted in colour. This manifested as seeing environments intensified in brightness or colour. For instance:

*“I played Psychonauts so much I find myself trying to set people on fire with my mind or I'll see things a lot more colourful and cartoony in real life”*(Soul7)

Also, for some, real life environments were only seen in the colour of the game. For instance:

*“Now I am seeing everything COD6 [Call of Duty 6] vision [green]”* (Mzy)

For others, gamers perceived environments in monochrome or opposite colours as from the game. This occurred immediately after stopping playing or with some delay triggered by associations. For instance:

*“Our real world turned monochrome. The red and white tiles made an optical trick in our eyes, and we could only see in green, yellow and the shades in between”* (Raceman)

*“I played from Friday night to Monday morning. I was playing both Assassin's Creed and Assassin's Creed 2 and sadly never slept ate or really anything when I finally snapped out of gaming I had to go to school and I swear I took in some of Ezio's skills. For times the two overlapped and I had times I would faint and right before I fainted I lets say I used eagle vision and that was not pleasant but VERY real”* (Vern)

Additionally, an altered perception of colour could also be triggered by an association between stimuli. For instance:

*“Well this explains why I'm seeing everything in red, blue, yellow and black every time I see a yellow 'Y' after I played Assassin's Creed: Brotherhood's Campaign”.* (Amol)

*Textural after-effects (n=3)*

In this category, gamers reported seeing textures from the game. Real life objects were also seen with shades as the ones from game. For instance:

*“Went through a period of playing Borderlands for 5-6 hours non-stop on LAN with my brothers... started seeing everything cell-shaded... weirdness XD”* (Jay)

Some gamers reported nauseas or headaches when playing video games with textures. For instance:



*“Minecraft has a similar effect, for some reason, except I get more nausea than I do headaches” (Oka)*

*Grid vision (n=3)*

Some gamers experienced seeing a grid over things; sometimes when waking up or turning on the light. For instance:

*“Doesn't really happen to me. The only time something similar occurred was when I had a mammoth, all-night Chu Chu Rocket puzzle mode session (yup, really). When I stepped out blinking into the light the next morning everything looked like it had a grid over it. It was pretty weird” (Fedex)*

In one case, a gamer saw everything on a grid when turning on the light when not being able to sleep. For instance:

*“I played ‘Minecraft’ for 72 hours straight. I went to bed but I could not sleep. I turned the light on and looked around. Everything was on a square. [A] grid...I started freaking out, and I moved my furniture around to make it fit perfectly on the grid. My dresser did not fit on a square and I went to bed crying” (Sha)*

Another gamer saw the world as ‘blocky’ when being sick and under the influence of medication. For instance:

*“I played Minecraft for about five days straight while I was home sick for a week. The fever + medicine + too much Minecraft made me feel like I was in a completely different dimension. Getting up to go to the bathroom, I would see the world in blocky Minecraft dimensions. It would feel like a tunnel I had dug out” (Brechts)*

*Perceive things smaller (n=1)*

Some gamers have perceived things smaller than they really were. This was associated with a game that consist in move an object, which attract other objects and it slowly grows bigger and bigger.

*“After play Katamari I feel that everything is smaller than me” (Yo\_222)*

*Ambiguous perceptual distortions (n=4)*

Some gamers reported perceiving real life environments as in the game, although it was not possible to establish exactly in what way. For instance:

*“Oh fucking hell Minecraft. I still have trouble looking at the world normally”*

(Marshall)

*“Holy s\*\*t after staying up till 5 playing borderlands then waking up a 9 then drinking the world totally looks like borderlands. Please if someone knows what I’m talking about I’ll give you a dollar”* (Karman)

*“I saw the world in the oblivion engine for a while. Freaky stuff”* (Boeltron)

*Seeing particular objects distorted (n=16)*

In these experiences (rather than environments), particular objects were perceived as distorted. These experiences were divided into: (i) Changes in shape, (ii) pixelated vision of objects (iii) objects float and spin, (iv) 3D – depth.

*Changes in shape (n=9)*

Some gamers experienced seeing real life objects with properties of the video game. These experiences appeared to resemble *metamorphosia* where objects appear distorted, for example, in shape (Shiga, Makino, Ueda, & Nakajima, 1996). For instance:

*“After few hours of nonstop ‘Frozen Bubble’, I saw everything insanely blocky. Even quite round shapes were looking like blocks. It only lasted a few minutes though”*

(Danilop)

*“At some point, after playing copious amounts of Kirby Air Ride, I began seeing Shadow Star map symbols instead of spots when I was tired”* (Chirsty\_99)

*Pixelated vision of objects (n=4)*

In other cases, some gamers saw real life objects as being pixelated. This visual distortion share similarities with seeing ‘visual snow’ or television-like static that is usually a symptom of migraine aura (Curioso, Kepka, Cabello, Segura, & Kurth, 2010) or as warning signs to the beginning of an epileptic seizure (Gupta, Jeavons, Hughes, & Covanis, 1983). For instance:

*“For the week or so before, I have been playing an old Final Fantasy game. Suddenly, during a lecture, I realized that the teacher’s head became pixelated. I was tired. I stared at him for some time, and then nothing she said made any sense” (Joey)*

*Objects float and spin (n=2)*

One gamer reported perceiving a static object in movement. Perceiving a static object in movement is referred to as *Kinetopsia* (Blom, 2009). For instance:

*“I had this, but from ‘Rock Band’. It's left a lasting effect. If I ever see a screenshot or picture of the gameplay board-thing, it just starts floating up on the page” (Eric)*

Another gamer reported seeing objects with *“a trail leading behind it”*:

*“After playing Osmos (2D game, think moons revolving around planets and planets revolving around suns) for a few hours, I can't look at something without seeing it revolving around some other point, with a trail leading behind it” (Ossi)*

Additionally, another gamer reported that while reading he saw real life elements such as letters flying from the page and zooming past his head in the same way as cars. For instance:

*“The worst I got it ever though was when I tried to read a book in bed after a marathon session of Burnout 3. I would see individual letters from the book leap from the page and zoom past my head just like the cars I would pass in the game did! It was like reading in warp speed! First and only time in my life I got motion sickness from lying immobile in bed reading a book on solid land” (Saly20X)*

*3-D – depth (n=1)*

One gamer reported perceiving things that were not three dimensional in 3-D after playing a game on the portable game console *3DS* by *Nintendo* that have a feature to project stereoscopic 3-D effects. For instance:

*“3DS. I started seeing non-3D things as 3D” (Patsy)*

***Altered perceptions/sensations in movement and time (n=85)***

This included sensation of movements or feelings as if the time had slowed down. (i) Visual motion after-effects, (ii) motion sickness, (iii) perceptual distortions of time and slow motion sensation.

*Visual Motion After-effects (n=75)*

One of the most common visual after-effects reported by the gamers has been referred to as motion after-effect (MAE). MAE occurred due to the visual adaptation to the movements of the video game elements and occurred when the gamers took their eyes off the game screen and looked at a stationary point. Following this, objects appeared to levitate or look like a reversed waterfall, resembling the waterfall aftereffect (Goldstein, 2010). Gamers also reported seeing things as “warped,” “wavy,” and “expanding.” Usually, these experiences lasted for a short period, but some gamers reported that the effect lasted for hours or more, whereas some experienced it episodically. For instance:

*“After playing a marathon Guitar Hero or Rock Band session, everything I look at appears to scroll or move towards me” (Jepry)*

*“The worst was with ‘Frequency’ ...After playing a match I would see everything going upwards like a reverse waterfall. It almost makes me dizzy” (Marol47)*

In another game similar to *Frequency* called *Amplitude*, the player controls a ship sliding in a colourful tunnel with varying shining geometrical shapes and lengths (Wikipedia, 2012b). Here, players experienced seeing everything sliding down, and the effect lasted for hours. For instance:

*“Amplitude was a great game and also made the walls and everything else slide down for hours after playing” (Paul)*

Usually, these experiences lasted either for seconds although some lasted for hours or longer, after stopping playing, and occasionally they were experienced episodically.

*“I've played ‘Guitar Hero’ pretty much non-stop all week. I'm sitting at work, not played ‘Guitar Hero’ since last night, and everywhere I look I can still see stuff moving” (Alf)*

*“Oh, and I get it with Guitar Hero games all the time. I sometimes think I see my curtains 'scrolling' like the bar on Guitar Hero” (791Paxy)*

*“After playing RB / GH [Rock Band/ Guitar Hero] on expert for a while something strange happens to my eyes. When I look away, the whole room and the objects inside*

*it seem to be rising rapidly and it takes like 15 minutes for my vision to return to normal...Is it just my funky eyes? :)" (Malcom)*

*Motion sickness (n=3)*

Other gamers reported feeling as if their body were in movement, which seems to be similar as motion-sickness side-effects due to the haptic effects in the games. Symptoms of motion sickness include headaches, dizziness and fatigue (Viirre & Bush, 2002). For instance:

*"What's really horrible is playing Audiosurf for ten hours without a break and then stopping. I just kind of want to lie down and be sick. Feels like I'm constantly in motion and I get these explosive headaches" (Oka)*

*"I would be playing tons of Armored Core, and trying to fall asleep that night. I could 'feel' the constant movement of an arena fight because I had done the whole damn arena list before bed. I can liken this to feeling the waves at the beach after you get home" (Norma)*

*Perceptual distortions of time and slow motion sensation (n=7)*

In this category, gamers experienced feeling that everything was happening slowly. Related to chronoceptive perceptions. They perceived everything in slow motion sometimes accompanied by body sensations of stiffness. These types of experiences were related to haptic effects (e.g., fast velocity or slow motion effects). For instance:

*"Today, I was busy playing Crysis with a "slo-mo" script on. For the next hour afterward, I felt like everything was going in slow motion" (Pilloman)*

*"After playing 'Crysis' with infinite ammo for an extensive period of time, only blowing things up (which slow down the frame rate), I saw the world in a slower frame rate. It was kind of awesome. It was not incredibly slower or frustrating. It just felt a little stiffer. It lasted for maybe two days. I could induce intentionally when it started to wear off. It was awesome" (Giles)*

After playing a high rate velocity racing game, one player experienced driving slowly. For instance:

*“I remember playing F-Zero GX for hours at at time...then I would go out and drive to the store. Only it felt like I was driving 2 mph and I kept feeling like I needed to side-swipe any car that got too close to me. Not cool” (Brahmpass)*

### **Visual misperceptions (n=43)**

This category included experiences where gamers confused real life objects with something from the game, or when gamers saw video game content in ambiguous real life stimuli. Sometimes it was difficult to be sure if the gamers’ misperceptions were experienced as a thought, or if the gamers actually experienced perceptual distortions.

#### ***Seeing video game elements in ambiguous real life stimuli (n=8)***

Sometimes gamers interpreted ambiguous stimuli based on video game experiences. This known as pareidolia when random, ambiguous patterns or obscure stimuli are interpreted as significant (French, 2001). The brain is hardwired to recognize patterns and faces (Berenbaum, 2005) but seeing pareidolia has been correlated with pathology (e.g., dementia, schizophrenia and obsessive compulsive behaviours) (Fontenelle, 2008; Uchiyama et al., 2012). For instance:

*“More recently with ‘Left For Dead 2’. I was at a store and they had a frying pan on display, I could almost see a silhouette of the damn thing and I was actually going to pick it up” (Jenice)*

*“I had a series trip with Condemned 2 when I looked in the window of a shop I for a very brief moment saw the mask on my face that Ethan’s alcohol demon wears. It was around Halloween too and I was at a novelty shop so the two must of just meshed together and pop! There it was” (Fish\_max)*

#### ***Confusing RL stimulus with video game elements (n=8)***

Also, some gamers confused a real-life stimulus with a video game element that shared similar features. For instance:

*“For minutes I would confuse airplanes in the sky for [unmanned aerial vehicles] in ‘Modern Warfare 2’” (Fillipes)*

### ***Thought to have seen a video game element in real life (n=5)***

Here the players thought that they saw a video game element for a few moments. For instance:

*“I thought I’ve seen landmines on the road on numerous occasions after Warhawk binges” (868)*

*“When I was still working on Super Mario 64, whenever I went outside I thought I saw floating red coins over the tops of trees” (Marucios)*

### ***Making analogies between real life stimuli and video game experiences (n=7)***

These experiences appear to have strong cognitive elements. However, the way gamers described them appear to be mostly perceptual. For instance:

*“One time, I had been playing Guitar Hero so much that I was talking to my friend and realized I thought her nose looked like a held note and her eyes looked like a chord” (Capri)*

*“Well at least hard science finally gives me an explanation why sometimes everyone looks like zombies” (Lorela)*

### ***Seeing things as blocks (n=15)***

In addition, gamers reported seeing the real world in terms of blocks. This appeared to occur while players were assimilating the information from the real-life environment after having been adapted to play monotone games, where patterns and stereotypical geometrical figures are manipulated. For instance:

*“I saw the real life in terms of blocks. Envisioning a tree build by blocks from the game. It lasted several hours. I was truly tempted” (Ossie)*

*“After a long MC [Minecraft] session a while back I went outside and honestly, I was seeing the world in terms of minecraft. Was excellence and concerning” (Samuel)*

### ***Digitally Induced Images (n=474)***

In this category, video game images arose either in the mind, as retinal sensations, or as a projection of video game images “out there” and multisensory experiences and cross-sensorial experiences, and comprised (a) mind visualizations, (b) retinal sensations, (c) seeing video games elements projected in the real world, (d) multisensory experiences, and (e) cross-

sensorial experiences. When it was not possible to establish how gamers saw the video games images they were classified as seeing unspecified video game elements. Video game images appeared as static or in motion.

### ***Mind visualizations (n=136)***

In this category gamers visualized video game elements in their mind either as: (i) stereotypical visualizations of video game images, or (ii) picturing video game elements in real life environments. The visualizations of video game elements share similarity with seeing video game images with closed eyes and appear to be more stereotypical than when the gamers have fantasies about video games. The experiences were classified in this category when the words “mind”, “head” or “in the mind’s eye”, were included.

#### *Recurrent mind visualizations (n=112)*

Here the players kept seeing images from the video game in their mind. These can be experienced in stereotypical ways when the players closed their eyes, zoned out or were trying to fall asleep. For instance:

*“Once I played so much ‘Cricket Captain’ [and] every time I closed my eyes, images of it just rushed into my head uncontrollably” (Samsam)*

Sometimes the mind visualizations could be prolonged and the gamers actually played the game in their mind. It appeared that the gamers had some control over the game play. For instance,

*“This happened with ‘Meteos’ to the point where I could really play the game in my head. Not only watch the game, but play it” (Alb)*

#### *Picturing video game elements (n=24)*

Here, the players pictured video game elements in real life sceneries. This meant that the players were not actually seeing the video game images but they pictured or visualized them in specific real life sceneries. These experiences appear to have been triggered by the association between real life stimuli and video game elements. The players’ experiences appeared to be more stereotypical than when the players created their own fantasies with video game contents. For instance:



*“Whenever I have a pleasant interaction, I still picture the ‘positive social icon’ from ‘The Sims’ above people’s heads” (Londyx)*

*“I have this weird combo of Breakout and Pong, where I would imagine a ball bounce around the walls and off the objects on the wall, very odd but it would entertain me for hours” (Vol178)*

### ***Seeing video game images (n=287)***

In this category gamers actually saw video game elements in a variety of ways. (i) seeing video game images with closed eyes or as retinal sensations, (ii) seeing video game images with open eyes or seeing video game elements projected, (iii) seeing video games elements unspecified (open/closed eyes).

#### *Seeing video game images with closed eyes or as retinal sensations (n=140)*

These visual phenomena occurred when the gamers recurrently or episodically saw video game elements in the back of their eyelids or with closed eyes. Usually, it was associated with stereotypical and repetitive tile-matching puzzle games such as *Tetris*-like games and music-based games such as *Guitar Hero* and *Rock Band*. It appeared mostly when the gamers closed their eyes or blinked. The video game images that arose were similar to typical afterimages. However, according to the descriptions of some gamers, these images were of higher fidelity and were seen either as positive afterimages, because the images preserved the colours from the game, or as negative afterimages in opposite colours as the ones perceived in the game. Sometimes these were presented with movement and at great speed. These images were considered the most intrusive experiences because the episodes were short but the full experience could last for hours or longer. For instance:

*“When I was playing ‘Dance Dance Revolution’ every day I would see scrolling arrows whenever I closed my eyes” (Babur)*

Also, different gamers reported seeing images from the game when trying to sleep, occasionally provoking sleep deprivation or not being able to concentrate on something else. Sometimes the gamers reported that this occurred on the first occasion they played the game. For instance:

*“The first time I got ‘Meteos’, I played it constantly for days. It was not possible to sleep for a while after that because every time my eyes were closed, I would see the Meteos pieces falling” (Mars)*

Occasionally, when the gamers saw video game images when lying in bed, the experiences became more elaborate and some gamers reported having full video game sessions replayed. It could perhaps be speculated that gamers here were in a hypnagogic state (Mavromatis, 2010). For instance:

*“I don’t usually play it in the evening now...When I go to bed, I can see Tetris shapes on the back of my eyelids and I try to make the shapes all fit together...It’s sort of fun for a while but then I think ‘I need to sleep!’” (Aiden00)*

*Seeing video game images with open eyes or seeing video game elements projected (n=131)*

In this category, gamers claimed they actually saw video game images with open eyes. These experiences occurred either immediately after stopping playing without any external stimuli identified as trigger, or triggered by an external stimuli or activity.

This occurred immediately after stopping playing, and appears to have been triggered by blinking. For instance:

*“I dunno which game it was (probably WoW [World of Warcraft]). After I played a long time and blinked I saw a health bar for a split second...” (Mapy)*

*“Lumines, oh god. I play 3 days and I have seen those damn squares everywhere, even when my eyes open...” (Ethan017)*

Also, associations between real life stimuli that resembled the video game elements appeared to have triggered seeing images from the game. In some cases the images appear superimposed on real life objects. For instance:

*“After a long ‘Black Ops [Call of Duty]’ session I saw a red player tag above a woman riding a bicycle. Fortunately, I didn’t have my gun on hand” (Max4)*

*“See chromatic lines of notes and chords scrolling past on the ground before you? Does that count?”* (Jeul)

Furthermore, seeing video game images with open eyes appear to have been facilitated by automatic activities. For example, some gamers saw video game images while driving. Driving is an activity that tends to become automatic, especially on monotonous roads, and studies have showed that driving without awareness can lead to micro-sleeps (Briest, Karrer, & Schleicher, 2006). This may, for example, facilitate an association between a game object in *Guitar Hero* and the road, since the game object (a holder of the “sheet music”) has some resemblance to the centre lines on the road. For instance:

*“When playing Battlefield 2 once saw a landmine on the road, and I swerved to avoid it. Hilarity ensued, and by hilarity, I mean a ticket”* (Masterhit)

Additionally, some gamers reported seeing video game images while doing automatic day-to-day activities (e.g., searching for things, starting a conversation, arranging things, etc.). For instance:

*“I saw the Grenade indicator when scanning the video store. Fortunately I realized it was a hallucination before I went commando rolling”* (Janus)

*“At one point, my mom asked me to pick up my sister, and I swore I saw the dead rising scoop timer pop up in the corner of my”* (Maury)

Interestingly, video game images were reported as being preserved in the position where they were originally seen in the game (e.g., bottom, corner). For instance:

*“Every time I talk to someone, the ‘Mass Effect’ conversation wheel comes up at the bottom of my vision”* (Pats)

*Seeing video games elements unspecified (open/closed eyes) (n=16)*

Some gamers did not specify if they saw the images with closed or open eyes. For instance:

*“I started seeing note charts after playing too much Guitar Hero or Rock Band”*  
(Tolky)

### ***Multisensory experiences (n=10)***

This category included actually seeing video game images with open eyes, on the backs of one's eyelids, or as mind visualizations. This was mainly at bedtime, but it was also experienced in day-to-day contexts when the images were accompanied by hearing music from the game and association between video game elements and real-life stimuli were automatically established. Sometimes, visualized video game elements were accompanied by hearing the music from the video games. Sometimes this was when trying to get to sleep, which suggests that gamers were in a hypnagogic state (Mavromatis, 2010). For instance:

*“Once I spent all the day playing ‘Pitfall’. That night, all I saw against my closed eyelids was Pitfall, hearing the sound effects and everything” (Yazul)*

Also, some gamers saw or visualized images accompanied by involuntary movements of limbs (e.g., fingers pushing buttons as they would on the gamepad, legs moving as they would in steps in the video game). These experiences share similarities with what is known as myoclonic jerking (Grunewald, Chroni, & Panayiotopoulos, 1992) and hypnagogic jerk or myoclonic twitch (Mitchell, 1890). These experiences mainly occurred at bedtime. For instance:

*“It's annoying, but very interesting. First this happened when started to play ‘DDR [Dance Dance Revolution]’, as I was falling asleep I would literally feel my feet moving with an image I made up of the game in my head...Recently for ‘Robot Unicorn Attack’, as I fall asleep, I picture the game blowing by in my head, with my fingers twitching (at least they feel like they are moving) to control the unicorn” (Boris)*

### ***Cross-sensorial modalities (n=14)***

In this category, a stimulus in one sensory modality (e.g., auditory) triggered seeing or visualizing video game elements in another. These cross-sensorial associations can be understood as “artificial synaesthesia” or induced synaesthesia. For instance:

*“Playing so much ‘Rock Band’, some songs make me see green, red, yellow, blue and orange notes in my vision” (Mayaz)*

*“When I first got really into Guitar Hero whenever I would hear music, saw the gems floating down in front of my eyes as I would imagine what it would be like to play in GH. It's worn off now but it went on for probably 3 years” (Rene)*

***Seeing /visualizing video game elements (unspecified) (n=27)***

Some gamers did not specify if they visualized or actually saw the images. For instance:

*“I always see video game images after I play this game” (Jola)*

**Unspecified GTP-V (n=14)**

Some experiences reported indicated that the gamers experienced something visual related to the game but it was not possible to classify in any of categories. For instance:

*“My perceptions are full by the game” (Mari)*

**Visual experiences not directly associated with a specific video game's visual effect (n=3)**

In most of the posts, it was possible to identify which visual effect in the video games was related to the VTGP experience. However, in a few cases the gamers reported visual phenomena that did not appear to be directly triggered by any specific visual effect, or where gamers' experiences appeared to depend mainly from gamers' particular visual or clinical conditions. In one case, a player claimed that parts of his vision disappeared. This is usually a visual distortion effect that precedes migraine and is known as visual symptoms in migraine aura (Podoll & Robinson, 2000; Podoll & Robinson, 2001). Blurred vision has been associated with epileptic seizure (Schacter & Shafer, 2013). For instance:

*“After playing ‘World of Warcraft’ a few years back, I started not being able to see normally. Some parts of my vision would go fuzzy or disappear. My arm went numb, which spread to my face. It was scary as hell. This also happened more than one time after when not playing ‘WoW’ and once my parents took me to the hospital” (Suzette)*  
*“‘Tunnel Vision’ gets me a lot, whether I'm playing Guitar Hero or staring at the road too much on the highway” (Claude)*

## Discussion

The purpose of this study was to identify, classify, and explain gamers' visual perceptual experiences to contribute to the understanding of the effects of post-video game playing, and encourage healthy and safe gaming. Findings in this study suggest that video game playing sessions (and in many cases intense video game playing) can induce altered visual

perception manifesting itself as (i) misperceptions and (ii) visual distortions of real life objects and environments, stereotypical visual experiences that arise from (iii) mind visualization, and (iv) pseudo-hallucinatory experiences including multi-sensorial, and cross-sensorial experiences with video game content. The analysis of the gamers' experiences and observation of video game features associated with GTP-V suggests in the most of the cases a relationship between the video games' visual effects and the gamers' altered perceptions. The gamers' experiences can be explained by the interplay of physiological, perceptual and cognitive mechanism. The gamers' experiences appeared to have occurred spontaneously, without control and premeditation, with the exception of a few cases where the gamers reported that they could control and self-induce their visual experiences. The experiences occurred while playing, directly after stopping playing or after a while when triggered by automatic associations between real life stimuli and video game elements. Only 21% of the gamers' experiences were triggered by external stimuli.

### **Perception of environments or objects distorted**

It was observed how the exposure to particular video game effects resulted in visual after-effects due to neural adaptations. According to LaViola (2000), physiological adaptations can take place when virtual environment devices alter the person's vision. In this study, gamers' saw environments in monochrome colours, intensified colour, objects changing shape or moving, pixelated objects, coloured outlines like halos around objects, trailing phenomena, illusion of movement such as seeing static objects in movement, motion after-effects, and/or everything in slow motion or motion sickness sensations. Furthermore, some gamers experienced distortions of time. One player said that he experienced the world in a slower frame rate and that he felt a little bit more rigid, and that when the effect started to wear off, he could induce it, making it last around two days.

On several occasions, the gamers remarked that they had been playing the whole day or longer. A large number of these experiences occurred immediately after stopping playing, but the most interesting finding was that in some cases, the perceptual distortions and revivals of video game images were triggered by associations between real life elements and video game elements. For instance, one gamer perceived everything blackish with some objects glowing. Another gamer experienced it just when standing up after playing and the experience lasted for a couple of days and longer. In another instance, one gamer experienced *eagle vision*

every time he saw a yellow Y after playing the game. For instances, there is a yellow “Y” on the gamepad on the Xbox 360 that is also shown on the screen. It appears that the yellow “Y” seen during the game play was paired with the visual effect of the *eagle vision*. Research has demonstrated that top-down expectations can induce perceptual outputs (Vercammen & Aleman, 2010). For example, Vercammen and Aleman (2010) examined how auditory verbal expectations lead to hearing a word even when the word was not presented. Here, it is speculated that the gamers expected to see the visual effect from game when they saw particular stimuli in real life context and that this led to their altered perceptions. Moreover, gamers also reported altered perceptions of time, when feeling that everything has slowed down, typically associated with games with high velocities or slow motion effects. Additionally, altered body related perceptions were reported when a gamer felt shortly after playing a game with where the character was short. Interestingly, the self-perception of body size works a reference to perceive the external world (Banakou, et al., 2013; Proffitt, 2006). This has been demonstrated when participants in an experiment overestimated the size of objects when they experienced the illusion of the ownership of a child’s body, and when the self-perception of a larger or smaller body size led to perceiving the world accordingly (Banakou, et al., 2013; Proffitt, 2006).

### **Visual misperceptions**

The current study suggests that the exposure to the simulation of real life stimuli influenced gamers’ perception and responses to the stimuli in real life, at least momentarily. These types of experiences also showed how gamers’ perceptions were influenced by their expectations. Cognitive theories about perception argue that *“deciding what it is that we are seeing can be solved before the stimulus is even presented”* (Summerfield, Egner, Mangels, & Hirsch, 2006, p. 500). Some gamers confused real life objects with video game elements when the objects shared features with elements in the video games or when they were encountered in similar setting as in the game such as confusing seagulls with planes from a game. Theories about visual object recognition argue that objects are more difficult to discriminate when they share similar features; the context where the objects were seen and the relation with the stimuli around them is also important. For example, perceiving a mailbox as a loaf of bread if other objects around the mailbox suggest that it is in the kitchen (Palmer, 1975 cited in Summerfield, et al., 2006). Furthermore, gamers saw video game content in ambiguous real life stimuli.

Object recognition is an essential function of the visual system, when a stimulus is ambiguous the brain tries to make sense of it (Summerfield, et al., 2006).

### **Visualizing or seeing images from the game**

In other cases, instead of perceived distortions of context and objects, the gamers visualized or saw images from the video game. This was the most prevalent category and was referred to as *Digitally-Induced Images (DII)*. Here, the images were seen with closed or open eyes. Sometimes the images suddenly appeared just floating without any real life context, while in other cases the images emerged as superimposed on real life objects.

The simplest experiences in this category occurred when the gamers *pictured video game elements in real life settings*. In other cases, the gamers experienced intrusive video game images that popped up intermittently in their heads as *mind visualizations*, but also in the back of their *eyelids or with closed eyes*. These experiences were usually associated with simple, primitive shapes, repetitive and stereotypical video games such as tile puzzle games or music games. Some of the images appeared to keep the video game content intact and they were very stereotypical showing striking similarities between gamers' self-reports, while in other cases the images appeared to be influenced by remote memories and produced novel content. Some gamers reported seeing or visualizing images from the game for extended periods, usually when they were trying to sleep but they also occurred when they were performing day-to-day activities. Some images were seen during the whole day or even longer.

In the current study, the images in the majority of the cases were considered of an intrusive nature especially when the gamers were unable to sleep due to the visualizations. Recurrently seeing images from the game share similarities with symptoms of *Hallucinogen Persisting Perception Disorder (HPPD)* (i.e., re-experiencing perceptual symptoms – e.g. positive afterimages, geometric hallucination, intensified colours, halos around objects – as those induced by the drugs after the effect have ceased) (American Psychiatric Association, 2013). Also, individuals under the influence of anaesthesia have reported figurative closed eyes hallucinations (Otomo, Sugita, & Yano, 2008). Also, these experiences appear to share similarities with visual perseveration or palinopsia which is “the persistence or recurrence of visual images after the removal of the exiting visual stimulus object” (Heiser, Shippman, & Cohen, 1997, p. 197).



Similar experiences were reported by gamers in a previous interview study about GTP (Ortiz de Gortari, et al., 2011b). The gamers' experiences appear to be related to reports where people have revived images of previous objects they have previously perceived. Similar visual experience have been reported even in amnesiacs what suggest the images are subcortical in nature (Stickgold, et al., 2000). Historically, as mentioned by Mavromatis (2010), these type of images have been called *recurrent images* (Hanawalt, 1954; Titcher, 1915) or *delayed after sensations* (Warrens, 1921). Some have considered them as *visual perseverence*, (Robinson & Watt, 1947) that is, defined as the persistence or recurrence of visual images after the object that triggered it has been removed from sight (Cleland, Saunders, & Rosser, 1981; Robinson & Watt, 1947). According to Kinsbourne and Warrington (1963), when an object has been fixated long enough it might persist for hours or days (Kinsbourne & Warrington, 1963). This is interesting to point out because playing video games is an engaging, repetitive activity, and can be considered as a hyper-sensorial experience based on visual information. Playing a game implies getting immersed and experiencing psychological absorption (Funk, Chan, Brouwer, & Curtiss, 2006; Wood, et al., 2007).

In terms of the characteristics, the images appear to be like positive afterimages, preserving the colour of images from the game, although, one gamer stated that all the arrows he saw were in pink colour. The images were clearly identified by the gamers and appear to have been seen with higher fidelity. According to Hanawalt (1954), these types of image appear as idealized and look "better" than the actual object perceived. In fact, some gamers reported that they replayed video game sessions. Some gamers saw the images with movement retaining the direction seen in the game; top-to-bottom, or moving in an opposite direction (in games such *Tetris*, *Guitar Hero*, *Rock Band*). One gamer said that he saw the images enlarged.

Mavromatis (2010) described the experience of Dallenbach where after travelling all day, at night he saw visual afterimages with closed or open eyes. The images moved toward him, opposite to how he perceived the roadway. Darkness has been suggested as a precipitant for altered perceptions (Abraham, 1983), visualization of images in the HPDD are elicited by darkness, stress and fatigue (American Psychiatric Association, 2013). This study only relied on players' self-reports and therefore it is impossible to know if the gamers were actually in hypnagogic states, but it may be speculated that – in some cases – they were. According to Stickgold and Wamsley, the images arise in the first phases of sleep. Hypnagogic imagery is one of the most common pseudo-hallucinations even among the non-clinical population (Collerton, et al., 2005). According with Wamsley (2010), activation of recent memory

observed during sleep can also take place during moments of calm and restful vigil. Certainly, visualization of images have been induced in experimental studies during hypnagogic states (Kusse, et al., 2012; Stickgold, et al., 2000; Wamsley, et al., 2010) but in the current study, the seeing of images does not seem to require trance states and in some cases they were elicited recurrently every time that the gamers blinked or closed their eyes.

Mavromatis (2010) argues that whatever similarity of the hypnagogic images with retinal phenomenon is incidental. However, Richardson (1969, p. 22) claimed that *“though the circumstances in which these visual recurrent images appear might lead to them being called hypnagogic images the antecedent conditions of prolonged and intense retinal stimulation makes them a distinctive phenomenon and in this respect more like the afterimage”*. Interestingly, the gamers’ self-reports did not include those seeing images of a computer or external controls such as gamepad, keyboard, etc. This coincides with findings in previous studies (Kusse, et al., 2012; Stickgold, et al., 2000; Wamsley, et al., 2010), which may be an indicator of immersion in the game. All the previous studies that induced visualization of video game images used very stereotypical and repetitive games such as *Tetris* and *Alpine Race II*. This might have facilitated the reactivation of the images during hypnagogic states. In the present study, a large number of the experiences were reported in association with similar games (e.g., *Tetris*, *Guitar Hero*) but not exclusively. Players reported seeing health bars, heads-up displays, and maps (i.e., elements that were crucial in the game and that tend to be presented recurrently).

Furthermore, the experiences when the gamers saw video game images with open eyes were more likely to be triggered associations between real life stimuli and video game elements. *“Associations are activated unintentionally, difficult to control, and not necessarily endorsed at a conscious level”* (Galdi, Arcuri, & Gawronski, 2008, p. 1100).

The simplest type of image seen with open eyes occurred when the gamers saw an image immediately after stopping playing. These images appear to have been seen just once, the same as typical afterimages. Other types of image seen were triggered by associations. Some appeared in front of the players’ eyes (e.g., at the corner, bottom, central, or peripheral part of their vision) without any real life context but situated in the exactly same position as previously perceived in the video game. For example, in the game *Mass Effect*, the “conversation wheel” is seen at the bottom part of the screen, and one gamer reported seeing the image of the conversation wheel at the bottom of the visual field when being in a conversation. The same happened with maps popping-up in the corner of players’ eyes. These

images were usually triggered by activities in real life context associated with the game. These types of images resemble the *eidetic imagery* where an image is seen superimposed exactly in the same place (Jaensch & Oeser, 1970).

The other type of image seen with open eyes appeared superimposed on particular real life objects associated with game elements, such as completing the pieces in a puzzle. Here, for example, the players experienced seeing video game elements hovering above people's heads as was reported in a previous study about GTP (Ortiz, et al., 2011) or saw sparkling or scrolling images on the ground. Kinsbourne and Warrington (1963) reported the case of a 73-year old female who reported sudden headaches. She had a heart deficiency but no neurological problem identified before her death and was diagnosed with *visual perseveration*. "*One day after a Christmas party the woman started to see a Santa Claus beard superimposed in the face of the people who spoke to her*" (Meadows & Munro, 1977, p. 5).

Both classical conditioning (Pearce, 1987) and priming mechanisms can explain the eliciting of images in the presence of certain stimuli or events (Schneider, Engel, & Debener, 2008). In addition, some gamers reported cross-sensorial experiences where a stimulus in one modality (e.g., auditory) triggered another perception (e.g., visual).

Playing music games such as *Guitar Hero* and *Rock Band* resulted in synaesthesia-like experiences since the gamers visualized or saw images in front of their eyes or in their mind when listening to music. In a previous study about GTP, it was shown that just by hearing a word ("guitar") associated with the game triggered a gamer seeing images from the game (*Guitar Hero* frets) (Ortiz, et al., 2011). Only a few individuals are considered to have real synaesthetic abilities, however, multi-sensory experiences can be induced. Experimental studies have demonstrated that people can even draw associations between sensations in different modalities (Goldstein, 2010; Marks, 1974). According to Mavromatis (2010), a common characteristic of hypnagogia is synaesthesia.

Experiences where gamers saw video game images with open eyes were considered pseudo-hallucinatory experiences, since the gamers appeared to be aware of the unreality of the images and did not experience delusions. However, this does not mean that the gamers were not surprised, did not get scared for a moment, and/or respond impulsively when seeing the video game images in real life contexts. For instance, one gamer started to move his house furniture to arrange it as in *Minecraft* to make it fit in the grid he saw. He mentioned that because his dresser did not fit in the grid, he went to bed crying.

There was not enough information about the duration, circumstances, and other factors that could have contributed to gamers' altered perceptions. However, more of the gamers' experiences took place when they were performing normal day-to-day activities than when they were in bed. Some gamers provided information about the activities they were doing. The activities included: listening to a lecture, watching a film, listening to music, staring at things, zoning out, being less alert or performing automatic activities such as driving or walking. Altered states of consciousness could have been facilitated by the gamers' relatively passive and automatic activities. Under these particular circumstances, the images may qualify as hypnagogic pseudo-hallucinations (Mavromatis, 2010) or para-hypnagogia as Gurstelle and de Oliveira (2004) prefer to call them when the hypnagogic experiences take place during the day.

The duration of the experiences appear to be short (e.g., seconds or minutes) but in some cases they occurred episodically during some periods of time (e.g., a day or longer) and in some case the experiences were intrusive and annoying. For example, seeing video game images with closed eyes could provoke sleep deprivation or make it difficult to concentrate on something else. However, some gamers thought that the altered perceptions were fun and even wanted to induce them, while other gamers got scared and worried.

Many gamers reported that they had been playing intensively when GTP-V occurred, sometimes for hours, even the whole day or longer. Moreover, a few gamers' reported that they were sleep deprived or fatigued, being sick or under the influence of some substance. These circumstances are important precursors for altered perceptions (Mahowald, et al., 1998) and epileptic seizures (Bigal, et al., 2003b). Also, in a previous interview study about GTP, gamers reported that in situations of arousal, anxiety, stress, and fatigue were when they experienced some altered perceptions. This could occur as an escape or homeostatic mechanism when in a socially anxious situation (Ortiz de Gortari, et al., 2011b). According to Mavromatis (2010), the hypnagogic imagery works as a distractor, detaching the individual from the conflicted situation for a short period.

Findings in this study are based solely on self-report data, as the psychological profiles of the gamers were unknown. Furthermore, it is not known if any of the gamers used psychoactive drugs, which may make them more susceptible to experience some GTP-V. Nor is it known why some gamers experienced GTP-V with certain games, whereas others did not. Furthermore, we do not know what situational conditions (e.g., illumination), game platform (e.g., TV screen, tablet), level of engagement (e.g., immersion), and/or what individual characteristics make some gamers more susceptible to experience GTPV. GTP-V were

reported when playing console games but also when playing in mobile devices. In a few cases the gamers mentioned that similar experiences to GTP-V had happened when doing other activities (e.g., feeling motion sickness after being at the beach). Studies suggest that individuals with dissociative tendencies tend to experience more visual illusions (Lipsanen, Lauerma, Peltola, & Kallio, 1999). Also, persistent afterimages are associated with hypnotic susceptibility and proneness to fantasy (Atkinson & Crawford, 1992). Little is known about what individual traits are correlated with neural adaptation (Welch, 2002) when it comes to video games.

### **Limitations**

There are numerous limitations in the present study that should be acknowledged. First, classifying and explaining gamers' experiences focusing only on gamers' self-reports without corroboration can lead to misinterpretation and misclassification of the perceptual phenomena due to lack of information. However, in this study's distinctions between perceiving, visualizing, imagining, misperceiving, and experiencing sensations were established in creating the categories. Secondly, some experiences such as seeing video game images when falling to asleep suggests that the gamers were in hypnagogic trance states but such speculations are not possible to corroborate in this study. Thirdly, the experiences were divided into perceiving distorted environment, confusing real life stimuli with stimuli from the game, seeing video game images in ambiguous real life scenarios, and seeing video games images with closed or open eyes because different types of experiences may have different psychosocial implications. However, some authors may argue that these experiences should be classified in two main categories, visual after-effects and hallucinations. Fourthly, videos of game play, and images from video games were watched to understand and explain gamers' experiences. However, more systematic observation of video games, gaming videos, and gaming images is recommended. With respect of the data collection outlet, participants in online forums do not commonly include demographic information in their posts. The same happened when trying to collect information about general characteristics of VGTP. Second, even though different online video game forums were used to collect the data (54 forums), the high recurrence of some experiences may be due to the use of forums about specific video games (e.g., *Guitar Hero*, *Tetris*). Third, classifying visual experiences exclusively based on gamers' self-reports have important limitations mainly due to the lack of contextual information. Also, comments collected from forum posts may have been misunderstood by the

researchers. However, the data were coded in a database preserving the gamers' exact words. Furthermore, online self-reports may be more vulnerable to include non-truthful and/or exaggerated claims or participants may influence each other with their posts.

### **Conclusions and Implications**

This is the first study to examine altered perceptions among a large number of video game players and has addressed the psychosocial implications of these experiences. Gamers perceived distorted environments or objects, confused real life stimuli with something from the video game, saw video game content in ambiguous images, and saw images from the video game in the back of their eye lids or with open eyes. In the majority of the cases, the altered perceptions occurred in a single sensory modality, but in some cases multi-sensorial and cross-sensorial experiences took place.

It is well known that in some instances, video game playing can induce epileptic seizures mainly in photosensitive individuals (Bureau, et al., 2004; Kasteleijn-Nolst Trenite, et al., 2002; Millett, Fish, & Thompson, 1997; Takahashi et al., 1995). In some cases, visual after-perceptions identified in the GTP studies appear to be warning signs of possible seizures and this should be further investigated. A few gamers reported suffering from headaches. Previous research have reported that headaches can be associated with video game playing (Griffiths & Hunt, 1998). Typically, photosensitive individuals are sensitive to geometric patterns, mainly stripes, certain colours (e.g., red and blue) and combination of such stimuli (Bureau, et al., 2004). Monotonous patterns and stereotypical game play were more likely to be reported with recurrent afterimages in the back of the eyelids. Special visual effects (e.g., eagle vision, slow motion) were reported as perceptual distortions, while video game images that appeared recurrently on the screen were more likely to have been seen with open eyes or be related to misinterpretation of real life objects. Findings in this study suggest that it is important to investigate neural adaptations induced by video game playing and the physiological, cognitive, psychological, and social implications of these phenomena. Future research should investigate GTP in the visual modality in a randomly selected sample and attempt to systematically examine the relationship between particular altered visual perception and video games' psychosocial effects. It is important to ascertain (i) how prevalent the altered visual perceptions are among gamers, (ii) which individuals are more susceptible to these experiences, and (iii) what the consequences are of prolonged exposure to particular visual stimuli can have (e.g., flash rate, choice of colours, patterns, contrast, etc.). Most importantly, we need to know if

moderating certain video game effects or gaming ergonomics (e.g., sitting away from the monitor, playing in darkness), type of game device (e.g., tablet) can reduce some of the altered visual perceptions identified in this study.

## Chapter 5 - Altered Auditory Perceptions in Game Transfer Phenomena

"GTP shows the rewarding nature of playing and repetition, and the obsessive nature of the brain of reviving a stimulus even in its absence".

(Ortiz de Gortari, 2013)

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Modern video games are rich in sensory cues. Auditory effects are crucial for enhancing the playing experience by increasing the awareness of surroundings, capturing the attention, and eliciting emotions in combination to visual cues (Nacke, Grimshaw, & Lindley, 2010). Auditory cues in video games include theme songs, melodies, background sounds, and ambient sounds, spoken narrations and dialogue, and even spectral silence (Collins, 2005). Furthermore, sounds are used as rewards, punishment, and as feedback in response to gamer actions.

The very first video games were limited to simple melodies of the 8-bit machines and MIDI. Nowadays, sound effects in video games include high quality soundtracks and high aural realism (Västfjäll, 2003). Some video games' soundtracks or background music have even merited awards, and video game music by itself is starting to be considered a music genre. Furthermore, video game music is commonly available as soundtracks or as ringtones. Special music-based or rhythm-based video games such as *Guitar Hero*, *Rock Band* and *Step Mania* have become popular. In these games the player has reproduce rhythmical patterns according to music by pushing buttons either from the gamepad or using imitation instruments, or reproduce rhythmical steps or body movements. This type of game instigates motor responses in co-ordination with visual, auditory, and kinaesthetic stimuli – that is, real-time choreography that can potentially induce artificial synaesthesia. Another type of video game with music includes the simulation of musical instruments where gamers can reproduce musical pieces by touching a virtual battery, piano or guitar using touch interfaces, usually in mobile devices or tablets. These games encourage finger movements according to the presentation of simulation of music notes (Kayali & Pichlmair, 2008). The literature review in this chapter begins with an overview of the dimensions in which auditory replays of sounds have been investigated. This is then followed by an overview of studies related to the effects of auditory cues in different domains. Finally, the effects of auditory cues in video games are briefly reviewed.

### **Research into Involuntary Replays of Sound**

The phenomenon of hearing music, sounds, and/or voices without any source of the sounds heard has been investigated in clinical and non-clinical populations (Hyman et al., 2012; Williamson et al., 2012). Auditory phenomena can be classified in five main domains: (i) involuntary auditory imagery mostly related to replays of music, (ii) verbal hallucinations when hearing voices, (iii) auditory misperceptions, (iv) inner-speech when hearing thoughts voiced out loud in the mind, and (v) neural adaptations to sounds and voices.

### **Involuntary auditory imagery**

This phenomenon has not been deeply investigated and has been referred in a variety of ways such as: imagined music (Bailes, 2007), involuntary semantic memories (2004b), involuntary music imagery (Liikkanen, 2012a), stuck song syndrome and earworm (Beaman & Williams, 2010). In the present study, this phenomenon is referred to as Involuntary Auditory Imagery (IAI). Involuntary auditory imagery is considered a dominant type of involuntary memory that is strengthened by repeated exposure (Liikkanen, 2008). According to a survey conducted by Liikkanen (2008) with a large sample of 12,420 Finnish internet users, involuntary music imagery is a fairly common phenomenon. The study reported that 91.7% of the participants experienced involuntary music imagery at least once a week. Usually familiar music is that which sticks the most. However, 26% reported that the auditory replays corresponded to music that was new. Hyman (2012) conducted a series of studies (questionnaire, collection of diary experiences, and three experimental studies) about auditory imagery and found that the songs that stuck the most were the ones that people knew and enjoyed. Also, they found that intrusive songs were triggered by environmental stimuli.

### **Inner speech, verbal misperceptions and auditory verbal hallucinations**

There are several definitions of *inner speech*. This includes: "subjective phenomenon of talking to oneself, of developing an auditory image of speech without uttering a sound" (Levine, Calvanio, & Popovics, 1982, p. 391) or "thinking in words" (McGuire et al., 1995, p. 596). It is commonplace that some people engage in internal monologues or hear a voice inside their heads when thinking, reading, writing or remembering something (Oppenheim & Dell, 2008). According to Vygotsky (1987) inner speech is of a social nature as a result of the internalization of dialogues between children and caregivers.

Two different models have been proposed to explain auditory verbal hallucinations. The inner speech model, the most prominent is the one that argues auditory verbal hallucinations are a disorder of inner speech due to failure in monitoring inner speech that turn into not recognizing one's own thoughts and perceiving them as alien (Huang, Carr, & Cao, 2002; Jones, 2010). Neuroimaging and behavioural studies have supported such arguments (Allen, Aleman, & McGuire, 2007; McGuire et al., 1996). A second model to explain hallucinations (the perceptual release theory), argues that auditory hallucinations are "previously recorded information: percepts, engrams, templates, neural traces, etc.". (West,

1962, p. 281 in Jones, 2010). This perspective sustains that verbal auditory hallucinations are the result of two deficits: (i) failure in intentional inhibition which the ability to intentionally suppress thoughts when something is considered irrelevant (Nigg, 2000), (ii) memory deficit in which memories are activated unintentionally resulting in confusion between what is real and what is not (West, 1962 in Jones, 2010). This is what is known as a source-monitoring error (Johnson, 1997). Sub-categorizations of the verbal hallucinations are suggested to conciliate both models (Jones, 2010).

Auditory verbal hallucinations include a variety of phenomena such as hearing a known or unknown voice or voices, speaking sequentially and/or simultaneously either in first, second and/or third person. The contents can be comments, give commands, insult or encouragement (Jones, 2010).

Traditionally, auditory verbal hallucinations have been studied mostly on clinical population. However, more recently, studies have been carried out on non-clinical populations (Daalman et al., 2011; Waters et al., 2012). Verbal hallucinations are very common among people with schizophrenia, and approximately 70% of the patients report having verbal hallucinations. Failures in self-recognition and misattribution to their own thoughts by perceiving the voices as alien are typically found among people with schizophrenia. Also, the voices are experienced as intrusive and uncontrollable, differing for the individual's own verbal thoughts. The vividness of the voices can be described by their loudness, pitch and clarity. Emotional responses surrounding the beliefs about the voices develop, and the voices are considered malevolent or benevolent. In non-clinical populations, the prevalence of auditory hallucinations is approximately 15% (Waters, et al., 2012).

A longitudinal study conducted with clinical and non-clinical populations over a one-month period showed that the location of the voices happened inside or outside of the individual's head, and that the number of the voices, loudness, and personification of the voices were not different between the two groups. The most relevant differences between the groups were the emotional appraisal of the voices' content. The clinical population perceived auditory hallucinations as more negative, and the non-clinical group felt they had more control over the auditory hallucinations. The negative emotional valence of the hallucinations predicted 88% of the psychotic disorder (Daalman, et al., 2011).

### **Neural adaptation and priming to sounds**

Additionally, similarly as adaptation to visual cues and movement, research studies have shown that neural adaptations to auditory cues can take place. Schwinberger (2008) demonstrated this in an experiment adaptation to voices. For a long period of time the participants were exposed to male voices, and later on androgynous voices were perceived as more female. In another experiment, Alexander and Nygaard (2008) found that the velocity at which participants read a text depended on whether the text was previously heard as being read by a slow or fast speaker. As the authors noted, this implies that the participants engaged in auditory imagery preserving the perceptual characteristics of the heard stimuli.

### **The effects of auditory cues**

The psychological and physiological effects of auditory stimuli and music are well known (Storms, 2002). Auditory cues are typically embedded in movies or video games since they are one of the most effective ways to induce mood (Flannery & Walles, 2003). In fact, music is one of the most effective ways to induce mood in experimental psychology studies (Flannery & Walles, 2003). Gerra et al., (1998) investigated neuro-endocrine changes in participants when exposed to different types of music. They found that 30 minutes of techno resulted in significant increases in heart rate, systolic blood pressure and cortisol, and significant changes in self-reported emotional states. Whereas classical music resulted in emotional state enhancement but no significant changes were observed in hormonal concentrations. Personality traits and temperament appeared to influence the response to music.

The effects of the prolonged exposure to high or low frequency sounds under work conditions have been investigated. The exposure to a chronic industrial noise has been associated with increasing cortisol levels, fatigue, and irritability after work (Melamed & Bruhis, 1996). Also, the exposure to low frequency noise (ventilation sound) versus the exposure to a flat frequency spectrum for two hours has been compared at work. Changes in cortisol levels were found on individuals sensitive to noise when they were exposed to the low frequency noise. These participants also qualified the noise as more annoying and disruptive (Waye et al., 2002).

### **The effects of auditory cues in virtual environments**

Empirically, the effects of auditory features embedded within video games has been little studied. Mood modifying states, physiological reactions while playing, immersion, and a better sense of presence in the virtual environment have been reported in association to auditory cues embedded in virtual environments (Anderson & Casey, 1997; Hendrix & Barfield, 1995). Another study showed that sensory input can boost memory of objects in the virtual environment (Dinh, et al., 1999). For example, horror games use audio to induce fear (e.g., screams, whispers, claps, bangs, ticks, voices coming from anywhere). Major keys, the absence of harmonized melodies, and faster tempos tend to be associated with happiness whereas melodies with the opposite characteristics tend to be associated with sadness (Webster & Weir, 2005). Grimshaw (2009), and Garner, Grimshaw and Nabi (September, 2010) found that manipulating the loudness, frequency equalization, and pitch have the capacity to intensify gamers' emotional responses during playing.

Västfjäll (2004) found that emotional reactions to auditory events in the virtual environment were moderated according to the audio channels (mono, stereo, and six-channel reproduction). Stereo and six-channel reproductions were found to be strongly correlated with changes in emotional reactions when compared to the mono condition. Additionally, six-channel reproductions showed the highest ratings of presence and emotional realism. Hebert, et al. (2005) examined the effect in cortisol secretion triggered by techno music in a violent video game. They found that the group who played with music showed significantly higher cortisol levels, which suggested the importance of music in inducing stress by playing the game. Eui Jun, Bohil and Biocca (2011) found that playing a violent video game with screams of pain and blood resulted in increased arousal compared with the control conditions. The results showed that screams resulted in higher physiological arousal. Similarly, Lauter, Mathukutty, and Scott (2008) investigated the effects on the nervous system of erratic breathing sounds heard in some video games while the character is frightened, wounded and running. Their experiment showed that hearing erratic breathing (compared to quiet breathing) affected the human nervous system. According to the researchers, these findings together with studies that show that video game playing provoke arousal (Hebert, et al., 2005) support the fact that anxiety and panic can be elicited by playing video games. It has also been argued that the loudness of sounds may favour the experienced realism of virtual experiences (Viirre & Bush, 2002) and that a larger number of sensory cues lead to a greater sense of presence (Dinh, et al., 1999). Salkski and Whitbred (2010) investigated the effects of image and sound quality on

presence and enjoyment. They found that sound had greater effect on players' enjoyment and presence than image quality.

In gambling studies, the effects of music and sounds have been explored to further understand gambling behaviour. Video games share important structural characteristics with gambling machines, especially slot machines (e.g., lights, sounds) (Wood, Griffiths, Chappell, et al., 2004) as do contemporary online betting games. Dixon, Trigg and Griffiths (2007) investigated the effects of background music. They found that musical tempo affected gambling behaviour. More specifically, participants tended to bet faster while listening to high tempo music although a relation between the size of the bet and the total amount of money spent was not found (Dixon, et al., 2007). Another similar experiment was conducted by Spenwyn, Barrett & Griffiths (2010) on a virtual roulette game. In this experiment, the effects of music and lights on gambling behaviour were investigated. Again the participants' betting speed was influenced the by musical tempo but not light. Additionally, a combined effect of auditory and visual features was found. When fast tempo music was combined with red lights, the participants gambled faster. Mentzoni et al., (2014) compared the effects of music on gambling behaviour. They found that participants who listened to low-tempo music increased the overall number of bets, while those who listened to high-tempo music placed bets faster. Loba et al. (2001) manipulated the features in a video lottery terminal (VLT) game to examine the role of the effects of the speed and sound of a game. The results indicated that slower and silent machines were less attractive to pathological gamblers. In fact, as a responsible gambling measure, limitations on visual and auditory stimulus have been proposed as a way to reduce the potentially addictive nature of gambling machines (Spenwyn, et al., 2010).

A relatively large number of studies have been conducted on the psychological and physiological effects of music in addition to the phenomenology of involuntarily re-experiencing auditory cues. However, only a few studies have focused on exploring the effects of video games' auditory cues on gamers during playing (Hebert, et al., 2005). The present study is the first that examines hearing involuntary re-plays of auditory cues from video games after stopping playing. The aim of this study was to investigate gamers' auditory experiences (e.g., hearing music, sound effects, or characters' voices) that occurred directly after stopping playing or sometime after stopping playing via the triggering of automatic associations. For encouraging strategies that predict, prevent and/or reduce certain post-video game playing effects and promote safe and healthy gaming. This was done by identifying, classifying, quantifying, and analysing gamers' auditory experiences. These experiences will be referred to

as Game Transfer Phenomena auditory (GTP-AUD) and contributes to the understanding of the effects of auditory features in video games, and the phenomenology of non-volitional experiences (e.g., auditory imagery, semantic memories, and hallucinations).

## Method

### Sample

A total of 192 auditory experiences from 155 players were collected from 31 different online forums. Only 37 players reported their age (ranging from 14 to 30 years;  $M = 20.03$  years,  $SD = 4.32$  years). The majority were male (95%). A few players reported more than one GTP- AUD experience. Therefore, the number of experiences was larger than the number of participants in the study. A total of 95 different video game titles were found among gamers' experiences, ranging from tile-matching puzzle games to first-person shooters. Also, gamers reported the sound alerts coming from consoles (e.g., *Xbox* achievement<sup>14</sup> and alerts from *Steam*'s message service<sup>15</sup>).

### Data collection

Initially, a total of 2,000 gamer's experience were collected from the online video game forums. However, later on some data were excluded because some self-reports did not contain enough information and/or were ambiguous. This resulted in a total of 1,681 gamers' experiences usable and identified as GTP in one or more modalities and sub-modalities (e.g., altered visual or auditory perceptions, thoughts and, behaviours). The "altered auditory perception GTP" were collected from 60 publicly available online video game discussion forums<sup>16</sup> over a seven-month period. Most of the forums had thousands of members and/or visitors although the specific size and characteristics of each forum were not recorded. Online video game forums were searched with the Google search engine using the keywords: "Tetris effect", "bleeding effect AND video games", "hallucinations video games", "video games AND/OR real life/reality", and "Game Transfer Phenomena". Posts that included explicit

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<sup>14</sup> Xbox-achievement is in short a pop up that appears on the screen every time you complete something in the game (a challenge, quest or part).

<sup>15</sup> Steam is a platform for purchasing and downloading games and software. The platform is developed by Valve Corporation.

<sup>16</sup> Online video game forums included comments to articles on websites, as these are considered discussion platforms.

information about the gamers' experience were coded along with gamers' response posts if relevant to auditory GTP.

### **Data Analysis**

A mix of content analysis (Hsieh & Shannon, 2005) and thematic analysis (Boyatzis, 1998) and was done in a number of stages. First, the gamers' auditory experiences were extracted from the forums and recorded in a table. The experiences were then coded in a database in order to systematically classify and quantify them. Each gamers' self-report included information about the forum, gamer nickname, demographic information (e.g., age, gender) [if the gamer provided], name of the game, type of GTP (e.g., visual, auditory), nature of the GTP (associative or non-associative), number of occurrences (e.g., once, more than once), duration of the experience (e.g., seconds, minutes), the situation where it occurred (e.g., waking up in bed), perceived location (e.g., head, ears, coming from an external source), the gamers' physiological conditions while experiencing the GTP (e.g., tired), playing habits (e.g., long sessions), video game elements mentioned (e.g., explosions), real life elements that worked as a trigger (e.g., vacuuming sound) and gamers' perception of the experience (e.g., positive, neutral, negative).

The interpretation of the data was informed by literature concerning involuntary auditory phenomena, implicit memory, semantic memory, and priming theories. Videos of walkthroughs were watched to examine if auditory cues in the game could explain the gamers' experiences. The author played some of the games associated with the data. In order to protect gamers' online identity and reduce the possibility of gamers being tracked, the posts used as examples were paraphrased when possible, without decontextualized gamers experiences. This was challenging due to the risk of losing the context of the experiences. Paraphrasing consisted in using synonyms, changing tenses, and/or removing irrelevant information. The gamers' pseudonyms were also modified.

## **Results**

### **General characteristics of GTP-AUD**

Only a few posts included information about the characteristics of GTP-AU. Details of the GTP-AU experiences collected included: (i) players' perception about their experiences,



(ii) perceived location of the auditory cue, (iii) coping strategies, (iv) duration of the GTP-AU experiences, (v) frequency of the GTP-AU occurrence, (vi) hours played per session when having GTP-AU, (vii) activities associated with GTP-AU, and (viii) physiological factors associated with GTP-AU.

***Players' perception about their experiences (n=144)***

There were a larger number of players' posts that explicitly included negative expressions (n=29) (e.g., "I hope I'm not going crazy", "scary", "annoying", "freak me out", "maddening", "disconcerting") than the ones that were neutral (e.g., "it is not unpleasant", "no big deal") (n=4) or positive (e.g., "entertainment", "fun way of using imagination", "creative") (n=2).

***Perceived location of the auditory cue (n=47)***

A number of players experienced auditory cues in their head (n=37) (e.g., "in my head") while others heard something coming from nowhere or outside their head (n=11) (e.g., "from the speakers", "the sound is coming from somewhere"); players also heard auditory cues in their ears (n=2) (e.g., "in my ear", "echoing through my ears"). Additionally, some players heard auditory cues in their dreams (n=5).

***Coping strategies (n=7)***

A few players said they sang along when a song got stuck in their head (n=4), while other players either closed their eyes or tried to focus on something else (n=2), or reduced their gaming (n=1).

***Duration of the GTP-AUD experiences (n=75)***

Quite a few of the players' posts specified that the experiences occurred all the time/lasted a very long time (n=15) (e.g., "forever", "indefinite earworm") or lasted at least a day (n=14) (e.g., "about 3 days", "most of the next day", "all day"). Others reported that GTP-AU lasted for weeks (n=3) (e.g., "two weeks"), for a while (n=2), (e.g., "for quite some time"), and seconds/minutes (n=21) (e.g., "30 minutes"). Here, some players reported experiences that appeared to have occurred episodically and lasted seconds (e.g., "the door shut behind me, I

heard the same sound that spiders make", "walking past a construction site and I'll swear I heard someone creating a portal").

### ***Frequency of the GTP-AUD occurrence (n=191)***

The majority of the players in the total sample mentioned that the auditory experiences happened only once or they only reported one experience (n=104). However, there were also some players that experienced GTP-AU more than once (n=66), anytime/every time (n=17), and many times (n=4).

### ***Hours played per session when having GTP-AUD (n=39)***

No player indicated that the GTP-AU experiences occurred when playing short video game sessions. They all occurred when playing very long sessions (n=6) (e.g., "4 days straight", "2 days straight") or very long session (n=33) (e.g., "+10hrs straight", "enough", "all night").

### ***Activities associated with GTP-AUD (n=61)***

A larger number of posts mentioned that the experiences happened when they were trying to sleep (n=21), while dreaming (n=5), and when just waking up (n=3). The experiences also occurred while doing daily activities. These activities included: packing (n=3), in a lecture (n=3), driving (n=2), walking (n=4), hurrying (n=2), and in a cognitive demanding activity (n=2). Other auditory experiences occurred while swimming, climbing stairs, and walking through a crowd.

### ***Physiological factors associated with GTP-AUD (n=7)***

Very few players mentioned how they were feeling when their auditory experiences occurred. A few said that they were sleep deprived (n=2), tired (n=3) or stressful (n=2).

## **Types of GTP-AUD**

Gamers' experiences were classified into a variety of categories. The categories were created based on reviews of auditory phenomena such as auditory imagery, inner speech and auditory hallucinations. While the different types of GTP-AUD were imbalanced, the

categorization made was the most appropriate based on the different types of auditory phenomena identified among the data collected. Gamers reported having heard replays from music, sound and voice from the game. A larger number of experiences were reported in the auditory imagery category (83%). Only 19% of the GTP-AUD experiences occurred via associations between video game elements and real life stimuli.

Game Transfer Phenomena in the auditory sub-modality were defined as hearing auditory cues from the game (sound, music, voices) in the head or as externalized, episodically or continuously, as well as misinterpreting auditory cues from real life context by something from the game. The gamers' experiences were categorized as: (i) Involuntary auditory imagery, (ii) auditory verbal hallucinations, (iii) inner speech, (iv) auditory misperceptions, and (v) multi-sensorial experiences (See Table 5.1 for a complete quantification of all the subcategories and total of experiences).

**Table 5. 1** *Auditory Game Transfer Phenomena (GTPAUD) categories and sub-categories among video game players (n = 155)*

| Type of GTP-AUD  | Number<br>of<br>GTP | GTP-AUD<br>Experiences<br>(%) | GTP-AUD<br>Categories<br>(%) |
|--|---------------------|-------------------------------|------------------------------|
| <b>Involuntary Auditory imagery</b>                    |                     |                               |                              |
| Not triggered by associations                          |                     |                               |                              |
| Music  | 71                  | 50                            |                              |
| Sounds from game                                       | 57                  | 41                            |                              |
| Sounds from console                                    | 10                  | 7                             |                              |
| Undefined sound/music                                  | 3                   | 2                             |                              |
| Triggered by associations                              |                     |                               |                              |
| Music  | 3                   | 16                            |                              |
| Sound  | 8                   | 42                            |                              |
| Sounds/music triggered by some other<br>sound or music | 8                   | 42                            |                              |
| <b>Subtotal</b>  | <b>160</b>          |                               | <b>83</b>                    |
| <b>Inner speech</b>                                    |                     |                               |                              |
| Not triggered by associations                          | 2                   | 22                            |                              |
| Triggered by associations                              | 7                   | 78                            |                              |
| <b>Subtotal</b>  | <b>9</b>            |                               | <b>5</b>                     |
| <b>Auditory adaptation</b>                             |                     |                               |                              |
| Hear everything with the voice from the game           | 1                   |                               | <1                           |
| <b>Auditory verbal pseudo-hallucinations</b>           |                     |                               |                              |
| Hearing voices not triggered by associations           | 12                  | 85                            |                              |

|  |            |    |              |
|--|------------|----|--------------|
| Hearing voices triggered by associations                         | 2          | 15 |              |
| <b>Subtotal</b>  | <b>14</b>  |    | <b>7</b>     |
| <b>Auditory misperceptions</b>                                   |            |    |              |
| Have confused a real life sound with a sound from the video game | 5          | 62 |              |
| Think they have heard a sound from the video game                | 3          | 38 |              |
| <b>Subtotal</b>  | <b>8</b>   |    | <b>4</b>     |
| <b>Multisensory auditory experiences</b>                         | <b>1</b>   |    | <b>&lt;1</b> |
| <b>Total</b>   | <b>192</b> |    |              |

### **Involuntary auditory imagery (n=160)**

In this category, gamers re-experienced music, sounds from the game. These experiences manifested either episodically or persistently, were heard in the head, in the ear or appeared as coming from external sources, or from nowhere. They appeared when being exposed to multiple external stimuli in day-to-day settings or to limited stimuli while trying to sleep. These types of experiences were divided in two main sub-categories: (i) Auditory experiences not triggered by an identifiable cue, and (ii) auditory experiences triggered by associations.

#### ***Auditory experiences not triggered by an identifiable cue (n=141)***

In this sub-category, gamers heard music, sounds from the game but their experiences appear to have not been triggered by external stimuli, or at least they did not report a trigger for their experiences. Gamers heard music from the games sometimes while trying to sleep or waking up. For instance:

*"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)*

Some gamers reported hearing sounds from the games that were presented repetitively or episodically in the game. These sounds included loud sounds such as shooting, explosions,

vehicles, groans, screams, beeping. Additionally, more low sounds were reported, including breathing, and percussive sounds, lasers, swords, bullets, spreading of a web, creating a portal, rings, and falling. Additionally, gamers reported sound from the consoles such as the plonk from Xbox achievement. For instance:

*"When I played Half-Life, sometimes heard exactly the same noises as in the game. I thought they were real. Damaged lights, sparkles, creaking... at that time I was just awaiting a head crab behind the next corner"* (Raven22)

Other players hear sound intermittently while trying to sleep. For instance:

*"After playing 100 hours of Killing Floor, I heard constantly chainsaws and the grunts constantly... Maybe I need a break"* (Xoel)

Furthermore, some gamers reported that they heard sounds from the game coming from external sources. For instance:

*"After a Team Fortress 2 binge one day, I started hearing Spies decloaking around the house. Would move my head around before I noticed what I was doing"* (Link3000)

Some gamers heard sounds in their dream and thought that it came from external sources in real life. For instance:

*"I will wake up sometimes and check if my computer is off because I swear I heard video game music coming out of my speakers. I need help"* (AraRider)

Lastly, there are gamers' self-reports that were not possible to identify if the gamers heard music or sound effects from the game. For instance:

*"After Devil May Cry 3, all the super modes in all video games are a 'Devil Trigger'"*  
(FashionXo)

*"Pokemon, need for speed and guitar hero left me seeing or hearing things for day after"*  
(Ganon123)

#### ***Auditory experiences triggered by associations (n=19)***

In this category, gamers heard music, sounds, or voices from the game and their experiences occurred episodically when triggered by external stimuli associated with the game.

The associations could be coming across an object, hearing a sound, engaging in an activity, or experiencing some event. In some instances, gamers heard music from the game when performing some similar activities as in the game in real life settings. For instance:

*"Every time I stack a trolley or cab I heard the Tetris theme in my head and try to stack everything without gaps"* (Pepertony)

*"Every time I climb stairs at random places, be it work, school or elsewhere, I always hear Bloody Tears"* (Lovess)

Another player heard the sound from the sword in a *Zelda* game when playing pool. It could perhaps be speculated that the sound produced when hitting the ball may have triggered the auditory imagery. For instance:

*"At one time, when I was around 13, I had been playing Zelda on Gameboy really a lot...I was playing some pool and started hearing the sound of Link's sword. First I was not sure if I was just thinking about that sound or if I was actually hearing it. I looked around and didn't see anything the sound could be coming from and it didn't change in volume when I moved around. I was sure I wasn't just remembering because I couldn't make it stop and when I was thinking of other things I still heard it. It went on for approx. 30 minutes, and I became a bit concerned I was going insane"* (FlashPlus)

On other occasions, stimuli or events that were somehow associated with the game triggered sounds from the game. Sometimes these auditory experiences resulted in gamers carrying out some action to avoid danger or sometimes they got scared. For instance:

*"I keep a flashlight next to my bed, and sometimes when I walk in a dark area I hear the sound the radio makes near a monster in Silent Hill, I turn around if I don't see anything in front of me"* (CrownDave)

### **Inner speech (n=9)**

Here, the players heard internal voices as inner speech (McGuire et al., 1995). Sometimes the voices were regulated by ongoing activities. Some of these were triggered by associations while others were not. This category included: (i) inner speech triggered by automatic associations, and (ii) inner speech not triggered by automatic associations.

***Inner speech triggered by automatic associations (n=7)***

Sometimes gamers thought in voice commands from the game in real life situations.

For instance:

*"Sometimes I think in voice commands from Team Fortress, especially Go Go Go! to make people move in the subway" (FashionXo)*

On other occasions, gamers heard an internal voice with some instruction from the game when they were performing some activity. For instance:

*"After years of playing Outrun whenever I drive under a sign on the road, I hear in my head "CHECKPOINT!" (Yates1000)*

Additionally, gamers sometimes completed phrases in their mind as some sort of feedback with content from the game when someone said something. For instance:

*"Every time someone welcomes me, no matter the phrase I hear 'Wind' from Castlevania: Portrait of Ruin in my head saying 'you are back' I have played too much" (Oregatech)*

*"The Team Fortress 2 announcer. Every time a football commentator has mentioned that a game might go into overtime, a voice at the back of my mind has yelled 'Overtime! OVERTIME! OVERTIME!'" (Souly)*

***Inner speech not triggered by automatic associations (n=2)***

Another type of experience took place was when the gamers experienced inner speech in a generalized way, and not triggered by an evident cue. The inner voice heard by the gamers preserved the perceptual details or the phonetic features from voices heard in the game. This manifested either (i) when voices from someone else were heard preserving the phonological characteristics of the voices in the game, or (ii) when gamers' inner speech preserved the phonological characteristics of the voices in the game.

A gamer said that after playing he could hear his inner voice as a game character. For instance:

*"Played Metal Gear Solid 4 for 15 hours when it first came out. When I went on MSN afterwards everything was being read aloud in my brain with David Hayter's voice. I always have this :)"* (Jackson\_m)

### **Distortions of sounds (n=1)**

In this case, a gamer said that he heard everything as the voice in the game. For instance:

*"After a marathon of Portal/Portal 2, I heard everything in GLaDOS's voice for about three days"* (Peartech)

### **Auditory verbal pseudo-hallucinations (n=14)**

In this sub-category most of the gamers' experiences appear to have not been triggered by external stimuli, or at least they did not report a trigger for their experiences. Sometimes the voices could be heard repeatedly. In these experiences the gamers did not indicate if they heard the voices in their heads and therefore these experiences were considered different than those heard in the head classified as inner speech. These types of experiences were divided in two main sub-categories: (i) Auditory verbal pseudo-hallucinations not triggered by an identifiable cue, and (ii) Auditory verbal pseudo-hallucinations triggered by associations.

. Perceiving voices coming from outside frightened some gamers.

#### ***Auditory verbal pseudo-hallucinations not triggered by an identifiable cue (n=12)***

Some gamers heard the voices of the video game characters after playing. In one occasion, a gamer experienced it as a background voice. For instance:

*"I constantly heard someone whispering 'Death' in the background. After I played Black and White for a many hours. It lasted a few days"* (Zullo)

Other gamers heard a voice from the game constantly. For instance:

*"Once after I played Battlefield 2 for long, I kept hearing 'ENEMY BOAT SPOTTED, ENEMY BOAT SPOTTED'"* (Se13)

Some hear the voices while trying to sleep. For instance:



*"I heard when Trying to fall asleep after playing Counterstrike 1.3, "Hold this position, hold this position" (Nexo7)*

***Auditory verbal pseudo-hallucinations triggered by associations (n=2)***

Other types of experiences took place when the gamers heard voices from the game when they encountered certain stimuli related to the game or certain circumstances in real life contexts. For instances:

*"After playing Clive Barker's [Jericho] for a couple of hours I heard that shivering voice saying "loooooook" when I passed a painting...I scared the hell out of me" (Radion56)*

*"When I'm home alone at night, sometimes I hear a little girls voice saying, 'Come along now Mr. Bubbles' and she mutters things about chocolate being better than grapes...It's creeping me out. But maybe not exactly in the confusing reality" (Rollberia)*

***Auditory misperceptions (n=8)***

In this category, gamers mistook a sound or speech as something from the video game. For instance:

*"Quite often I mistake sounds in real-life for sounds I hear in video games" (Trevor\_Class)*

Sometimes the gamers' auditory replays appeared to have been triggered by other sounds, although the presence of the sounds could only be incidental. This was experienced when being exposed to ambiguous or monotonous auditory stimuli. For instance:

*"I walked into the school as the door shut behind me, I heard the same sound that spiders make when they're attacking in Minecraft, and I ran like hell" (Jelor)*

Lastly in this category, gamers heard speech with content from the game. For instance:

*"I was in London, someone gave me directions, he said Wardour Street, but I swear I heard Ulduar Street" (ManuelXas)*

### **Multisensory auditory experiences (n=1)**

This category comprised gamers' auditory experiences where they heard music from the game in their heads accompanied by body movement. Gamers also reported seeing video game elements while hearing the music from the game (This was coded in the visual sub-modality; see chapter 4 for know more about these experiences). For instance:

*"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)*

### **Discussion**

The aim of this study was to investigate how video games' auditory cues were experienced by gamers after stopping playing. Re-experiencing music, sound effects, and voices were associated with auditory cues in the game, could occur in the absence of an appropriate stimulus, and appeared to be out of the gamers' control.

Different players acknowledged that they had been playing intensively when GTP-AUD happened (i.e., either playing long sessions or playing frequently).

Typically, hearing involuntary replays of music has been associated with recent or repeated exposure to music (Hyman, et al., 2012; Liikkanen, 2012b). According to Hyman (2012) if the song is re-experienced directly after the exposure it is more likely it returns again later on (e.g., Hyman, et al., 2012). However, not all cases resulted in auditory replays corresponding to a recent exposure to the auditory cues. A gamer reported hearing music from a game that he had played years ago and was triggered by doing a similar activity as in the game. This supports the arguments about the involvement of long-term memory in involuntary auditory imagery. Studies investigating involuntary semantic memories suggest that the exposure to stimuli for prolonged periods of time (e.g., repetitive priming) plays an important role in involuntary mind popping (Kvavilashvili & Mandler, 2004a).

Numerous studies have showed that auditory imagery preserves structural properties of auditory stimuli, including pitch, loudness, distance, timbre, melody, tempo, etc. (Johns, Hemsley & Kuipers, 2002; Johns, et al., 2001). Some gamers said that the auditory cues were heard exactly as in the game (e.g., pitched or loud with such vividness that they thought it was a real sound for at least a moment). The localization of the auditory replays was experienced in the head, the ears, or coming from external or unidentifiable sources. The experiences could

suddenly arise without any evident trigger or was triggered by particular stimuli in some way associated with the game.

Gamers auditory experiences were classify in a variety of categories: (i) involuntary auditory imagery, (ii) inner speech, (iii) auditory verbal pseudo-hallucinations, (iv) auditory misperceptions and, (v) multi-sensorial auditory experiences. The most recurrent category was involuntary auditory imagery (90%). The auditory replays occurred persistently or episodically and in the most of the cases gamers' experiences were not triggered by automatic associations (81%).

Only a few gamers mentioned under what circumstances their auditory experiences occurred. A large number of gamers heard some auditory cue from the game when trying to sleep, but quite a few gamers experienced GTP-AUD when waking up or in their dreams. Visualizations of video game images accompanied by music from the game were found while trying to fall asleep or while being awake in the study about visual experiences. Other gamers heard something while doing daily routines such as being in a lecture, packing, walking, driving but also when doing activities that required high cognitive overload such a attending an exam or designing something. These findings are consistent with previous studies in other GTP sub-modalities (chapter 4 and 6) and studies that suggest that intrusive songs arise in periods of low cognitive load when performing automatic activities, but also in high cognitive loads (Hyman, et al., 2012). For this reason, auditory experiences appear to be related to mind wandering (Smallwood & Schooler, 2006). A few gamers reported that they were sleep deprived, fatigued or stressed when GTP- AUD occurred. This has been also found in previous studies about GTP and physiological factors have been previously suggested as precipitants for auditory experiences (Johns, Hemsley, & Kuipers, 2002).

Gamers interpreted and responded to their experiences in different ways and used different coping mechanisms. Sometimes they looked for video game elements in real life sceneries until they realized what they were doing or checked if the game was on. Furthermore, some gamers vocalized the songs. Singing, humming, or whistling along with auditory imagery is very common (Hyman, et al., 2012). Other coping mechanisms included trying to think about something else, trying to control the auditory cues, and moving to see if the volume of the sound changed. Other gamers found themselves expecting that something would happen as in the video game. Hearing music and sounds from the game were the most prevalent experiences.

### **Involuntary auditory imagery**

Music from the video games was usually experienced constantly, especially when video games used music as a background such as in *Pokémon* or *Tetris*, while sound effects or voices appeared to have occurred episodically. The replays of music included hearing high pitched music in addition to calm and classical music.

Sounds re-experienced after playing appear to be the sounds that tended to be presented repeatedly and many of the ones that were aimed to elicit emotions in gamers. These sounds included: rewards in games (e.g., rings falling), warnings about certain situations (e.g., beeping, radio static<sup>17</sup>, sound from vehicles, bullets, explosions), or sounds used to create an ambience (e.g., groans, screams, breathing), or in-game tools (e.g., lasers, swords, creating a portal, web spreading). Furthermore, some gamers woke up because they heard sound effects from the video game. One gamer said that he heard the sound coming out from the speakers so he stood up to check them. Cases of hearing music that appear to be of external origin (e.g., music coming from a turned off radio or television) had been reported (Sacks, 2010). Also, users of mobile phones have reported hearing the phone ringing when it was not; this is referred to as phantom ringing or “ringxiety” coined by David Laramie (2007).

Some of the gamers’ auditory experiences were triggered by associations with physical objects or the carrying out of activities. It has been argued that in many cases involuntary auditory replays are actually triggered by external stimuli but individuals failed to identify the external stimuli that acted as a trigger (Hyman, et al., 2012). Observation of video game features and in-game events confirmed that it was actually the similarities between real life stimuli and video game elements that triggered the gamers’ auditory experiences. For instance, every time one gamer stacked a trolley or cab he heard the *Tetris* theme in his head and tried to stack everything without gaps. Thinking about *Tetris* has been previously reported when packing something in the automatic and behaviour study. Moreover, body movements (e.g., climbing the stairs) have activated hearing music from the video game in a similar way that hearing the word ‘guitar’ triggered seeing images from the video game in front of the eyes, as reported in a previous study about GTP (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011a).

Furthermore, some gamers heard sounds from the game due to false expectations. For instance, hearing the mobile phone ring or vibrate when it is not have been associated with expectation of a call (Sauer, Eimler, Maafi, Pietrek, & Krämer, 2015). Seeing video game

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<sup>17</sup> Static sound from the radio in *Silent Hill*: <https://www.youtube.com/watch?v=JdLrooeI3wU>

images, experiencing automatic thoughts and behaviours triggered by automatic associations due to false expectations have been found among the studies of GTP (e.g., Ortiz de Gortari, Aronsson and Griffiths, 2011). Examples in the current study included the case of a gamer that sometimes when walking in a dark area heard the sound the radio makes near a monster and he turned around to find nothing was there. The radio is an item found early in *Silent Hill* that emits a 'static-like sound' to warn about the presence of a monster. Another gamer heard someone creating a portal from the game *Portal* when passing by a construction site. The setting of *Portal* is in a large and deserted set of rooms surround by empty walls where portals can be created on white surfaces to complete different puzzles. Liikkanen (Liikkanen, 2008) found that people that tend to experience music imagery also experience a variety of involuntary semantic memories (i.e., images, words, sentence, odours or smells, kinetic patterns, and/or tactile sensations). This may imply that people that are susceptible to experiencing GTP- AUD are also prone to experience GTP in other modalities.

Moreover, not only objects associated with the game triggered auditory replays from the game, other sounds also appeared to have played a role in evoking some gamers' experiences. For instance, one gamer heard the sound the spiders make in *Minecraft* when a door closed, and another player heard music from *Pokémon* when vacuuming. One explanation to these experiences could be that the gamers' minds were trying to make sense of ambiguous and monotonous sounds with familiar video game content like seeing familiar objects in ambiguous shapes (i.e., pareidolia) (Fontenelle, 2008). Another explanation could be that the real life sound somehow shared actual features with auditory cues from the game and this is why GTP- AUD occurred. The presence of a sound could also be purely incidental, and the presence of other stimuli may better explain the gamers' experiences.

Gamers reported also having heard *voices* from the game. Some voices were experienced as coming from external sources while other voices were experienced as inner speech when being experienced in the head.

### **Inner speech**

Experiences with verbal auditory content manifested when the gamers heard voices in their head such as "thinking in words" (Hahm et al., 2007, p. 596). This was usually activated by the presence of an external stimulus. This is known as *inner speech*, which is defined as "subjective phenomenon of talking to oneself, of developing an auditory image of speech

without uttering a sound" (Levine, et al., 1982, p. 391). It is interesting to note that inner speech preserve the phonetic features from the game.

These types of experience were acknowledged by gamers as being experienced within them. These experiences manifested in different ways. One gamer thought in a voice command "Go Go Go!" when he was in the subway and wanted people to move away or when gamers completed actions alongside verbal thoughts. For instance, one gamer heard the "wind" from *Castlevania* in his head saying "you are back" every time someone welcomed him. In fact, in a previous study about GTP, some gamers reported that they felt compelled to say something as in the game when something happened in real life (Gold & Cundiff, 1980). Although these gamers did not mention if they experienced inner speech, it is speculated that inner speech preceded gamers' verbal outbursts or at least played an important role.

Moreover, some gamers experienced inner speech while reading a text. Here also, the phonological characteristics from the video game character's voice were preserved. Also, these findings are in concordance with experiments conducted by Alexander and Nyggard (1997) where the participants' reading velocity were dependent on the ownership of the text, either by a slow or fast speaker. When participants read a passage from the slow speaker they read it significantly slower. According to the researchers, this suggests that the participants engage in auditory imagery preserving the features of the speaker's voice.

### **Auditory verbal pseudo-hallucinations**

Hearing voices can be experienced by clinical and non-clinical population with the phenomenological difference that the clinical population experience them more frequently and interpret them negatively leading to the development of delusions (Daalman, et al., 2011; Waters, et al., 2012; Waters, Badcock, Michie, & Maybery, 2006). The voices heard by the gamers (either as auditory imagery or inner speech) included key phrases such as commands (e.g., "hold this position"), suggestions for performing actions (e.g., "we must construct additional pylon", "come along now Mr. Bubbles"), as well as phrases with condensed content (e.g., "check point!", "death", "you are back") as these types of verbal stimuli are commonly used in video games. Sometimes the voices were heard as whispers (Nayani & David, 1996) and appeared to be to have been regulated by the gamers' ongoing activities using commands. For instance, one gamer heard a "shivering" voice saying " loooooook" when passing a painting after having played *Clive Barker's Jericho* and got scared, or another one heard a suggestion "not enough time units" when being in a hurry. Hearing voices was mainly

experienced in day-to-day settings but some gamers also heard it when falling asleep. For instance, one gamer heard instructions from the game such as "hold position, hold position" while trying to sleep after playing *Counter-Strike*. Hearing voices during hypnagogic states include hearing one's name being called, neologism, quotations, and references to spoken conversation (Mavromatis, 2010). However, according to Jones, Fernyhough and Larøi (2010), hearing voices during hypnagogic or hypnopompic states rarely include commands and questions. In the present study, this was an exception because this type of verbal construct was the one typically used in video games.

### **Misinterpretations of real life sounds**

In the experiences classified as misinterpretation of auditory cues in real life, the gamers' reported that they confused sounds or verbal cues in real life with some auditory cues from the video game. They also thought they had heard something from the video game. One gamer said that every sound outside sounded like zombies. Another gamer misheard a street name in London for a street name from the video game he had been playing. According to the predicting coding theory, the brain predicts what is going to happen next based on previous experiences (Friston, 2012), therefore when for example we hear a sound the brain predicts what other sound is more likely to happen next. If the predictions are wrong then the brain automatically make a new prediction to reduce the error (Zimmer, 2014, February 13).

### **Auditory adaptations**

Moreover, a gamer reported that he heard everything in the voice of GLaDOS<sup>18</sup> in *Portal* after a three days marathon session. This experience appears to be related to what Schwinberger (2008) demonstrated in an experiment about adaptation to voices. In this experiment, the participants were exposed to male voices for a prolonged period of time, and later on androgynous voices were perceived as more female. However, also the exposure to excessive sound pressure can manifest in symptoms that include distorted or muffled sounds or difficulty to understand speech, which could be an explanation to this experience (Apple,

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<sup>18</sup> GLaDOS is a robotic female voice that has been described as funny and sinister, and it is the narrative voice in the *Portal* games. Usually the players hear monologues with her voice. The developers observed that testers were highly motivated when hearing the voice (Gamasutra, 2008, January 10). GLaDOS is one of the best video game characters between the years 2000 and 2009 (Wikipedia. The Free Encyclopedia, 2014). Hear GLaDOS' voice: <https://www.youtube.com/watch?v=j0PDGp1hL4w>

n.d.). Although, in the experience it is not clear if the gamer actually heard sounds preserving the voice features from the game or if the gamer heard the replays of voices in the head which could indicate neural adaptation to sounds in the game manifesting as inner speech.

### **Multisensory**

Finally, one gamer reported a multi-sensorial experience. After playing *Tetris* he heard the music from the video game and his finger twitched occasionally. Similar experiences were reported in a previous GTP study focusing on visual experiences. In that study, gamers reported experiencing involuntary movements of fingers or body while seeing the images from the game, as well as seeing

### **Limitations**

A number of limitations of the present study need to be acknowledged. First, the experiences were collected from online video game forums, so in some cases, they were not as detailed as ideally desired. Second, many gamers' demographic and psychological profile were unknown as only a few of them provided information about their age and gender. Third, from all the studies based on gamers' experiences collected from online video game forums, the auditory sub-modality was the one that contained the least number of reported experiences. This is likely to be due to the type of words used when searching the online video game forums. However, this does not mean that the experiences are less common than other GTP modalities, just that they were the least reported. This also limited the analysis about GTP-AUD characteristics and perhaps the variation in types of auditory experience. There are also more general limitations. For instance, the study suffers from the same weaknesses as any other self-report study in that there is no way of knowing how accurate the data are and whether the reports collected were honest, accurate and valid. Additionally, it was not known if there was any recall bias or whether comments were biased due to social desirability factors. While there may have been some advantages in using other methods of data collection, the authors believed that the use of online form data would be the most honest and accurate compared to experimental or survey designs.



## Conclusions and implications

Gamers heard music, sounds and/or voices inside their heads and as externalized phenomena. Listening to sound is different than interacting with sounds as typically happens when playing video games (Collins, 2013). Auditory cues in the games are used with specific purpose. They can either act as signals in combination with events and visual cues and/or create an ambience in the game that elicit gamers' emotions and make them believe the situations in the game. Therefore, involuntary auditory replays from the game elicit thoughts, emotions, and false expectations where the gamers thought that something from the game was going to happen in real life, and appear to be accompanied by physiological responses and behaviours as a coping mechanism. These findings may suggest that re-experiencing auditory cues from the game have additional psychological implications that are rarely observed when music get stuck in the head after just listening to it.

It has been argued that auditory verbal hallucinations tend to evolve with time, but the evolution of these phenomena is not well understood. Jones (2010) called this as dynamic developmental progression (DDP). The nature of the auditory hallucinations, the distress and the beliefs associated with the experience, change over the time. In some cases, pathological auditory hallucinations start benign and as non-clinical symptom but progress over the time. Some auditory verbal hallucinations "first appear as the ordinary dream; then they appear in the hypnagogic state; then finally in the full waking state" (Bleuler, p. 572 as cited in Jones, 2010). Certainly, the evolution of the involuntary auditory phenomena (e.g., inner monologue becoming actual heard voices outside the head) were not observed by a single individual in this study, but GTP in the modality involuntary thoughts, behaviours, and altered visual perceptions found that while some gamers have experienced intrusive thoughts about using video game elements in a real life context, other gamers actually saw video game images in front of their eyes regulated by ongoing daily activities. These findings appear to support cognitive theories that argue that hallucinations are misattributions or errors in recognizing internally generated information such as images, one's own thoughts or inner speech that are experienced as externalized phenomena. In other words self-monitoring failures where the influence of top down expectations on conscious perception appears to be crucial (Hadjikhani et al., 2001; Morrison, Haddock, & Tarrier, 1995). Also, it has been argued that distortions between imagery and perception may occur due to increased imaginary vividness or decreased perception (Aleman, Böcker, Hijman, de Haan, & Kahn, 2003; Aleman, Böcker, Hijman, Kahn, & de Haan, 2002). Some studies suggest a correlation between video game playing and

daydreaming (Dauphin & Heller, 2010; Rosenthal, Soper, Folsie, & Whipple, 1998). Other theories argue that verbal hallucinations are the result of unintentional activation of memories (Waters, et al., 2006) or the failure to inhibit memories of prior events (2005). In this sense, the voices were associated with traumatic experiences and are commonly feature the voice of the abuser. Some experiences from the games can very well qualify as traumatic experiences and potentially induce involuntary replays. Not being able to stop thinking about the game or recurrently seeing video games images in the back of the eyelids were reported in previous GTP studies.

More research is needed to understand the prevalence of GTP AU and their psychological, social, and/or physiological implications, especially when the auditory cues from the game are associated with aversive or dangerous situations in the game (e.g., groans, screams, explosions). Previous research suggests the effects of music (e.g., techno music) on physiological arousal and anxiety; particularly on violent video games (Freeman, et al., 2008; Hebert, et al., 2005). According to Hyman and colleagues (2012) intrusive songs can be experienced as positive or negative. Only a few gamers mentioned how they perceived their experiences. A few explicitly said it was positive, whereas more gamers used negative adjectives when referring to their auditory experiences. Intermittent auditory experiences were perceived as annoying, and provoked sleep deprivation in some gamers. Persistent and intrusive experiences were reported previously as visualizations of video game images in the back of the eyelids or as uncontrollable thoughts about the game (Gold & Cundiff, 1980) Furthermore, episodic GTP-AUD such as hearing sounds and voices resulted in the gamers getting disconcerted and frightened to the point where in a few cases they questioned their own sanity, even though they were aware that their experiences were explained due to their high engagement in the game. It also appears that distress stemmed in some gamers due to lack of control over the GTP-AUD and surprise relating to the vividness of the sounds that made them look around their immediate environment for the source of the sound.

Hearing voices may be the most stressful of the auditory experiences. I speculated that the gamers' cognitive affective and behavioural responses to the voices may depend on different factors: (i) in-game events associated with auditory cues, (ii) degree of affective attachment to the auditory cues, and (iii) if the players retained or did not retain the features of the auditory cue, (iv) changes of the nature of the experience, (v) recurrent encounters with evocative stimuli, and (vi) content of verbal cues.

- (i) *In-game events associated with the auditory cues.* Here, the auditory cue is associated with harmless or dangerous situations in the game, or with benevolent or malevolent characters.
- (ii) *The degree of affective attachment to the auditory cues and the characters.* This refers to how aversive or positive an auditory cue was experienced by the gamer in the game.
- (iii) *Retaining the features of auditory cues.* On one hand, heard auditory replays typically preserved the features from the game (e.g., pitch, loudness) can facilitate GTP- AUD being experienced as more real, and therefore gamers expected that something was going to happen as in the game. On the other hand, it may have helped gamers to clearly identify the experiences as induced by video game playing. However, it could be the case that features of the auditory cues were not retained or distorted. In this case, sounds or voices may have appeared as not familiar but equally strange and provoking even more anxiety. Experiments have shown that pitch distortions tend to contribute to misattributions of own thoughts and into the severity of the delusions (Cahill, Silbersweig, & Frith, 1996).
- (iv) *Change of the nature of the experience.* In some cases, the nature of the phenomena changed from being experienced as inner speech to verbal auditory hallucinations, or from auditory hypnagogic, misinterpretations of sound to hearing the auditory replays externalized. Different types of experiences may be interpreted differently and may have different psychological implications.
- (v) *Recurrent encounters with evocative stimuli.* If associations with external stimuli associated or simulated in the game were identified, they could have facilitated the recurrence of the experiences that in some cases could become uncomfortable due to the uncontrollable nature of the phenomena. Identification of stimuli associated with the involuntary replays may have helped gamers to explain their GTP AU and give them peace of mind.
- (vi) *Content of verbal cues.* This particularly occurred when the voices included commanding phrases typically used in the video games (e.g., “look”, “come along now”, “Go Go Go!”). They could have been experienced as stressful, especially if the content was controversial or negative. In extreme cases, it might have led to performing of the suggested behaviour in a playful way or developing delusions.

Furthermore, it is important to consider the consequences of prolonged exposure to constant ambient sounds or intermittent exposure to loud sounds experience in games. The UK National Health Service recommends applying the rule of 60:60 that means a person should

use a maximum 60% of the volume for maximum 60 minutes per day. User guide recommendations for the *iPod Shuffle* from *Apple* (Apple, n.d.) suggest listening responsibly. Hearing loss can occur due to the repeated exposure to loud sounds over time.

The gamers' psychological profiles in this study are not known but other studies suggest that music-related activities (Liikkanen, 2012b) neuroticism, and obsessive-compulsive disorders are related to intrusive song experiences (Gardner, 1985). Cahill, Silbersweig and Frith (1996) argue that susceptibility to experiencing unusual perceptual phenomena in combination with a dysfunctional belief system result in pathological hallucinations. For this reason, individuals that tend to commit cognitive distortions such as judgemental bias, being overconfident or jump to conclusions quickly may be at more risk to develop a pathological understanding of auditory experiences induced by video games. Demystifying these phenomena may be particularly beneficial to this group of the population. More studies need to be conducted to understand the prolonged effects of experiencing auditory replays from video games.

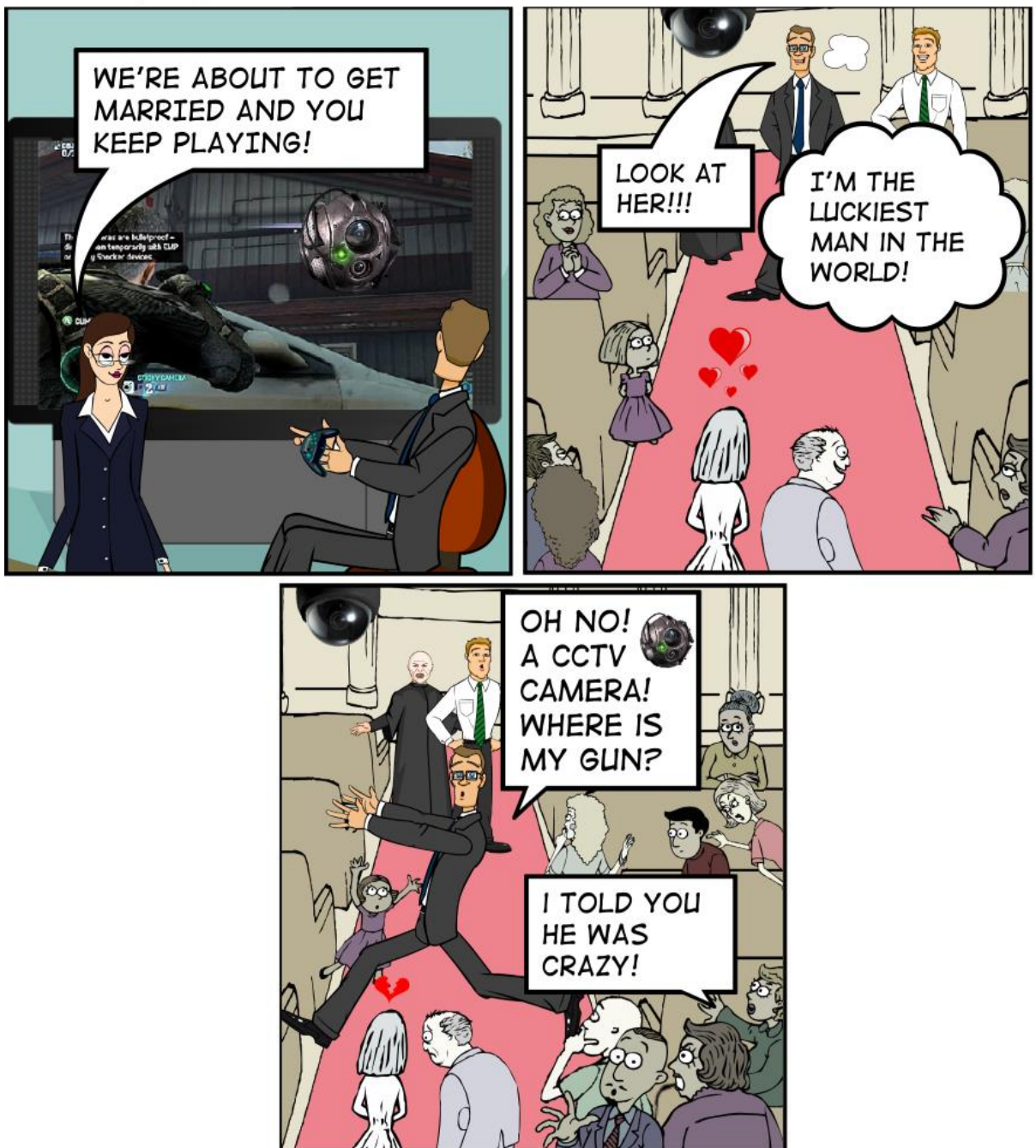
## Chapter 6 - Mental Processes, Actions and Behaviours in Game Transfer Phenomena

“Objects and events associated with the game have become evocative which elicit thoughts, emotions, sensations, and sometimes even altered sensorial perceptions resembling the game experience”.

(Ortiz de Gortari, 2013)

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There is a tendency to believe that it is possible to have full control over our own thoughts and actions (Bandura, 1982). However, a large percentage of the daily actions occur automatically and environmental stimuli can activate cognitions, impulses and behaviours without self-awareness (Bargh & Chartrand, 1999). Studies have demonstrated that virtual immersion can have both intended effects (Brown, Standen, Evett, Battersby, & Shopland, 2010) and unintended effects (Anderson & Dill, 2000; Beullens, et al., 2011; Champney, et al., 2007). Many research studies have investigated how video games influence thoughts and behaviours, while only a few studies have closely examined how video game playing can influence the perception and interpretation of real life objects associated with the game (Ortiz de Gortari, Aronsson, & Griffiths, 2011e; Poels, et al., 2014). Little is known about the gamers' unconscious information processing that occurs when playing video games.

The literature review in the present chapter focuses on understanding the nature of non-volitional thoughts and behaviours that would be helpful to examine GTP experiences reported in this modality.

## **Research into Mental Processes, Actions and Behaviours**

### **Involuntary thoughts as a failure of cognitive control**

Intrusive cognitions include thoughts, sensory mental images and impulses (Rachman, 1981). Involuntary thoughts are uncontrollable and can appear repeatedly, be pervasive or sporadic in contrast to deliberative recollection of events. The content can be amusing, creative, increase motivation and relieve boredom, and can be unwanted, unacceptable, persecutory and punitive (Clark & Purdon, 1995). The ways most non-clinical persons deal with intrusive cognitions include: reasoning with the self about the irrational and unimportant of the thoughts, trying to do or think of something else to get distract, getting worried, looking for social support, seeking reassurance, or seeking no further action (Berry & Laskey, 2012). Involuntary thoughts can arise when the mind wanders to unrelated tasks and they can be triggered by external stimuli. Thinking about the previous video game experiences triggered by external stimuli has been reported (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011b; Poels, et al., 2014). The most common involuntary cognitions relevant to the current study include: (i) daydreams, (ii) rumination, and (iii) obsessions.

*Daydreams* are an internal and private mental activity. Through daydreams individuals can freely engage in autobiographical thoughts, problem solving, planning, ideas and wishes

without restrictions and evaluation (Mooneyham & Schooler, 2013; Valkenburg & van der Voort, 1994). Daydreams typically arise when the mind wanders away to unrelated thoughts to the task at hand; they are a type of creative dissociation, although it is argued that daydreams can be self-induced and self-directed they usually just pop up (Valkenburg & van der Voort, 1994) and they have a cost in performance (McVay & Kane, 2010; Smallwood, Obonsawin, & Heim, 2003). Some authors understand mind wandering as distributed attention phenomena that consume executive resources (Smallwood, et al., 2003), while other authors argue that mind wandering is a result of failures in cognitive control (McVay & Kane, 2010, p. 188). Positive and constructive daydreaming has been related to video game engagement, but also poor attentional control in daydreaming that result in neglect of chores has been associated with daydreaming about video games (Dauphin & Heller, 2010).

*Rumination* appears to occur in the continuum from self-reflexion about ones' experiences, thoughts and feelings to particularly focus on distress repetitively and without taking any further action (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). According to cognitive neo-association theory, when ruminating one is capable of maintaining thoughts, feelings and behavioural tendencies active in the semantic memory (Berkowitz, 1990). In fact, ruminating (e.g., thinking about one's performance in the game and identifying ways to improve for the next session) about the game has been associated with more aggressive behaviour in a laboratory tasks conducted 24 hours after playing a violent video game (Bushman & Gibson, 2011).

*Obsessions* are defined as recurrent, persistent thoughts, ideas, impulses or images. They can appear when intrusive thoughts escalate (Clark & Purdon, 1995). They are experienced as intrusive, inappropriate and provoke anxiety or distress where the individual try to ignore, suppress or control them by neutralizing them with other thoughts or actions (compulsions – perform certain acts or avoid certain stimuli) (APA, 2000). The most upsetting obsessions in non-clinical individuals are related to harm (e.g., running the car off the road, self-harm, etc.), accidents (leaving the house without doing something important) and unacceptable sex (e.g., sexual activity contrary to one's sexual preference) (Clark, Purdon, & Byers, 2000; Purdon, Rowa, & Antony, 2005). One of the main differences in obsessions between clinical and non-clinical individuals is how thoughts are appraised. Clinical individuals consider them less acceptable, less able to resist and less dismissible (Clark & Rhyno, 2005). Preoccupation about video game playing has been extensively investigated

(Keepers, 1990; King & Delfabbro, 2014; Kuss, et al., 2012) but there is not much understanding of what obsessive thoughts are related to game content.

In extreme cases, obsession with the game has ended up in gamers having delusions with video game contents (See chapter 1 for more detail).

Another type of involuntary cognitions focus on memories that appear without any deliberate attempts to recall or forget are the ones that arise as bits of thoughts or fragmented thoughts. These are less elaborate and less pervasive than the intrusive cognitions discussed previously. These include: (i) involuntary autobiographical memories, and (ii) involuntary semantic memories. *Involuntary autobiographical memories* are abrupt and unintentional recalls of an episode of one's past that typically arise when doing automatic tasks and are mostly triggered by external cues. Kvavilashvili and Schlagman (2011) found that these type of memories are mostly triggered by negative external cues and therefore it may have an adaptive function as warning signs for protecting the individual from potentially unsafe or unpleasant circumstances. *Involuntary semantic memories* show the priming effects in daily life (Kvavilashvili & Mandler, 2004a). Implicit memory or non-declarative memory involves memories that we are not aware of and do not require conscious recollection. One of the most studied phenomena involving implicit memory is repetition or direct priming where the exposure to a word or object facilitate the later identification of a word by semantic or associative priming (Schacter, Chiu, & Ochsner, 1993). According to Kvavilashvili and Mandler (2004a) involuntary semantic memories manifest as when fragmented bits of thoughts, words, or tunes pop up in the mind that lack personal meaning. They are triggered by the presence of stimuli that have been previously primed (usually recent priming) and that are latent in the semantic network, the identification of the triggers required an analysis of the cues surrounding the mind popping or remembrance of the events that recently precede the intrusion.

### **Failures of motor control and involuntary behaviours**

Executive control functions regulate perceptual and motor processes so that they respond adequately to novel or changing task demands (Miller & Cohen, 2001). Involuntary behaviours can be initiated by neural, cognitive or both mechanisms. In terms of non-volitional behaviours there are some concepts particularly relevant to the effects of video game. These include: (i) lack and failures of motor control, (ii) automatic imitation and mimicking, and (iii) habits, impulses and compulsion.



### **Lack and failures of motor control**

It is very common to engage in stereotypical behaviours (tapping a foot, playing with our fingers, rocking to music, etc.). However, in extreme cases these movements are intense, prolonged, peculiar, and even self-injurious or interfere with normal activity (Freeman, Soltanifar, & Baer, 2010). These are referred to as dyskinesia which are unintended, involuntary and uncontrolled movements (e.g., twitches, tics, jerks, twisting or simple restlessness) that are typically associated with neurological or mental disorders (European Parkinson's Disease Association, 2014). Repetitive movements of limbs trying to control wearable technology has been reported by a man who apparently suffered withdrawal symptoms from the use of Google Glass (Yung, et al., 2015).

However, lack of motor control can also be experienced due to neural adaptation to virtual environments or virtual simulators. This include postural instability (disequilibrium) (Gray Cobb & Nichols, 1998), proprioceptive errors (Stanney, et al., 1999), lack of motor flexibility (ataxia), uncoordinated and jerky movements, dyskinesia (Cobb, 1999). The side-effects are temporal but can persist for hours and can affect the user's ability to walk, drive a car and use machinery or perform senso-motoric demanding tasks (Hakkinen, Vuori, & Paakka, October, 2002). In extreme cases proprioception, errors have resulted in accidents. Strauss (1995) reported the case of a woman that after the virtual exposure using a head mountain display (HMD) "tried to drink soda by pouring the soft drink into her eye". In another case, reported by Burnett (1996) "a child after play a home base virtual environment system for extended period of time, thrust a cue stick into his eye while playing billiards" (Stanney, et al., 1999, p. 28).

Moreover, individuals can get involved in unintentional behaviours better explained by typical cognitive failures, a slip of action "when a thought that was not intended to be voiced or performed gets done anyway" (Norman, 1981, p. 3). A can happen due to the well-formed habit that translated into inappropriate circumstances. People usually identified the slips, sometimes the caught themselves in the act. Norman (1981) classified slips of actions according to the mechanism that contribute to in their initiation: (i) the formation of intention (the action is appropriate for the situation but inappropriate for the actual situation, e.g., slide the finger over the computer screen after using a touch screen, replacing the lid to the sugar container on the coffee cup that have similar shape), (ii) faulty activation of schemas (the schema networks are activated due to thoughts or external stimuli resulting in an action where it was not expected or actions decline before they were completed. It is a type of stimuli

generalization, if habits are strong enough partial matches can activate the relevant schemas e.g., taking copies from the copying machine and found oneself counting “1”, “2”, “3”, “4”, “5”, “6”, “7”, “8”, “9”, “10”, “Jack”, “Queen”, “King”, standing staring into the refrigerator wondering why you were there), (iii) faulty triggering (e.g., appropriate schema is selected and activated but they result in a slip because it was triggered inappropriately either at the wrong time or not at all. This lead to reversals of components in events, this is referred to as Spoonerism, e.g., saying ”suppose you put a string around a ten-foot earth” instead of “put a string around a ten-foot ball”).

### **Automatic imitation and mimicking**

Automatic imitation (which is different from conscious imitation or modelling) includes mimicking facial expressions, emotions, speech pattern, physical movements, behaviours, postures or mannerism in order to match others, as an adaptive mechanism (Iacoboni, 2009). This is referred to by Chartrand and Barg (1999) as the “chameleon effect”. According to research, the automatic imitation is guided by the mirror-neuron system, the simple act to observe someone doing something initiates a process in our mirror-neurons similarly as when we involve in such behaviours (Iacoboni, 2009). The mirror-neurons system can be activated in different ways: (i) by observing a movement performed by someone else , (ii) when similar movements is performed, or (iii) when imagining the movement (Hägner, et al., 2008).

### **Habits, and failures in control inhibition**

Another spectrum of behaviours that involve executive control includes habits, compulsions, and impulses. Self-regulation is “the ability to override or change one’s inner responses, as well as to interrupt behavioural tendencies (such as impulses) and refrain from acting on them” (Tangney, Baumeister, & Boone, 2004, p. 274) and it plays an essential role for developing and maintaining a behaviour (Baumeister & Heatherton, 1996; LaRose, et al., 2003). Once an activity has become a habit (mannerism, customs, rituals) it is stereotyped and sequential (Graybiel, 2008), it is done almost without thinking. The attention is decreased and together with it the possibilities to self-monitoring the behaviour. Dysfunctional habits include behaviours that cannot be held back. Such compulsions are “repetitive behaviours or mental acts with the goal of reducing or preventing anxiety or distress, rather than providing pleasure

or gratification”. The most common compulsions include washing of hands, checking, and counting (APA, 2000). On the other hand, failures in control inhibition result in impulsivity; “failure to resist an impulse, drive, or temptation to perform an act, drive by internal or external stimuli without regard for negative consequences” (APA, 2000, p. 663). In this case, there is a sense of gratification before or after the performance.

### **Selective attention, reasoning bias and memory misattributions**

There are a large variety of cognitive biases, in certain cases they can be beneficial as homeostatic mechanics (Cummins & Nistico, 2002), but in the most of cases maintain dysfunctional cognitive processes and patterns of behaviour (Koster, Fox, & MacLeod, 2009). For example, *attentional bias* occur when the attention is focused on particular stimuli (selective attention) ignoring other information (Matlin, 2009). Attentional biases are important for understanding video games’ effects and GTP because video game playing train gamers to pay attention to certain stimuli, particularly action video games enhance selective attention (Green & Bavelier, 2003). For instance, individuals classified as addicted gamers have showed respond inhibition and shortened reaction times in the Stroop test toward stimuli associated with a video game, which suggest cue-reactivity toward gaming-related stimuli (Decker & Gay, 2011; Metcalf & Pammer, 2011; Van Holst, et al., 2012; Zhou, et al., 2012). Also, anxious individuals tend to allocate their attentional resources to insignificant potential threats in the environment, and show hyper-vigilance for threats by monitoring for potential dangers by excessive scanning of the environment, repetitive ocular movements which in turn lead to lack of attention on relevant tasks (Richards, Benson, Donnelly, & Hadwin, 2014). Attentional bias does not only imply focusing the attention in particular stimuli, the appraisal of a stimuli tend to lead to exaggerated physiological responses which in the case of individuals with pathology contributed to maintaining dysfunctional behaviours (Richards, et al., 2014). In a previous GTP interview study, gamers reported paying attention to ceilings or looking at buildings, when they had been playing games where they could climb (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011b).

Another type of cognitive bias interesting to explore, is the *beliefs bias* effect, when judgments are established based on prior beliefs and general knowledge rather than logical evaluation of a situation (Matlin, 2009). For example, individuals with panic disorder tend to misinterpret body sensations as symptoms of illness (e.g., pain in the chest as heart attack).

Also, individuals with Post Traumatic Stress Disorder, phobia or obsessive compulsive behaviours develop unrealistic expectations and avoid certain stimuli as much as possible in order to avoid threats (Rachman, 1997; Warren, Zgourides, & Jones, 1989). Similarly, in the previous interview study about GTP, a gamer reported just wanting to walk on a certain side of the road because there he were less likely to be attacked by monsters from the game, or walking in the forest and thinking that they might be murdered after playing the video game *Alan Wake* (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011b). *Hostile attributions bias* (Bushman & Anderson, 2002; Hassan, Bègue, Scharnow, & Bushman, 2012) occur when individuals “perceive harmful actions by others as intentional rather than accidental” and has been correlated with violent video game playing (Bushman & Anderson, 2002).

Moreover, misattributions of memories that include source monitoring errors and false recall. Memories are classified according to schemas and expectations (Berkowitz, 1990), and sometimes this can lead to mistakes. According to Johnson (2007) memory bias can occur in terms of errors by identifying memories originated internally (thoughts, imagination, dreams, autobiographic memories, knowledge, beliefs) from externally originated events, and as errors when discriminating if events are veridical, imagined, or mediated (e.g., virtual, televise) (Johnson, 2007). Virtual memories share similarities with memories from the real world that are rich in perceptual, spatial, temporal, semantic and affective information in comparison to imagined events (Johnson, 2007), so it is expected that memories from the virtual world are vivid. Perceptual detail in virtual memories may enhance episodic memories and facilitate source monitoring errors (Hoffman, Garcia-Palacios, Thomas, & Schmidt, 2001; Segovia & Bailenson, 2009).

Another dimension of misattribution memories are false memories. Experiments have demonstrated that virtual tasks that are less immersive than video games can also result in false memories. For instance, Hoffman et al., (2001) conducted an experiment where participants touched a physical object with their real finger or a virtual object with a virtual finger. One week later, participants could recall more objects touched with the real finger than objects touched with the virtual finger, but in the effort to discriminate between real and virtual memories of the objects touched during the experiment, participants made mistakes introducing false memories from objects not showed in the experiment (Hoffman, et al., 2001). Another experiment were conducted by Segovia and Bailenson (2009) to investigate the effects of the use of high immerse virtual environment by preschool and elementary children. They measured false memories in different conditions: (i) narrative, (ii) mental imagery, where participants

imagined themselves performing an activity, and (iii) immersive virtual environments, where participants were passive or active. They found that young elementary children developed more false memories either when imagining themselves performing an activity or interacting in the virtual world, demonstrating the importance of self-engagement in an activity for the formation of false memories. This may suggest the potentially difference in induced false memories between passive media such as movies and interactive media such as video games.

The present study investigated the influence of video game playing on gamers' mental processes and responses to real life stimuli (e.g., objects, environments, events) in day-to-day settings. Particularly, this study focused on two of the three modalities of GTP: Mental processes (GTP-MP) and behaviours (GTP-B). In this paper I will refer to them as "Mental process and behaviour GTP" (MPB-GTP).

This study took into account the gamers' experiences, that occurred in natural settings in contrast to laboratory experiments, quantified (e.g. thoughts, movements, verbal execution) and systematically operationalized their self-reports (e.g. mental perseveration, atypical body movements), as well as, contrasted gamers' self-reports by watching film clips of gameplay and playing some of the games to better understand these particular experiences. The purpose of the present study was to extend the previous findings in the GTP interview study conducted with 42 Swedish frequent gamers (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011b).

## Method

### Sample

A total of 1,022 experiences from 762 gamers from 44 publicly available online video game discussion forums<sup>19</sup> were collected and classified as GTP-MPB. Some online gaming forums were related to specific video games whereas others were more general gaming forums. A total of 262 different video games were identified as having been associated with GTP-MPB experiences. Only 172 gamers reported their age ranging in age from 12 to 56 years ( $M=20.19$ ,  $SD=5.71$ ) and comprising 191 males and 22 females.

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<sup>19</sup> Online video game forums included comments to articles on websites, as these are considered discussion platforms.

## Data collection

Initially, a total of 2,000 gamer's experiences were collected from the online video game forums. However, later on some data were excluded because some self-reports did not contain enough information and/or were ambiguous. This resulted in a total of 1,681 gamers' experiences were usable and identified as GTP in one or more modalities/sub-modalities (e.g., altered visual or auditory perceptions, thoughts, behaviours). These were collected from 60 publicly available online video game discussion forums over a seven-month period. Gamers' experiences identified as GTP-MPB were extracted from a larger dataset for the analysis in the current study. Some gamers reported more than one GTP-MPB experience. Therefore, the number of experiences is larger than the number of participants in the study. Game genres included: puzzle games, massively multiplayer online role-playing games, and first-person shooter games. Video game forums were searched using the Google search engine with the following keywords: "Tetris effect", "bleeding effect AND video games", "hallucinations video games", "video games AND/OR real life/reality". The topics of the online forums included: "suffered the Tetris Effect", "Minecraft Effect", "Guitar Hero effect", "Game Transfer Phenomena", "games stuck in your head", and "video game persists in real life". The number of posts relating to GTP in each online forum varied.

## Data analysis

A mix of content analysis (Hsieh & Shannon, 2005) and thematic analysis (Boyatzis, 1998) was used to code and analyse the data. First, the gamers' visual experiences were extracted from the forums and recorded in a table. The following step was to systematically record gamers' experiences in a database for a systematic coding and quantification. Gamers' self-reports about dreams were also excluded from analysis. Categories and variables in the database were modified until all gamers' experiences were coded under a specific category (e.g., persistent thoughts). Other information that was coded (if provided) included: (i) gamers' profile (nickname, age, gender), (ii) GTP-MPB characteristics (e.g., frequency of occurrence, duration), (iii) playing habits (e.g., frequency of play, length of playing sessions), (iv) gamers' perception of their GTPATB experiences (e.g., positive, neutral, negative), and (v) content of the experience (e.g., educational, dangerous, criminal). The data analysis was informed by a rigorous literature review concerning automatic mental processes and automatic behaviours. In addition to this, some video games identified in the posts were played by the author. This was

to gain a clearer idea of the mechanisms and concepts described by the gamers. This was also supplemented by the watching of gameplay videos that also provided further insight into what gamers were describing. The words of the gamers were respected. Words that contained expressions, adjectives, and keywords were not modified. However, some words in the self-reports used as examples in this chapter were paraphrased to reduce the possibility of gamers' experiences being tracked and to protect the gamers'. This was challenging due to the risk of losing the context of the experiences. This included using synonyms, changing tenses, and/or removing extraneous information. Gamers' pseudonyms were also modified.

## **Results**

The results are presented in two sections: (i) general characteristics of GTP-MPB, and (ii) types of GTP-MPB identified. The majority of GTP-MPB experiences reported (85 %) were triggered by an association with an external (real life) stimulus. Only a few posts included information explaining the general characteristics of GTP-MPB.

GTP-MPB were defined as controlled and automatic mental processes, and controlled or automatic behaviours influenced by video game playing. More specifically, they manifest as intrusive thoughts, impulses, cognitive bias, commission errors, automatic mental actions, uncontrolled body movements and voluntary and involuntary behaviours. These phenomena in the majority of the cases are triggered by automatic associations between real life stimuli and events, and video game elements.

### **General characteristics of GTP-MPB**

Only a few posts included information explaining the general characteristics of ATB-GTP.

#### ***Gamers' perception about their GTP-MPB experiences (n=78)***

More posts (n=59) included negative expressions about GTP-MPB experiences (e.g., "worry", "unhealthy", "PTSD", "problem", "messed up", "embarrassing", "had to quit playing") than posts that considered GTP-MPB experiences to be normal (n=3) (e.g., "no big deal", "normal", "surprise") or positive (n=13) (e.g., "entertainment", "funny", "good times", "nerdy", "awesome"). Some gamers also referred to GTP-MPB as "weird" and "crazy" (n=22).

### ***Duration of the GTP-MPB experiences (n=45)***

GTP-MPB experiences were reported as lasting seconds or minutes (n=19). In other cases GTP-MPB experiences were reported as lasting hours (n=5; e.g., “all the night”, “for a while”). Some gamers mentioned that GTP-MPB experiences lasted days or longer (n=21; e.g., “several weeks”, “over 6 months”, “for years”).

### ***Frequency of GTP-MPB occurrence (n=1,022)***

The majority of the gamers mentioned that GTP-MPB experiences happened only once or only reported one experience (n=721). However, there were also gamers that experienced GTP-MPB more than once (n=237), many times (n=28), or anytime/every time (n=36).

### ***Hours played per session when having GTP-MPB experiences (n=147)***

In most of the cases, the posts included details indicating that the gamers played long sessions (n=110; e.g., 3.5 h) or very long sessions (n=37; e.g., “all the day”, and “many hours straight”). A total of 123 gamers’ narrations indicated explicitly that they were playing excessively (e.g., “junkie”, “too much”, “a week no-sleep”, “all waking hours”, “addicted”, and “days straight”).

### ***Activities associated with GTP-MPB experiences (n=307)***

The activities mentioned by most gamers associated with experiencing ATB-GTB were: driving (n=91), walking (n=84), waking up (n=18), passenger in a vehicle or public transport (n=13), and lying in bed and/ or trying to sleep (n=12). Other activities (n=89) included: being passive or bored, talking with others, attending a lecture, listening to music, packing or arranging things, training, reading or surfing the web, typing or writing, and during playing. Additionally, automated activities such as cooking, getting dressed, taking a shower, washing the dishes, eating, and stressful situations (e.g., fighting, taking a test/exam) were also reported.



***Physiological conditions associated with GTP-MPB experiences (n=14)***

The conditions associated with GTP-MPB included being sleep deprived, tired, exhausted, sick, feeling dizzy and/or having headache.

***Content of the GTP-MPB experiences (n=298)***

The content of GTP-MPB experiences was classified as either being: educational, dangerous, or criminal. Educational experiences (n=4) included the experience of building something, reflecting about the nature or their own behaviour, and avoiding an accident. Some gamers also used GTP-MPB to strategically analyse and explore real life environments (n=132). Dangerous content (n=56) included “speeding ticket”, “side-swipe any car”, “tried running on a wall”, “leaning into curves”), and criminal content (n=40; e.g., “consider pick-pocketing”, “jump out of my car and jack it”, and “hitting people with my car”. Gamers also reported feeling paranoid or hyper-vigilant (n=67) and reported such things as “everybody is a spy”, “afraid of backstabs [in real life]”, “observant and cautions”, and “paranoid”.

**Main GTP-MPB categories**

The gamers’ GTP-MPB experiences mainly occurred either immediately after stopping playing or sometime after stopping playing, with a few occurring while playing. Seven main categories were created based on the data collected: (i) thoughts about video game content, (ii) cognitive errors and distortions influenced by video game content, (iii) subjective sensations of unreality, (iv) urges and impulses to do something as in the video game, (v) automatic and involuntary mental actions involving video game content, (vi) carrying out automatic actions, and (vii) behaviours influenced by video game experiences. Table 6.1 contains a complete quantification of all the subcategories of GTP-MPB identified based on the online forum data collected (See table 1 for percentages in each category and subcategory).

**Table 6. 1** *GTP-MPB categories and sub-categories*

| Type of GTP-MPB  | Number of<br>GTP | GTP-<br>MPB<br>type<br>(%) | GTP-<br>MPB<br>category<br>(%) |
|--|------------------|----------------------------|--------------------------------|
| <b>Thoughts about video game content</b>   |                  |                            |                                |
| Persistent thoughts about video game content                                     |                  |                            |                                |
| Uncontrollable thoughts about video game content                                 | 31               | 33                         |                                |
| Thoughts that involved strategic thinking from a video game applied to real life | 13               | 14                         |                                |
| Episodic thoughts about video game content                                       |                  |                            |                                |
| Thoughts about the video game triggered by external stimuli                      | 17               | 18                         |                                |
| Selective attention to external stimuli related to the video game                | 30               | 32                         |                                |
| Worries about losing control and confusing real life with a video game           | 4                | 4                          |                                |
| <b>Subtotal</b>  | <b>95</b>        |                            | <b>9</b>                       |
| <b>Cognitive errors and distortions influenced by video game content</b>         |                  |                            |                                |
| Source monitoring errors between real life content and video game content        | 28               | 18                         |                                |
| Misinterpretation of real life stimuli and events with that in a video game      | 58               | 37                         |                                |
| False expectations in real life based on the content of a video game             | 72               | 46                         |                                |
| <b>Subtotal</b>  | <b>158</b>       |                            | <b>15</b>                      |
| <b>Subjective sensations of unreality</b>  |                  |                            |                                |
| In real life, feeling as though they were in the video game                      | 8                | 33                         |                                |
| In real life, feeling as though they were a video game character                 | 4                | 67                         |                                |
| <b>Subtotal</b>  | <b>12</b>        |                            | <b>1</b>                       |
| <b>Urges and impulses to do something as in the video game</b>                   | <b>115</b>       |                            | <b>11</b>                      |
| <b>Automatic and involuntary mental actions involving video game content</b>     |                  |                            |                                |
| Automatic mental actions immediately after stopping playing                      | 17               | 92                         |                                |
| Automatic mental actions after some delay after stopping playing                 | 207              | 8                          |                                |
| <b>Subtotal</b>  | <b>224</b>       |                            | <b>22</b>                      |
| <b>Carrying out automatic actions</b>  |                  |                            |                                |
| Carrying out stereotypical motor executions                                      | 13               | 6                          |                                |
| Slips of action with video game content  |                  |                            |                                |
| Involuntary outburst with video game content                                     |                  |                            |                                |

|   |              |    |           |
|---|--------------|----|-----------|
| Verbal slips  | 23           | 10 |           |
| Making a sound or singing without awareness                                     | 3            | 1  |           |
| Slips involving manipulation of control devices                                 | 5            | 2  |           |
| Slips involving video game elements   |              |    |           |
| Automatic thoughts when trying to use video game elements                       | 161          | 70 |           |
| Involuntary movements of limbs triggered by stimuli associated with video games | 26           | 11 |           |
| <b>Subtotal</b>   | <b>231</b>   |    | <b>23</b> |
| <b>Behaviours influenced by video game experiences</b>                          |              |    |           |
| Involuntary behaviours elicited by stimuli associated with the video game       |              |    |           |
| Nearly performing an action triggered by associated stimuli                     | 15           | 8  |           |
| Performing an action elicited by stimuli associated with the game               | 39           | 21 |           |
| Involuntary mimicking   | 13           | 7  |           |
| Change in behaviour due to video game experiences                               |              |    |           |
| Mood states influenced by video game experiences                                | 29           | 15 |           |
| Avoiding real life elements or events   | 7            | 4  |           |
| Feeling compelled to do something or say something related to the video game    | 43           | 23 |           |
| Behaviours where the level of executive control was unknown                     | 13           | 7  |           |
| Voluntary behaviours involving video game content                               |              |    |           |
| Doing an activity inspired by video game content                                | 9            | 5  |           |
| Telling jokes and repeating phrases from video games                            | 8            | 4  |           |
| Conscious imitation/modelling of video game content                             | 11           | 6  |           |
| <b>Subtotal</b>   | <b>187</b>   |    | <b>18</b> |
| <b>Total</b>  | <b>1,022</b> |    |           |

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### Thoughts with video game content (n=95)

In this category, some gamers' transfer experiences manifested themselves as thoughts. This category included: (i) persistent thoughts about video game content, and (ii) episodic thoughts about video game content.

***Persistent or recurrent thoughts about video game content (n=44)***

Here, gamers involuntarily kept thinking about the video game after they had stopped playing. These experiences manifested themselves as: (a) uncontrollable thoughts about video game content, (b) thoughts that involved strategic thinking from a video game applied to real life.

***Uncontrollable thoughts about video game content (n=31)***

Here, the gamers could not stop thinking about the video game. These thoughts were unwanted and in some cases unpleasant:

*“I cannot stop thinking about Minecraft. It’s ruining my life” (Becareli)*

***Thoughts that involved strategic thinking from a video game applied to real life (n=13)***

Some gamers also found themselves thinking about how to apply video game strategies to real life or thinking how they would act in hypothetical scenarios using knowledge from a specific video game. For instance:

*“I kept planning ways to avoid being seen while invisible...Man, I’m messed up”  
(Cozymed)*

*“Splinter Cell thinking about what would happen if I were to sneak up behind someone”  
(Brace)*

***Episodic thoughts about video game content (n=51)***

Here, involuntary episodic thoughts were typically elicited by external real life stimuli. This category of experiences was subdivided into: (a) thoughts about the video game triggered by external stimuli, and (b) selective attention to external stimuli related to the video game, and (c) worries about losing control and confusing real life with a video game.

***Thoughts about the video game triggered by external stimuli (n=17)***

In some cases, gamers provided analogies and/or made comparisons between real life stimuli and elements in the video game. For instance:

*“Every time I hear old school music I think of Fallout 3” (SamuelIX)*

*Selective attention to external stimuli related to the video game (n=30)*

Here, gamers found themselves paying attention to specific real life stimuli and/ or environments relevant to those in a video game. This is known as attentional bias (Matlin, 2009). For instance:

*“Since I started playing Minecraft and Dwarf Fortress, I find tiled floors extremely distracting” (Debi08)*

*Worries about losing control and confusing real life with a video game (n=4)*

Some gamers experienced thoughts about losing control by confusing real life with the video game. For instance:

*“It was scary because I would always worry that if I was tired or not paying attention I would by mistake switch over to Grand Theft Auto IV mode and drive over cars and people” (ChronosBob)*

**Cognitive errors and distortions influenced by video game content (n=158)**

In this category, many gamers found themselves making judgemental errors when they interpreted real life stimuli with the logic of the video game or mixed-up real life events and video game events. This category included: (i) Source monitoring errors between real life content and video game content, (ii) misinterpretation of real life stimuli and events with that in a video game, and (iii) false expectations in real life based on the content of a video game.

*Source monitoring errors between real life content and video game content (n=28)*

Here, gamers made memory errors that led to them confusing real life events and/ or objects with experiences from within the video game. Some gamers claimed that confusion occurred between the information source (e.g., who said what) or memories about the origin of the information (e.g., whether events occurred in-game or outside the game). For instance:

*“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 game I was playing”(Draven)*

*“Sometimes get my Sims mixed up with people. ‘remember when you’....oh no, wait, that was my Sim ” (Lorela).*

***Misinterpretation of real life stimuli and events with that in a video game (n=58)***

Here, some gamers interpreted real life events and/or objects using experiences they had encountered in a video game. For instance:

*“When I was really into Fable 2, when I let my dogs out into the back garden, if I saw them sniffing at the ground, I would think ‘oh they must have found a dig spot’”  
(Jackson)*

Furthermore, some gamers got surprised that things in real life did not work or look as they did in the video game. For instance:

*“I was freaked out when I went outside and trees were round and not square like the video game I had been playing” (IneedAce)*

***False expectations in real life based on the content of a video game (n=72)***

Sometimes gamers claimed that they experienced unrealistic expectations or assumed that something that happened in the video game would happen in real life. These experiences were in many cases triggered by the activities that the gamers were doing when this happened and can be understood as a sort of reasoning or beliefs bias (Matlin, 2009). For instance:

*“I had been playing Mass Effect 2 for 7 h, my mum walked into the room and said something. I paused for about 5 s looking at her waiting for a wheel of options to appear. Weird” (PricelessWil)*

*“After a marathon of Grand Theft Auto, I was driving and saw a car flipped upside down and thought “Go! It is going to explode in 5 seconds!” (Jamal)*

***Subjective sensations of unreality (n=12)***

Here, gamers experienced subjective experiences of unreality relating to one’s sense of self and the outside world (Aardema, et al., 2010). This resembles dissociation experiences which are “temporal disruption in conscious awareness” (i.e., desrealization and depersonalization experiences) (Leonard, Telch, & Harrington, 1999). These experiences were sub-divided into: (i) in real life, feeling as though they were in the video game, and (ii) in real life, feeling as though they were a video game character.

***In real life, feeling as though they were in the video game (n=8)***

Here, some gamers felt that in real life they were still in the video game. For instance:

*“I was playing Star Wars: Knights of the Old Republic about four hours straight. When I stood up I had a massive head rush. I thought I was a Jedi in a cave for about five seconds. I was worried that the giant birds in the game’s caves were going to attack me. I was confused, and afraid” (Sushy)*

One gamer reported that he suddenly connected with the video game and that his fast reactions learned from a video game helped him to solve a real life situation effectively:

*“Need for Speed 2 helped me through a bad slide on ice. When I hit the ice, my brain immediately went into gaming mode. It felt like I was with the PlayStation controller in my hand...I ended up off the slide” (BirdGal)*

***In real life, feeling as though they were a video game character (n=4)***

Some gamers felt in real life that they were a video game character. This occurred directly after stopping playing or was triggered by an external stimulus similar to that in a video game or because they performed an activity in real life similar to that in the video game. For instance:

*“I kind of do this with any game I play too much. But when I played Batman: Arkham Asylum for a long time, and I went to sleep thinking I was Batman” (NekoX)*

Another gamer felt as a video game character. This experience was triggered by external stimuli. For instance:

*“Our subway system here often announces stops and service announcements, and I swear it feels as if I'm Gordon Freeman going into work every morning” (Stormsy)*

***Urges and impulses to do something as in the video game (n=115)***

Here, some gamers experienced urges to do something as they would in the video game when they encountered real life stimuli that shared characteristics with elements within a video game or performed certain activities as they would in a video game. For instance:

*“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)*

*“After playing Katamari Damacy, I had a sudden urge to roll over things. This is not good when you are driving. Rows of orange cones should not look like a golden opportunity” (Panter44).*

### **Automatic and involuntary mental actions involving video game content (n=224)**

Here, many gamers engaged in automatic and involuntary mental actions where they replayed the video game inside their heads. These types of mental actions went way beyond simple involuntary thoughts popping into their minds as outlined above. These experiences either occurred immediately after stopping playing or were triggered by real life stimuli and involved strategic thinking when gamers found themselves exploring and evaluating real life objects or environments in a strategic way as they would in a video game. Automatic mental actions involve observing, monitoring, tracking, and/or assembling real life objects, and they depend upon the video game content. These experiences appeared to be mainly related with activities in the video game that required a sequence of actions and were typically associated with repetitive action video games (e.g., tile puzzle games) or those video games that featured repetitive activities (e.g., climbing buildings).

#### ***Automatic mental actions immediately after stopping playing (n=17)***

These phenomena appeared to be stereotypical and occurred immediately after stopping playing. Gamers’ thoughts appeared to be fixated and had lowered cognitive flexibility to switch from virtual to real life tasks as when occurring with persevering mental states (Van den Linden, Frese, & Meijman, 2003). Sometimes, real life stimuli acted as triggers, but in other cases their presence appeared to have been incidental. For instance:

*“I played Vice City and got all the hidden packages at once. When I quit playing I was looking in the corners of the rooms for hidden packages. It was really odd” (Forlife9)*

*“Lumines. For sometime I was looking at everything! And trying to see how to drop things correctly for get another square or color” (AnnBeast)*

*“Anyone ever get the Portal effect? Where you’re working out where to place portals... and it is not entirely voluntary, you are just half aware of it” (Amanda00).*



Only examples that included automatic mental actions are described in this section. However, it appeared that under perseverative mental states, gamers experienced other GTP-MPB experiences.

### ***Automatic mental actions after some delay after stopping playing (n=207)***

These types of experience were fairly stereotypical but did not occur immediately after stopping playing. All these experiences were triggered by external stimuli that somehow resembled the video game's elements, environments, and/or activities in the game. For instance:

*“Once I stayed up all night to play Lemmings. The next day, when I was trying to read, I kept trying to figure out how to get the Lemmings across the sentences” (Bluesjazz)*

In other cases, even though these phenomena initiated automatically, it appeared that after some time, gamers obtained control over their experiences. They then appeared to engage fairly voluntarily in playful replays of the video game every time they encountered the external stimuli that initially triggered the automatic mental actions, and became a routine. Selective attention to particular stimuli appears to guide gamers' experiences. For instance:

*“I do this to this day. I do not actively look for grind combos, but sometimes my eyes will just find and follow some crazy good grind combo. Caused by Pro Skater 3 not 2 though” (Karlypex).*

### **Carrying out automatic actions (n=231)**

These experiences included involuntary actions such as involuntary movements or verbal outburst related to video game content. These experiences were further categorised as: (i) carrying out stereotypical motor executions, and (ii) slips of action with video game content.

### ***Carrying out stereotypical motor executions (n=13)***

These experiences included atypical body movements when the gamers reported moving as they would in the video game such as strafing (i.e., moving side-ways). This mostly (but not always) occurred immediately after stopping playing. These experiences appeared to have strong components of neural adaptation. For instance:

*“Many times! Quake 2, made me literally strafe my way around corners in real life!”*

*(Jamal6)*

*“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)*

### ***Slips of action with video game content (n=218)***

These experiences occurred involuntarily due to failures in controlling impulses and led to different types of slips (e.g., verbal, motor) that were mostly triggered by automatic associations between real life stimuli and elements in the video game. These manifested as: (a) involuntary outburst with video game content, (b) slips involving manipulation of control devices, and (c) slips involving video game elements,

#### ***Involuntary outburst with video game content (n=26)***

Here, the gamers said something involuntarily involving video game content.

This included (i) verbal slips, and (ii) making a sound or singing without awareness. Sometimes gamers found themselves saying something from the video game without intending to. For instance:

*“I had been playing lots of war games. We had to get the students in a line so I was trying to tell the other teacher to go first and I said ‘you take point. I will cover rear’”*

*(Rocksdeal)*

*“I once had the Tank theme from Left 4 Dead as my ringtone, but after it went off in public and I yelled ‘TANK!’ I changed it” (Glitz)*

On other occasions, gamers found themselves reproducing some sound or melody from the video game without intending to. For instance:

*“I haven’t played a Zelda game for 2 years... I was looking in the drawers a game. When I found it without even realising I sang the open chest theme” (Twistmax)*

#### ***Slips involving manipulation of control devices (n=5)***

This sub-category contained experiences where gamers made slips trying to manipulate other devices or other software as they would in playing the video game. For instance:

*“Playing too much World of Warcraft, then looking at pictures online, I try to drag the picture around with my mouse to get a better view” (Soulseptic)*

***Slips involving video game elements (n=187)***

Here, gamers thought momentarily about using video game elements to resolve something in real life, and then realized it was not possible. Sometimes these manifested as (i) automatic thoughts when trying to use video game elements, but also as (ii) involuntary body reflexes when gamers tried to use video game elements in real life. These experiences were also observed as an attachment to video game elements. Gamers typically tried to use video game elements that were used repetitively in the game, and that had a function or provided feedback in the game such as maps, heads-up displays (HUDs), zooming functions, teleports, menus, save options, and/or reload options.

*Automatic thoughts when trying to use video game elements (n=161)*

Here, gamers thought about using the video games in real life after popping up in gamers' minds. For instance:

*“Never mind I’ve saved at the last checkpoint...wait what? Quick saved too many times to care” (Intelus)*

Sometimes gamers experienced an episodic dissociation when looking for the video game controller in real life. For instance:

*“After playing too much Grand Theft Auto: San Andreas. I was riding my bicycle and I need to brake. I thought: ‘where is the R1 button for the handbrake’. I got scared when I just understand what had just happened” (Paxel\_00)*

On other occasions, gamers felt weird not having the ability or the element that they had used in the video game in real life. For instance:

*“After playing Oblivion for the first time 15 hours straight, I became extremely disorientated and extremely confused because there wasn't a bar telling me where my destination was located. I actually got slightly lost that night on the way to my friend's house. Not really a hallucination, but still...weird” (Kepchux)*

*Involuntary movements of limbs triggered by stimuli associated with video games (n=26)*

Here, the gamers' thoughts resulted in involuntary body movements of fingers, hands, or arms when gamers tried to use video game elements in real life. For instance:

*"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" (Megamaxin)*

*"A friend flung out his arm. He became embarrassed...without thinking he was trying to use the grappling hook from a Quake 2 to swing under the bridge" (superpaul)*

*"I used to play Guitar Hero and Rock Band all the time... Now always my fingers dance trying to play the song that is playing. No sure if it is annoying or anything but I cannot stopping doing it" (Sael)*

**Behaviours influenced by video game experiences (n=67)**

These experiences were not limited to involuntary movements, verbal outbursts or isolated actions with video game contents. Here, gamers fully performed behaviours influenced by video game experiences. These were further sub categorised as (i) involuntary behaviours elicited by stimuli associated with the video game, (ii) change in behaviour due to video game experiences, and (iii) voluntary behaviours involving video game content.

*Involuntary behaviours elicited by stimuli associated with the video game (n=67)*

Here, the gamers experienced an episodic lack of awareness and performed a behaviour without intending to do so. This category were sub- divide in (i) nearly performing an action triggered by associated stimuli, (ii) Performing an action elicited by stimuli associated with the game, and (iii) Involuntary mimicking.

*Nearly performing an action triggered by associated stimuli (n=15)*

These experiences manifested as automatic responses were either incapable of controlling their impulses and nearly performed something as in the video game but held back, or actually performed the behaviour as in the video game.

*“After days of playing Grand Thief Auto 4, I was at the gas station. There were two cars by each other, and I thought there would be enough room to squeeze through. I got all the way up to the cars and then realized that this was real life” (Sosa)*

*Performing an action elicited by stimuli associated with the video game (n=39)*

Here, gamers actually performed some action as in the game when encountering stimuli that reminded them of their game experiences. Sometimes this occurred as an overreaction. For instance:

*“I was driving...and when I hit the bump in the road, I tried to flick my steering wheel back to get my turbo-boost. (Mario Kart Wii lets you get turbos off of almost any little bump)” (Polaryys)*

*“I ducked at helicopter after playing lots of Call of Duty 4” (Mariza)*

*“After full weekend of Red Dead Redemption, I was walking and moved from the grass to the sidewalk, expecting that I would go faster by doing so” (Bets)*

*Involuntary mimicking (n=13)*

Gamers involuntarily mimicked video game characters. For instances:

*“Finally, when I first started playing Fallout 3 to the time I finished it, I would always cross my arms when I talked to people like the characters do in-game” (Malor)*

***Change in behaviour due to video game experiences (n=92)***

Here the gamers' behaviours were modified due to their video game experiences. These manifested as (a) changed mood state influenced by video game experiences, (b) avoiding real life elements or events, (c) feeling compelled to do something or say something related to the video game, and (d) behaviours where the level of executive control was unknown.

*Mood states influenced by video game experiences (n=29)*

In these experiences gamers' mood states influenced by previous video game experiences sometimes resulted in sensations but also in impulsive responses. In some occasions, hyper-vigilant mood states resulted in an overreaction. For instance:

*“I noticed that after I play for a while, the Phoenix Wright games, my mood becomes a lot more assertive, I tend to think that people have something to hide for an hour or so after played” (FeaturedPoet)*

*“After two 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)*

Gamers also overreacted while playing due to their immersion in the video game. For instance:

*“I played more or less 18 hours Alien vs. Predator 2 in darkness. My father come in, I turned around and shout swearwords while clicking the trigger of the non-existent gun in my hands...He disconnected the plugs from the PC” (Korma)*

In a few cases, some gamers felt empowered and thought they were capable of doing things in real life as they could in the video game. For instance:

*“This happens to me all the time. When I played Assassin’s Creed 2. I started to think I could climb stuff” (StyleFire)*

Here, the presence of certain stimuli associated with the game modified the gamers’ mood. For instance:

*“It was foggy and the church’s bells stopped. It felt so docile, possibly my most relaxing moment that month...in Silent Hill 1 in the school after the boss fight, you play in hell and then wake up to this foggy, calm astonishing world” (Stormsy)*

#### *Avoiding real life elements or events (n=7)*

Some gamers avoided specific real life objects or environments because they considered them threatening influenced by their experiences in the games. For instance:

*“When I played too much World Ware 2 Online, I always refused to go near churches...I said I was not fan of churches...but truth be told...I was afraid that French snipers where laying down under the bell, waiting to pull the trigger” (Normax)*

*“I avoided water fountains for an hour after I had played Fallout 3 for too long. Then I realized that I was acting really stupid” (Darklord22)*

*Feeling compelled to do something or say something related to the video game (n=43)*

Here, gamers felt compelled to do something as they did in the video game or to say something as in the game. Gamers stated that they “had to do it”. These types of experiences also manifest as: organizing real life objects as in the game and collecting items related to the video game. For instance:

*“The last time I experienced this and it turned out problematic was when I played too much Mirror’s Edge. If I saw something red I had to jump to it or try to run across it”  
(Josh\_66)*

On other occasions, the gamers felt the compulsion to say things as in the video game that later on become outbursts with video game content. These experiences were different than saying something without awareness. For instance:

*“Thanks to Mass Effect, there are now certain words I have to say in a ‘quarian’ accent. ‘Migrant’, ‘Fleet’, ‘Normandy’, ‘Engineer’” (Libra)*

*Behaviours where the level of executive control was unknown (n=13)*

Also, there were other experiences where it was difficult to establish the level of executive control of the gamers. For instance:

*“If I have been playing a driving game a lot (Burnout or Daytona), I tend to be a little more aggressive in the highway, and drive a little faster. I start thinking about powersliding when I come to curves, but of course I don’t” (peachblue)*

*“I always, ALWAYS get a ticket if I drive less than five hours after playing GTA: San Andreas” (Paulx)*

***Voluntary behaviours involving video game content (n=28)***

Here gamers voluntarily applied video game contents into their daily lives by (i) doing something inspired by video game content, (ii) telling jokes and repeating phrases from video games, and (iii) mimicking video games for amusement. This category can be categorized as the playful portrayal of video games in real life situations and can be found on places such as YouTube.

*Doing an activity inspired by video game content (n=9)*

Here, the gamers performed some activity or took a decision inspired by something that happened in the video game they played. For instance:

*“I tried to remove the pilot light from a stove for garbage to make a shish kebab in Fallout 3” (Bambooman)*

*“Too much Mirror's Edge. I climbed on the roof of my house to jump onto the shed, and onto the doghouse, then go inside to take a leak” (Samuels)*

*Telling jokes and repeating phrases from video games (n=8)*

There were also cases where gamers used phrases from the video games for joking or interacting with others. For instance:

*“Once I was in a car with a friend who was driving and I told him if he ran over the old lady we would get 30 points” (pax2000)*

*Conscious imitation/modelling of video game content (n=11)*

Here, some gamers deliberately imitated video game content for amusement and to interact with other people. For instance:

*“Whenever I'm bored, I will look at people far away and try to rail them. I make a reticule with my hand” (Waffleater)*

## **Discussion**

The aim of this study was to investigate the post-play influence of video games on gamers' mental processes and behaviours. The present study shows how gamers' cognitive control was compromised by video game playing, and how on many occasions external triggers worked as initiators of GTP. The important role that the association between real stimuli and video game elements plays has been argued in previous GTP studies (e.g., Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011). Most important to note was that experiences that are transferred into the real life world appeared to be directly related to video game content.

GTP occurred immediately after stopping playing, or a while after stopping playing. The majority of the experiences were triggered by automatic associations with external stimuli and they appeared to occur episodically and these episodes lasted for a relatively short period of time but could occur recurrently once the associations had gained associational strength.



There were not enough information in the data about the characteristics about GTP-MPB but many gamers reported that when GTP-MPB occurred they had been playing intensively, sometimes for days in a row. Excessive gaming has also been reported in the other studies conducted in this thesis (chapter 4 and 5 and Ortiz de Gortari & Griffiths, 2012b), and in a previous study about GTP (Ortiz de Gortari, et al., 2011c).

Only a few of the posts from the forums included information about what activities the gamers were doing at the time of their GTP-MPB experiences. The majority of the experiences occurred in a social context and the activities reported by the gamers included being engaged in automated behaviours such as walking, driving, or packing. These findings appear to mirror research into mind wandering (McVay & Kane, 2010; Smallwood, et al., 2003) musical imagery (Hyman, et al., 2012) and GTP identified in other modalities (Chapter 4 and 5). GTP-MPB also occurred when the gamers felt tired, sleep deprived, or stressed. States of anxiety and stress have also been reported in previous GTP studies (Ortiz de Gortari, et al., 2011b). Overall, this study found that GTP-MPB manifested as thoughts, sensations and impulses, automatic mental actions, automatic actions, voluntary and involuntary behaviour with video game content.

### **Thoughts with video game content**

The first category identified was *thoughts with video game content*. Thoughts manifested recurrently or episodically, and in many cases were triggered by external stimuli. Sometimes the gamers' created fictitious situations based on video game content in their mind or used real life scenarios. These experiences shared similarities with daydreaming but the content was more stereotypical in comparison to free daydreaming. Daydreaming about video games has been reported (Dauphin & Heller, 2010; Ortiz de Gortari, 2010; Poels, et al., 2010; Poels, et al., 2014). Poor attentional control when daydreaming about the game has been associated with neglect of chores (Dauphin & Heller, 2010).

In these cases, the thoughts appeared to have amused the gamers, while in other cases, they could not stop thinking about the game, and the thoughts were unwanted and intrusive. Not being able to stop thinking or ruminate about the game is considered a symptom of obsessive behaviours (Lee & Kwon, 2003) and being completely preoccupied by gaming is one of the core symptoms of gaming disorder (e.g., Griffiths, 2002) and it is considered as a cognitive manifestation of deficient self-regulation (Baumeister & Heatherton, 1996; LaRose, et al., 2003). Individuals with obsessions can be ruminating constantly about particular content,

but they can also suffer recurrent thoughts that raise anxiety and fear and result in compulsions to avoid accidents, commit a crime, to be contaminated by virus, bacteria, etc. (Clark, et al., 2000; Purdon, et al., 2005). This is interesting, since some video game content relies on performing controversial, dangerous or illegal activities; in some cases the gamers' thoughts have been activated around similar content. Additionally, when an activity is incomplete it tends to keep active in the mind until is completed (Zeigarnik effect) (Mäntylä & Sgaramella, 1997). In this category attentional bias was also observed when gamers found themselves paying attention to video game related stimuli in real life contexts.

### **Cognitive errors and cognitive distortions**

Among some gamers, GTP-MPB manifested as cognitive errors and distortions. Here, irrational thoughts popped up in the gamers' minds when interpreting real life events using the logic from the video game, making reasoning biases, and expecting that something in real life would happen as in the video game. For example, some gamers expected loading pauses or believed video game characters, icons, and menus would appear. Hostile bias expectations ("the tendency to expect other to react to potential conflict with aggression") after playing violent video games have been reported (e.g., Bushman & Anderson, 2002, p. 1680). False expectation may be explained because video games consist of sequences of events, which usually tend to be repetitive. The progress through games is with trial and error. The gamers learn that every action have a consequence, therefore when they are in real life scenarios that somehow remind them of their game experiences, they automatically apply the scripts learned in the game to interpret, evaluate and respond to real life events (i.e., structured sequences of events associated with a well-known activity) (Anderson, 1983).

It was also found that some gamers misattributed memories from video game characters and events with those in real life. Source monitoring errors and false memories have been found in previous research relating to watching movies (Roberts & Blades, 1999), narratives, and virtual worlds (Hoffman, et al., 2001; Segovia & Bailenson, 2009). Video games are very good at simulating reality, as well as inducing the sense of presence in the virtual environment. Additionally, they are rich in sensory cues that may facilitate confusion between video game and real life memories (Hoffman, et al., 2001; Segovia & Bailenson, 2009).

### **Subjective sensations of unreality**

Other types of GTP-MPB were classified as *subjective sensations of unreality*. In this category, not just thoughts with video game content were experienced by the gamer but also sensations of derealisation and depersonalization like; some triggered by external cues associated with the game; some without triggers. Here, the gamers – for a moment – thought they were still in the game or felt as the video game character directly after stopping playing, which appear to be explained by perseverative mental states and the lack of flexibility when changing between the virtual and the real life tasks. Short-lived disruption of conscious awareness (Leonard, et al., 1999) have been correlated with exposure to virtual reality, especially in individuals that are prone to experience dissociation (Aardema, et al., 2010). Also, dissociations has been easily induced in laboratory in non-clinical individuals by simple tasks (i.e. dot staring and audio/photic stimulation, stimulus deprivation task) (Leonard, et al., 1999). Depersonalization and derealisation are typically reported as a pre-phase of a panic attack in individuals with anxiety disorders (Miller, Brown, DiNardo, & Barlow, 1994). For instance, one gamer thought he was a Jedi in a cave and he was confused and afraid to be attacked by the huge birds from the game *Star Wars: Knights of the Old Republic* once he stopped playing. Another gamer went to bed thinking he was Batman. In other cases, gamers have felt that they actually were in the game. Their experiences were triggered by external stimuli associated with the game such as the one that said he felt like Gordon Freeman in *Half-life* when the subway announced the stops everyday he went to work.

### **Automatic and involuntary mental actions**

Another main category was automatic *mental actions with video game content* that manifested as stereotypical replays of the game in real life environments. The main characteristic of this type of experiences were that the gamers engaged in automatic mentally replays of the game using real life elements, therefore these experiences were not limited to simply experiencing intrusive thoughts with video game contents. These experiences either occurred immediately after stopping playing suggesting a lack of cognitive flexibility to change between different tasks, or were triggered by automatic associations. For instance, some gamers kept trying to mentally combine and fit real life objects as if they were pieces from *Tetris*. Also, another gamer said that when he stopped playing he was automatically scanning for packages he had been collecting in the game at the corners of the rooms he walked into. During a short

break from the game, another gamer started to eat cereals as a way to destroy enemies. Some gamers found themselves analysing real life environments, watching for places where to do grinds after played *Tony Hawk's Pro Skater*, mentally climbing buildings after playing *Assassin's Creed*, etc. In these experiences, selective action is evident when the gamers focused their attention on particular stimuli relevant in the game. This appears to resemble when individuals with gaming or alcohol problems in experimental tasks responded more to stimuli related to gaming or alcohol (Cox et al. 2002; Zhou et al. 2012).

### **Carrying out automatic actions**

A large variety of *involuntary actions and behaviours* were reported by the gamers. Some experiences were simply explained by neural adaptations, as when they experienced stereotypical motor executions that appeared to be explained by lowered motor flexibility when changing tasks between the virtual world and real life. For instance, some gamers found themselves strafing around corners, and one gamer experienced his arms rising automatically as if they were going to push the buttons on the video game control pad unintentionally. These experiences showed the effects of pushing buttons repeatedly but also demonstrated how simulations of body movements in virtual environments can have similar effects. In fact, the illusion of self-motion in virtual environments is being used for rehabilitation means. The movements learned in the virtual world are transferred to the real world to equivalent tasks and in some cases the skills are generalized to novel tasks (Rosenthal, et al., 1998). Also, previous research has found neural adaptation effects after the exposure to virtual environment simulators such as the reduction of complex psychomotor flexibility, and reduced motor control and proprioception errors (Gray Cobb & Nichols, 1998) especially the first times of use (Champney, et al., 2007).

In other cases, the gamers were incapable of controlling their impulses and thoughts with content from the video games, ending up in a variety of *slips of action that manifested verbally or as involuntary movements of arms or fingers*. For example, hearing music led to automatic movements of fingers or legs when gamers played rhythm music games controlled by continual body movements (e.g., pushing buttons of a plastic instrument that served as a game controller, or stepping on a dance mat). This coincided with reports of pianists who when listening to well learned pieces of music experienced involuntary movements of the respective fingers to execute the playing of the piano. This suggests an activation of the contralateral

primary motor cortex by listening to the music (Haueisen & Knösche, 2001). Also, neuroimaging studies with monkeys have demonstrated that the mirror neuron system becomes activated when hearing sounds associated with certain movements (Kohler et al., 2002), which provides a biological explanation of the relation between perception and action.

Additionally, gamers reported involuntary movements of limbs when trying to use video game elements in a real life context. For instance, one gamer involuntarily moved his arm when trying to use the grappling hook from a video game when he wanted to swing under a bridge. This shows the relevance of associations between activities and video game elements, as well as the importance of virtual embodiment and attachment to artificial bodies, which has been demonstrated in experimental studies where visual illusions of the ownership of a rubber hand or someone else's body parts has been induced (Petkova & Ehrsson, 2008). Gamers reported attachment to video game elements that were salient in the game and provided some type of feedback.

Moreover, gamers reported finding themselves suddenly mimicking video game characters' movements or making some sound from the game.

### **Behaviours influenced by video games**

Other types of behaviours occurred when the gamers not only performed actions as slips, but when they *completed behaviours influenced by their video game experiences*. This manifested as involuntary behaviours, change of behaviours, routines, mood modifications, feeling compelled to do something as in the game but behaviours where the degree of executive control was unknown were also identified.

Certainly, the majority of the gamers in the current study were able to contain their impulses but occasionally some gamers lost their executive control and were either very close to or actually performed something as in the game. Lower control inhibition has been correlated with video game playing (Chan & Rabinowitz, 2006; Kronenberger, et al., 2005; Swing & Gentile, 2010). These experiences were mainly characterized by impulses and short lacks of awareness or dissociations where the gamers impulsively overreacted to particular real life stimuli associated with the game. For example, some gamers overreacted to real life stimuli such as ducking down when they saw a security camera.

On other occasions, conditioned objects elicited the urge to do things as in the video game. For instance, different gamers reported an urge to climb buildings and drive through red lights. Game content appeared to have been active in the gamers' minds leading to impulsive

responses. “Impulses arise when a latent motivation meets an activating stimulus that is suitable for satisfying this latent motivation” (Friese & Hofmann, 2009).

Mood modification was also reported by some gamers when they felt empowered by the video games but also when they felt hyper vigilant and were expecting that something as in the video would game happen in real life contexts. More serious cases occurred when the gamers’ hyper-vigilant mood states resulted in impulsive behaviour (such as when one gamer slapped someone that came up from behind). This also occurred when being highly immersed in the video game. The effects of media such as movies, music, and video games on mood states is well known (Ribbens & Malliet, 2010), and research has shown how some gamers use video game playing as a way to consistently and reliably shift their mood states (Bertolini & Nissim, 2002; Ferguson & Rueda, 2010; Ortiz de Gortari, 2010). Some gamers also avoided real life stimuli that had become aversive – at least momentarily – due to their video game experiences. Such experiences can be understood as “conditioned avoidances” (Costello, 1970, p. 254). These responses appear to be of an adaptive nature in avoiding expected harm (as opposed to non-adaptive that occur in phobic behaviours).

In some cases the gamers carried out involuntary harmless behaviours as in the video game without awareness. For instance, one gamer picked up a bobby pin that is used in the game *Fallout* for lock-picking doors. There were also a few extreme cases such as the gamer that broke a barrel in a store expecting to find bananas so he could get an extra life, while others gamers found themselves driving as in a game shortly after stopping playing. Involuntary behaviours identified in this study appear to have been automatically triggered, influenced by cognitive bias such as false expectations due to video game experiences and should not be interpreted as intention to harm.

### **Voluntary behaviours**

Also, some gamers reported using video game content for amusement and interaction with friends as was previously reported in the interview study about GTP (Ortiz de Gortari, et al., 2011b). Also, use slang from video games were reported by Poels and colleagues (2014). In addition, some gamers engaged in real life activities inspired by the game. For instance, one gamer started to play guitar after playing a *Guitar Hero* game, while another started to collect pieces to build a sword. There were experiences where the level of executive control could not be identified. In other cases, the gamers felt compelled to do something as in the game, similarly as in obsessive-compulsive behaviour (Berry & Laskey, 2012). Perhaps when some

activity in the video game becomes salient, gamers have difficulty in managing their thoughts, and in extreme cases, obsessions, so they need to reproduce the activity at some level as a way of reducing the anxiety or distress or perhaps impulses should be release somehow as a way of gratification.

### **Limitations**

While the initial findings of this study are promising, a number of limitations need to be considered. First, this study used secondary data (i.e., gamers' self-reports, collected in online video game forums). This has a number of shortcomings: (i) while the researchers did not influence gamers' self-reports with direct questions, there may have been researcher bias in the selection of gamers' self-reports, (ii) since there were large number of self-reports, it was not possible to clarify the content with the gamers and the interpretation of what was reported was the researchers' rather than the participants' view, (iii) the gamers' socio-demographic and psychological profiles were largely unknown and only a few gamers included their age and gender in their posted comments, and (iv) it was not possible to be certain about the veracity of the gamers' self-reports. However, this study analysed data from 54 different online video game forums, and similar experiences have been found in the other studies about GTP previously conducted. However, none of these studies (including this one) has been able to indicate the actual percentage of gamers that have experienced GTP-MPB. Future studies could perhaps sample a significant number of posts in a random fashion and determine how often such experiences come up in online discussion posts. That way, researchers may be able to estimate how common such Game Transfer Phenomena are among gamers. In the present study, two modalities of GTP were examined – thoughts and behaviours. For this reason this study comprehends a large number of gamers' experiences and subcategories of GTP. It was considered that there were a clear continuity between thoughts and behaviours and that the analysed sequence from thoughts to impulses to behaviours was important in order to understand the effects of video game playing.

### **Conclusions and Implications**

This study contributes to the understanding of the effects of video game playing and shows how gamers' cognitions and behaviours can be influenced by video game playing. More specifically the gamers experienced automatic thoughts, sensations, impulses, automatic

mental processes, actions and behaviours with video game content. The interplay between physiological, perceptual and cognitive factors appears to explain many of the GTP-MPB. First of all, this study demonstrated that commercial video games played at home can produce neural adaptations. Neural adaptations manifested as a lack of cognitive and motor flexibility that suggests it is crucial to investigate neural adaptations induced by video game playing and not engage in demanding activities directly after stopping playing certain games. Postural instability or proprioceptive disarrangement after the virtual immersion may have safety implications when engaging in driving or operating machines, although some studies suggest that postural instability is moderate and short-lived (Cobb, 1999). Second, this study showed what type of thoughts has been experienced by gamers and how they dealt with them. In general GTP-MPB can be considered as a type of ruminative behaviour and preoccupation for the video game that in some cases can manifest in different ways (e.g., intrusive thoughts, stereotypical mental replays in real life settings). According to cognitive neoassociation theory, rumination is capable of maintaining thoughts, feelings and behavioural tendencies that are active in semantic memory (Berkowitz, 1990). Research has also found that daydreaming about video games is positively correlated with problematic gaming (Dauphin & Heller, 2010; Demetrovics, et al., 2012). For this reason, the relationship between GTP and the effects of video game content (both positive and negative) should be further investigated.

Third, this study demonstrated how gamers' reasoning and ways to respond to real life stimuli and events were compromised (at least shortly) after stopping playing. It appears that real life objects and events simulated in the game have become conditioned stimuli, "evocative objects", that trigger thoughts, feelings and behaviours associated with the game experience, which confirm the effects of priming by playing video games (Roskos-Ewoldsen, Roskos-Ewoldsen, & Dillman Carpentier, 2002). Cognitive errors and distortions ended up as misinterpretations and mix-ups between real life and video game stimuli and events, and lack of awareness and dissociations ended up as impulsive responses when the gamers encountered stimuli and events associated with the game. How video game contents influenced the gamers' cognitions after stopping playing should be deeply investigated. Applying learned skills from the game without awareness may help gamers to be prepared and actually resolve risk situations but cognitive bias and perseverative mental states can also end up in misjudgements of real life events and result in non-reflexive and impulse responses that put gamers or others in uncomfortable, embarrassing or risk situations.



Fourth, the relevance of simulation of real objects, ambiences, and activities in virtual environments was evident when automatic associations between stimuli elicited GTP-MPB. The increase of realistic elements and contents may facilitate GTP. The importance of sensory realism in the effects of video games has been demonstrated in previous studies (Jeong, et al., 2012). These findings suggest that it is important to examine and perhaps regulate the way real life objects and ambiences are used in the video games not limited to violence or visual cues such as red blood.

Fifth, this study suggests that the transfer of effects from the video games to real life is complex. Transfer of effects does not occur in a generalized way rather it appears to depend of the presence of particular stimuli in real life context that resemble video games contents. The performance of behaviours appears to depend on the affordances found in the real life environment. While gamers allowed themselves to perform video game activities that were playful and harmless, the most of the time the gamers were capable to controlled their impulses in risky situations.

Sixth, this study suggests how important it is to distinguish between voluntary and involuntary thoughts and behaviours influenced by video games to actually understand the effects of video game playing. In some cases, gamers voluntarily behaved as in the video game or suddenly performed something as in the game without control and awareness, and in other cases it appears as if the gamers were unable to contain their impulses and performed something as in the game due to feeling compelled to do so rather than actually wanting to do so.

The findings in this study should be interpreted carefully and should not be generalized. Indeed, in this study, gamers reported similar experiences in the same games, as reported in previous studies about GTP in this thesis, and confirm the relevance of the video game content in the experiences. However, it is important to note that GTP-MPB manifested after playing games with different content, and that more systematic research is needed to make definitive statements about particular behaviours and their further implications. Furthermore, similar phenomena to those identified in this study have also been experienced by engaging intensively in other non-gaming activities (e.g., watching movies, repetitive activities, etc.). However, particular phenomena appear to be enhanced by the virtual embodiment and the repetitive manipulation of video game controls and, gamers' habits (e.g., frequent and prolonged exposure). It is speculated that gamers are more prone to manifest stronger responses in front of real life stimuli associated with the video game immediately after stopping playing under perseverative mental states or during playing. The levels of response may depend on the

gamers' personality characteristics and/or level of immersion. Individuals with pathological personality traits and/or ones with poor impulse control may be more prone to experience the negative effects of GTP-MPB by not controlling their impulses when not discriminating between real life stimuli and video game situations. It is expected that highly engaged video game playing and gamers with gaming disorders experience more GTP triggered by associations since these individuals tend to highly respond to stimuli associated with the game (Decker & Gay, 2011; Metcalf & Pammer, 2011; Van Holst, et al., 2012; Zhou, et al., 2012).

A large number of studies examining media effects have showed a correlation between video game playing and subsequent effects. This study suggests – by contrasting gamers' experiences with video game content –that there may be a causal relationship between gamers' GTP-MPB experiences and video game content. However, other factors may play an important role in triggering the experiences. Further work needs to examine which individuals are more susceptible to experience GTP-MPB and to establish whether experiencing GTP-MPB has long-term cognitive, psychophysiological, and psychosocial effects. Symptoms of disorientation (such as motion sickness) tend to reduce with the prolonged and repetitive exposure to virtual environments simulators (Stanney, et al., 1999) and this might be the case in some of the GTP-MPB experiences. It is important to inform gamers about how to identify and interpret the Game Transfer Phenomena they experience.

## Chapter 7 - Cross-cultural Comparison between English and Spanish Speaking Gamers

### Speaking Gamers

“It is nice to see that all those weird things which have happened to me, when it feels that my gaming experiences are sort of bleeding into my reality, actually has a name [Game Transfer Phenomena], and it wasn't just me :P” (Participant in the online survey)

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Today people of all ages play more games than previous generations (Williams, Yee, & Caplan, 2008). The stereotypical picture of the gamer has changed (Griffiths, Davies, & Chappell, 2004; Williams, et al., 2008) and it is no longer the socially isolated adolescent typified in research from the 1980s (Shotton, 1989). The average age of the gamer in USA is 31 years old and has been playing for 14 years (Entertainment Software Association, 2014). In Europe, 51% of the gamers are under 35 years old (Interactive Software Federation of Europe, 2012). Video game playing is still predominantly an activity engaged in by males but 45% of European and American gamers are female. In countries like USA and UK, the age of the gamer is more evenly distributed. For instance, in the USA 32% are under 18 years, 32% are aged between 18-35 years, and 36% are older than 35 years (Entertainment Software Association, 2013; Interactive Software Federation of Europe, 2012). In Spain, gamers tend to be younger with 61% of males aged 16-34 years old playing, but only 26% of males aged 35 and 64 years (Interactive Software Federation of Europe, 2012). Around 25% of European gamers play games at least once a week. On average, gamers spend 12 hours per week on gaming (Interactive Software Federation of Europe, 2012), and 62% of the gamers play with other people, either online or in person. It is expected that since adolescent gamers have less responsibilities and time flexibility they spend more time playing games than adults, as was found by Griffiths, Davies, and Chappell (2004). However, the picture appears to change in terms of the session length, as older gamers play longer sessions than younger ones since their playing may be constrained to play just a few days per week when they are free from other responsibilities (Hussain, Griffiths, & Baguley, 2012). Also, women tend to play longer sessions than men in online games such as Massively Multiplayer Online Role-playing Games (MMORPG) (Hussain, et al., 2012; Williams, Consalvo, Caplan, & Yee, 2009; Williams, et al., 2008). Research appears to suggest that culture does not directly affect gaming patterns, rather that gaming patterns are mediated by the players' expectations of outcomes of playing online games (Lee & Wohn, 2012). However, the contexts in which video games are played vary in different cultures.

Research into the psychosocial effects of video game playing has mainly focused on understanding video game content and excessive playing. For instance, studies into problematic online gaming have examined the relationship between gamer demography (e.g., age, gender, etc.) (Ng & Wiemer-Hastings, 2005), personality traits (Mehroof & Griffiths, 2010), brain functioning (Ko, et al., 2009) comorbid with psychiatric symptoms (Chan & Rabinowitz, 2006), video game habits and motivations for playing (Kuss, et al., 2012), and

identification with characters (Smahel, Blinka, & Ledabyl, 2008). Moreover, research into video game content has explored how violent or pro-social content modifies cognition and behaviour at least for short periods of time (Barlett, Branch, et al., 2009a), where cultural differences have not been strong enough to moderate the effects of playing violent video games (Anderson et al., 2010).

So far, the author has analysed a large number of gamers' experiences from interviews (Ortiz de Gortari, 2010, Ortiz de Gortari, et al., 2011) and data collected in online video game forums (see Chapters 4 to 6). Also, a large number of media articles and anecdotal data have been generated about GTP during the period of this PhD. However, we do not know how common GTP are, and what factors can be associated to GTP. Therefore this study takes a first step to fill the gap and answer some of the main unanswered questions concerning GTP.

Different phenomena come to mind when thinking about which individual factors have the potential to make gamers more susceptible to experiencing GTP. Fantasy proneness which overlaps with dissociation (Giesbrecht, Geraerts, & Merckelbach, 2007) involves investing extensive time in fantasizing (Giesbrecht & Merckelbach, 2006). Research has found that fantasizers typically (i) have vivid memories from childhood, (ii) report paranormal experiences, (iii) have intensive religious experiences, (iv) have unusual vivid imagery and hallucinatory experiences, (v) commission errors (Giesbrecht, et al., 2007), (vi) are susceptible to being hypnotized (Merckelbach & van de Ven, 2001; Sánchez-Bernardos & Avia, 2004; Wilson & Barber, 1982), (vii) report sleep experiences such as narcolepsy, and experience vivid and unusual dreams (Giesbrecht & Merckelbach, 2006). It has also been suggested that cognitive failures such as source memory confusions are associated with fantasy proneness but such assertions have not been proved (Aleman & de Haan, 2004).

Atkinson and Crawford (1992) investigated the significance of individual differences in hypnotic proneness and visuospatial skill on afterimage persistence. They found that individuals who were more efficient in sustaining their attention (i.e., focus their attention on relevant cues and activities) were more likely to experience persistent afterimages and were more susceptible to be hypnotized. This is interesting because video games absorb the attention and has been associated with trance states (Wood, et al., 2007), enhance memory recollection of objects (Sungur & Boduroglu, 2012), and enhance visuospatial skills (e.g., selective attention in place and selective attention to objects, fast reaction times on mental rotations) (Green & Bavelier, 2012; Okagaki & Frensch, 1994; Sungur & Boduroglu, 2012). However, video game experience has also been associated with failures in cognitive control (Bailey, et

al., 2010; Kronenberger, et al., 2005; Mathews et al., 2005). More specifically, it has been implicated in proactive cognitive control, which is involved in the individual ability to maintain the attention in the task at hand, but not interfere with reactive control, which is involved in resolving conflicts or ambiguities when unexpected distracting stimuli appear (Bailey, et al., 2010). Also, studies have found positive correlations with video game playing and measures related to attention deficits and hyperactivity (Chan & Rabinowitz, 2006; Swing & Gentile, 2010). Executive functions such as planning, working memory, impulse control, inhibition and mental flexibility are typically impaired in individuals with attention deficit hyperactivity disorder (ADHD), obsessive compulsive disorder, Tourette syndrome, schizophrenia, and autism spectrum disorder (Hill, 2004).

The occurrence of GTP suggest failures in cognitive control and executive functioning when gamers pay attention to thoughts unrelated to the current task or when gamers exhibit impulsive or reflexive responses to real life stimuli associated with elements in the game. Furthermore, gamers reported a lack of cognitive and motor flexibility when they kept applying the rules from the game to real life settings or kept moving as in the video games such as strafing (see chapter 6), or seeing video game images after prolonged video game sessions (see Chapter 4), that suggest neural adaptive mechanisms play an important role. Neural adaptation symptoms (e.g., recurrent visual flashbacks, continued balance disturbance and hand-eye incoordination) have been experienced by pilots for hours or days following their virtual experience with a flight simulator (Ungs, 1989). Moreover, GTP share similarities with a broad number of symptoms seen in photosensitivity epilepsy, migraine aura, schizophrenia, and hallucinogen persisting perception disorder. Gamers have also reported seeing video game images or hearing voices from video games triggered by associations with external stimuli (see Chapters 4 and 5).

Additionally, there is some evidence in the qualitative GTP studies that suggest GTP is related to excessive video game playing (Ortiz de Gortari, et al., 2011c; Ortiz de Gortari & Griffiths, 2012b{Ortiz de Gortari, 2010 #776}). Research has found that males have more tendency to develop problems with video games than females (Griffiths & Hunt, 1998; Ko, Yen, Chen, Chen, & Yen, 2005), although a few studies have not found any gender differences in pathological gaming (Li, Liau, & Khoo, 2011). Some of the GTP experiences appear to share similarities with symptoms of medical conditions; this is why it was important to investigate this variable. The comorbidity between gaming/internet addiction and mental disorders has been reported in several studies. More specifically, research has found correlations between

internet addiction and symptoms of ADHD and depression (Yen, Ko, Yen, Wu, & Yang, 2007). Other comorbidity include generalized anxiety disorders, social anxiety disorders, borderline personality, avoidant personality, eating disorders and alcohol/substance abuse disorders (Choi, et al., 2009; Gong et al., 2009; Lam, Peng, Mai, & Jing, 2009; Van Rooij, et al., 2014).

Moreover, in this study it was important to examine to what extent GTP were experienced by individuals who had consumed psychoactive substances or if the gamers were under the influence of psychoactive substances when they experienced GTP, because under the influence of psychoactive substances, individuals are more susceptible to experience altered perceptions (Ohayon, 2000), and may be more susceptible to experience GTP.

### **Aim, Research Questions and Hypothesis**

The aim of this study was to investigate the generalities of GTP and examine if demographic factors, video game playing habits, and other individual factors contribute to GTP. This was examined in the full population and then across the two samples, the English-speaking sample (EnS) and Spanish-speaking sample (SpS) for further comparative and cross-cultural analysis. This was done by comparing individuals who had experienced GTP with those who had never experienced GTP in the full population and then by individual samples to further compare and contrast the findings. Specific phenomenological differences based on the participants' profiles (e.g., age, playing habits) in each sample and cultural language context differences were addressed for explaining the instances of GTP.

The main research questions were: (i) How common are GTP in the sample of gamers? (ii) Which GTP are the most common among gamers? (iii) What are the general characteristics of GTP? (iv) How are GTP associated with the gamers' profiles, habits, motivations, medical conditions, drug consumption, and tendency to recall dreams? No previous study has ever examined the relationship between GTP and other factors, but based on findings in the qualitative studies conducted to date about GTP, and previous reviews of literature, it was expected that GTP would be significantly associated with (i) video game playing session length, (ii) having a medical or clinical condition, (iii) having taken psychoactive substances, and (iv) having a high tendency to recall dreams. Lastly, it was expected that playing motivations such as immersion, exploration, escape, and customization would be significantly associated with GTP. It was also expected that some factors would be negatively associated with GTP such as wanting to finish the game as fast as possible, socialization and competition.

## Method

### Sample

A total of 2,362 gamers completed the online survey. A total of 1,284 gamers answered the English survey (57.9%) and 1,078 gamers answered the Spanish version (42.1%). The majority of the participants were male (86.0%). Nearly half of the participants (46.1%) were between 18 and 22 years old (with ages ranging from 18 to 54 years or older). The participants that completed the survey resided in 78 different countries. The vast majority of the participants who reported their residence (n=2,077) were from Mexico (33.8%), United States (20.0%), United Kingdom (11.4%), Sweden (5.4%) and Canada (4.7%). Numerous countries accounted for the remaining of the total sample (e.g., Spain, Netherlands, Venezuela, Philippines, Singapore, and Saudi Arabia).

### Procedure

The participants were recruited via online gaming community forums, *Facebook*, and *meetup.com* groups between June and December 2012. The recruitment of the participants was supplemented by snowball sampling via participants that were recruited with the help of leaders in video game groups and gaming organizations. A pilot survey was carried out before the main study. Informed consent was obtained from all participants before they began the survey. Ethical approval for the study was granted by the university's Research Ethics Committee. Once the participants had submitted their responses, the data were exported into SPSS 21 (IBM, Armonk, NY, USA) for analysis. This study used a cross-sectional design where two independent data sets were collected using a questionnaire in two languages.

### Materials

A questionnaire in English language was translated into Spanish and then back into English. Multiple translators were involved in the translation process. The English survey was translated into Spanish by a bilingual speaker and then the Spanish questionnaire was translated into English by another bilingual speaker, and contrasted with the original English questionnaire. The survey comprised 30 questions.

**Video game habits.** Questions 1 to 3 asked about participants' playing habits, typical length of video game playing sessions, frequency of video game playing, and what type of



gamer they considered themselves (i.e., newbie, casual, hard-core, or professional). These were categorical questions and participants could select only one choice.

**Motivations for play and in-game behaviours.** Question 5 included one multiple-choice question, with nine different choices. The motivations examined were: (i) to “finish the game as fast as possible” as a contrast to in-game behaviour that required paying attention to game elements such as exploration and customization, and (ii) playing for excitement as a measure of play for arousal. Other motivations included in the questionnaire were based on Yee’s (2006) players’ typology motivations. These were: playing for (i) rules and mechanism, (ii) scoring and competition, (iii) socializing, (iv) exploration, (v) immersion, (vi) customization, and (vii) escape.

**GTP modalities/sub-modalities.** Questions 7 to 11 included items about GTP developed based on gamers' self-reports about GTP. All the items were scored on a Likert scale that assessed frequency (i.e., ‘all the time’, ‘many times’, ‘a few times’, ‘once’ and ‘never’). Each question included one example of a GTP experience previously reported by some gamers to help participants better understand the question. Also, an open –ended response space was included at the end of each section, in case gamers wanted to make additional written comments about their experiences. Five dimensions of GTP were investigated. There were four questions per each GTP dimension (i.e., visual, body sensations, auditory, and automatic thoughts and behaviour). More specifically: *Visual experiences* comprised questions about (i) mind visualization and/or seeing video game images in the back of the eyelids, (ii) seeing video game images with open eyes, (iii) perceiving real life environments distorted such as visual after-effects, and (iv) misperceiving real life objects as something from the video game. *Body sensations* comprised questions about (i) motion-sickness, (ii) tactile sensations associated with video game experiences, (iii) altered perceptions of time or body, and (iv) out-of-body experiences. *Auditory experiences* comprised questions about (i) hearing the music, (ii) sounds effects, or (iii) voices of video game characters when not playing, and (iv) misinterpreting real life sounds as something from the video game. *Automatic thoughts* comprised questions about (i) wanting or feeling the urge to do something in real life after seeing something that reminded them of the video game, (ii) experiencing still being in the mind-set of the game, (iii) finding themselves thinking about using something from the video game in real life, and (iv) momentarily mixing up video game events with real life events. *Behavioural experiences* comprised questions about (i) involuntary body movements associated with video game playing; (ii) singing, shouting or saying something unintentionally relating to video game

content, (iii) acting out behaviours or performing some activity that was influenced by the video game, and (iv) acting differently in real life situations unintentionally due to the video game.

**GTP Characteristics.** Questions 13 to 23 comprised two sections. The first section had multiple-choice questions relating to: (i) genre of games played related to GTP (e.g., puzzle, First Person Shooter), (ii) name of the game (if remembered), (iii) average number of hours played per week when GTP occurred, (iv) average length of video game sessions when GTP occurred, (v) average duration of GTP experiences (e.g., seconds, hours, days), (vi) when GTP occurred (e.g., while playing, weeks after playing), (vii) circumstances under which GTP occurred (e.g., when falling asleep, while doing activities), and (viii) impact of the experience (e.g., unpleasant, pleasant). Each question included a space for an open answer if the participant wanted to leave additional written comments. The second section comprised single-choice questions about whether the participants had: (i) experienced GTP recurrently or episodically over a period of time (e.g., did they experience GTP every time they encountered something in real life, every time they blinked or closed the eyes, etc.), (ii) been distressed or affected socially, occupationally or in other areas of day-to-day functioning by the experience, and (iii) been under the influence of any psychoactive substance (i.e., prescribed medication, alcohol, illicit drugs) when they experienced GTP. Only participants that answered affirmatively to at least one of the 20 questions about GTP had access to this section. The remainder of the participants were automatically redirected to the demographic questions.

**Demographic information.** Questions 24 to 27 asked participants for their gender, age, occupation, and main country of residence.

**Other relevant variables.** Question 6 was a frequency question and asked about dream recall frequency. Question 28 asked about medical conditions. In the English survey (EnS) this was a multiple-choice question and in the Spanish survey (SpS) it was a single-choice question. This occurred due to technical differences between the questionnaires. Questions 29 and 30 were frequency questions and asked about experiences with illicit drugs, and about the experience of flashbacks as a side-effect of psychoactive drug consumption. These questions were included because it was important to know whether GTP were associated with clinical conditions (e.g., epilepsy, mental disorders, and visual disorders) and/or the consumption of psychoactive drugs. Furthermore, the recurrence of flashbacks is important to know because recurrent visualization of images and other altered perceptions may have been as a consequence of using illicit drugs such as hallucinogens.

### **Statistical analysis**

Descriptive statistics were conducted to obtain information about the frequency of the GTP modalities and characteristics about GTP. Only participants that responded affirmatively to at least one of the items about GTP modalities were able answer the section relating to GTP characteristics. Chi-square tests of independence were conducted to examine the differences between participants who had experienced at least one type of GTP at some point and participants that had never experienced GTP. Not all participants answered every question, therefore, the total sample size may be different in the analysis of different questions. A new dichotomous variable was created to measure the prevalence of GTP experiences (having experienced GTP included the responses ‘all the time’, ‘many times’, ‘a few times’, ‘once’, or ‘never’). Participants who had experienced GTP were classified in the group “GTP”, and participants who had never experienced GTP were classified in the group “No GTP”.

Most of the participants reported that they had experienced at least one type of GTP at least once (89%, n=2,281), while 11% answered that they either never had experienced GTP (N=81), or answered none of the questions about GTP (N=203). Since there were large numbers of participants who reported having experienced GTP at some point, participants who answered affirmative to some of the items of GTP were classified in four different levels of GTP. Low GTP: having experienced between 1 and 5 GTP, medium GTP: 6 to 10 GTP, high GTP: 11 to 15 GTP and very high GTP: 16 to 20 GTP. The analysis of the data was conducted in each sample individually to allow cross cultural comparisons and also because there were a few differences between the questions used in the ENS and SPS questionnaire. Following analysis of the dataset as a whole, the English-speaking survey sample (EnS) was separated from the Spanish-speaking survey sample (SpS) in order to conduct comparison of the results between the samples.

### **Results**

This section includes the results of descriptive statistics and Chi-square analyses for the full sample and each of the sub-samples, the English speaking sub-sample (EnS) and the Spanish speaking sub-sample (SpS). First in each section the result is presented for the full sample and then for each of the sub-samples. The result includes the following sections: (i) demographics, (ii) individual characteristics, (ii) video game habits, (iii) gaming motivations and in-game behaviours, (iv) GTP modalities/sub-modalities, and (v) GTP characteristics.

Descriptive statistics and chi-square analyses are discussed together when appropriate. Only significant chi-squares are further described.

### Demographic Variables

#### *Gender (n=2,079)*

**Full sample.** The majority in the GTP group were male (86.0%) but also there were more females in the GTP group than in the No GTP group (14.0% vs. 11.8%).

**Sub-samples.** In the GTP group, the majority was male (80.3% EnS; 92.9 SpS). More than 20% of the expected values were less than five in the SpS, so Fisher’s exact test was selected in this case instead of chi-square. In the EnS there were more males in the GTP group (80.3%) than in the No GTP group (19.7%). Similarly, in the SpS there were more males in the GTP (92.9.1%) than in the No GTP group (7.1%). Differences are observed among the female gamers. In the EnS there are more female in the GTP group (19.7%) than in the No GTP group (10.8%), but in the SpS there are less females in the GTP group (7.1%) than in the No GTP group (12.9%).

Gender was not significantly associated with whether or not having experienced GTP (Table 7.1).

**Table 7. 1**

*The relationship between the GTP and the No GTP group in terms of gender in the full and in the both samples.*

|               | <b>Full sample</b> |               | <b>English Speaking</b> |               | <b>Spanish Speaking</b> |               |
|---------------|--------------------|---------------|-------------------------|---------------|-------------------------|---------------|
|               | $X^2 = 0.279$      |               | $X^2 = 1.812$           |               | $X^2 = 1.513$           |               |
|               | $d.f = 1$          |               | $d.f = 1$               |               | $d.f = 1$               |               |
| <b>Gender</b> | $p\ value = 0.597$ |               | $p\ value = 0.178$      |               | $p\ value = 0.275^a$    |               |
|               | <b>GTP</b>         | <b>No GTP</b> | <b>GTP</b>              | <b>No GTP</b> | <b>GTP</b>              | <b>No GTP</b> |
|               | <b>N(%)</b>        | <b>N(%)</b>   | <b>N(%)</b>             | <b>N(%)</b>   | <b>N(%)</b>             | <b>N(%)</b>   |
|               | <b>n=2,011</b>     | <b>n=68</b>   | <b>n=1,106</b>          | <b>n=37</b>   | <b>n=905</b>            | <b>n=31</b>   |
| Male          | 1729(86.0)         | 60(88.2)      | 888(80.3)               | 33(89.2)      | 841(92.9)               | 27(87.1)      |
| Female        | 282(14.0)          | 8(11.8)       | 218(19.7)               | 4(10.8)       | 64 (7.1%)               | 4 (12.9%)     |

\*p < .05. \*\*p < .01. \*\*\*p < .001 <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher’s exact test was selected.

**Age (n=2,001)**

**Full sample.** Nearly half of the gamers (46.1%) were between 18 and 22 years old, 26.5% were between 23 and 27 years old, 15.0% were between 28 and 32 years old, 7.6% were between 33 and 38 years old, 2.3% were between 39 and 43 years old and, 2.4% were 44 years old or older. The majority in the GTP group were either 18 to 22 years old (46.5%) or 23 to 27 years old (26.6%). More than 20% of the expected values were less than five in so Fisher's exact test was selected in this case instead of chi-square. Age was significantly associated with having experienced GTP in the full sample ( $\chi^2 (7) = 17.586, p < 0.01$ ). Participants who were 33 to 38 years old in the full sample were significantly less likely to have experienced GTP.

**Sub-samples.** The majority of the participants were between 18 and 27 years old (67.8% EnS, 78.7% SpS). There were more participants who had experienced GTP in the SpS between 18 to 22 years old than in the EnS (40.3% EnS, 54.2% SpS), and more participants in the EnS that were 23 to 27 years old than in the SpS (27.4% EnS, 25.6% SpS).

More than 20% of the expected values were less than five in the SpS, so Fisher's exact test was selected in this case instead of chi-square. Age was only significantly associated with whether or not having experienced GTP in the SpS ( $\chi^2 (7) = 46.916, p < 0.001$ ). In the SpS, more than half of the participants in the GTP group were 18 to 22 years old (54.2%). Those who were 18 to 22 years old were significantly more likely to have experienced GTP, while those 33 to 38 years old and 39 to 43 years old were significantly less likely to have experienced GTP (Table 7.2).

**Table 7. 2**

*The relationship between the GTP and the No GTP group in terms of age in the full and in the both samples.*

| Age                   | Full sample  |                        | English Speaking  |                        | Spanish Speaking  |                        |
|-----------------------|--|------------------------|---|------------------------|---|------------------------|
|                       | X <sup>2</sup> = 17.586**<br>d.f = 7<br>p value = 0.009 <sup>a</sup> |                        | X <sup>2</sup> = 3.624<br>d.f = 7<br>p value = 0.735 <sup>a</sup> |                        | X <sup>2</sup> = 46.916***<br>d.f = 1<br>p value = 0.000 <sup>a</sup> |                        |
|                       | GTP<br>N(%)<br>n=1,934   | No GTP<br>N(%)<br>n=67 | GTP<br>N(%)<br>n=1,072  | No GTP<br>N(%)<br>n=36 | GTP<br>N(%)<br>n=862  | No GTP<br>N(%)<br>n=31 |
| 18-22 years old       | 899(46.5)  | 24(35.8)               | 432(40.3)   | 19(52.8)               | 467(54.2)   | 5(16.1)                |
| 23-27 years old       | 515(26.6)  | 16(23.9)               | 294(27.4)   | 6(16.7)                | 221(25.6)   | 10(32.3)               |
| 28-32 years old       | 291(15.0)  | 9(13.4)                | 165(15.4)   | 5 (13.9)               | 126(14.6)   | 4(12.9)                |
| 33-38 years old       | 137(7.1)   | 15(22.4)               | 94(8.8)   | 4(11.1)                | 43(5.0)   | 11(35.5)               |
| 39-43 years old       | 44(2.3)  | 3(4.5)                 | 44(4.1)   | 2(5.6)                 | 0(0.0)  | 1(3.2)                 |
| 44-48 years old       | 24(1.2)  | 0(0.0)                 | 21(2.0)   | 0(0.0)                 | 3(0.3)  | 0(0.0)                 |
| 49-53 years old       | 10(0.5)  | 0(0.0)                 | 9(0.8)  | 0(0.0)                 | 1(0.1)  | 0(0.0)                 |
| 54 years old or older | 14(0.7)  | 0(0.0)                 | 12.6(1.2)   | 0.4(0.0)               | 1(0.1)  | 0(0.0)                 |

\*p < .05. \*\*p < .01. \*\*\*p < .001 <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher's exact test was selected.

### **Occupation (n=2,101)**

**Full sample.** Almost half of the participants (46.1%) were students, while 28.4% were working full-time, 9% part time, 6.8% self-employed, 5.9% unemployed, 1.3% homemakers, 0.2% retired or unable to work and 1.9% reported 'Other' (Table 7.3). The majority of the participants in the GTP group were students (46.6%) or employed full-time (28.4%). There were more students in the GTP group than in the No GTP group. More than 20% of the expected values were less than five in both EnS and SpS, so Fisher's exact test was selected instead of chi-square. Occupation was significantly associated with having experienced GTP in the full sample ( $\chi^2(4) = 15.158, p < 0.01$ ). Those who were self-employed and retired were significantly less likely to have experienced GTP.

**Sub-samples.** Being a student was the most prevalent occupation in both groups (39.0% EnS vs. 54.8% SpS) but there were more students in the SpS. There were more students

in the GTP group than in the not GTP group in both samples. More than 20% of the expected values were less than five in both EnS and SpS, so Fisher's exact test was selected instead of chi-square. According to the tests occupation was significantly associated with whether or not having experienced GTP but only in the SpS ( $\chi^2 (7) = 28.151, p < 0.001$ ). In the SpS there were more students that have experienced GTP (43.2% EnS, 56.0% SpS). Those who were students in the SpS were significantly more likely to have experienced GTP, while those being a homemaker or self-employed were significantly less likely to have experienced GTP (Table 7.3).

**Table 7.3**

*The relationship between the GTP and the No GTP group in terms of occupation in the full and in the both samples.*

| Occupation         | Full sample  |                        | English Speaking  |                        | Spanish Speaking   |                        |
|--------------------|--|------------------------|---|------------------------|--|------------------------|
|                    | GTP<br>N(%)<br>n=2,031                                       | No GTP<br>N(%)<br>n=70 | GTP<br>N(%)<br>n=1,119                                    | No GTP<br>N(%)<br>n=37 | GTP<br>N(%)<br>n=912   | No GTP<br>N(%)<br>n=33 |
|                    | $X^2 = 18.067^*$<br>$d.f = 8$<br>$p \text{ value} = 0.017^a$ |                        | $X^2 = 7.728$<br>$d.f = 8$<br>$p \text{ value} = 0.484^a$ |                        | $X^2 = 28.151^{***}$<br>$d.f = 7$<br>$p \text{ value} = 0.000^a$ |                        |
| Full-time employed | 576(28.4)  | 22(31.4)               | 369(33.0)   | 12(32.4)               | 207(22.7)  | 10(30.3)               |
| Part-time employed | 185(9.1)   | 6(8.6)                 | 126(11.3)   | 3(8.1)                 | 59(6.5)  | 3(9.1)                 |
| Self-employed      | 133(6.5)   | 11(15.7)               | 56(5.0)   | 3(8.1)                 | 77(8.4)  | 8(24.2)                |
| Unemployed         | 119(5.9)   | 5(7.1)                 | 82(7.3)   | 2(5.4)                 | 37(4.1)  | 3(9.1)                 |
| Homemaker          | 25(1.2)  | 2(2.9)                 | 21(1.1)   | 0(0.0)                 | 4(0.4)   | 2(6.1)                 |
| Student            | 946(46.6)  | 23(32.9)               | 435(38.9)   | 16(43.2)               | 511(56.0)  | 7(21.2)                |
| Retired            | 3(0.1)   | 1(1.4)                 | 3(0.3)  | 1(2.7)                 | 0(0.0)   | 0(0.0)                 |
| Disable to work    | 3(0.1)   | 0(0.0)                 | 1(0.1)  | 0(0.0)                 | 2(0.2)   | 0(0.0)                 |
| Other              | 41 (2.0)   | 0(0.0)                 | 26(2.3)   | 0(0.0)                 | 15(1.6)  | 0(0.0)                 |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$  <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher's exact test was selected.

## Individual characteristics

The next section includes the results of the analysis of possible underlying reasons for experiencing GTP; medical conditions, use of drugs, and tendency to recall dreams.

### *Medical conditions (n=2,210)*

**Full sample.** The majority of the participants did not have any medical condition (81.4%). However, the EnS had the possibility to answer multiple options, while the SpS could respond to only one option. Therefore a new dichotomous variable was created called “Merged medical condition” (having a medical condition/not having a medical condition for further analysis. Only one response was accounted for each participant into this new variable). Of those in the GTP group, 19.1% had a medical condition, while 3.9% in the No GTP had a medical condition. According to Chi-square test, having a medical condition was significantly associated with having experienced GTP ( $\chi^2(1) = 11.528, p < 0.01$ ). Those who had a medical condition in the full sample were significantly more likely to have experienced GTP. Another new variable was created by reclassifying the results from the EnS and SpS in terms of physical and psychological medical conditions. More than 20% of the expected values were less than five in the full sample for the physical medical condition variable, so Fisher’s exact test was selected in this case instead of chi-square. This was done to further examine if having a physical (e.g., epilepsy, visual disorder) or psychological (e.g. sleep disorder, mental disorder) medical condition was associated with having experienced GTP in the full sample. Only those who had a psychological medical condition were significantly more likely to have experienced GTP. ( $\chi^2(1) = 7.052, p < 0.01$ ) (Table 7.4).

**Sub-samples.** Most participants from both the EnS (n=1,284) and the SpS (n = 926) did not have any medical condition (76.2% EnS, 88.7% SpS).

Of those who have GTP, 6.3% reported a sleep disorder (see Table 7.5 for the full results). Moreover, participants could freely specify medical condition outside the pre-defined options. Those that both sub-samples reported were: Attention deficit hyperactivity disorder (ADD/ADHD), migraines, obsessive-compulsive disorder (OCD), chronic pain, asthma/allergy, colour blindness, and hypertension. All except one of the gamers who freely reported having a medical condition (across both groups) had experienced some type of GTP at some point. Chi-square in this case was analysed per sample, using a new dichotomous variable (having a medical condition or not having a medical condition) “medical condition EnS” and “medical condition SpS”. This was created exclusively from data from the EnS or SpS (rather than using the previously created “Merged medical condition”).



In the EnS, the majority of participants did not have a medical condition (76.2%). Furthermore, 26.7% of those in the GTP group had a medical condition, and 2.7% of those in the No GTP group. More than 20% of the expected values were less than five in the SpS, so Fisher's exact test was selected in this case instead of chi-square. In this sample, having a medical condition were significantly associated with have experienced GTP. Only 24.6% have a medical condition. However, those who had a medical condition were significantly more likely to have experienced GTP ( $\chi^2 (1) = 11.666, p < 0.01$ ). Further analysis was conducted to examine if having a physical or psychological medical conditions were associated with GTP. It was found that only 9.4% have a physical medical condition and 13.0% have a psychological medical condition in the GTP group. A significant association was found in having a psychological medical condition in the EnS ( $\chi^2 (1) = 5.524, p < 0.05$ ). More than 20% of the expected values were less than five in both EnS and SpS in both the physiological and physical medial conditions variables, so Fisher's exact test was selected instead of chi-square. Those who had a psychological medical condition were significantly more likely to have experienced GTP. In the SpS, the majority did not have a medical condition (88.5%). Of those in the GTP group, 11.5% had a medical condition compared to 6.1% of those in the No GTP. Only 4.1% had a physical condition and 10.3% had a psychological medical condition in the GTP group. Having a medical condition was not significantly associated with having experienced GTP ( $\chi^2 (1) = 0.948, p > 0.05$ ).

**Table 7. 4**

*The relationship between the GTP and the No GTP group in terms of medical conditions in the full sample and sub-samples*

|   | <b>Full sample</b>  |                              | <b>English Speaking</b>                                       |                              | <b>Spanish Speaking</b>                                   |                              |
|---|---|------------------------------|---|------------------------------|---|------------------------------|
| <b>Merged medical condition<sup>1</sup></b> | $X^2 = 11.528^{**}$<br>$d.f = 1$<br>$p \text{ value} = 0.001$ |                              | $X^2 = 11.666^{**}$<br>$d.f = 1$<br>$p \text{ value} = 0.001$ |                              | $X^2 = 0.948$<br>$d.f = 1$<br>$p \text{ value} = 0.572^a$ |                              |
|   | <b>GTP</b><br><b>N(%)</b>                                     | <b>No GTP</b><br><b>N(%)</b> | <b>GTP</b><br><b>N(%)</b>                                     | <b>No GTP</b><br><b>N(%)</b> | <b>GTP</b><br><b>N(%)</b>                                 | <b>No GTP</b><br><b>N(%)</b> |
|   | <b>n=1,956</b>  | <b>n=69</b>                  | <b>n=1,073</b>  | <b>n=37</b>                  | <b>n=883</b>  | <b>n=32</b>                  |
|   | 408(21.2)   | 3(4.3)                       | 305(26.7)   | 1(2.7)                       | 103(11.5)   | 2(6.1)                       |

|  |                      |             |                      |             |                      |             |
|--|----------------------|-------------|----------------------|-------------|----------------------|-------------|
| <b>Physical medical condition<sup>1</sup></b>      | $X^2 = 1.757$        |             | $X^2 = 1.930$        |             | $X^2 = 0.072$        |             |
|  | $d.f = 1$            |             | $d.f = 1$            |             | $d.f = 1$            |             |
|  | $p\ value = 0.231^a$ |             | $p\ value = 0.246^a$ |             | $p\ value = 1.000^a$ |             |
|  | <b>n=1,956</b>       | <b>n=69</b> | <b>n=1,073</b>       | <b>n=37</b> | <b>n=883</b>         | <b>n=32</b> |
|  | 137(7.0)             | 2(2.9)      | 101(9.4)             | 1(2.7)      | 36(4.1)              | 1(3.1)      |
| <b>Psychological medical condition<sup>1</sup></b> | $X^2 = 7.052^{**}$   |             | $X^2 = 5.524^*$      |             | $X^2 = 1.761$        |             |
|  | $d.f = 1$            |             | $d.f = 1$            |             | $d.f = 1$            |             |
|  | $p\ value = 0.008$   |             | $p\ value = 0.010^a$ |             | $p\ value = 0.242^a$ |             |
|  | <b>n=1,956</b>       | <b>n=69</b> | <b>n=1,073</b>       | <b>n=37</b> | <b>n=883</b>         | <b>n=32</b> |
|  | 231(11.8)            | 1(1.4)      | 140(13.0)            | 0(0.0)      | 91(10.3)             | 1(3.1)      |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$  <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher's exact test was selected. <sup>1</sup> The dichotomous variables created for this table only had one response accounted from each participant.

**Table 7.5**

*Medical conditions reported in the full sample and sub-samples*

|  | <b>Full sample</b> |               | <b>English Speaking</b> |               | <b>Spanish Speaking</b> |               |
|--|--------------------|---------------|-------------------------|---------------|-------------------------|---------------|
|  | <b>GTP</b>         | <b>No GTP</b> | <b>GTP</b>              | <b>No GTP</b> | <b>GTP</b>              | <b>No GTP</b> |
|  | <b>N(%)</b>        | <b>N(%)</b>   | <b>N(%)</b>             | <b>N(%)</b>   | <b>N(%)</b>             | <b>N(%)</b>   |
|  | <b>n=2,090</b>     | <b>n=70</b>   | <b>n=1,207</b>          | <b>n=38</b>   | <b>n=883</b>            | <b>n=32</b>   |
| None                                   | 1,542(73.8)        | 66(94.3)      | 786(65.1)               | 36(94.7)      | 756(85.6)               | 30(93.8)      |
| Epilepsy                               | 13(0.6)            | 0(0.0)        | 11(0.9)                 | 0(0.0)        | 2(0.2)                  | 0(0)          |
| Visual disorder                        | 101(4.8)           | 1(1.4)        | 89(7.4)                 | 1(2.6)        | 12(1.4)                 | 0(0)          |
| Hearing disorder                       | 30(1.4)            | 1(1.4)        | 26(2.2)                 | 0(0.0)        | 4(0.4)                  | 1(3.1)        |
| Sleeping disorder                      | 132(6.3)           | 1(1.4)        | 82(6.8)                 | 0(0.0)        | 50(5.7)                 | 1(3.1)        |
| Mental disorder                        | 86(4.1)            | 0(0.0)        | 80(6.6)                 | 0(0.0)        | 6(0.7)                  | 0(0)          |
| Problematic gaming or Gaming addiction | 74(3.5)            | 0(0.0)        | 46(3.8)                 | 0(0.0)        | 28(3.2)                 | 0(0)          |
| Other                                  | 112(5.4)           | 1(1.4)        | 87(7.2)                 | 1(2.6)        | 25(2.8)                 | 0(0)          |

The question in the English version allowed multiple responses, while the Spanish version just allowed one response. The full sample is a merge of the English and Spanish samples. <sup>1</sup>Excluding short-sightedness/long-sightedness. <sup>2</sup>Excluding insomnia provoked by the visualization of video game images.

***Drug consumption (n=2,210)***

**Full sample.** Over two-thirds (69.3%) of the participants had never taken drugs, 14.8% had taken drugs a few times, 7.4% once, 6.8% many times, and 1.7% all the time. A dichotomous variable was created, which showed that 29.5% of those in the GTP group had consumed drugs, while in the No GTP group 21.4% had done it. However, a Chi-square test did not show significant associations with whether or not they had experienced GTP ( $\chi^2 (1) = 2.904, p > 0.05$ ).

**Sub-samples.** More than half of the participants in both groups had never consumed psychoactive drugs, but participants in the EnS consumed more drugs than the SpS (39.1% EnS, 20.4% SpS). However, those in the EnS GTP group had consumed more drugs than the No GTP group (39.7% GTP, 18.9% No GTP), while those in the SpS GTP group had consumed less drugs than the No GTP group (20.2% GTP, 24.2% no GTP). More than 20% of the expected values were less than five in both the EnS and SpS, so Fisher's exact test was selected instead of chi-square. According to the test significant associations were only found between having consumed drugs in the EnS ( $\chi^2 (1) = 6.519, p < 0.05$ ). Those who had consumed drugs were more likely to have experienced GTP (Table 7.6).

***Flashbacks as side-effects of drug consumption (n=641)***

**Full sample.** Over three-quarters of the sample (77.1%) had never experienced flashbacks as a side-effect of drug consumption, 12.7% had flashbacks a few times, 5.7% had experienced flashbacks once, 2.0% many times, 0.9% all the time and 1.5% did not remember.

A dichotomous variable was created which showed that the majority of the sample (78.3%) had not experienced flashbacks as after-effects of drug consumption. The majority in the GTP group had not experienced flashbacks but more people that had experienced GTP had experienced flashbacks compared to those who had not experienced GTP (21.9% GTP, 13.3% No GTP). Flashbacks were not significant associated with GTP in the full sample ( $\chi^2 (1) = 0.631, p > 0.05$ ).

**Sub-samples.** The majority of the participants in both samples had not experienced flashbacks as a side-effect of drug consumption (EnS 80.0%, 74.4% SpS). The majority in the GTP group had not experienced flashbacks but more people that had experienced GTP had experienced flashbacks compared to those that had not experienced GTP (20.0% GTP, 14.3% No GTP EnS; 26.2% GTP, 12.5% No GTP SpS). Experiencing flashbacks as a side-effect of

drug consumption was not significantly associated with whether or not having experienced GTP in any instance (EnS ( $\chi^2(1) = 0.143, p > 0.05$ , SpS ( $\chi^2(1) = 0.756, p > 0.05$ ) (Table 7.6).

**Table 7.6**

*The relationship between the GTP and the No GTP group in terms of drugs and flashbacks in the full sample and sub-samples*

| <b>Drugs</b>      | <b>Full sample</b>        |               | <b>English Speaking</b>     |               | <b>Spanish Speaking</b>   |               |
|-------------------|---------------------------|---------------|-----------------------------|---------------|---------------------------|---------------|
|                   | $X^2 = 2.904$             |               | $X^2 = 6.519^*$             |               | $X^2 = 0.318$             |               |
|                   | $d.f = 1$                 |               | $d.f = 1$                   |               | $d.f = 1$                 |               |
|                   | $p \text{ value} = 0.088$ |               | $p \text{ value} = 0.011^a$ |               | $p \text{ value} = 0.573$ |               |
|                   | <b>GTP</b>                | <b>No GTP</b> | <b>GTP</b>                  | <b>No GTP</b> | <b>GTP</b>                | <b>No GTP</b> |
|                   | <b>N(%)</b>               | <b>N(%)</b>   | <b>N(%)</b>                 | <b>N(%)</b>   | <b>N(%)</b>               | <b>N(%)</b>   |
|                   | <b>n=2040</b>             | <b>n=70</b>   | <b>n=1,125</b>              | <b>n=37</b>   | <b>n=915</b>              | <b>n=33</b>   |
|                   | 632(31.0)                 | 15(21.4)      | 447(39.7)                   | 7(18.9)       | 185(20.2)                 | 8(24.2)       |
| <b>Flashbacks</b> | $X^2 = 0.631^a$           |               | $X^2 = 0.143^a$             |               | $X^2 = 0.756^a$           |               |
|                   | $d.f = 1$                 |               | $d.f = 1$                   |               | $d.f = 1$                 |               |
|                   | $p \text{ value} = 0.543$ |               | $p \text{ value} = 1.000$   |               | $p \text{ value} = 0.682$ |               |
|                   | <b>n=15</b>               | <b>n=626</b>  | <b>n=7</b>                  | <b>n=439</b>  | <b>n=8</b>                | <b>n=187</b>  |
|                   | 137(21.9)                 | 2(13.3)       | 88(20.0)                    | 2(14.3)       | 49(26.2)                  | 1(12.5)       |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$  <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher's exact test was selected.

### ***Tendency to recall dreams (n=2,360)***

**Full sample.** Two-fifths of the sample (39.4%) sometimes recalled their dreams, 30.2% very often, 21.0% rarely, 6.9% always, and 2.6% never. Those in the GTP group mostly recalled their dreams sometimes (39.7%) or very often (30.3%), while those in the No GTP group more recalled dreams sometimes (30.9%) or rarely (27.2%). A Chi-square test showed that dream recall was significantly associated with having experienced GTP ( $\chi^2(1) = 15.158, p < 0.01$ ). Those who never recalled dreams were significantly less likely to have experienced GTP ( $\chi^2(1) = 11.863, p < 0.01$ ).

**Sub-samples.** Recalling dreams sometimes was the most prevalent in both samples (39.6% EnS, 39.0% SpS). There were more participants that recalled dreams sometimes in the GTP group (39.8% EnS, 39.6% SpS) than those who recalled dreams sometimes and had not experienced GTP in both samples (36.4% EnS, 24.3% SpS). There were also more participants that recalled dreams very often in the GTP group (27.8% EnS, 33.3% SpS) than those in the

No GTP group (22.7% EnS, 29.7% SpS) in both samples. Dreams were only significantly associated with whether or not have experienced GTP in the SpS ( $\chi^2(4) = 11.482, p < 0.05$ ). In the SpS those who never recall their dreams were significantly less likely to have experienced GTP (Table 7.7).

**Table 7.7**

*The relationship between the GTP and the No GTP group in terms of tendency to recall dreams in the full sample and sub-samples*

|                                  | <b>Full sample</b>  |   | <b>English Speaking</b>                                 |   | <b>Spanish Speaking</b>                                    |   |
|----------------------------------|---|---|---|---|--|---|
| <b>Tendency to recall dreams</b> | $X^2 = 15.158^{**}$<br>$d.f = 4$<br>$p \text{ value} = 0.004$ |   | $X^2 = 7.332$<br>$d.f = 4$<br>$p \text{ value} = 0.119$ |   | $X^2 = 11.482^*$<br>$d.f = 4$<br>$p \text{ value} = 0.022$ |   |
|                                  | <b>GTP</b><br><b>N(%)</b><br><b>n=2,279</b>                   | <b>No GTP</b><br><b>N(%)</b><br><b>n=81</b> | <b>GTP</b><br><b>N(%)</b><br><b>n=1,240</b>             | <b>No GTP</b><br><b>N(%)</b><br><b>n=44</b> | <b>GTP</b><br><b>N(%)</b><br><b>n=1,039</b>                | <b>No GTP</b><br><b>N(%)</b><br><b>n=37</b> |
| Always                           | 156(6.8)  | 6(7.4)                                      | 73(5.9)   | 1(2.31)                                     | 83(8.0)  | 5(13.5)                                     |
| Very often                       | 691(30.3)   | 21(25.9)                                    | 345(27.8)   | 10(22.7)                                    | 346(33.3)  | 11(29.7)                                    |
| Sometime                         | 904(39.7)   | 25(30.9)                                    | 493(39.8)   | 16(36.4)                                    | 411(39.6)  | 9(24.3)                                     |
| Rarely                           | 473(20.8)   | 22(27.2)                                    | 293(23.6)   | 13(29.5)                                    | 180(17.3)  | 9(24.3)                                     |
| Never                            | 55(2.4)   | 7(8.6)                                      | 36(2.9)   | 4(9.1)                                      | 19(1.8)  | 3(8.1)                                      |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

### Gaming Habits and type of gamer

This section analyses data relating to the participants' self-concept, frequency of video game playing, and length of video game sessions.

#### *Type of gamer (n=2,337)*

**Full sample.** The majority of the sample consisted of hard-core gamers (59.9%), followed by casual gamers (32.1%), professional gamers (6.7%) and newbie gamers (1.4%). The majority of those in the GTP group were hard-core (60.3%) followed by casual gamers (32.0%), in the No GTP group the majority were also hard-core but there were less than in the GTP group (49.4%) and there were more casual gamers (34.6%) than in the GTP group. More than 20% of the expected values were five, so Fisher's exact test was selected in this case

instead of chi-square. Type of gamer was significantly associated with having experienced GTP in the full sample ( $\chi^2(3) = 9.183, p < 0.05$ ). Participants who were professionals were significantly less likely to have experienced GTP.

**Sub-samples.** In both samples, more than half of the participants classified themselves as hard-core (55.6% EnS, 65.0% SpS), but there was a bigger concentration of hard-core gamers in the SpS. There were more casual gamers in the EnS (36.3% EnS, 27.0% SpS) and a few newbies and professional gamers in both groups. More than half of the participants in the GTP group were hard-core gamers (56.2% EnS, 65.1% SpS); in the No GTP group there were less hard-core gamers, much fewer in the EnS (38.6% EnS, 62.2%). More than 20% of the expected values were five in the SpS, so Fisher's exact test was selected in this case instead of chi-square. According to the tests that gamer type was significantly associated with whether or not having experienced GTP although only in the EnS ( $\chi^2(3) = 7.989, p < 0.05$ ). The SpS was close to being significant ( $\chi^2(3) = 6.982, p > 0.05$ ) according to the Fischer's exact test. In the EnS, more than half of participants in the GTP group were hard-core gamers (56.2%). Those who were professional gamers were significantly less likely to have experienced GTP (Table 7.8).

**Table 7.8**

*The relationship between the GTP and the No GTP group in terms of gamer type in the full sample and sub-samples*

| Gamer type            | Full sample   |                        | English Speaking  |                        | Spanish Speaking  |                        |
|-----------------------|---|------------------------|---|------------------------|---|------------------------|
|                       | GTP<br>N(%)<br>n=2,276                                    | No GTP<br>N(%)<br>n=61 | GTP<br>N(%)<br>n=1,236                                      | No GTP<br>N(%)<br>n=44 | GTP<br>N(%)<br>n=1,040                                    | No GTP<br>N(%)<br>n=17 |
|                       | $X^2 = 9.183^*$<br>$d.f = 3$<br>$p \text{ value} = 0.027$ |                        | $X^2 = 7.989^*$<br>$d.f = 3$<br>$p \text{ value} = 0.038^a$ |                        | $X^2 = 6.982$<br>$d.f = 3$<br>$p \text{ value} = 0.055^a$ |                        |
| Newbie gamer          | 29(1.3)   | 3(3.7)                 | 13(1.1)   | 0(0.0)                 | 16(1.5)   | 3(8.1)                 |
| Casual gamer          | 728(32.0)   | 28(34.6)               | 445(36.0)   | 20(45.5)               | 283(27.2)   | 8(21.6)                |
| Hard-core gamer       | 1372(60.3)  | 40(49.4)               | 695(56.2)   | 17(38.6)               | 677(65.1)   | 23(62.2)               |
| Professional<br>gamer | 147(6.5)  | 10(12.3)               | 83(6.7)   | 7(15.9)                | 64(6.2)   | 3(8.1)                 |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ . <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher's exact test was selected.

***Frequency of playing. (n=2,361)***

**Full sample.** Just over one-third of the sample (35.2%) played two to four times per week while 34.3% played every day, 22.1% five to six times per week, 5.2% once a week and 3.3% less than once time per week. Most played 2 to 4 days per week in both the GTP group (35.2%) and in the No GTP group (35.8%). Also, 34.4% of those in the GTP group and 30.9% in the No GTP group played every day. Frequent video game playing was not significantly associated with whether or not having experienced GTP.

**Sub-samples.** The most common frequency in the EnS was to play every day (40.2% EnS, 27.2% SpS), while in the SpS it was to play 2 to 4 times per week (29.0% EnS, 42.6% SpS). In the EnS most participants in the GTP played every day (40.4% GTP, 34.1% No GTP). In the SpS almost the same number of participants in both the GTP and No GTP played every day (27.2% GTP, 27.0% No GTP). Frequency of playing was not significantly associated with having experienced GTP in any of the samples (Table 7.8).

***Typical video game session length (n =2,361)***

**Full sample.** Most gamers played sessions between 1-2 hrs and 59 min (43.2%) or 3-5 hrs and 59 min (41.3%) while some gamers played longer sessions of 6-7 hrs and 59 min (6.6%), more than 8 hrs (4.9%). More participants in the GTP group played 3 to 5 hours 59 minutes (41.8%) than those in the No GTP group (28.4%), while more participants in the No GTP group (50.6%) played 1 to 2 hours 59 minutes than those in the GTP group (42.9%). A chi-square test showed that video game session length was significantly associated with having experienced GTP ( $\chi^2(4) = 25.580, p < 0.01$ ). Those who played sessions of less than 1 hour were significantly less likely to have experienced GTP.

**Sub-samples.** More than two-fifths in both samples typically played video game sessions of 1 hour to 2 hours 59 minutes, (41.7 % EnS, 44.9% SpS) and almost the same percentage played sessions of 3 hours to 5 hours 59 minutes (41.4 % EnS, 41.2% SpS). For the purpose of the chi-square analysis and to reduce the number of cells with less than five observations, the two longest categories (6 to 7 hours 59 minutes and more than 8 hours) were merged into a new category (i.e., 6 hours or more). Less participants in the GTP group played 1 to 2 hours 59 minutes sessions (41.6% EnS, 44.5% SpS) than participants in the No GTP group played this session length (45.5% EnS, 56.8% SpS), while more participants in the GTP group played 3 to 5 hours 59 minutes (41.6% EnS, 42.0% SpS) than those who have not experienced GTP (36.4% EnS, 18.9% SpS). Video game session length was significantly

associated with having experienced GTP in both samples ( $\chi^2(3) = 9.212, p < 0.05$  in the EnS;  $\chi^2(3) = 15.221, p < 0.01$  in the SpS). More than 20% of the expected values were less than five in the SpS, so Fisher's exact test was selected in this case instead of chi-square. In the EnS, those who played sessions shorter than one hour were significantly less likely to have experienced GTP. In the SpS those who played sessions less than 1 hour were significantly less likely to have experienced GTP, while those who play 3 to 5 hours 59 minutes were significantly more likely to have experienced GTP (Table 7.9).

**Table 7.9**

*The relationship between the GTP and the No GTP group in terms of frequency of playing and session length in the full sample and sub-samples*

| Frequency of playing       | Full sample  |                        | English Speaking  |                        | Spanish Speaking  |                        |
|----------------------------|--|------------------------|---|------------------------|---|------------------------|
|                            | GTP<br>N(%)<br>n=2,280   | No GTP<br>N(%)<br>n=81 | GTP<br>N(%)<br>n=1,240                                    | No GTP<br>N(%)<br>n=44 | GTP<br>N(%)<br>n=1,040  | No GTP<br>N(%)<br>n=37 |
|                            | $X^2 = 9.295$<br>$d.f = 4$<br>$p \text{ value} = 0.054$        |                        | $X^2 = 5.662$<br>$d.f = 4$<br>$p \text{ value} = 0.226$   |                        | $X^2 = 7.210$<br>$d.f = 4$<br>$p \text{ value} = 0.125$         |                        |
| Less than once a week      | 75(3.3)  | 2(2.5)                 | 46(3.7)   | 0(0.0)                 | 29(2.8)   | 2(5.4)                 |
| Once a week                | 112(4.9)   | 10(12.3)               | 63(5.1)   | 5(11.4)                | 49(4.7)   | 5(13.5)                |
| 2-4 times a week           | 803(35.2)  | 29(35.8)               | 358(28.9)   | 15(34.1)               | 445(42.8)   | 14(37.8)               |
| 5-6 times a week           | 506(22.2)  | 15(18.5)               | 272(21.9)   | 9(20.5)                | 234(22.5)   | 6(16.2)                |
| Every day                  | 784(34.4)  | 25(30.9)               | 501(40.4)   | 15(34.1)               | 283(27.2)   | 10(27.0)               |
| <b>Session length</b>      | $X^2 = 25.492^{***}$<br>$d.f = 3$<br>$p \text{ value} = 0.000$ |                        | $X^2 = 9.212^*$<br>$d.f = 3$<br>$p \text{ value} = 0.027$ |                        | $X^2 = 15.221^{**}$<br>$d.f = 3$<br>$p \text{ value} = 0.001^a$ |                        |
| Less than 1 hour           | 82(3.6)  | 11(13.6)               | 42(3.4)   | 5(11.4)                | 40(3.8)   | 6(16.2)                |
| 1 hr. to 2 hrs. 59 minutes | 979(42.9)  | 41(50.6)               | 516(41.6)   | 20(45.5)               | 463(44.5)   | 21(56.8)               |
| 3 hr. to 5 hrs. 59 minutes | 953(41.8)  | 23(28.4)               | 516(41.6)   | 16(36.4)               | 437(42.0)   | 7(18.9)                |
| 6 hr. or more              | 266(11.7)  | 6(7.4)                 | 166(13.4)   | 3(6.8)                 | 100(9.6)  | 3(8.1)                 |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ . <sup>a</sup>The analysis showed that one cell had an expected count less than five, so Fisher's exact test was selected.



***Comparing typical session length and length when GTP occurred***

**Full sample.** When comparing typical session length with session length when GTP occurred, both 1 hour to 2 hours 59 minutes and 3 hours to 5 hours 59 minutes got fewer responses for when GTP occurred (60.7% in total), compared to the same lengths in the variable typical session length (84.7% in total). Playing six hours or longer got more responses for when GTP occurred (20.6%) compared to the typical session length (13.2%).

**Sub-samples.** When directly asked how long the video game sessions were when GTP occurred, the two session lengths after one-hour got the largest number of responses: 1 hour to 2 hours 59 minutes (21.0% EnS, 29.4% SpS) and 3 hours to 5 hours 59 minutes (34.2% EnS, 38.0% SpS). However, when comparing typical session length with session length when GTP occurred, both 1 hour to 2 hours 59 minutes and 3 hours to 5 hours 59 minutes got fewer responses for when GTP occurred (55.2% EnS in total, 67.4% SpS in total), compared to the same lengths in the variable typical session length (82.1% EnS in total, 86.1% SpS in total). Playing six hours or longer got more responses for when GTP occurred (16.3% EnS, 23.0% SpS) compared to the typical session length (13.2% EnS, 9.6% SpS) (Table 7.10).

**Table 7. 10**

*Comparing typical session length and length when GTP occurred in the EnS and SpS*

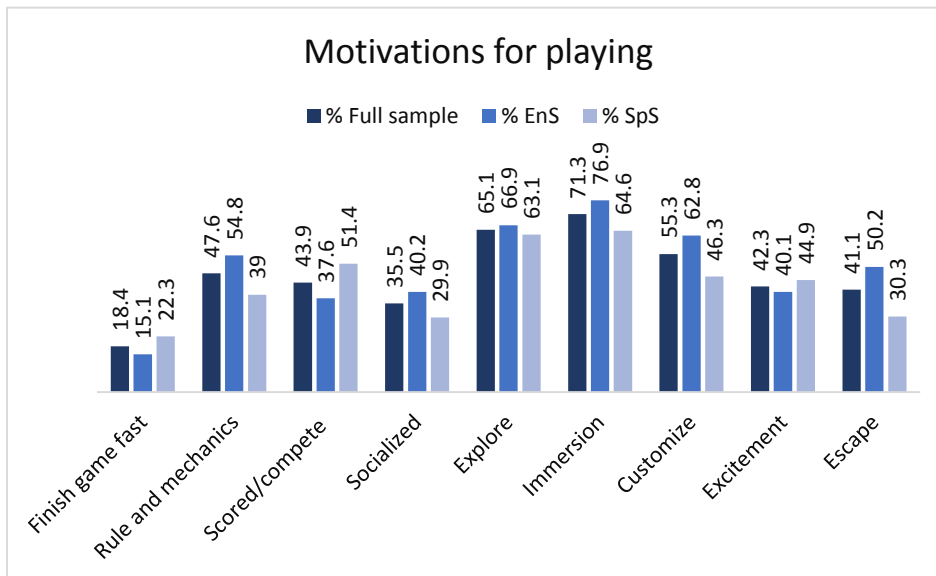
|   | <b>Full<br/>sample<br/>N(%)</b> | <b>English<br/>Speaking<br/>N(%)</b> | <b>Spanish<br/>Speaking<br/>N(%)</b> |
|---|---------------------------------|--------------------------------------|--------------------------------------|
| Less than 1 hour                              | 115(4.5)                        | 47(3.7)                              | 46(4.3)                              |
| Less than 1 hour when GTP happened            | 131(6.1)                        | 33(2.8)                              | 98(10.0)                             |
| 1 hr. to 2 hrs. 59 minutes                    | 1,102(43.0)                     | 536(41.7)                            | 484(44.9)                            |
| 1 hr. to 2 hrs. 59 minutes when GTP happened  | 537(24.8)                       | 249(21.0)                            | 288(29.4)                            |
| 3 hrs. to 5 hrs. 59 minutes                   | 1,046(40.8)                     | 532(41.4)                            | 444(41.2)                            |
| 3 hrs. to 5 hrs. 59 minutes when GTP happened | 776(35.9)                       | 404(34.2)                            | 372(38.0)                            |
| 6 hrs. or more                                | 299(13.2)                       | 196(13.2)                            | 103(9.6)                             |
| 6 hrs. or more when GTP happened              | 415(20.6)                       | 265(16.3)                            | 310(23.0)                            |

***Motivations and In-game Behaviours (N=2,362)***

**Full sample.** In terms of motivations there was a wide range of responses since the participants could tick as many statements as they wanted about what they like to do in the game as motivation to play. Most gamers chose the option to play for immersion (70.7%), followed by explore (64.6%), customize (54.8%), rules and mechanism (47.2%), improve

scores and compete with others (43.8%), excitement (42.0%), escape (40.3%), socialize (35.3%) and, finish the game as fast as possible (18.6%). A Chi-square test of association was performed and showed different results according to the different motivations. Out of nine motivations, five were found to be significantly associated to having experienced GTP. Those who played for immersion ( $\chi^2 (1) = 12.495, p < 0.01$ ), exploration ( $\chi^2 (1) = 7.223, p < 0.01$ ), customization ( $\chi^2 (1) = 6.678, p < 0.05$ ) rules and the mechanism ( $\chi^2 (1) = 4.344, p < 0.05$ ) and escape ( $\chi^2 (1) = 14.789, p < 0.01$ ) were significantly more likely to have experienced GTP.

**Sub-samples.** The motivations that were most prevalent in both groups were to play for immersion and exploration, but more gamers in the EnS liked getting immersed (76.1% EnS, 64.2% SpS) and exploring (66.2% EnS, 62.8% SpS). More participants in the EnS liked to customize (62.4% EnS, 45.7% SpS), know about rules and mechanisms (54.5% EnS, 38.4% SpS), socializing (40.2% EnS, 29.4% SpS) or playing for escape from the real world (49.3% EnS, 29.7% SpS), while more participants in the SpS like to improve scores and compete with others (37.9% EnS, 50.8% SpS), play for excitement (39.7% EnS, 44.7% SpS) or finishing the game as fast as possible (15.4% EnS vs. 22.4% SpS).



**Figure 7. 1** Motivations and in-game behaviours modality

A Chi-square test was conducted to find out whether or not having experienced GTP was significantly associated with specific types of motivation. The only variable that was significant in both groups was playing for escape. In the EnS, participants who played for escape were significantly more likely to have experienced GTP ( $\chi^2 (1) = 10.763, p < 0.01$ ),

while participants in the SpS who played for escape were significantly less likely to have experienced GTP ( $\chi^2 (1) = 4.800, p < 0.05$ ). In the EnS, other significant motivations significantly associated with whether or not having experienced GTP were: immersion ( $\chi^2 (1) = 11.625, p < 0.01$ ) and exploration ( $\chi^2 (1) = 6.947, p < 0.01$ ). Those who played for exploration were significantly more likely to have experienced GTP (66.9% EnS, 63.1% SpS). This was the same for immersion (76.9% EnS, 64.6% SpS). In the SpS, the other significant motivations with having or not having experienced GTP were: customization ( $\chi^2 (1) = 3.954, p < 0.05$ ), and playing to follow rules and mechanics ( $\chi^2 (1) = 4.562, p < 0.05$ ). Those who played for customization or rules and mechanics were significantly less likely to have experienced GTP (Table 7.11).

**Table 7. 11**

*The relationship between the GTP and the No GTP group in terms of motivations for playing for the full sample and sub-samples*

|  | Full sample            |                        |        | EnS   |            |                        | SpS                    |       |       |            |                        |                        |        |       |            |
|--|------------------------|------------------------|--------|-------|------------|------------------------|------------------------|-------|-------|------------|------------------------|------------------------|--------|-------|------------|
|  | No GTP<br>N(%)<br>n=81 | GTP<br>N(%)<br>n=2,281 | $X^2$  | $d.f$ | p<br>value | No GTP<br>N(%)<br>n=44 | GTP<br>N(%)<br>n=1,240 | $X^2$ | $d.f$ | p<br>value | No GTP<br>N(%)<br>n=37 | GTP<br>N(%)<br>n=1,041 | $X^2$  | $d.f$ | p<br>value |
| Finish the game as fast as possible      | 20(24.7)               | 419(18.4)              | 2.054  | 1     | 0.152      | 11(25.0)               | 187(15.1)              | 3.186 | 1     | 0.074      | 9(24.3)                | 232(22.3)              | 0.085  | 1     | 0.770      |
| No                                       | 61(75.3)               | 1,860(81.6)            |        |       |            | 33(75.0)               | 1,051(84.9)            |       |       |            | 28(75.7)               | 809(77.7)              |        |       |            |
| Rule and mechanics                       | 52(35.8)               | 1,196(47.6)            | 4.344* | 1     | 0.037      | 21(47.7)               | 679(54.8)              | 0.847 | 1     | 0.357      | 8(21.6)                | 406(39.0)              | 4.562* | 1     | 0.033      |
| No                                       | 29(64.2)               | 1,085(52.4)            |        |       |            | 23(52.3)               | 561(45.2)              |       |       |            | 29(78.4)               | 635<br>(61.0)          |        |       |            |
| Improve score and/or compete with others | 47(42.0)               | 1,280(43.9)            | 0.116  | 1     | 0.734      | 21(47.7)               | 466(37.6)              | 1.858 | 1     | 0.173      | 13(35.1)               | 535(51.4)              | 3.779  | 1     | 0.052      |
| No                                       | 34(58.0)               | 1,001(56.1)            |        |       |            | 23(52.3)               | 774(62.4)              |       |       |            | 24(64.9)               | 506(48.6)              |        |       |            |
| Socialize                                | 58(28.4)               | 1,470(35.5)            | 1.729  | 1     | 0.189      | 17(38.6)               | 498 (40.2)             | 0.045 | 1     | 0.833      | 6(16.2)                | 311(29.9)              | 3.211  | 1     | 0.073      |
| No                                       | 23(71.6)               | 809(64.5)              |        |       |            | 27(61.4)               | 740 (59.8)             |       |       |            | 31(83.8)               | 730(70.1)              |        |       |            |

|            |          |             |           |   |       |          |           |          |   |       |          |           |        |   |       |
|------------|----------|-------------|-----------|---|-------|----------|-----------|----------|---|-------|----------|-----------|--------|---|-------|
| Explore    | 40(50.6) | 794(65.1)   | 7.223**   | 1 | 0.007 | 21(47.7) | 827(66.9) | 6.947**  | 1 | 0.008 | 17(54.1) | 384(63.1) | 1.255  | 1 | 0.263 |
| No         | 41(49.4) | 1,484(34.9) |           |   |       | 23(52.3) | 410(33.1) |          |   |       | 20(45.9) | 657(36.9) |        |   |       |
| Immersion  | 38(53.1) | 655(71.3)   | 12.495*** | 1 | 0.000 | 24(54.5) | 953(76.9) | 11.625** | 1 | 0.001 | 19(51.4) | 673(64.6) | 2.749  | 1 | 0.097 |
| No         | 43(46.9) | 1,626(28.7) |           |   |       | 20(45.5) | 287(23.1) |          |   |       | 18(48.6) | 368(35.4) |        |   |       |
| Customize  | 48(40.7) | 1,020(55.3) | 6.678*    | 1 | 0.010 | 22(50.0) | 779(62.8) | 2.977    | 1 | 0.084 | 26(29.7) | 559(46.3) | 3.954* | 1 | 0.047 |
| No         | 33(59.3) | 1,261(44.7) |           |   |       | 22(50.0) | 461(37.2) |          |   |       | 11(70.3) | 482(53.7) |        |   |       |
| Excitement | 53(34.6) | 1,317(42.3) | 1.901     | 1 | 0.168 | 13(29.5) | 497(40.1) | 1.970    | 1 | 0.160 | 15(40.5) | 467(44.9) | 3.954  | 1 | 0.603 |
| No         | 28(65.4) | 964(57.7)   |           |   |       | 31(70.5) | 743(59.9) |          |   |       | 22(59.5) | 574(55.1) |        |   |       |
| Escape     | 65(19.8) | 1,344(41.1) | 14.780*** | 1 | 0.000 | 11(25.0) | 622(50.2) | 10.763** | 1 | 0.001 | 5(13.5)  | 315(30.3) | 4.800* | 1 | 0.028 |
| No         | 16(80.2) | 937(58.9)   |           |   |       | 33(75.0) | 618(49.8) |          |   |       | 32(86.5) | 726(69.7) |        |   |       |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

## **GTP Modalities, Sub-modalities and Types**

This section includes general analysis of the frequencies of GTP in the full sample, and Chi-square analysis between the EnS and the SpS in terms of specific GTP variables to further examine differences and similarities between the samples. This section is divided in two parts: general GTP analysis and analysis per modalities/sub-modalities and types of GTP.

### ***GTP general analysis***

Almost all of the participants in each sample had experienced GTP at least at some point (96.6%). In terms of frequency of GTP, most participants experienced GTP more than once (95.3%). Most participants (28.9%) have experienced between 6 and 10 different types of GTP (out of 20 possible) (see Table 7.13). The results showed that large percentages were registered in all modalities/sub-modalities. The most prevalent GTP type was “visualized or seen video games images with closed eyes” (76.8%) which is in the altered visual perception sub-modality, and the least prevalent was “I have felt as though my mind has disconnected from my body after playing” (28.5%) which is in the altered body perception sub-modality (Table 7.12 show the prevalence of GTP per type).

**Sub-samples.** Almost all of the participants in each sample had experienced GTP at least at some point (96.6%). In terms of frequency of GTP, most participants experienced GTP more than once (95.3%). In terms of number of types of GTP experienced, most experienced 6 to 10 types (medium number of GTP) (29.6% EnS; 28.1% SpS). Least participants in both samples experienced low number of GTP (1 to 5 types of GTP) (18.9% EnS; 15.5% SpS). Those who had experienced “very high number of GTP” (16 to 20 different types of GTP) were significantly more likely to be from the SpS, and significantly less likely to be from the EnS (19.3% EnS, 27.0% SpS) ( $\chi^2(1)=18.425, p < 0.001$ ). Those who had experienced “low number of GTP” (1 to 5 different types of GTP) were significantly more likely to be from the EnS ( $\chi^2(1)=4.409, p < 0.036$ ).

**Table 7. 12**

*Number of GTP experienced by the full sample and the sub-samples*

|                                 | <b>Total<br/>sample<br/>N(%)<br/>(n=2,353)</b> | <b>English<br/>Speaking<br/>N(%)<br/>(n=1,281)</b> | <b>Spanish<br/>Speaking<br/>N(%)<br/>(n=1,072)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p<br/>value</b> |
|---------------------------------|--|--|--|----------------------|------------|--------------------|
| 1-5 (Low number of GTP)         | 380(17.4)                                      | 226(18.9)  | 154(15.5)  | 4.409*               | 1          | 0.036              |
| 6-10 (Medium number of GTP )    | 632(28.9)                                      | 353(29.6)  | 279(28.1)  | .565                 | 1          | 0.452              |
| 11-15 (High number of GTP)      | 594(27.2)                                      | 340(28.5)  | 254(25.6)  | 2.293                | 1          | 0.130              |
| 16-20 (Very high number of GTP) | 489(22.8)                                      | 230(19.3)  | 268(27.0)  | 18.425***            | 1          | 0.000              |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

**Table 7. 13**

*GTP modalities, sub-modalities and types in the full sample and sub-samples*

|   | <b>Total<br/>sample<br/>N(%)<br/>(n=2,362)</b> | <b>English<br/>Speaking<br/>N(%)<br/>(n=1,281)</b> | <b>Spanish<br/>Speaking<br/>N(%)<br/>(n=1,072)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p<br/>value</b> |
|---|--|--|--|----------------------|------------|--------------------|
| <b>I. Altered perceptions</b>   | 2,217(93.9)                                    | 1,211(94.3)  | 1,006(93.4)  |                      |            |                    |
| <b>Altered visual perceptions Sub-Modality</b>                            | 1,997(84.8)                                    | 1,133(88.2)  | 864(80.6)  | 26.423 ***           | 1          | 0.000              |
| Visualized VG images/seen with closed eyes                                | 1,807(76.8)                                    | 1,094(85.4)  | 713(66.5)  | 116.874***           | 1          | 0.000              |
| Seen VG images with my eyes open  | 720 (30.6)                                     | 355 (27.7)   | 365(34.1)  | 11.342 **            | 1          | 0.001              |
| Seen distorted real life environments and/or objects                      | 837 (35.7)                                     | 410 (32.0)   | 427 (40.0)   | 16.181 ***           | 1          | 0.000              |
| Misperceived a real life object as something from a VG                    | 1,067 (45.5)                                   | 544 (42.6)   | 523 (49.0)   | 9.649 **             | 1          | 0.002              |
| <b>Altered body perceptions Sub-Modality</b>                              | 1,705(72.7)                                    | 894(70.1)  | 811(75.7)  | 9.212 **             | 1          | 0.002              |
| Bodily sensations of movement as if I was in a VG                         | 1,195 (50.9)                                   | 610 (47.7)   | 585 (54.7)   | 11.230 **            | 1          | 0.001              |
| Tactile (touch) sensation associated with a VG                            | 967 (41.3)                                     | 492 (38.7)   | 475 (44.5)   | 7.956 **             | 1          | 0.005              |
| Perceived time and/or my body feeling differently after playing a VG      | 1,151 (49.3)                                   | 600 (47.2)   | 551(51.9)  | 5.249*               | 1          | 0.022              |
| I have felt as though my mind has disconnected from my body after playing | 666 (28.5)                                     | 388 (30.6)   | 278 (26.0)   | 5.998*               | 1          | 0.014              |



|   |              |              |             |            |   |       |
|---|--------------|--------------|-------------|------------|---|-------|
| <b>Altered auditory perceptions Sub-Modality</b>  | 1,993(85.2)  | 1,054(83.0)  | 939(87.8)   | 10.819 **  | 1 | 0.001 |
| Heard the music from a VG when not playing  | 1,727 (73.9) | 894 (70.5)   | 833 (78.0)  | 16.881 *** | 1 | 0.000 |
| Heard a sound from a VG when not playing  | 1,510 (64.6) | 793 (62.4)   | 717 (67.3)  | 5.890*     | 1 | 0.015 |
| Heard a character's voice from VG when not playing  | 1,064 (45.9) | 539 (42.7)   | 525 (49.8)  | 11.626 **  | 1 | 0.001 |
| Misinterpreted a sound IRL as something from a VG   | 1,524 (65.3) | 789 (62.2)   | 735 (69.0)  | 11.952 **  | 1 | 0.001 |
| <b>II. Automatic mental processes Modality</b>  | 2,050 (87.4) | 1,132 (88.8) | 918 (85.7)  | 4.976*     | 1 | 0.026 |
| Wanted or felt the urge to do something IRL after seeing something that reminded me of the VG | 1,697 (72.3) | 920 (72.2)   | 777 (72.5)  | 0.045      | 1 | 0.832 |
| I have experienced still being in the mind-set of a VG after playing                          | 1,468 (62.8) | 931 (73.1)   | 537 (50.4.) | 127.382*** | 1 | 0.000 |
| Thinking about using something from a VG IRL  | 1,744 (74.6) | 993 (78.1)   | 751 (70.4)  | 18.053 *** | 1 | 0.000 |
| I have momentarily mixed up VG events with actual RL events                                   | 994 (42.5)   | 485 (38.0)   | 509 (47.8)  | 22.790 *** | 1 | 0.000 |

|   |              |            |            |            |   |       |
|---|--------------|------------|------------|------------|---|-------|
| <b>III. Actions and Behaviours Modality</b>   | 1,823(77.7)  | 894(70.1)  | 929(86.7)  | 91.901***  | 1 | 0.000 |
| Reflex body reaction associated with VG   | 1,035 (44.2) | 529 (41.5) | 506 (47.4) | 8.265 **   | 1 | 0.004 |
| Sang, shouted or said something from a VG IRL unintentionally                                   | 1,357 (57.9) | 568 (44.6) | 789 (73.9) | 204.561*** | 1 | 0.000 |
| Acted out a behaviour or performed an activity influenced by a VG                               | 929 (39.8)   | 459 (36.1) | 470 (44.3) | 16.128 *** | 1 | 0.000 |
| Acted differently in RL situations because something I have experienced in a VG unintentionally | 1,138 (48.8) | 480 (37.9) | 658 (61.8) | 132.275*** | 1 | 0.000 |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

***Analysis by modality/sub-modality and type of GTP***

The participants were asked how frequently they have experienced GTP. These experiences were grouped in five different modalities/sub-modalities in this study: Altered visual perceptions, altered auditory perceptions, altered body perceptions, automatic mental processes, and actions and behaviours. Most of the participants reported to have experienced at least one type of GTP at some point. Large percentages were registered in most main modalities/sub-modalities in the full population. The most prevalent modality was thoughts (87.4%), while the least number of participants have experienced one or more GTP in the altered body perception modality (72.7%) (Figure 7.3).

The most prevalent modality of GTP in the EnS was automatic mental processes (88.8%) while the most prevalent modality in the SpS was altered auditory perceptions (87.8%). The least prevalent modality in the EnS was altered body perceptions (70.1%) and actions and behaviours (70.1%), while in the SpS was altered body perceptions (75.7%) (see Figure 3 for comparison of the total of percentages in each modality). The most prevalent type of GTP in the EnS was “visualized or seen video games images with closed eyes” (85.4%) and in the SpS “heard the music from a game when I was not playing” (78.0%) and the least prevalent was “seen video game images with my eyes open” (27.7%) in the EnS and “felt as the mind disconnect from the body” in the SpS (26.0%).

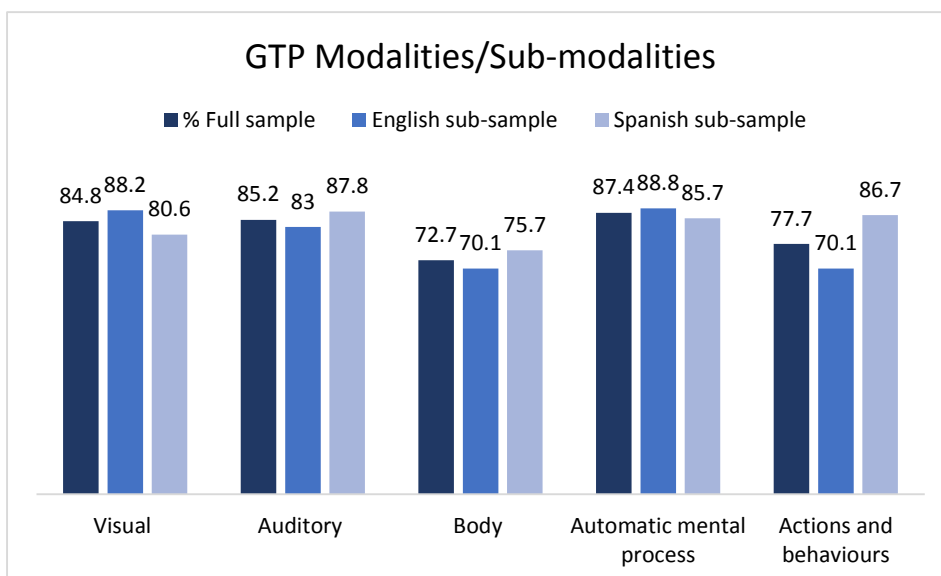


Figure 7. 2 GTP modality/sub-modality

**Sub-samples.** The Chi-square analysis showed significant difference between the EnS and the SpS in the majority of the items that assessed GTP. Those who had experienced some altered visual perception (88.2% EnS, 80.6% SpS) ( $\chi^2(1) = 26.423, p < 0.001$ ), or automatic mental processes (85.7% EnS, 88.8% SpS) ( $\chi^2(1) = 4.976, p < 0.05$ ) were significantly more likely to be from the EnS. Those who had experienced some altered auditory perception (83.0% EnS, 87.8% SpS) ( $\chi^2(1) = 10.819, p < 0.01$ ), altered body perception (70.1% EnS, 75.7% SpS) ( $\chi^2(1) = 9.212, p < 0.01$ ), or automatic actions and behaviours (70.1% EnS, 86.7% SpS) ( $\chi^2(1) = 91.901, p < 0.001$ ) were significantly more likely to be from the SpS.

*Altered Visual Perceptions Modality (GTP-V)*

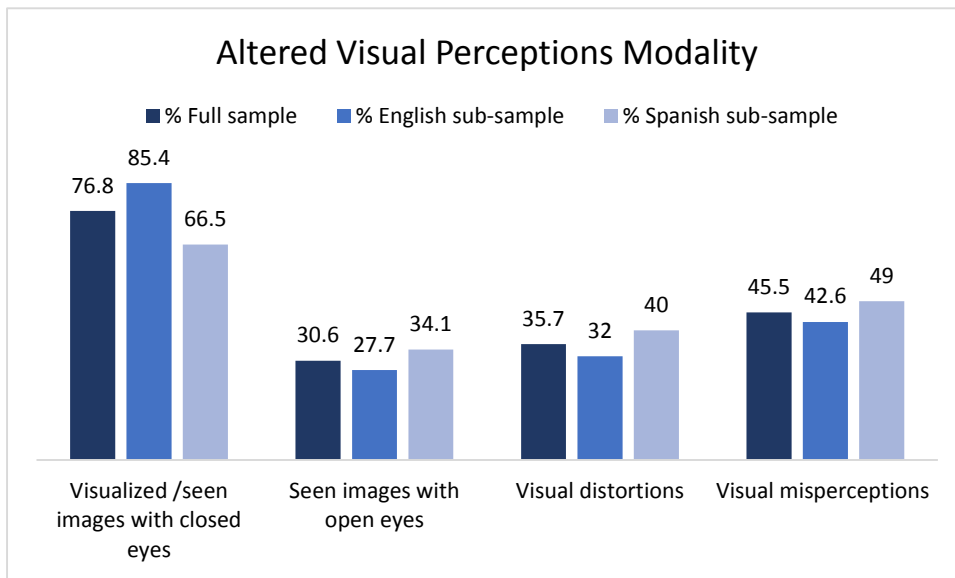


Figure 7. 3 Altered visual perceptions modality

**Full sample.** Of all the variables in the visual modality, the largest number of participants (76.8%) had visualized video game elements in their mind or with closed eyes. Also, a little bit less than half (45.5%) had confused real life stimuli with video game elements, while less number of participants had experienced seeing real life objects and environments distorted (35.6%) or had seen video games images with open eyes (30.6%) (Figure 7.4).

**Sub-samples.** The largest difference between the two samples was found in visualized or having seen video game images with closed eyes (GTP-V1) (85.4% EnS, 66.5% SpS). Those who had experienced GTP-V1 were significantly more likely to be from the EnS and significantly less likely to be from the SpS ( $\chi^2(1) = 116.874, p < 0.001$ ). This type was also the most prevalent visual type of GTP in both samples. The least prevalent type of altered visual

experiences was seeing video game images with open eyes (GTP-V2) (27.7 % EnS, 34.1% SpS). Those who had experienced GTP-V2 ( $\chi^2 (1) = 11.342 p < 0.01$ ) were significantly more likely to be from the SpS. Gamers also reported misperceiving real life objects with something from the game (GTP-V4) (42.6% EnS, 49% SpS). Those who had experienced GTP-V4 ( $\chi^2 (1) = 9.649, p < 0.01$ ) were more likely to be from the SpS. Those who had perceived objects or environments distorted after playing (GTP-V3) were significantly more likely to be from the SpS and significantly less likely to be from the EnS (32.0% EnS, 40.0% SpS) ( $\chi^2 (1) = 16.181, p < 0.001$ ).

*Altered auditory perception modality (GTP-AUD)*

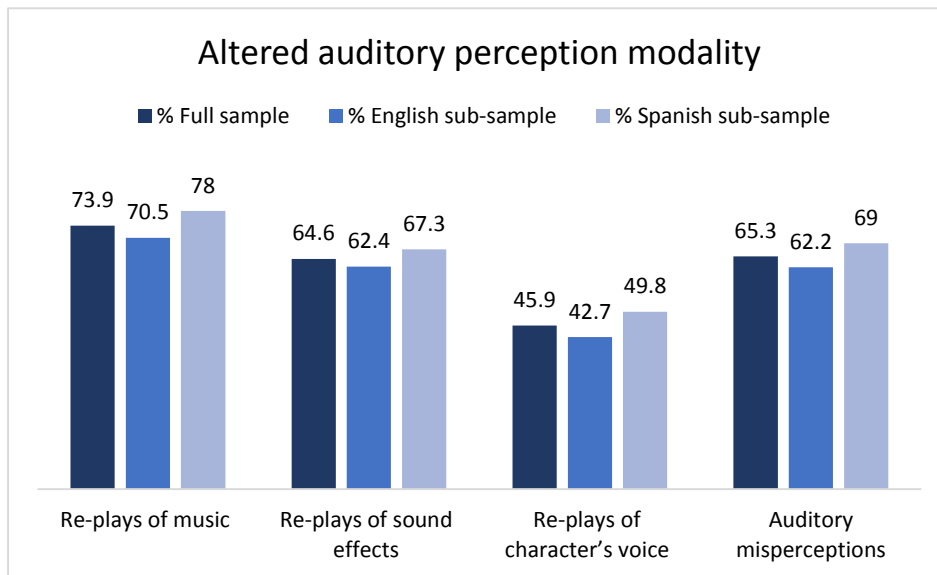


Figure 7. 4 Altered auditory perceptions modality

**Full sample.** Of all the auditory experiences measured in the survey, most participants had heard the music (73.9%) or sound effects (64.6%) from the video games when not playing, but also more than half had confused some real life sound with sounds from the video games (65.3%) while the least number of participants had heard voices from characters in the game in real life at some point (45.9%) (Figure 7.5).

**Sub-samples.** The most prevalent auditory experiences were hearing music from the game (GTPAU1) and were reported by a majority of the participants in both samples, (70.5% EnS, 78.0% SpS). Those who had experienced GTPAU1 were significantly more likely to be from the SpS and less likely to be from the EnS ( $\chi^2 (1) = 16.881, p < 0.001$ ), and more than half in both samples had confused real life sounds with sounds from the game (GTP-AUD4)

(62.2% EnS, 69.0 % SpS). Those who had experienced GTPAU4 were significantly more likely to be from the SpS ( $\chi^2(1) = 11.952, p < 0.01$ ). More from the SpS heard replays of sounds from the game (GTP-AUD2) (62.4% EnS, 67.3% SpS). Those who had experienced GTP-AUD2 were significantly more likely to be from the SpS ( $\chi^2(1) = 5.890, p < 0.05$ ). Least participants in both samples had heard voices from the games (GTP-AUD3) (42.7% EnS, 49.8% SpS). Those who had experienced GTP-AUD3 were significantly more likely to be from the SpS ( $\chi^2(1) = 11.626, p < 0.01$ ).

*Altered body perception modality (GTP-B)*

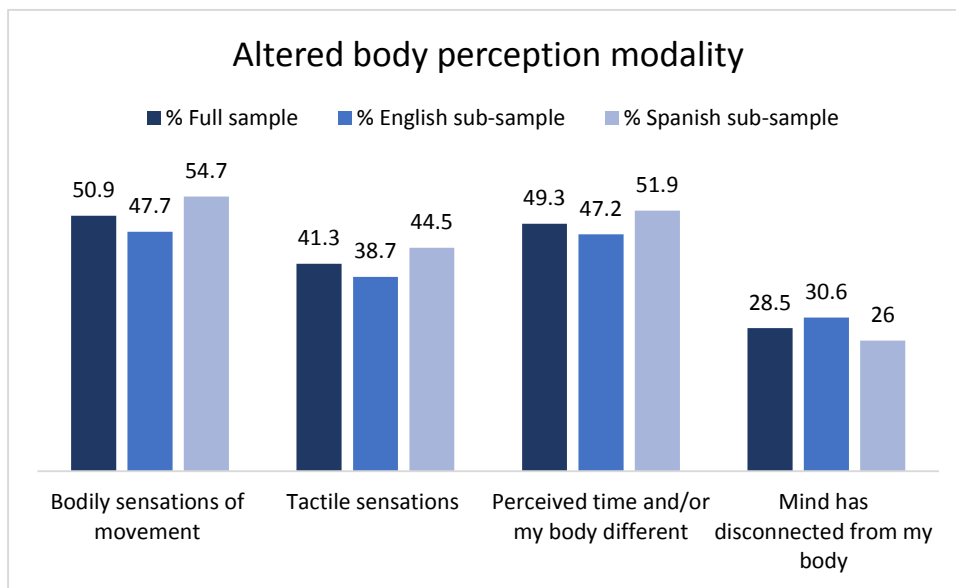


Figure 7. 5 Altered body perception modality

**Full sample.** Half had experienced sensations of body movements after playing a game (50.9%) and a bit less than half had perceived their body differently, and the time distorted (49.3%) or had experienced tactile sensations associated with their playing (41.3%) and less than one third had felt their mind disconnected from their body (28.5%) (Figure 7.6).

**Sub-samples.** The majority of both samples had experienced some type of altered body perception (70.1% SpS, 75.7%). Having the sensation of bodily movement after playing was the most prevalent category in both groups (GTP-B1) (47.7% EnS, 58.5% SpS). Those who had experienced GTP-B1 were significantly more likely to be from the SpS ( $\chi^2(1) = 11.230, p < 0.01$ ). This type was followed by perceiving time distorted or feeling the body different (GTP-B3) (47.2% EnS, 51.9% SpS). Those who had experienced GTPB3 ( $\chi^2(1) = 5.249, p < 0.01$ ) or tactile sensations (GTPB2) were significantly more likely to be from the SpS (38.7%

EnS, 44.5% SpS) ( $\chi^2(1) = 7.956, p < 0.05$ ). The type with fewest answers in this modality was feeling as if the mind was disconnected from the body after playing (GTP-B4) (30.6% EnS, 26.0% SpS). Those who had experienced GTP-B4 were significantly more likely to be from the EnS ( $\chi^2(1) = 5.998, p < 0.05$ ).

*Automatic mental processes modality (GTP-AMP)*

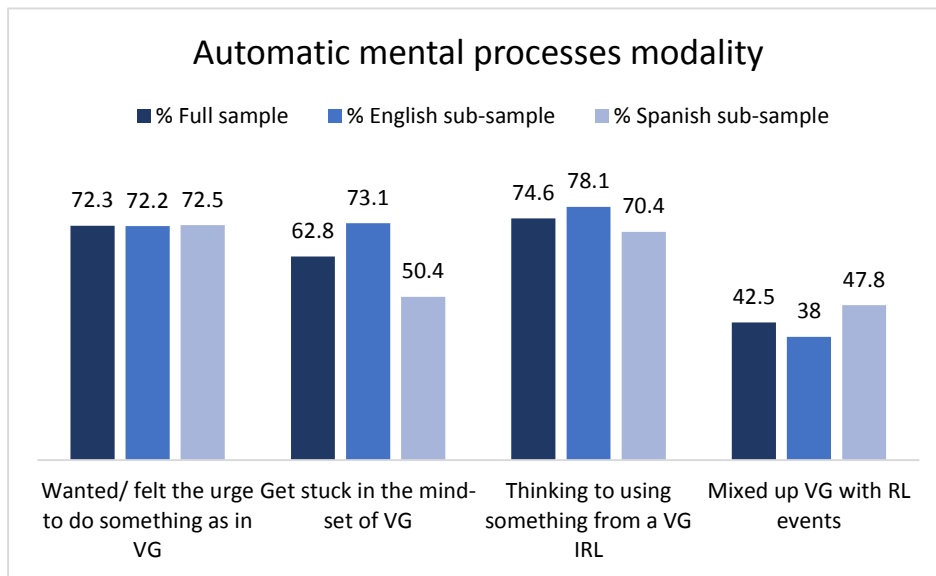


Figure 7. 6 Automatic mental processes modality

**Full sample.** A majority of the participants had found themselves thinking to use (74.6%), or had felt the urge to do something as in the game in real life scenarios (72.3%), while more than half had experienced still being in the mind-set of the game after stopping playing (62.8%) and fewest had momentarily mixed up video game events with actual real life events (42.5%) (Figure 7.7).

**Sub-samples.** The majority of both samples had experienced some type of automatic mental processes (88.8% EnS, 85.7% SpS). The most prevalent in the EnS was gamers who had found themselves thinking about using something from a video game in real life (GTP-AMP3) (78.1% EnS, 70.4% SpS). Those who had experienced GTP-AMP3 were significantly more likely to be from the EnS and significantly less likely from the SpS ( $\chi^2(1) = 18.053, p < 0.001$ ). Those who had felt the urge to do something as in the video game in real life settings (GTP-AMP1) were more likely to be from the SpS compared to EnS (72.2% EnS, 72.5% SpS). This was the only type of GTP that was not significant different between the samples ( $\chi^2(1) = 0.045, p > 0.05$ ). Still being in the mind-set of a game after I had stopped playing (GTPAMP2)

was also highly prevalent in the EnS (73.1% EnS, 50.4% SpS). Those who had experienced GTP-AMP2 were significantly more likely to be from the EnS and less likely to be from the SpS ( $\chi^2(1) = 127.382, p < 0.001$ ). The least in both samples was mixed up video game events with actual real life events (GTP-AMP4) (38.0% EnS, 47.8% SpS). Those who had experienced GTP-AMP4 were significantly more likely to be from the SpS and significantly less likely to be from the SpS ( $\chi^2(1) = 22.790, p < 0.001$ ).

*Actions and behaviours modality (GTP-AB)*

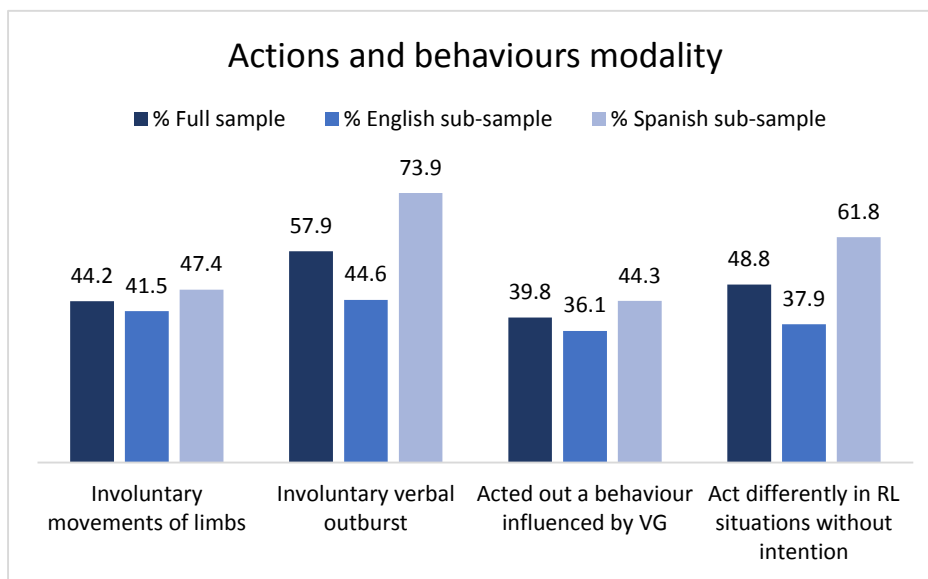


Figure 7. 7 Actions and behaviours modality

**Full sample.** Of all the variables in the behaviours modality, more than half of the participants had at some point sang, shouted or said something from the game in real life without intention (57.9%), and almost half had acted differently in real life situations involuntarily due to experiences from the game (48.8%). Participants had also experienced a body reflex associated with the game (44.2%), while the least number of gamers (39.8%) acted out behaviour or performed an activity influenced by a video game (Figure 7.8).

**Sub-samples.** The majority of both samples experienced some type of automatic action or behaviours. The largest percentages were observed in the SpS (86.7% EnS, 70.1% SpS). The type that was most prevalent in both samples was involuntary verbal outbursts (singing, shouting or saying something with video game content) (GTP-AB2), although more had experienced it in the SpS (44.6% EnS, 73.9% SpS). Those who had experienced GTP-AB2



were significantly more likely to be from the SpS and significantly more likely to be from the EnS. ( $\chi^2 (1) = 204.561, p < 0.001$ ).

Also, more participants in the SpS group had involuntarily acted differently in real life situations due to experiences from the video game (GTP-AB4) (37.9% EnS, 61.8% SpS). Those who had experienced GTP-AB4 were significantly more likely to be from the SpS and significantly less likely to be from the EnS ( $\chi^2 (1) = 132.275, p < 0.001$ ). Quite similar responses between the samples were found in the samples in experiencing an involuntary movement of limbs related with video game experiences (GTP-AB1) (41.5% EnS, SpS 47.4%). Those who had experienced GTP-AB1 were more likely to be from the SpS compared to EnS ( $\chi^2 (1) = 8.265, p < 0.01$ ). There were more SpS participants in the type acting out behaviours or performing activities influenced by something from a video game (GTP-AB3) (36.1% EnS, 44.3% SpS). Those who had experienced GTP-AB3 were significantly more likely to be from the SpS and significantly less likely to be from the EnS ( $\chi^2 (1) = 16.128, p < 0.001$ ).

### **GTP Characteristics**

This section include general analysis of the frequencies of GTP in the full sample, and Chi-square analysis between the EnS and the SpS in terms of GTP characteristic to further examine differences and similarities between the samples. The GTP characteristics were asked as multiple-choice questions since they may have varied according to each GTP. Consequently, some percentages are larger than 100%. The GTP characteristics provide an overview in understanding GTP but it was not possible to focus particularly in each GTP modality or sub-type in order to reduce the length of the survey.

#### ***Video games genre and GTP (n=2,161)***

**Full sample.** More players had experienced GTP with video games genres such as adventure (54.2%), role-play games (53.4%), action (49.1%) and first person shooter (47.2%). The least number of gamers had experienced GTP with educational (3.5%) and sport games (9.7%) (Table 7.14).

**Sub-samples.** In the EnS those who had experienced GTP played role-playing games (RPG) (57.1%), first person shooters (FPS) (51.0%), adventure games (51.0%) and action games (47.8%) were the most prevalent genres. In the SpS those who had experienced GTP mainly played adventure games (58.2%), action games (50.7%), role-playing games (48.9%),

and first person shooters (42.7%). According to Chi-square tests different genres were significant with either the SpS or the EnS. Those who played FPS games ( $\chi^2(1) = 14.556$   $p < 0.001$ ) (51.0%, EnS, 42.7% SpS), puzzle games ( $\chi^2(1) = 52.418$ ,  $p < 0.001$ ) (27.4%, EnS, 14.5% SpS), Massive Multiplayer Online Role Play Games (MMORPG) ( $\chi^2(1) = 43.010$   $p < 0.001$ ) (32.4%, EnS, 19.8% SpS), role-playing games ( $\chi^2(1) = 14.706$ ,  $p < 0.001$ ) (57.1%, EnS, 48.9 % SpS), or simulation games ( $\chi^2(1) = 20.448$   $p < 0.001$ ) (23.3%, EnS, 15.5 % SpS) when GTP happened were significantly more likely to be from the EnS. Those who played adventure games ( $\chi^2(1) = 11.206$   $p < 0.001$ ) (51.0% EnS, 58.2%, SpS), music games ( $\chi^2(1) = 17.004$   $p < 0.001$ ) (13.5%, EnS, 20.1% SpS), or sport games ( $\chi^2(1) = 6.868$   $p < 0.001$ ) (8.2%, EnS, 11.6 % SpS) when GTP happened were significantly more likely to be from the SpS. Those who played music games when GTP happened were significantly less likely to be from the EnS, while those who played FPS, puzzle, MMORPG, role-playing or simulation games when GTP happened were less likely to be from the SpS.

**Table 7. 14**

*Video game genres where participants have experienced GTP in the full sample and subsamples*

| <b>Video game genres</b> | <b>English Speaking N(%) (n=1,183)</b> | <b>Spanish Speaking N(%) (n=978)</b> | <b>Full sample N(%) (n=2,161)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p value</b> |
|--------------------------|--|--------------------------------------|-----------------------------------|----------------------|------------|----------------|
| Action                   | 565 (47.8)                             | 496 (50.7)                           | 1061 (49.1)                       | 1.872                | 1          | 0.171          |
| Adventure                | 580 (51.0)                             | 409 (58.2)                           | 989 (54.2)                        | 11.206**             | 1          | 0.001          |
| FPSVG                    | 580 (51.0)                             | 560 (42.7)                           | 1140 (47.2)                       | 14.556***            | 1          | 0.000          |
| Racing VG                | 236 (19.9)                             | 188 (19.2)                           | 424 (19.6)                        | 0.179                | 1          | 0.672          |
| Fighting VG              | 191 (16.1)                             | 172 (17.6)                           | 363 (16.8)                        | 0.796                | 1          | 0.372          |
| Puzzle VG                | 324 (27.4)                             | 142 (14.5)                           | 466 (21.6)                        | 52.418***            | 1          | 0.000          |
| Music/Dance VG           | 160 (13.5)                             | 197 (20.1)                           | 357 (16.5)                        | 17.004***            | 1          | 0.000          |
| Educational VG           | 46 (3.9)                               | 30 (3.1)                             | 76 (3.5)                          | 1.063                | 1          | 0.302          |
| MMORPG VG                | 383 (32.4)                             | 194 (19.8)                           | 577 (26.7)                        | 43.010***            | 1          | 0.000          |
| RPG VG                   | 676 (57.1)                             | 478 (48.9)                           | 1154 (53.4)                       | 14.706***            | 1          | 0.000          |
| Simulation VG            | 276 (23.3)                             | 152 (15.5)                           | 428 (19.8)                        | 20.448***            | 1          | 0.000          |
| Strategy VG              | 383 (32.4)                             | 308 (31.5)                           | 691 (32.0)                        | 0.192                | 1          | 0.662          |
| Sport VG                 | 97 (8.2)                               | 113 (11.6)                           | 210 (9.7)                         | 6.868**              | 1          | 0.009          |

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

***Hours played per week when GTP happened (n=2,161)***

**Full sample.** Most participants played 11 to 20 hours per week when GTP happened (19.8%) while least played 51 hours or more (4.8%).

**Sub-samples.** In the EnS the most prevalent hours played per week when GTP happened were 21 to 30 hours (20.7%) and 11 to 20 hours (19.7%). In the SpS the most prevalent hours played per week were 10 hours or less (21.8%) and 11 to 20 hours (19.9%). According to Chi-square tests no significant differences were found between the EnS and the SpS when playing 11 to 20 hours, 41 to 50 hours or 51 hours or more. However, there were predictors that were significantly associated either in the EnS or SpS: 10 hours or less ( $\chi^2 (1) = 45.017 p < 0.001$ ), 21 to 30 hours ( $8.762 \chi^2 (1) = p < 0.01$ ) and 31 to 40 hours ( $\chi^2 (1) = 8.223 p < 0.01$ ). Those who played between 10 hours or less per week when GTP happened were significantly more likely to be from SpS and significantly less likely from EnS (11.2%, EnS, 21.8 % SpS). Those who played between 21 and 30 hours or 31 to 40 hours per week when GTP happened were significantly less likely to be from SpS and significantly more likely from EnS (20.7%, EnS, 15.7 % SpS) (13.6%, EnS, 9.6 % SpS). This shows that SpS had more GTP when playing less per week and EnS had more GTP when playing more per week (Table 7.15).

**Table 7. 15**

*Hours played when GTP happened in the full sample and sub-samples*

| <b>Hours played</b> | <b>English Speaking<br/>N(%)<br/>(n=1,183)</b> | <b>Spanish Speaking<br/>N(%)<br/>(n=978)</b> | <b>Full Sample<br/>N(%)<br/>(n=2,161)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p value</b> |
|---------------------|--|--|---|----------------------|------------|----------------|
| 10 hours or less    | 132 (11.2)                                     | 213 (21.8)                                   | 345 (16.0)                                | 45.017               | 1          | 0.000          |
| 11 to 20 hours      | 233 (19.7)                                     | 195 (19.9)                                   | 428 (19.8)                                | 0.020                | 1          | 0.888          |
| 21 to 30 hours      | 245 (20.7)                                     | 154 (15.7)                                   | 399 (18.5)                                | 8.762**              | 1          | 0.003          |
| 31 to 40 hours      | 161 (13.6)                                     | 94 (9.6)                                     | 255 (11.8)                                | 8.223**              | 1          | 0.004          |
| 41 to 50 hours      | 84 (7.1)                                       | 54 (5.5)                                     | 138 (6.4)                                 | 2.233                | 1          | 0.135          |
| 51 or more          | 64 (5.4)                                       | 39 (4.0)                                     | 103 (4.8)                                 | 2.386                | 1          | 0.122          |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

***Video game session length when GTP happened (n=2,161)***

**Full sample.** The majority of participants played 3 to 5 hours 59 minutes (35.9%), or 1 hour to 2 hours 59 minutes (24.8%). Only a few participants played less than 1 hour (6.1%) or session of more than 8 hours (8.7%).

**Sub-samples.** In the EnS the more prevalent video game session played when GTP happened was 3 hours to 5 hours 59 minutes (34.2%) followed by 1 hour to 2 hours 59 minutes (21.0%). In the SpS similar results were found, participants mostly played 3 hours to 5 hours to 59 minutes (38.0%), followed by 1 hour to 2 hours 59 minutes (29.4%) (see Table 7.16). According to Chi-square tests no differences were found between the EnS and the SpS when playing session of 3 hours to 5 hours 59 minutes and more than 8 hours sessions. However, the predictors that were significant associated with either EnS or SpS were: playing less than 1 hour ( $\chi^2 (1) = 49.159 p < 0.001$ ) –1 to 2 hours 59 minutes ( $\chi^2 (1) = 20.228 p < 0.001$ ) and 6 hours to 7 hours 59 minutes ( $\chi^2 (1) = 4.106 p < 0.05$ ). Those who played less than 1 hour or 1 hour to 2 hours 59 minutes per day when GTP happened were significantly more likely to be from the SpS, and less likely to be from the EnS (2.8% EnS, 10.0% SpS,) (21.0 %, EnS, 29.4 % SpS). Those who played 6 hours to 7 hours 59 minutes when GTP happened were significantly more likely to be from the EnS, and less likely to be from the SpS (15.6% EnS, 12.6% SpS).

**Table 7. 16**

*Video game session length when GTP happened in the full sample and sub-samples*

| <b>Video game session length</b> | <b>English Speaking<br/>N(%)<br/>(n=1,183)</b> | <b>Spanish Speaking<br/>N(%)<br/>(n=978)</b> | <b>Full Sample<br/>N(%)<br/>(n=2,161)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p value</b> |
|----------------------------------|--|--|---|----------------------|------------|----------------|
| Less than 1 hour                 | 33 (2.8)                                       | 98 (10.0)                                    | 131 (6.1)                                 | 49.159***            | 1          | 0.000          |
| 1 hours to 2 hour 59 minutes     | 249 (21.0)                                     | 288 (29.4)                                   | 537 (24.8)                                | 20.228***            | 1          | 0.000          |
| 3 hours to 5 hour 59 minutes     | 404 (34.2)                                     | 372 (38.0)                                   | 776 (35.9)                                | 3.514                | 1          | 0.061          |
| 6 hours to 7 hour 59 minutes     | 185 (15.6)                                     | 123 (12.6)                                   | 308 (14.3)                                | 4.106*               | 1          | 0.043          |
| More than 8 hours                | 107 (9.0)                                      | 80 (8.2)                                     | 187 (8.7)                                 | 0.507                | 1          | 0.477          |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

***Duration of GTP (n=2,161)***

**Full sample.** The majority of the participants experienced GTP for short periods of time. Seconds (58.6%), or minutes (29.6%). Although, 71% said GTP lasted hours and also days (3.4%), weeks (1.8%) and months or years (0.9%). Gamers also reported that they

experienced GTP all the time (3.7%). Gamers also reported other responses (4.9%) (Table 7.17).

**Sub-samples.** For more than half of both samples, the duration of GTP was very short seconds (61.8 % EnS vs. 54.7 % SpS). According to Chi-square tests, the duration of GTP for days and months were similar in both samples, however, there were predictors that were significantly associated with being either EnS or SpS: seconds ( $11.088 \chi^2 (1) = p < 0.01$ ), minutes ( $5.316 \chi^2 (1) = p < 0.05$ ), hours ( $5.775 \chi^2 (1) = p < 0.05$ ) or weeks ( $4.250 \chi^2 (1) = p < 0.05$ ) and all the time ( $4.052 \chi^2 (1) = p < 0.05$ ). Those who had experienced GTP for seconds (61.8%, EnS, 54.7% SpS) were significantly more likely to be from the EnS, while those who had experienced GTP for minutes (21.6%, EnS, 32.1% SpS), hours (5.9%, EnS, 8.6 % SpS), weeks (1.3%, EnS, 2.5 % SpS) or all the time (3.0%, EnS, 4.6 % SpS) were significantly more likely to be from the SpS.

**Table 7. 17**

*Duration of GTP in the full sample and per sub-samples*

| <b>Duration of GTP</b> | <b>English Speaking N(%) (n=1,183)</b> | <b>Spanish Speaking N(%) (n=978)</b> | <b>Full Sample N(%) (n=2,161)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p value</b> |
|------------------------|--|--------------------------------------|-----------------------------------|----------------------|------------|----------------|
| Seconds                | 731 (61.8)                             | 535 (54.7)                           | 1,266 (58.6)                      | 11.088**             | 1          | 0.001          |
| Minutes                | 326 (27.6)                             | 314 (32.1)                           | 640 (29.6)                        | 5.316*               | 1          | 0.021          |
| Hours                  | 70 (5.9)                               | 84 (8.6)                             | 154 (7.1)                         | 5.775*               | 1          | 0.016          |
| Days                   | 42 (3.6)                               | 31 (3.2)                             | 73 (3.4)                          | 0.238                | 1          | 0.626          |
| Weeks                  | 15 (1.3)                               | 24 (2.5)                             | 39 (1.8)                          | 4.250*               | 1          | 0.039          |
| Months or years        | 10 (0.8)                               | 10 (1.0)                             | 20 (0.9)                          | 0.183                | 1          | 0.669          |
| All the time           | 35 (3.0)                               | 45 (4.6)                             | 80 (3.7)                          | 4.052*               | 1          | 0.044          |
| Other                  | 94(7.9)                                | 0(0)                                 | 94(4.3)                           |                      |            |                |
|                        | <b>(n=1,058)</b>                       | <b>(n=849)</b>                       | <b>(n=1,907)</b>                  |                      |            |                |
| Recurrences of GTP     | 540 (51.0)                             | 564 (66.4)                           | 1104 (57.9)                       | 45.774***            | 1          | 0.000          |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

***Recurrences of GTP (n=1,907)***

**Full sample.** GTP can occur as single episodic events or recurrently. The majority of the participants (57.9%) had experienced GTP recurrently or episodically at some point

triggered by association of stimuli or elicited by the blinking. 29.6% had never experienced GTP recurrently and 12.5% do not remember.

**Sub-samples.** More than half in each sample had experienced GTP recurrently or episodically (either every time they encountered something in real life, or every time they blinked or closed their eyes) (51.0% EnS, 66.4% SpS). A dichotomy variable was created and according to a Chi-square test those who had experienced GTP recurrently or episodically were significantly more likely to be from the SpS and significantly less likely to be from the EnS ( $\chi^2(1) = 11.836, p < 0.001$ ).

### ***Manifestation time of GTP (n=2,161)***

**Full sample.** GTP were experienced shortly after stopping playing by most, either hours after (47.0%) or direct after stopping playing (42.2%). But gamers had also experienced it days after (25.9%) or even after weeks or longer after playing the game (11.9%). However, GTP also had been experienced whilst playing (16.3%). 9.3% of the participants reported other answers (Table 7.18).

**Sub-samples.** GTP were mainly experienced as post-play phenomena. Half of the participants in the EnS experienced GTP directly after stopping playing (50.0%) or hour after (50.2%), while most in the SpS experienced GTP hours after (43.1%) or directly after playing (33.2%). According to Chi-square tests the duration of GTP for days and months were similar in both samples, however, there were predictors that were significant associated with being either part of the EnS or SpS. Chi-square tests showed that having experienced GTP directly after playing ( $61.942 \chi^2(1) = p < 0.001$ ) (50.0%, EnS, 33.2 % SpS) were more likely to be experienced by the EnS as well as having experienced GTP hours after ( $10.719 \chi^2(1) = p < 0.01$ ) (28.0%, EnS, 23.3 % SpS), days after ( $6.081 \chi^2(1) = p < 0.05$ ) (28.0%, EnS, 23.3 % SpS), or having experienced GTP whilst playing ( $15.573 \chi^2(1) = p < 0.001$ ) (19.2%, EnS, 12.9 % SpS). Those who had experienced GTP whilst playing or directly afterwards were significantly less likely to be from the SpS.

**Table 7. 18**

*When GTP were experienced in the full sample and sub-samples*

| <b>Manifestation time of GTP</b> | <b>English Speaking N(%) (n=1,183)</b> | <b>Spanish Speaking N(%) (n=978)</b> | <b>Full Sample N(%) (n=2,161)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p value</b> |
|----------------------------------|--|--------------------------------------|-----------------------------------|----------------------|------------|----------------|
| Experienced whilst playing       | 227 (19.2)                             | 126 (12.9)                           | 353 (16.3)                        | 15.573***            | 1          | 0.000          |
| Directly after playing           | 592 (50.0)                             | 325 (33.2)                           | 917 (42.4)                        | 61.942***            | 1          | 0.000          |
| Hours after                      | 594 (50.2)                             | 422 (43.1)                           | 1,016 (47.0)                      | 10.719**             | 1          | 0.001          |
| Days after                       | 331 (28.0)                             | 228 (23.3)                           | 559 (25.9)                        | 6.081*               | 1          | 0.014          |
| Weeks or more after              | 146 (12.3)                             | 111 (11.3)                           | 257 (11.9)                        | 0.503                | 1          | 0.478          |
| Other                            | 140(11.8)                              | 60(6.1)                              | 200(9.3)                          |                      |            |                |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

***Circumstances when GTP occurred (n=2,161)***

**Full sample.** The majority had experienced GTP while doing other activities except falling asleep or waking up (61.5%). Also, GTP had been experienced when the gamers were exposed to limited external stimuli either when lying in bed or when closing their eyes to sleep (30.8%) or falling asleep (27.5%). Some gamers had experienced GTP either when waking up (8.3%) or when just when they had woken up (7.9%) (Table 7.19).

**Sub-sample.** More than half of the gamers reported that they had experienced GTP when doing activities not related to sleep (61.8 % EnS, 61.0 % SpS).According to Chi-square tests, only having experienced GTP while doing any other activity except falling asleep or waking up were not significant different between the samples. However, there were predictors that were significant associated with be either EnS or SpS when experienced GTP: just lying down in bed and closing the eyes to sleep (72.538  $\chi^2$  (1) =  $p < 0.001$ ), falling asleep (22.732  $\chi^2$  (1) =  $p < 0.001$ ), when waking up (28.437  $\chi^2$  (1) =  $p < 0.001$ ) or had just woken up (5.005  $\chi^2$  (1) =  $p < 0.05$ ). Those who had experienced GTP when just they lay down in bed were significantly more likely to be from the EnS and significantly less likely to be from the SpS and (38.5%, EnS, 21.5 % SpS). Those who had experienced GTP when they were falling asleep were significantly more likely to be from the EnS and significantly less likely to be from the SpS and (31.7%, EnS, 22.5 % SpS).Those who had experienced GTP just when they woke up were significantly more likely to be from the EnS and less likely to be from the SpS and (9.0%,

EnS, 6.4 % SpS). Those who had experienced GTP when they were waking up were significantly more likely to be from the EnS and significantly less likely to be from the SpS (11.2%, EnS, 4.8 % SpS).

**Table 7. 19**

*Under what circumstances GTP has been experienced in the full sample and sub-samples*

| Under what circumstance   | English Speaking<br>N(%)<br>(n=1,183) | Spanish Speaking<br>N(%)<br>(n=978) | Full Sample<br>N(%)<br>(n=2,161) | X <sup>2</sup> | d.f | p value |
|---|---------------------------------------|-------------------------------------|----------------------------------|----------------|-----|---------|
| I just lay down in bed and closed my eyes to sleep                | 140 (38.5)                            | 60 (21.5)                           | 200 (30.8)                       | 72.538***      | 1   | 0.000   |
| I was falling asleep  | 375 (31.7)                            | 220(22.5)                           | 595 (27.5)                       | 22.732***      | 1   | 0.000   |
| I just woke up  | 107 (9.0)                             | 63 (6.4)                            | 170 (7.9)                        | 5.005*         | 1   | 0.025   |
| I was waking up   | 132(11.2)                             | 47 (4.8)                            | 179 (8.3)                        | 28.437***      | 1   | 0.000   |
| While doing any other activity except falling asleep or waking up | 731 (61.8)                            | 597 (61.0)                          | 132 (61.5)                       | 0.127          | 1   | 0.722   |
| Other   | 217( 18.3)                            | 76( 7.8)                            | 293 (13.6)                       | 51.058         | 1   | 0.000   |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

***Impact of GTP (n=2,161)***

**Full sample.** Almost half (47.2%) reported that they had not special feelings about experiencing GTP, while 3.9% reported that the experience had lasting effects. 25.9% reported that experiencing GTP was pleasant. Additionally, 21.2% wanted that it happens again, in contrast 5.4% had experienced GTP as unpleasant and 13.9% had felt confused (Table 7.20).

**Sub-samples.** Almost half of the participants in both samples reported having no special feelings about their GTP experiences (49.1% EnS vs. 44.1% SpS). Some experienced GTP as a pleasant experience (24.7% EnS vs. 27.4% SpS) or wanted that it happens again (23.4% EnS vs.18.6% SpS). According to Chi-square tests most variables about the impact of GTP were significantly different between the EnS and the SpS. No special feelings (4.023  $\chi^2$  (1) = p < 0.05), wanting it to happen again (7.391  $\chi^2$  (1) = p < 0.01), felt confused (20.442  $\chi^2$  (1) = p < 0.001), having lasting effects (6.501  $\chi^2$  (1) = p < 0.05), or feeling that the GTP experience was unpleasant (8.832  $\chi^2$  (1) = p < 0.01). Those who had no special feelings (49.1%, EnS, 44.8 % SpS), wanted that GTP happen again (23.4%, EnS, 18.6 % SpS), felt confused



(17.0%, EnS, 10.2 % SpS), had lasting effects (4.9%, EnS, 2.8% SpS), or unpleasant (6.7%, EnS, 3.8 % SpS) about their GTP experience were significantly more likely to be from the EnS and less likely to be from the SpS.

**Table 7. 20** *Impact of GTP in the full sample and sub-samples*

| <b>Impact of GTP</b>                     | <b>English Speaking<br/>N(%)<br/>(n=1,183)</b> | <b>Spanish Speaking<br/>N(%)<br/>(n=978)</b> | <b>Full Sample<br/>N(%)<br/>(n=2,161)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p value</b> |
|--|--|--|---|----------------------|------------|----------------|
| No special feelings                      | 581 (49.1)                                     | 438 (44.8)                                   | 1,019 (47.2)                              | 4.023*               | 1          | 0.045          |
| Unpleasant                               | 79 (6.7)                                       | 37 (3.8)                                     | 116 (5.4)                                 | 8.832**              | 1          | 0.003          |
| Pleasant                                 | 292 (24.7)                                     | 268 (27.4)                                   | 560 (25.9)                                | 2.063                | 1          | 0.151          |
| Lasting effects                          | 58 (4.9)                                       | 27 (2.8)                                     | 85 (3.9)                                  | 6.501*               | 1          | 0.011          |
| Felt confused                            | 201 (17.0)                                     | 100 (10.2)                                   | 301 (13.9)                                | 20.442***            | 1          | 0.000          |
| Want that it happens again               | 277 (23.4)                                     | 182 (18.6)                                   | 459 (21.2)                                | 7.391**              | 1          | 0.007          |
|  | <b>(n=1,053)</b>                               | <b>(n=848)</b>                               | <b>(n=1,901)</b>                          |                      |            |                |
| Distress or negative impact <sup>1</sup> | 177 (16.8)                                     | 196 (23.1)                                   | 373 (19.6)                                | 11.836**             | 1          | 0.001          |

\*p < .05. \*\*p < .01. \*\*\*p < .001. <sup>1</sup> Distress or being affected socially, occupationally or in other areas of day-to-day functioning.

***Distress or negative impact (n=1,901)***

**Full sample.** The majority (80.4%) had not been distressed or affected socially, occupationally or in other areas of their day to day functioning due to their GTP experiences, while the rest (19.6%) had been distressed at some point (Table 7.20).

**Sub-samples.** The majority of participants in both samples had never experienced distress or been affected socially, occupationally or in other areas of the day-to-day functioning due to GTP (83.2% EnS, 76.9% SpS). According to a Chi-square test, those who were distressed were significantly more likely to be from the SpS and significantly less likely to be from the EnS (11.836  $\chi^2$  (1) = p < 0.01) (16.8% EnS, 23.1% SpS).

***Influence of psychoactive substance when GTP occur (n=1,901)***

**Full sample.** The majority were not under the influence of any psychoactive substance (medicine or illicit drugs) when GTP occurred (79.3%) (Table 7.21).

**Sub-samples.** The majority of participants in both samples were not under the influence of psychoactive substances when GTP occurred (83.3% EnS, 91.9% SpS). A larger number of participants in the EnS had been under the influence of some psychoactive substance when GTP occurred. A chi-square test showed that those who were under the influence of substance when GTP occurred were significantly more likely to be from the EnS and significantly less likely to be from the SpS (16.7% EnS, 8.1% SpS) ( $30.631 \chi^2 (1) = p < 0.001$ ).

**Table 7. 21** *Influence of psychoactive substances when GTP in the full sample and sub-samples*

|  | <b>English<br/>Speaking<br/>N(%)<br/>(n=1024)</b> | <b>Spanish<br/>Speaking<br/>N(%)<br/>(n=850)</b> | <b>Full<br/>Sample<br/>N(%)<br/>(n=1,901)</b> | <b>X<sup>2</sup></b> | <b>d.f</b> | <b>p<br/>value</b> |
|--|---|--|---|----------------------|------------|--------------------|
| Influence of substance when GTP occurred (drugs or medicine) | 171 (16.7)  | 69 (8.1)   | 240 (12.8)                                    | 30.631***            | 1          | 0.000              |

\*p < .05. \*\*p < .01. \*\*\*p < .001.

## Discussion

The aim of this study was to investigate the generalities of GTP and examine what factors in terms of individual characteristics, video game habits, and motivations were significantly associated with having experienced GTP in a large sample of gamers that were English and Spanish speaking.

### Socio-demographics

Most of the participants who had experienced GTP were male, however there were more female who had experienced GTP than those who had not in the full sample and in the EnS. Gender was not significantly associated with having experienced GTP in the full population or in any of the samples. This suggests that GTP is not gender related. Age and occupation appeared to be relevant for GTP. The majority of those who had experienced GTP were between 18 to 22 years old. Age was significantly associated with having experienced GTP in the full sample and in the SpS. Participants who were between 18 to 22 years old in the SpS were significantly more likely to have experienced GTP, while those between 33 and 38 in the full sample and in the SpS, and those between 39 to 43 years old in the SpS were significantly less likely to have experienced GTP. Particularly, in Spanish-speaking countries

like Spain the gamers tend to be younger males (16 to 34 years old) (Interactive Software Federation of Europe, 2012). According to research, the brain is still maturing during the adolescent years and continue changing during the early 20s (Winters & McLellan, 2004). Also, some studies have found that older people have less “task-unrelated thoughts” (i.e., daydreaming, mind wandering) (Giambra, 1989) which may explain to a certain degree the high prevalence of some GTP experiences in the relatively young population. Futures studies should compare GTP experiences and factors related to GTP in minors versus adult gamers to obtain a clearer picture.

In terms of occupation, being student was the most prevalent occupation in the GTP group, but occupation was only significantly associated with having experienced GTP in the full sample and in the SpS. Students may engage in the game in a way that other groups of the population such as homemaker, self-employed and retired do not, since these latter ones were significantly less likely to have experienced GTP. This may be explained because besides students may have more free time as retired individuals, and more flexibility for leisure compared to self-employed individuals, students at a certain degree interact in a conducive environment for GTP to occur. First, students recurrently attend lectures that do not necessarily require constant active participation or a high level of attention, particularly in teacher-centred lectures (Wilson & Korn, 2007). During these periods, mind wandering with video game content may take place. Seeing or hearing something from the game and mind wandering about video games during lectures has been reported by gamers in previous qualitative studies (see Chapter 4 and 5) and in a previous study about GTP (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011b). Second, students interact with friends rather than with colleagues at work. This may facilitate the imitation of video game content and the use of video game content for amusement (e.g., jokes, phrases) that may somehow enhance the engagement with video games (Poels, et al., 2014).

In summary, no difference was observed in terms of gender. Being 18 to 22 years old and students was more prevalent in the GTP group, but only age and occupation were significantly associated with having experienced GTP in the full population and in one of the samples. The youngest group (18 to 22) were significantly more likely to have experienced GTP, while some of the oldest (33 to 43) were significantly less likely to have experienced GTP. In terms of occupation, students were significantly more likely to have experienced GTP, while begin self-employed, homemaker or retired were significantly less likely to be associated with GTP.

## **Gamer type and Gaming Habits**

The majority of the participants who have experienced GTP in all the samples classified themselves as hard-core gamers, while only a few gamers were newbies or professional gamers. Interestingly, professional gamers were significantly less likely to have experienced GTP in the full population and in the EnS. This was unexpected if we understand GTP taking in consideration the playing time and the salience of the gaming activity. However, this suggests that additional factors are crucial to experience GTP. Professional gamers tend to focus on one particular video game to progressively enhance their skills and master the game by training. In contrast, hard-core gamers tend to play a diversity of game types (Fritsch, Voigt, & Schiller, 2006; Westwood & Griffiths, 2010) that may favour their opportunities to experienced different types of GTP. Research has found that motion sickness side effects due to the use of virtual simulators is reduced or removed with the frequent use due to adaptation (Champney, et al., 2007), therefore it is speculated that something similar occurred with GTP. The repetitive exposure to the same game may reduce the chance to experience some GTP rather than increasing it. Moreover, neuroimaging studies have compared the brains of professional gamers and those with problematic gaming and besides that both have an intensive use of video games they have found important brain differences. Those with gaming disorder showed poor ability to control executive functions and sustain attention (Han, et al., 2012). Interestingly, failure of cognitive control appears to explain many of the GTP experiences (Chapter 4 to 6).

In terms of video game habits, the majority of the participants who had experienced GTP were frequent players, most played two to four times per week or every day but frequent video game playing was not significantly associated with having experienced GTP among the samples, while the length of the video game sessions was significantly associated with GTP. This results are interesting because while frequent playing in the majority of cases may just indicate interest in gaming and frequent exposure, length of the gaming session may better denote losing track of time (Wood, et al., 2007). Gaming for longer periods of time than intended is considered a sign of maladaptive (Ko, et al., 2005) and poor executive control. However, both longer session times and high frequency of playing have been associated with gaming disorder (Tejeiro Salguero & Morán, 2002). Also, research has found that the exposure time to virtual stimuli is proportional to the time of recovery after the neural adaptation takes place (Champney, et al., 2007). Similarly, prolonged immersion decreases the sense of presence in the objective reality leading to dissociation in susceptible individuals (Aardema, et al., 2010). This suggest that prolonged exposure may enhance GTP experiences.

According to Poels and colleagues (2014), associations between real life stimuli and game-biased perceptions (thoughts about the game triggered by physical objects or sound and music, daydreams, nightly dreams, intentionally use of words and expressions with video game contents) are positively related to increased playing time (e.g., the number of hours played on an average day during the last three months).

In the qualitative studies in this thesis (see chapters 4 to 6), several gamers reported playing for very long periods of time that went from six hours to more than a day when they experienced GTP, therefore it was expected that a larger number of gamers would report GTP when playing very extensive sessions, but findings in this study suggest that long and extremely long playing sessions are not required for experiencing GTP. More participants who had experienced GTP played 1 to 2 hours 59 minutes but GTP was significantly more likely to have occurred when playing 3 to 5 hours 59 minutes (at least in the SpS) and less likely to have occurred when playing sessions shorter than one hour in all the samples. In fact, when comparing typical session length with session length when GTP occurred showed that the number in the shorter periods (one hour to six hours) decreased when GTP occurred, while those playing 6 hours or more, increased. In other words, more participants played longer sessions when GTP occurred compared to usual session length in both samples.

In general, those who experienced GTP in the SpS played less frequent and shorter sessions when GTP happened compared to the EnS. Interestingly, even though the differences of video gaming habits between the sub-samples, both have exactly the same prevalence of GTP. This might suggest that SpS is more susceptible to experience GTP since even though they played less and shorter sessions they have the same prevalence of GTP, which in turn indicate the relevance of other factors rather than video game habits to explain GTP.

To summarize, most participants who had experienced GTP were hard-core gamers while professional gamers were significantly less likely to have experienced GTP. There is strong evidence that suggest that gamers who play shorter session are less susceptible to experience GTP, while those who played 3 to 5 hours 59 minutes session may be more susceptible to experience GTP, although this was just found in one of the samples. In fact, more played longer sessions when GTP occurred compared to their usual session length. This suggests that some gamers do not have to play very long sessions to experience GTP. Different types of GTP may require different periods of time and playing frequency to manifest, therefore to more clearly understand the extent to which the length of the video game sessions influence GTP it is suggested that each of the GTP types is individually examined.

### **Motivations for Playing and In-game Behaviours**

The motivations significantly associated with GTP were those that implied focusing on the game world or on the elements in the game space, rather than focusing on building interpersonal relationships by socializing while playing, or motivations related to achievement in the games such as competition, improving your own scores or playing for excitement. What is clear, is that liking to finish the game fast as possible, playing for excitement, and socializing while gaming were not significantly associated with GTP.

In the full sample, those who played for immersion, exploration, customization, escape and rules and mechanics were significantly more likely to have experienced GTP. Also, in the EnS playing for exploration, immersion and escape were significantly associated with GTP, while in the SpS those who play for rules and mechanics, customization and escape were significantly more likely to have experienced GTP.

Playing to explore the game world implies getting immersed in the game by discovering, collecting items, paying attention to particular elements, and engaging in repetitive in-game behaviours (e.g. smashing items, approaching corners, etc.). Immersion appears also to be crucial for GTP; immersion is central to the game experience and can take place in different ways. Ermi and Mäyrä (2005) propose three dimensions of immersion: sensory immersion, challenge-based immersion, and imaginative immersion. Sensory immersion is related to the video games' audio-visual features (Ermi & Mäyrä, 2005). Becoming sensory immersed in a game implies getting cognitively involved, dissociating from the objective reality by losing track of time due to focusing on virtual tasks and in some games even feeling dislocated from the physical location, and feeling present in the game space (Jennett, et al., 2008). Imaginative immersion focus on involvement in the story and in the game world, role-playing and identifying with the game characters (Ermi & Mäyrä, 2005; Poels, et al., 2014; Yee, 2006). In narratives, individuals get transported into the fictional story, and the person's disbeliefs and critical evaluations are suspended (Dill, 2009). Although, in the current study it is not known what type of immersion the gamers' referred to. According to Poels and colleagues (Poels, et al., 2014) there is a positive but weak relationship between video game content and physical objects, sounds and music and dreams and involvement in the games' narrative.

Customization usually requires focusing on appearance; accessorizing characters, vehicles, or being creative to personalize or to power up. It also implies engaging in repetitive manipulations of game menus, which have been found repetitively in self-reports of GTP (see

the qualitative studies in Chapters 4 and 5). Also, the customization of video game characters suggests the involvement and identification with the characters. In some games, customization is a creative task that requires high levels of time investment. However, the degree of customization varies in different games and customization may not be enough to contribute to the manifestation of GTP in all the cases.

In general movies, narratives and video games offer ways to escape from reality (Molesworth & Denegri-Knott, 2009). Escapism can be positive as a copying mechanics (Warmelink, Harteveld, & Mayer, 2009). However, escapism and the motivation play to understand the game mechanics have been found to be predictors of problematic gaming, even stronger predictors than time invested in playing, and contribute to the prevalence of problematic gaming (Kuss, et al., 2012).

In summary, motivations associated with GTP appear to be better related to different dimensions of immersion while GTP appear not related to socialization and achievement. A closer look at motivations correlated with each GTP modalities/sub-modalities in future studies is recommended.

## **Individual Characteristics**

### ***Recollection of dreams***

The expectation of high recollection of dreams was not fully-supported, as recalling dreams was only significantly associated with GTP in the full sample and in the SpS, although more participants who had experienced GTP recalled their dreams sometimes and very often in comparison to those who have never experienced GTP. Those who never recalled dreams were significantly more likely to not having experienced GTP in the full sample and in the SpS. This suggests that recalling dreams is relevant for GTP. This variable was included in the survey as a measure of fantasy proneness, and irregular sleep patterns typically associated with excessive video game playing (Achab, et al., 2011; Ng & Wiemer-Hastings, 2005).

According to research into dreams, individuals prone to absorption, imagination and fantasy tend to remember their dreams better and report vivid nocturnal experiences (Watson, 2003). Also, repetitive awakenings during night and low sleep quality have been associated with dream recall frequency (Schredl, 2009) and there is evidence of sleep disturbances among the GTP experiences analysed to date. For instance, gamers have reported abruptly waking up from dreams when sounds from the game were thought to be heard outside. Some also reported

experiencing sleep paralysis or kept seeing video game images that provoked sleep deprivation (see Chapters 4 and 5 for further details).

In the current study, sleeping disorder (excluding insomnia provoked by the visualization of video game images) was reported by 6.3% of the full population. Researchers have argued that disruptions in REM sleep are related to daydreaming (Giesbrecht & Merckelbach, 2006) and video game playing has been associated with disrupted sleep (Dworak, et al., 2007; Higuchi, et al., 2005; King, et al., 2013) which may explain the prevalence of task unrelated thoughts with video game content. The relation between sleep variables and GTP should be further investigated. This is mainly because poor sleep quality can affect executive control functions and facilitate the manifestation of GTP.

### ***Drug consumption***

According to research male adolescents that consume nicotine, alcohol and cannabis has been found to be almost twice more likely to report problematic gaming than those that do not consume these substances (Van Rooij, et al., 2014). Previous analysis of gamers' self-reports suggested that some gamers experienced GTP when being under the influence of psychoactive substances. The author speculated that consuming drugs, or having certain medical conditions (e.g., visual disorder, sleep disorder, mental disorder) may make the gamers more susceptible to experience GTP or in some cases the manifestation of symptoms of medical conditions could be manifesting as GTP, therefore these variables were investigated. The results suggested that the majority of the participants in both samples have never taken illicit drugs. Although, more participants who have experienced GTP had consumed drugs compared to those who had never experienced GTP in the full sample and in the EnS and those who had consumed drug were significantly more likely to have experienced GTP compared to those who had not consumed drugs, although only significant associations was found in the EnS, the sample that in fact reported to have consumed more drugs.

This partially confirms the author's hypothesis, that individuals who consume drugs may be more susceptible to experience GTP. Moreover, in the full population the majority were not under the influence of psychoactive substances (prescribed medicine or illicit drugs) when GTP occurred. This demonstrates that in the most of the cases, the occurrence of GTP is not explained by being under the influence of psychoactive substances. Furthermore, the majority of the full population had not experienced flashbacks as a secondary effect of the consumption of drugs. However, more participants of those who had experienced GTP had experienced



flashbacks in comparison to those who had never experienced GTP, but this predictor was not significantly associated with GTP in any of the samples.

### ***Medical conditions***

In terms of medical condition, the majority of the participants did not have any medical condition in the full sample, but more participants who had experienced GTP had a medical condition compared to those who had not experienced GTP. Those who had a medical condition were significantly more likely to have experienced GTP in the full sample and in the EnS, which corroborated the author's speculations. The medical conditions present in both samples were: depression, ADHD, migraines, and OCD. Further analysis to find out what type of medical condition were significant associated in the EnS showed that those who have a psychological mental condition were significantly more likely to have GTP.

In summary, there is evidence that suggest recollection of dreams is relevant to GTP. The majority of the participants have not been under the influence of psychoactive substances when GTP occurred. The majority of participants who had experienced GTP had never consumed drugs. However, those who have consumed drugs were significant more likely to have experienced GTP in the EnS than the SpS (EnS had more gamers who had consumed drugs). The majority of gamers did not have a medical condition but those who had a medical condition were significantly more likely to have experienced GTP in the full sample and in the EnS, particularly those who have a psychological medical condition were significantly more likely to have experienced GTP in the full sample and in the EnS. These results suggest that individuals that consume drugs and have a medical condition may be more susceptible to experience GTP. Moreover, participants who have experienced GTP have had flashbacks but this predictor was not significantly associated with having experienced GTP. Further research should examine if having a medical condition can be a predictor of GTP.

### **GTP modalities/sub-modalities and GTP types**

A very high percentage in the GTP types was observed among the GTP modalities/sub-modalities, with the lowest percentage being around one-quarter. Most participants had experienced GTP more than once. A large number of participants had experienced six to ten types of GTP. These results are similar to previous survey where 87% of the participants reported transfer of effects in a sample of 1,146 gamers (Bigl, 2013). The two most prevalent

GTP modalities/sub-modalities in the EnS were automatic mental processes and altered visual perceptions, while in the SpS they were altered auditory perceptions and behaviours. In general there were no differences in terms of sequences of the prevalence of GTP between the two samples. The most prevalent type, second most prevalent type, etc., in all modalities/sub-modalities were the same in both samples, for almost all types (see Figures 7.3 to 7.8).

### *Prevalence of GTP in terms of significant levels*

According to Chi-square test there were differences in the majority of GTP items between the EnS and the SpS. The only type of GTP that was not significantly different between the two samples was “wanted or felt the urge to do something in real life after seeing something that reminded me of the video game”. In a previous study and in the automatic mental process and behaviours chapter (see Chapter 6), gamers reported feeling the urge to do activities that were continuously repeated in the game such as climbing buildings (Ortiz de Gortari, et al., 2011a). In general, higher levels of prevalence of GTP were found in the majority of the items in the SpS. For instance, the majority of the SpS were Mexican and in the EnS the highest concentration of population per country was found in United States, United Kingdom, Sweden and Canada. The difference in the significant levels of GTP may reflect cultural differences that should be further investigate.

### *Altered visual perceptions*

Those who had experienced “visualized video game images/seen them with closed eyes” and were significantly more likely to be from the EnS than the SpS. The differences between the samples may be explained in terms of the video game genres. Having experienced GTP when playing puzzle games was significantly more likely to be associated with the EnS and when playing tile-matching puzzle games (e.g., *Tetris*) that are repetitive and stereotypical. Gamers have previously reported these types of GTP (Ortiz de Gortari et., al 2011 and chapter 4). Also, more participants in the EnS had visualized or seen video game images with closed eyes when being in bed (e.g., just lying down, falling asleep) or when waking up or just have woken up. This have commonly been reported when trying to fall asleep (see Chapter 4). Furthermore, more participants in the EnS had consumed drugs at some point (39.1% vs. 20.4%) that could have made them more susceptible to experience visualizations as side-effects

of drug consumption (Halpern & Pope Jr, 2003), although GTP were not significantly associated with flashbacks as side-effects of the use of drugs.

Another explanation for the differences in this item is the inconsistency in the question, since the SpS included an example while the EnS not. However, it is important to notice that even though there were inconsistencies, the number of affirmative responses to this item in both samples were two-thirds or more (EnS 85.5%, SpS 66.5%). This may suggest that the inclusion of the example lowered the percentages and that the exclusion increased the percentages or vice-versa. This should be considered in further constructions of instruments that measure GTP. The opportunity to observe the differences between items used to measure GTP at this first stage is highly valuable.

Furthermore, those who have seen video game elements with open eyes were significantly more likely to be from the SpS. Interestingly, cross-cultural differences have found between cultural groups in terms of hallucinations. For instance, one study found higher frequencies for auditory and visual hallucinations in non-European clinical individuals than in English and Continental Europeans (Bauer et al., 2011). Some consider hallucinations as phenomena that go beyond cultures (Van Dusen, 1970) and remain stable over time, while others claim that hallucinations are influenced by culture at least in terms of the content of the hallucinations (Kiev, 1972). Although studies have suggested that the influence of the immediate environment is more important than the influence of culture when it comes to hallucinations and delusions (Suhail & Cochrane, 2002; Wang, Morales, & Hsu, 1998).

Differences in visual hallucinations have been explained in terms of the influence of cultural differences of the cognitive styles (i.e., perceptual and attentional processing). For instance Westerners tend to pay more attention to salient objects than to contextual backgrounds, whereas East Asians attend more to relations and context than to salient objects (Kitayama, Duffy, Kawamura, & Larsen, 2003) and inclusive difference between cultures have been explained by differences in brain regions engaged in perception processing (Han & Northoff, 2008). The prevalence of visualization of memories have been suggested to be higher in individualistic cultures in comparison to collectivist cultures where auditory and narrative is more important (Rubin, Schrauf, Gulgoz, & Naka, 2007).

### *Altered auditory perceptions*

Hearing involuntary music imagery is a common phenomenon in the non-clinical population. 89.2% of the participants in a sample of 12,519 reported having experienced them

at least once a week (Liikkanen, 2012b). Those who heard music, sound or voices, and misperceived some sound as some sound from the game were significantly more likely to be from the SpS. Hearing music from the game may be more expected to occur when playing musical/dance games as qualitative data has showed (see Chapter 5), experiencing GTP with music/dance games were significantly more likely to have been experienced by the SpS. The exposure to music practice and listening has been positively related to the frequency of the auditory replays (Liikkanen, 2012b). Moreover, involuntary auditory imagery is related to semantic memories (Liikkanen, 2008) and in general memories can manifest in a large scope of phenomena according to the preferences of each individual such as “feel how what I felt then”, “reliving the event”, “see it in the mind” or actually seeing or hearing something the visual or auditory cortex activated (Rubin, et al., 2007). Differences have been observed between cultures more oriented to sound, image or narrations. For instance, hearing appears to be more important for Turks and they had higher correlations in auditory imagery than for Japanese and Americans (Rubin, et al., 2007). Latino-American cultures are characterized by music and dance. This may be factor that strengthens these experiences. Interestingly, remembering can manifest in a large scope of phenomena according to the preferences of each individual such as “feel how what I felt then”, “reliving the event”, “see it in the mind” or actually seeing or hearing something the visual or auditory cortex activated (Rubin, et al., 2007).

### ***Altered body perceptions***

The majority of the altered body perceptions types were significantly more likely to be experienced by SpS in comparison to the EnS. These types were “Perceived time and/or my body feeling differently after playing a game”, “Bodily sensations of movement as if I was in a video game” and “tactile (touch) sensation associated with a game” and they were typically reported at bedtime. Although, those who experienced GTP at bedtime were significantly less likely to be from the SpS. In previous studies, gamers have reported motion sickness sensations when feeling the body moving when lying in bed after playing. Some gamers also saw or visualized images accompanied by involuntary movements of limbs (e.g., fingers pushing buttons as they would on the gamepad, legs moving as they would in steps in the video game) (see Chapter 4). These experiences share similarities with what is known as myoclonic jerking (Grunewald, et al., 1992) and hypnagogic jerk or myoclonic twitch (Mitchell, 1890). Moreover, gamers have reported sensations of pushing buttons of the game pads or tactile

sensations when not playing (Ortiz de Gortari et al., 2011, Ortiz de Gortari, 2010). Similarly, phantom sensations of mobile phone vibrations have been reported (Drouin, Kaiser, & Miller, 2012; Sauer, et al., 2015).

The only variable in the altered body modality perceptions that was more prevalent in the EnS was “felt as though my mind has disconnected from my body after playing (e.g., out-of-body experience)”. This was one of the GTP types less prevalent in the full sample, although more than one quarter has experienced it. Interestingly, motion sickness side effects have been extensively reported after the use of virtual environment simulators (Champney, et al., 2007) and by playing video games via head-up displays (Häkkinen, Pölönen, Takatalo, & Nyman, 2006; Stoffregen, et al., 2008). Motion sickness symptoms (i.e., nausea, eyestrain, visual discomfort) involve the vestibular system (Hill & Howarth, 2000; Stoffregen, 2002) and disruption in multisensory integration processes or ambiguous inputs from different sensory systems (e.g., vestibular, proprioceptive, tactile, visual) are important precursors of out-of-body experiences and in autoscopy<sup>20</sup> (Seifert & Patalano, 1991) and suggests that disruption in multisensory integration and deep immersion may explain why some gamers have experienced out-of-body-like experiences after playing video games.

### *Automatic mental processes*

The only type of GTP in the automatic mental processes modality that was not significantly different between the groups was “wanted or felt the urge to do something IRL after seeing something that reminded me of the VG” (as mentioned above). Those who had experienced “I have experienced still being in the mind-set of a game after I have stopped playing” were significantly more likely to be from the EnS than the SpS. Still being in the mind-set of the game has similarly as visualizing or seeing video game images with closed eyes has been repeatedly reported in association with puzzle games. The EnS reported to play more of these games when GTP happened which may explain the differences between the samples.

Also, “thinking about using something from the VG IRL” was significantly more likely to have been experienced by those in the EnS. This type has recurrently been reported in previous studies (e.g., Ortiz de Gortari, et al., 2011; see Chapter 6). While some gamers have experienced thoughts popping up about using video game elements, others have seen video game images when wanting to use the video game elements in real life contexts. Moreover “I

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<sup>20</sup> Out-of-body experiences (OBE), manifest as seeing the own body and the world from a perspective outside the physical body. A closely related experience is autoscopy (Blanke & Mohr, 2005).

have momentarily mixed up VG events with actual RL events” was significantly more likely to have been experienced by those in the SpS. This indicates that the SpS experienced more irrational thoughts or cognitive bias when – for example – they found themselves expecting for a moment that something from the game could happen in real life.

### *Actions and behaviours*

All the behaviours were significantly more likely to have been experienced by those in the SpS. This suggests that more participants in this sample have experienced failures of control inhibition. It is important to notice that while the EnS tend to have experienced GTP manifesting more as something internal or endogenous (e.g., intrusive thoughts, urges, visualizing or seeing video game images in the back of the eye lids), a larger percentage of those in the SpS have more experienced GTP related to externalization of video game elements or acting out behaviours (e.g., involuntary movements of limbs as a response to external stimuli, verbal outburst, act out a behaviour, change behaviour, seeing images with open eyes). Culture delimited the tolerance for the expression of emotions and strong affect (Kirmayer, 2001) which may affect the degree in what behaviours are contained or expressed. In general phenomena that can be disconcerting and experience as bizarre (e.g., seeing video game images with open eyes, involuntary movements of limbs, jumping to conclusion when expecting that something happen in real life as in the game) were significantly more likely to have been experienced by the SpS – which may explain why more participants in this sample had experienced more distress when GTP occurred.

In summary, the GTP types were experienced by a large number of participants and large percentages were reported, and it is important to point out that the most prevalent GTP type in one sample was also the most prevalent in the other sample, same for the second most prevalent type and so on, for almost all types. Although, significant differences were found between the EnS and the SpS. Specifically those who have seen video game images with closed eyes or felt the mind disconnected from the body were significantly more likely to be from EnS, and they showed higher prevalence in almost all of the GTP types related to thoughts, and while the SpS showed higher prevalence in the majority of the GTP types related to behaviours. Differences between the samples may be explained by the game preferences. Those who played FPS, MMORPG, RPG, simulation or, puzzle games when GTP happened were significantly more likely to be from EnS, while those who played sport, music/dance or adventure games when GTP happened were significantly more likely to be from SpS. GTP is composed by a

large variety of non-volitional phenomena and they are complex phenomena to be studied. Differences between the samples may also be explained by the idiosyncrasy susceptibility of each culture that is not possible to explain at this stage, or due to technical differences between the questionnaires.

### **GTP Characteristics**

A section of the questionnaire was dedicated to trying to understand when, where, and for how long GTP occurred among other variables. Participants in the full population were more likely to have experienced GTP as post-play phenomena rather than phenomena experienced while gaming. More than half of the participants in the full sample experienced GTP hours after stopping playing and half of the participants experienced GTP directly after stopping playing. Similar results were observed in both samples. Although, no differences were observed in experiencing GTP per weeks, those who experienced GTP directly after, hours or days after stopping playing were significantly more likely to be from the EnS, but they were also more likely to have experienced GTP whilst playing in comparison to the SpS.

Supporting previous observations in the qualitative studies (see Chapters 4-6), GTP were usually short-lived phenomena (i.e., seconds or minutes), although while more gamers in the EnS experienced GTP only for seconds, more gamers in the SpS experienced GTP for minutes, hours, weeks or experienced GTP all the time. Also, the majority of the participants experienced GTP recurrently or episodically at some point triggered by association of stimuli or elicited by blinking. Those who experienced GTP recurrently were significantly more likely to be from the SpS.

The majority of the participants experienced GTP while doing activities not related to sleep. However, differences were observed between the samples. Those who experienced GTP in bed or while waking up were significantly more likely to be from EnS and significantly less likely from SpS. In the qualitative studies earlier in this thesis (chapter 4 and 5) constantly hearing music from the game or seeing video game images was frequently reported, when trying to fall asleep, although not exclusively. Other GTP experiences triggered by automatic associations between stimuli have been reported while doing daily chores.

In terms of the psychological impact of GTP experiences, the majority of the participants had no specific feelings about GTP. However, there were differences between the samples. Those who had no special feelings about GTP, wanted GTP to happen again, felt confused, or had lasting effects or experienced GTP as unpleasant were significantly more

likely to be from the EnS. No differences were found between the samples when it came to experiencing GTP as pleasant phenomena. Also, the majority of participants have never experienced distress due to GTP; although, those who have experienced some type of distress were significantly more likely to be from the SpS. Perhaps the participants in the SpS have experienced more distress due to GTP since a larger number of participants have reported that the duration of GTP were longer or happened all the time and recurrently in comparison to the EnS. However, more participants in the EnS reported GTP as unpleasant and felt confused due to the experience.

The contents and the circumstances where GTP were experienced have been suggested in the qualitative studies in this thesis to be important for how GTP are appraised. Cultural differences (e.g., values, beliefs, attitudes) may influence the interpretation of GTP since culture influences the source of distress, the way illness is experienced, the symptomatology, the interpretation of the symptoms, the motivation for looking for help, and the coping mechanism of and social response to distress (Kirmayer, 2001). Taking cultural differences into account appears to be important when evaluating the psychological implications of GTP, in terms of the present study. Magical thinking and superstitious beliefs are particularly well rooted in Latin-American culture (Subbotsky & Quinteros, 2002) with shamanism, astral influences, external locus of control (“leave it to the destiny”), and religion. Magical thinking (for example) in auditory hallucinations, is associated with beliefs about the omnipotence of the voices (Birchwood & Chadwick, 1997) which can have a negative effect when gamers hear or see something from the game, particularly when these experiences are manifested as exogenous and non-self-generated phenomena. Paying close attention to the effects of GTP in individuals and cultures that endorse magic thinking is recommended. Moreover, Hispano-American cultures tend to be less individualistic and more collectivistic (Triandis, 1995) which can in a way provide support resources, but also social stigma against anomalous phenomena and psychiatric disorders which may lead to feeling socially inadequate and feeling ashamed due to the bizarreness of GTP experiences. Distress can be experienced for fear of being judged if these experiences are communicated.

GTP were found in a wide variety of video game genres. Some of the video game genres reported by the participants are among the most popular ones (Entertainment Software Association, 2013) (e.g., first person shooters, adventure and action games, and role-playing games). Only a very few participants reported having experienced GTP in educational games. The interpretation of video game genres associated with GTP should be noted with caution,



since a higher prevalence of some genres may indicate that certain genres are the favourites rather than indicate that these genres are more related to GTP. Moreover, GTP may also be related to gamers' level of competence; failure in a sequence of a game lead to re-playing the same sequence several times. Repetition of the same sequence may enhance GTP by also eliciting different emotions in gamers.

### **Limitations**

A number of limitations to the present study should be addressed. This study was exploratory and cross-sectional but also the first to examine GTP on a large scale. The results show associations between the variables examined rather than causality. GTP manifest in a variety of ways and only some type of manifestations were addressed in the current study. An exhaustive examination of GTP and their characteristics was not possible in order to avoid participants' fatigue when completing the questionnaire. Future studies should examine the characteristics of GTP in each GTP modality. There were also some limitations in terms of the way participants were recruited. Links to the questionnaire were posted on particular online arenas, which may have targeted particular types of populations. Furthermore, it could be the case that gamers who participated in the study may be the ones that recognized GTP experiences, therefore the high incidence of GTP in the sample should be interpreted cautiously. Also, there are limitations in terms of how the data was analysed. The classification of groups as GTP and No GTP group was done based on a single affirmative answer to one of the 20 items for measuring GTP. This can be considered as a weak measure of GTP. However, a majority of the participants experienced 6 to 10 different types of GTP at some point. Finally, the use of a bilingual questionnaire may have caused some comparability issues. Even though different translators participated in the translation, a few differences between the items were found that may have influenced the participants' responses in the two questionnaires. Consequently, studies should use more systematic ways to translate the questionnaires.

Differences between the items forced the researcher to analyse the samples individually and compare the variables between them accordingly. Moreover, the samples were divided according the language they responded to in the survey, therefore a clear cut comparison between individuals from particular countries and cultures was not possible. Those who answered the English questionnaire included American, British and, Swedish participants, while those who answered the Spanish questionnaire included Latin-American and Spanish participants.

## Conclusion and Implications

In general, this study contributed to the understanding of GTP, and confirmed previous studies that examined gamers' self-reports about GTP in the different modalities/sub-modalities. Numerous gamers' self-reports about GTP were analysed previous to this study, but it was unexpected to find such a high prevalence of GTP in the population studied. A wide range of GTP experiences in the five different domains (altered visual, auditory and body perceptions, automatic mental processes, automatic actions and behaviours) were examined. Most participants had experienced GTP more than once and the majority had experienced 6 to 10 different types of GTP that was considered a medium level of GTP. GTP appear to be related with a wide variety of video game genres.

This study demonstrated that video game playing can induce altered visual perceptions mainly manifesting as visualizations of video game images or when seeing video game images with closed eyes or in the back of the eyelids; altered auditory perceptions, mainly when the player keep hearing the music from the video games; altered body perceptions mainly when experiencing bodily sensations of movement as in the video game; automatic mental processes mainly when the gamer wanted to use video game elements in real life context, due to habitual use of these to resolve issues in the game; and involuntary actions when thoughts suddenly were verbalized without intention.

GTP appear to be explained by failures of cognitive control and executive functioning when – for example – thoughts, urges, images and sounds with video game content arose while the gamers were doing game-unrelated tasks. They also arose when the gamers were unable to override habitual sequences of responses to stimuli simulated in the game responding in similar ways to the real life stimuli and acted out the impulse (e.g., involuntary verbal outburst, involuntary movements of limbs or involuntary behaviour). Previous studies have suggested that video game experiences contribute to failures of cognitive control (Bailey, et al., 2010; Kronenberger, et al., 2005; Mathews, et al., 2005). Further investigations about gamers' individual characteristics and GTP need to be conducted to refute or sustain such speculations.

Another factor that appears to be important to experience GTP are video game habits, as this study demonstrated to a certain extent that the length of video game session was significantly associated with GTP. Extremely long video game sessions do not appear to be necessary to experience GTP, although longer video game sessions were registered when GTP occurred and prolonged video game sessions may enhance the video game after-effects. This

suggests the importance to regulate gaming habits particularly the session length. It is expected that gamers are more susceptible to commit cognitive failures due to mental fatigue (Van den Linden, et al., 2003) after prolonged video game sessions that lead to a higher degree of absence in the objective reality and a higher degree of presence in the virtual world (Stanney, et al., 2002) and experiencing neural adaptations (Ungs, 1989). Prior studies concerning GTP have shown that gamers experienced a lack of cognitive and motor flexibility to change from virtual tasks to real life tasks (see Chapter 6). Moreover, playing video games before going to bed has been associated with deficits in sleep quality (Dworak, et al., 2007; Higuchi, et al., 2005; King, et al., 2013) that in turn can compromise the gamers' cognitive control, making them more susceptible to experience GTP. Exploring the relationship between sleep habits and GTP may provide interesting results.

This study suggests that GTP are experienced in different ways, with different durations, under variety of circumstances, and with different recurrences. The moderation of certain video game features may reduce GTP, but even when doing this there is little that can be done to overcome individual susceptibility. However, what can be done is to try to reduce the risks involved in some experiences. This could involve including conscious user recommendations and health warnings in the manuals of the games, promoting campaigns of responsible gaming, and identifying when it is necessary to implement re-adaptation strategies to resolve neural adaptation that take place after playing as socially responsible gaming policies. Fortunately, in this study only one-fifth of gamers had experienced some type of distress due to their GTP experiences and less than one-tenth of them had experienced GTP as unpleasant.

This study showed that GTP are phenomena that in the majority of the cases are not experienced under the influence of psychoactive substances or explained by the consumption of drugs or having a medical condition. Although, there is some evidence suggesting that individuals that have consumed drugs or had a medical condition were significantly associated with having experienced GTP, this suggests the importance to investigate if these factors can predict GTP.

Interestingly, even though the SpS played less frequent and shorter typical sessions compared to the EnS, more participants in the SpS had experienced a larger number of different GTP, the duration of their GTP were significantly longer (minutes, hours or, days). Also, more participants in the SpS reported having experienced GTP all the time and experienced GTP recurrently. Moreover, those who have experienced some type of distress were significantly

more likely to be from the SpS. Besides the differences in the video gaming habits between the samples, both had exactly the same prevalence of GTP experiences. This might suggest that SpS is more susceptible to experience GTP that in turn indicates the relevance of other factors rather than video game habits for explaining GTP.

Finally, it is relevant to point out that deficient self-regulation is related to cognitive control and has been suggested as being involved in gaming disorders (LaRose, et al., 2003; Lee & LaRose, 2007). In fact, participants who had experienced GTP in the EnS (3.1%) and in the SpS (2.9%) reported having problematic gaming or gaming addiction. GTP could very well be manifesting as a result of excessive video game playing, and symptoms of gaming addiction (e.g., preoccupation for gaming, abstinence symptoms, anticipation of expected outcome and gratifications when gaming or even as withdrawal). For this reason, a further examination of the relationship between GTP and gaming disorder is recommended. More research about GTP is needed to establish the psychological, sociological, and physiological effects of GTP.

## Part III. General discussion

### Chapter 8 - Conclusions, Implications, and Recommendations

The aim of this thesis was to examine the influence of video games on gamers' perception, cognitions and behaviours directly related to video games' structural characteristic, video game content, in-game activities, taking in consideration gamers' video game playing habits. This was done in order to develop a holistic and neutral approach to investigate the psychological and social effects of video games. Similar phenomena to those identified in this thesis can also be experienced in other situations (e.g., watching movies, repetitive activities, etc.). However, the particular phenomena identified and described in the studies about GTP appear to be enhanced by the virtual embodiment and the repetitive manipulation of video game controls and, gamers' habits (e.g., prolonged exposure). This final chapter integrates the findings in the different studies conducted in this doctoral research project.

#### Original Contribution to Knowledge

The findings in this thesis are relevant to gamers, policy makers, game developers, clinicians, and social scientists in the gaming studies and beyond. The main original contributions to knowledge of this doctoral research are as follows:

- (i) **New approach to investigate the psychosocial effects of video games.** Establishing a novel and multimodal framework to investigate the effects of video game playing by analysing video game content, features and in-game behaviours and gamers habits associated with gamers' altered perceptions, mental process and behaviours. (The method for analysing the gamers' experiences is explained in detail in the method chapter 3).
- (ii) **The pervasiveness of video game experiences in gamers' lives.** Showing how video game playing influences gamers' perceptions, cognitions, emotions and behaviours when not performing gaming-related tasks; as well as show how experiencing altered perceptions associated with game content can in some cases have further psychological and social implications.
- (iii) **Duration of the video games' effects.** The effect of GTP appear to last short periods of time and manifest soon after stopping playing but they can be triggered by associations

later on. Accidental associations appear to become habitual and are practiced by gamers in a playful way.

- (iv) **Neural adaptations provoked by commercial available video games and the psychosocial implications.** Side-effects due to neural adaptations have mainly been investigated in highly immersive virtual environment (e.g., virtual simulators) by mostly paying attention to the physiological and perceptual effects. This doctoral research shows that neural adaptation can also be induced by commercially available video games (e.g., perception of objects or environments distorted, uncoordinated body movements, etc.), and illustrates their psychological and social implications.
- (v) **Cognitive bias and selective attention to real life stimuli associated with the game in real life contexts.** Experimental studies have demonstrated that particularly individuals with gaming disorders show selective attention toward stimuli associated with the game in cognitive tasks (Decker & Gay, 2011; Metcalf & Pammer, 2011; Van Holst, et al., 2012; Zhou, et al., 2012). This doctoral research shows how physical objects associated with the video game can lead to conditioned responses that manifest as automatic thoughts, impulses, altered perceptions, and involuntary behaviours in real life contexts (and which can have further psychosocial implications depending on the circumstances where and when these phenomena are experienced).
- (vi) **Failures of cognitive control and control inhibition manifesting as altered perceptions, automatic thoughts and involuntary behaviours with content of the game.** Research has demonstrated the enhancement of cognitive skills through playing games (Boot, Blakely, & Simons, 2011a; Boot, et al., 2008; Green & Bavelier, 2003; Green & Bavelier, 2007; Green & Bavelier, 2012; Spence & Feng, 2010), but research has also shown failures of cognitive control associated with video game playing mostly through conducting experiments (Bailey, et al., 2010; Kronenberger, et al., 2005; Swing & Gentile, 2010). By analysing GTP experiences, this doctoral research showed failures in sustaining the attention, lapses of conscious awareness, reasoning bias toward stimuli associated with the game and failures in control inhibition with video game content in day-to-day contexts. Although, visuo-spatial skills and fast response times enhanced by the practice of video games (Basak, Boot, Voss, & Kramer, 2008; Boot, et al., 2008; Green & Bavelier, 2012) may moderate the effects.
- (vii) **Misattributions with video game content.** Cognitive models of hallucinations argue that misattributions of internal generated information (e.g., thoughts, images, inner-

speech) result in hallucinations (Larøi & Woodward, 2007). This doctoral research showed how non-clinical population experiences pseudo-hallucinatory like experiences (e.g., seeing text boxes above people's heads, hearing sounds) when gamers expect to see or hear something as in the game due to priming mechanism, which in some cases can lead to experiencing irrational thoughts that potentially can lead to harmful ideations. Moreover, the findings suggest that there is a sequence between gamers' intrusive thoughts about the game with actually seeing the video game images. This is noticed when while some gamers found themselves thinking about using video game elements other gamers have seen the video game elements in the corner of their eyes or superimposed on real life objects. In fact, Smailes, Meins and Fenyhough (Smailes, Meins, & Fernyhough, 2014) have found that a higher number of discrimination errors and intrusive thoughts predict hallucination susceptibility.

- (viii) **Effects of the attachment to virtual elements that provide functions.** The qualitative studies showed interesting findings in terms of the attachment to virtual objects that provide some kind of function in the game. The repetitive use of video game elements paired with activities in the game led gamers wanting to use these elements in real life. This manifests in different dimensions. More specifically, gamers: (i) felt strange when not having the video game elements in real life, (ii) had thoughts pop up and appear in their minds when wanting to use the video game elements to resolve real life issues, (iii) executed involuntary movements of limbs when trying to use the video game elements in a day-to-day context, and/or (iv) visualized or saw video game images or heard sounds when they wanted to use or experience such video game elements.
- (ix) **Contribution in terms of instruments to assess video games' effects.** Studies in this doctoral thesis showed that the use of instruments that focus only on violent-related content are narrow in scope. Behaviours influenced by video games do not necessarily involve premeditation or the intention to harm as stated in many of the items used in self-report measures and tasks. Automatic responses to real life stimuli occurred due to cognitive bias (e.g., breaking a barrel in a store expecting to find bananas to get extra points rather than consciously wanting to destroy others' property). This suggests that developing new instruments for measuring video game effects is appropriate. Ideally, instruments should be developed based on the content of the game rather than only measuring explicit thoughts and/or deliberative intentions to execute behaviours influenced by the games. Moreover, findings in this thesis suggest that it is important to

take into consideration physiological and psychophysiological symptoms (e.g., altered sensorial perceptions, involuntary movements of limbs) and not only cognitions and behaviours typically measured with the current instruments developed to measure gaming addiction. Researchers should distinguish between voluntary and involuntary behaviours influenced by video game playing.

- (x) **Suggests that the dichotomy of video game content (i.e., violent and prosocial) does not ensure the understanding of the video games' effects.** Transfer effects from the video game not only depend on the content of the game but also the affordances of the real life context that facilitate the associations (and perhaps the executions of the actions). Gamers have approached vehicles thinking they want to steal them, and they have also approached plants or trees thinking they can harvest them. Harmless acts such as jumping have ended in risky situations when thinking it was possible to jump from a hill, while “criminal” video game content have made gamers test their boundaries and reflected about moral issues based on video game content. Findings in these research studies suggest that the video games' effects should be better understood in terms of what activities are simulated in the game and what activities can actually be intended to be performed or actually be performed in real life contexts, rather than focusing on violent and prosocial content.
- (xi) **GTP and the relation with excessive gaming.** Several gamers reported having played excessively when GTP happened. One in ten of the gamers in the survey reported distress at some point due to GTP. Participants who had experienced GTP in the English speaking sample (3.1%) and in the Spanish speaking sample (2.9%) reported having problematic gaming or gaming addiction. Findings in this thesis suggest that GTP is relevant when addressing gaming addiction because GTP can contribute to the prevalence of the symptoms, since GTP manifest as: (i) intrusive and stereotypical experiences: video game content appear recurrently while doing daily activities or when trying to sleep, sometimes provoking sleep deprivation, (ii) automatic associations: associations between real life stimuli, and previous video game experiences triggering GTP, (iii) confusing real life objects and events: real life stimuli and events that resemble video game elements and events are misperceived, (iv) respond to real life stimuli and events as in the game: e.g. urge to perform actions as in the game; avoidance or overreaction to real life stimuli, (v) preservative replays of the game: gamers get stuck in the mind setting of the game, (vi) mood modification: e.g., development of hyper-vigilant behaviours, (vii) altered self-



perceptions: e.g. feel they are the game character, altered body sensations, feel as though they are still in the game, (viii) intrusive location: e.g. development of irrational thoughts are reinforced by rituals and habits (Ortiz de Gortari & Griffiths, 2012b) (See poster 2 appendix II).

### **Potential Contributions to Knowledge**

The areas where the work done in this doctoral research can potentially contribute include:

- (i) **Gaming-related disorders.** This thesis provides the initial items for developing an instrument about GTP that can be used as a complementary tool in the diagnosing and treatment of gaming-related problems. Furthermore this instrument could potentially be used in court cases to evaluate cases where the influence of video games is claimed in criminal behaviour.
- (ii) **Effects of augmented and wearable technologies.** Research concerning GTP has demonstrated to be effective in identifying video game features that lead to either positive or undesirable effects. For this reason, research in this thesis may contribute to understanding the post-effects of virtual immersion and envisaging what the effects of future technologies could be.
- (iii) **Developing engaging and effective learning video games.** The GTP framework can be used as a tool for identifying what features in the video games are more appealing and how the association between sensorial stimuli can be used to promote change in behaviours.
- (iv) **Understanding symptoms of mental disorders.** The studies about GTP examine non-volitional phenomena in non-clinical population. However, since these phenomena share similarities with symptoms of mental disorders (e.g., hallucinations, delirium, intrusive thoughts, intrusive images and sounds, perseverative mental states, etc.) it provides an ideal platform for actually investigating symptoms of actual disorders.

### **Framing and Defining Game Transfer Phenomena**

Research into Game Transfer Phenomena (GTP) presented in this thesis focuses on the different human sensorial channels (e.g., visual, auditory), mental processes, and behaviours that help classify the gamers' experiences. This author has modified the definition of GTP

during this research. Game Transfer Phenomena is understood as the transfer of video game experiences into the real world. GTP manifest as altered sensorial perceptions, mental processes, and behaviours based on the content of the video games. Research concerning GTP is particularly interested in examining non-volitional phenomena (internal processes and external behaviours) with video game content that arise spontaneously and without control of the gamers. However, sometimes it is difficult to determine the level of executive control, for this reason the GTP research approach also pay attention to mental processes and behaviours that are actively initiated by gamers and for which executive control is unknown. Associations between objects and events in contextual settings, and elements and experiences in the video game can trigger the transfer of the experiences. A clear difference is established between the transfer of experiences that occur voluntarily (e.g., jokes, imitating game characters, trying to do things as in the video game) and those that occur involuntarily (e.g., pseudo-hallucinations, automatic thoughts). The majority of the GTP experiences are of non-volitional nature since they occur involuntarily or without premeditation of the gamers and are difficult to control. The experiences can manifest in a single modality/sub-modality or across modalities and/or be multisensory.

A theoretically eclectic approach is taken to explain the interplay of physiological, perceptual, and cognitive mechanisms involved in GTP, mainly informed by socio-cognitive and behavioural theories. Previous experiences shape and modify the way we perceive, interpret and respond to the world around us. The GTP research approach sees the individual as a biopsychosocial being, inspired by Lazarus multimodal perspective:

*“We are biological organisms (neurophysiological/biochemical entities) who behave (act and react), emote (experience affective responses), sense (respond to tactile, olfactory, gustatory, visual and auditory stimuli), imagine (conjure up sights, sounds and other events in our mind's eye), think (entertain beliefs, opinions, values and attitudes), and interact with one another (enjoy, tolerate, or suffer various interpersonal relationships)”* (Lazarus, 1973, p. 2).

The purpose of the GTP framework is to understand what the psychological, cognitive and social effects of the gamers’ altered perceptions, mental processes and behaviours with video game content are. The video games’ effects are explored from a broad and multimodal approach rather than focusing on particular video game content or excessive gaming. The GTP research approach pays attention to the relation between the video games’ structural

characteristics, content and in-game behaviours, and the modalities (perceptions, mental processes and behaviours) in which gamers' experiences are transferred into real life contexts.

GTP are classified in three main modalities: altered perceptions, mental processes and behaviours. Each GTP modality include non-volitional phenomena that is explained by the interplay of physiological, perceptual and cognitive mechanism, and in some cases the phenomena can be better explained by either physiological, perceptual or cognitive mechanism.

*The altered perceptions modality* includes phenomena manifesting as sensorial experiences or sensations (e.g., hearing, seeing), and include non-volitional phenomena that is explained either by physiological, perceptual or cognitive mechanism, or by the interplay of all of them. It is referred to as altered perceptions because physical stimuli are perceived different or distorted and video game elements that are not present are perceived in real life context. In some cases, perceptual experiences (e.g., visual, auditory, tactile hallucinations) in this modality are triggered by gaming related cues in day-to-day contexts via priming mechanism.

*The mental processes modality* include phenomena mostly explained by cognitive mechanisms, however, some phenomena have strong perceptual components. Here the focus is the involvement of cognitions; however, impulses or urges are taken into account (e.g., intrusive thoughts).

*The behaviours modality* is defined as those experiences that manifest as actions of more elaborate behaviours. Some automatic actions appear to have stronger physiological and perceptual components (e.g., verbal outburst).

Figure 8.1 depicts an initial descriptive framework of GTP and shows the interaction between the game (e.g., structural characteristics, content) and the different GTP modalities (altered perceptions, mental processes and behaviours and the sub-modalities of GTP identified in this doctoral research (e.g., visual, auditory)) taking in consideration emotions, mood states, affect, and impulses presented in gamers' experiences.

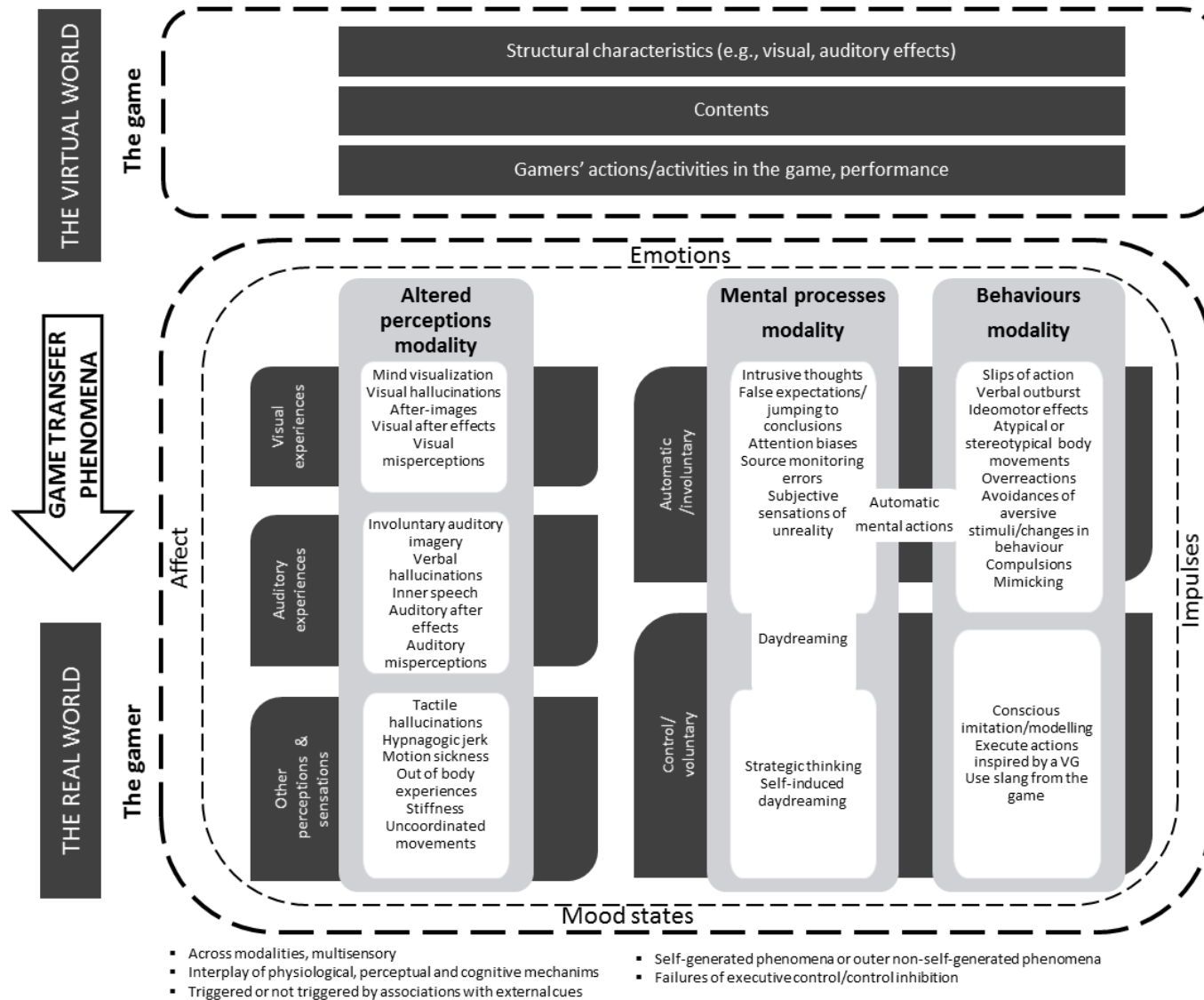


Figure 7. 8 Game Transfer Phenomena framework

## Main Findings from the Empirical Research

This thesis identified: (i) altered visual perceptions (including altered perceptions of time and/or velocity due to visual haptic illusions in the game), altered auditory perceptions, and altered body perceptions. This included kinaesthetic and prioperceptive altered perceptions; (ii) automatic and controlled mental processes; and (iii) automatic and controlled behaviours.

Content analysis of the gamers' experiences were complemented by watching videos of walkthroughs, and playing some of the games associated with the experiences, this suggested associations between the video games' features and/or in-game activities.

In this thesis, the majority of the GTP experiences appear to have occurred involuntarily but there were also some experiences that happened voluntarily (e.g., imitating a video game character for amusement) or cases where it was not possible to establish the gamers' degree of executive control. GTP manifest when (i) gamers perceived physical objects, environments, and/or sounds distorted according to video game features, (ii) gamers confused objects and sounds with something from the video game, (iii) gamers interpreted events in real life context with the logic of the game, (iv) images, sounds, tactile and kinaesthetic perceptions, thoughts arose, and when involuntary actions and behaviours were performed with video game content. The majority of the altered perceptions experiences occurred without association with external cues, but the mental processes and behaviours were (in the most of the cases) triggered by associations between the real life stimuli and video game elements and experiences. GTP can be classified in three larger categories taking into consideration if the GTP were triggered or not triggered by associations, and if they were voluntary or involuntary:

- (i) **Perseverative perceptual/cognitive and motor responses.** These occurred when the video gamers showed perceptual, cognitive, and lower motor flexibility when switching from tasks in the virtual world to real life (e.g., not being able to stop thinking about the video game, sensations of unreality such as feeling as still being in the game or feeling as being a video game character).
- (ii) **Mix-ups between real life objects and events, and video game experiences.** These occurred when external stimuli associated with the game appeared to have been crucial as triggers. These experiences appear to not necessarily occur immediately after stopping playing or during perseverative mental states (e.g., selective attention to external stimuli related to the video game, misinterpretation of real life stimuli).

- (iii) **Thoughts and voluntary behaviours involving video game content.** This includes thoughts and behaviours about the video game deliberately initiated by gamers (e.g., performing an activity inspired by video game content or thinking about strategies to improve in the game).

Among the gamers' experiences this author observed failures of cognitive control and executive functioning when thoughts, urges, images and sounds with video game content arose while the gamers were doing game-unrelated tasks. Also, this author found failures of control inhibition when the gamers were unable to override habitual sequences of responses acquired in the game and responded to physical objects and events that had been simulated in the game by acting out the impulse due to priming mechanism (e.g., involuntary verbal outburst, involuntary movements of limbs). According to the reflective impulse model (For more details see Strack & Deutsch, 2004), Friese and Hofmann (2009) explained "impulses originate in an associative network of long-term memory. Upon encountering an object, affect associated with the object is automatically activated. These affective associations serve as precursors of impulsive behaviours because they in turn activate behaviour schemata that are related to the object" (p. 796). Failures to discriminate real life objects that had been simulated in the game were guided by false expectations and irrational evaluations that in certain cases led to impulsive behaviours, such as the gamer that broke a barrel in a store after having played a *Donkey Kong* game for 15 hours straight because he was looking for bananas.

The results suggest that the associative network of scripts and schemas (i.e., sequences of events) acquired in the video game resulted in irrational interpretation of real life objects and events, and false expectations that not only suddenly popped up in the gamers' minds, but gamers also perceived distorted environments, and experienced pseudo-hallucinatory visual and auditory phenomena (e.g., seeing and hearing video game elements and sensations of unreality).. Also, some gamers confused memories from the video game with events and persons in the real world which suggest source monitoring errors (Johnson, 1997).

### **General characteristics of GTP**

The video gamers' experiences occurred spontaneously, without control and premeditation, with the exception of a few cases where the gamers reported that they could control and self-induce their GTP experiences. GTP were more likely to be experienced as post-play phenomena rather than phenomena experienced while gaming. According to the

survey study, more than half of the participants experienced GTP hours after stopping playing but a large percentage also experienced it directly after stopping playing (with a significant percentage experiencing GTP days or weeks after playing). GTP manifested episodically or intermittently as inner self-generated phenomena (e.g., hearing it in the head or ears, visualizing images or seeing images in the back of the eyelids or as retinal sensations, hearing own thoughts with a voice from the game) or as outer self-generated phenomena (seeing menus in the bottom of the vision, corner of the eye, etc.). Also, in some cases GTP were experience as outer, non-self-generated phenomena (“heard someone creating a portal”, “saw a landmine on the road and swerved to avoid it”, sound or music “coming from somewhere”). The duration of GTP were typically very short (seconds or minutes) but the majority experienced it recurrently or episodically at some point triggered by association of stimuli or elicited by blinking.

### **Circumstances of GTP**

In general, two types of conditions where gamers experienced GTP were identified: (a) where the gamers were exposed to no (or limited) external stimulus, specifically when lying in bed and (b) when the gamers were in a normal daily context. The majority of the participants experienced GTP when doing daily activities but some also experienced it when falling asleep and a few when they were lying down, or as morning phenomena when waking up or have just woken up. Incorporation of video game elements into dreams was also reported. In the qualitative studies, gamers reported experiencing GTP while doing automatic activities (e.g., walking, packing, cooking, driving, listening to music, listening to a lecturer, watching a film, staring at things, zoning out, being less alert) that do not require focus of attention and that allow the mind to wander away. Experiencing GTP such as constantly hearing music from the video game, seeing video game images or sensations of body movement or limbs were frequently reported when lying in bed (although not exclusively). Other GTP experiences triggered by automatic associations between stimuli have been reported while doing daily chores. The altered perceptions were more likely to be experienced without any external stimuli as triggers. However, elicitation of thoughts, automatic mental actions, and automatic actions and behaviours were more likely to occur when stimuli in the physical context were associated with elements and experiences from the video game.

### **Prevalence of GTP**

According to the survey study, the majority of players reported having experienced GTP more than once and had experienced 6 to 10 different types of GTP. Of the whole sample, the modality with the largest prevalence was automatic mental processes. In the qualitative studies, a large majority was found in this modality but there were also a large variety of behaviours and visual experiences particularly visualizing and seeing video game images with closed or open eyes. This may have been explained by the words used for locating the video game forums. Interestingly, visualizing and seeing video game images with closed eyes were the most prevalent GTP type in the survey.

### **Factors relevant for the occurrence of GTP**

Game content and the exposure to certain video game features (e.g., visual or auditory effects, tactile sensation of the gamepad) is what manifested as GTP in the different modalities, but individual characteristics and video games habits appear to be some of the factors that may make some gamers more susceptible than others. The results were as following:

#### ***Video game habits***

In terms of habits, the survey study showed that the length of the video game session rather than the frequency of playing were relevant for experiencing GTP. It is expected that gamers are more susceptible to commit cognitive failures due to mental fatigue (Van den Linden, et al., 2003) after prolonged video game sessions that lead to a higher degree of absence in the objective reality and a higher degree of presence in the virtual world, (Stanney, et al., 2002) which facilitate experiencing neural adaptations (Ungs, 1989).

The majority who experienced GTP in the survey study played one to two hours fifty nine minutes. This suggests that it is not necessary to play very long sessions (e.g., 6 hours or more) to experience GTP, as several gamers reported in the qualitative studies. However, those who were hard-core gamers were significantly more likely to have experienced GTP but not those that were professional gamers. Also, more gamers reported playing longer sessions when GTP happened. While those who played less than an hour were less likely to experience GTP, in one of the samples, those who played 3 to 6 hours were significantly more likely to have experienced GTP. Interestingly, independently that one sample played less frequent and fewer



hours it was found in both samples the same prevalence level of GTP and suggests that there are other factors relevant for GTP than length of the video game sessions.

Physiological states were identified in some video gamers' self-reports. Gamers reported being sleep-deprived or fatigued after playing for hours, and they also felt sick or were under the influence of psychoactive substances. Being in these circumstances have been suggested as precursors of altered perceptions (Mahowald, et al., 1998) and epileptic seizures (Bigal, Lipton, Cohen, & Silberstein, 2003a) in non-clinical populations. The author suspected some influence of psychoactive substances when GTP occur, however, the majority in the survey were not under the influence of any psychoactive substance (e.g., medicament or drug) when GTP occurred and neither had the majority consumed drugs. Moreover, interviews conducted with gamers outside the time frame of this thesis (Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c; Ortiz de Gortari, et al., 2011d) and observations in the study about altered visual perceptions in this thesis suggested the interplay of arousal, anxiety, fatigue, and stress when GTP occurs, perhaps as escape in social situations.

### *Individual characteristics*

In terms of individual characteristics, the survey study showed that those who were 18 to 22 years old, had a medical condition, and had consumed drugs (in the sample where more participants had consumed drugs) were significantly more likely to have experienced GTP. Moreover, those who were students were significantly more likely to have experienced GTP but just in the one of the samples, while those who were 33 to 38 years old, self-employed or retired were significantly less likely to have experienced GTP, as well as those who never recalled their dreams. The tendency to recall dreams may indicate fantasy proneness (Watson, 2003) and sleep disturbances (Schredl, 2009) but a very high frequency of dream recalls were not found among gamers.

### *Video game genres and video game elements related to GTP*

GTP were reported in a wide variety of video game genres, including both old and modern video games. In the qualitative studies, gamers reported GTP experiences in over 400 unique video game titles. Some of the video game genres reported by the participants in the survey are among the most popular genres: adventure, role-playing, action games, and first-person shooters. Fewer gamers had experienced GTP with educational or sport games. These

findings should be interpreted carefully since the low prevalence of such genres may indicate that these genres were not commonly played by the population investigated, rather than being the genres more unlikely to provoke GTP. Interestingly, a high prevalence of automatic mental processes and automatic actions in sport games was expected since those games resemble reality that facilitates associations, but this appears not to be the case in this study. Although, Bigl (2013) found transfer of effects in sport games. No systematic analysis was done focusing on video game features and video game genres but it is possible to see some patterns in the data collected. These are presented according each of the GTP modalities/sub-modalities:

- *Altered Visual perceptions.* Monotonous patterns and stereotypical video game play were more likely to be reported with recurrent afterimages in the back of the eyelids. Special visual effects (e.g., eagle vision, slow motion, images in fast velocity) were reported as perceptual distortions, while video game images that appeared recurrently on the screen associated with activities in the game were more likely to have been seen with open eyes or be related to misinterpretation of real life objects. Some genres included puzzle and music/dance games.
- *Altered auditory perceptions.* These included repetitive sounds associated with crucial activities in the video game or used as background music. Among others, high pitched and loud sound (e.g., bullets, explosions, screams, binaural sounds as background) but also more discrete sounds (lasers, spreading of a net, sound of making a portal), instructions, sound embedded as rewards, alerts or punishment, commands, and echoing voices and whisperings were reported.
- *Altered kinaesthetic/body perceptions.* These experiences were associated with games that use effects of velocity, slow motion, constant or fast movements, haptic feedback gamepads.
- *Automatic mental process.* This included repetitive activities in the game (e.g., climbing, jumping, running), and use of video game elements that have a function such as feedback elements (e.g., health bars, maps, bionic arms, hook).
- *Automatic Behaviours.* This modality included simulation of real life activities (e.g., driving, searching, jumping, climbing buildings).

### **Appraisal of GTP and psychosocial implications**

According to the results in the survey study, slightly more than half of the participants were indifferent to their GTP experiences and the tendency was to experience GTP as

something pleasant, and gamers wanted to experience them again. However, slightly less than one-fifth of the gamers had felt confused or experienced GTP as unpleasant. Among gamers' self-reports used in the qualitative studies, GTP were experienced positively or negatively, but in general more negative expressions than positive were reported by gamers. Gamers reported surprise, confusion, hyper-vigilant mood states, fright, and anxiety, sleep deprivation, lack of concentration, frustration, embarrassment, behaving irrationally, and/or having engaged in risky behaviours. When the gamers overreacted to real life stimuli or acted out behaviours involuntarily due to their video game experiences, some gamers had a good laugh, while others felt embarrassed, got concerned and/or worried. It depends on the circumstances where GTP manifested and were experienced. Although, some video gamers thought the experiences were fun, creative, and reflected about the content in the video games, their own personal boundaries, and their video game habits. Additionally, some GTP experiences appear to instigate moral reasoning and personal boundary testing when urges to do controversial things were stimulated. As commonly occurred with cognitive intrusions the gamers either reasoned with the self about the irrationality and unimportance of the thoughts, tried to do or think of something else to get distracted, got worried, looked for social support, sought reassurance, or sought no further action (Berry & Laskey, 2012). In terms of specific GTP sub-categories, while sometimes the intermittent visualization of video game images or the constant hearing of sounds from the game resulted in annoyance or caused sleep deprivation, in other cases the gamers thought they were fun. A few even wanted to induce them.

The gamers also engaged in reproduction of video game content for amusement, which may be one of the healthiest ways to release video game content that are activated in the mind. In general, the majority of the GTP appear to not have ended in negative consequences for the gamer. In most of the cases, the gamers were able to hold back their impulses but in some cases the put themselves and others in risk. Also, among gamers experiences were also found transfer of skills, emotions, slang and, experiences from the video game to real life context, and dreams with video game contents. This coincides with previous studies (Bigl, 2013; Gackenbach, Rosie, et al., 2011; Ortiz de Gortari, 2010; Ortiz de Gortari, et al., 2011c; Poels, et al., 2014). Moreover, there is some evidence in the qualitative studies and in anecdotal data that fast responses when applying the skills acquired in the game were beneficial to the gamers. For instance, one gamer reported that when driving on a bad icy road and to avoid having an accident, his "brain went immediately into gaming mode" and he "felt like he was with the PlayStation controller in the hands". A similar experience was reported by journalist Sally

Adee in a *New Scientist* article (Adde, December, 2011) when she played *Mario Kart*. Other cases in media where gamers have transferred skills acquired in the game to real life context include the case of a 12-year old child who used his skills acquired in *World of Warcraft* to save his sister who was attacked by a Moose (Cavalli, 2007, December 6), and the 10-year old child who took over the driving when his grandmother fainted, applying his driving skills from *Mario Kart* (Golden, 2013, July 27).

Perhaps, confronting dangerous situations in (simulation) video games help the gamers to better manage dangerous real life situations using skills acquired in the game. Most importantly, regulating emotional displays, as has been found that high frequent gamers, have better control of the events that occur in their dreams, do not perceive their dreams as frightening, independently of the violent content in comparison to individuals who play less video games (Gackenbach, Ellerman, & Hall, 2011; Gackenbach & Kuruvilla, 2008). Researchers that have investigated the continuity between video games and dreams have found that high frequency gamers have better control of the events in their dreams. They argue that since the gamers are confronted with threatening situations in the video games they are better at controlling the events that occurred in their dreams.

Only 19.6% of the gamers had experienced distress or had been affected socially, occupationally, or in other areas of their day-to-day functioning because of GTP at some point. However, it is important to note that this is a significant prevalence rate of problems associated with gaming, particularly if we paid attention to the prevalence rates of gaming addiction that studies suggesting prevalence rates as high as 8% (Porter, Starcevic, Berle, & Fenech, 2010) and 11.9% (Grusser, Thalemann, & Griffiths, 2007). The interpretation of GTP and the copying mechanism may be influenced by cultural idiosyncrasy (e.g., attitudes, beliefs) as was argued in the comparative analysis between the English and Spanish speaking gamer samples.

Individuals that interpreted their GTP experiences as anomalous and those with poor impulse control are the ones that may be at higher risk to act out their impulses by not discriminating between real life stimuli and video game situations. Based on the analysis of the gamers' appraisals about GTP, it is speculated that the following factors are relevant for the psychosocial implications of GTP: (i) the players' individual characteristics (e.g., psychological stability), (ii) frequency and recurrence of the phenomena (e.g., once, episodically all the time), (iii) duration of the phenomena (e.g., minutes or long periods of time), (iv) internal or external nature of GTP (e.g., outer self-generated phenomena or outer non-self-generated phenomena), (v) circumstances of occurrence (e.g., in compromised

situations such as driving or while lying in bed), (vi) content of the phenomena (e.g., abstract video game shapes or realistic video game content), (vii) the gamers' interpretation and reactions to the event (e.g., indifferent or frightened), (viii) coping mechanism (e.g., stopping playing the game for a while or develop irrational ideas), and (ix) looking for support from peers and others by communicating about their GTP or keep the experience to themselves for fear of being laughed upon or perceived as "crazy".

### **Main findings per GTP modality**

Altered perceptions included altered visual perceptions, altered auditory perceptions, and other altered perceptions such as altered kinaesthetic perception, proprioception, tactile perception, and time perception.

#### ***Altered visual perceptions (GTP-V)***

In this modality, video game images were seen in the mind, with closed or open eyes, and environments and objects were misperceived by something from the video game or were perceived distorted, mostly preserving the characteristics from the video game. The visual experiences comprised: (i) digitally-induced images that were further subdivided into: visualizing video game images in the mind or picturing them in real life contexts, retinal sensations when seeing video game images in the back of the eyelids and seeing video game images project when seeing images with open eyes, (ii) visual distortions that occurred when perceiving objects and environments distort (e.g., seeing everything pixelated, wavy, with changed colour or shape), (iii) visual misperceptions of objects (e.g., confusing physical objects with something from the game). (See Chapter 4 for further details).

The images were seen intermittently or episodically, sometimes could last longer periods of time. Seeing environment distorted or visual misperceptions usually lasted short time. Visualizing or seeing images could be experiences as multisensory experiences when the gamers saw video game images accompanied by music or body movements and also cross-sensorial when gamers heard music and saw video game images. The more common visual experiences reported in the survey study were visualizing video game images or seeing video games images with closed eyes, followed by visual misperceptions. In the qualitative studies, the highest prevalence was found in seeing video game images in the back of the eyelids and seeing video images with open eyes. (See Chapter 4 for further details). Only 21% of the total

GTP-V experiences reported in the qualitative study occurred by association between real-life stimuli and video game elements.

Perceptual distortions appear to be explained by sensorial adaptations that result in visual after-effects immediately after stopping playing. However, in some cases, these experiences were triggered by automatic association between real life stimuli and video game elements, and suggest interplay of cognitive processes. Furthermore, in some cases, physiological conditions due to sleep deprivation, sensory deprivation and the consumption of psychoactive substances appear to have played important roles. These experiences appear to be related to visual after-effects (Goldstein, 2010), hallucinations (Shiga, et al., 1996), after-images (Virsu & Laurinen, 1977), eidetic imagery (Jaensch & Oeser, 1970), recurrent images (Hanawalt, 1954; Titcher, 1915), visual perseveration or palinopsia (Meadows & Munro, 1977), and hypnagogic imagery (Mavromatis, 2010). The experiences share broad similarities with symptoms of pathologies and side-effects of drug use (e.g., hallucinogen persisting perception disorder) (American Psychiatric Association, 2013), and epileptic seizures mainly in photosensitive individuals (Bureau, et al., 2004; Kasteleijn-Nolst Trenite, et al., 2002; Millett, et al., 1997; Takahashi, et al., 1995).

#### ***Altered auditory perceptions (GTP-AUD)***

In this modality, the gamers heard auditory cues from the video game in their heads and in their ears, but also coming from external sources. These experiences were classified as: (i) involuntary auditory imagery (e.g., hearing music or sounds from the game), (ii) auditory verbal hallucinations (e.g., hearing voices coming from external sources), (iii) inner speech (e.g., completing phrases in the mind), (iv) auditory misperceptions (e.g., confusing real life sounds with video game sounds), and (v) multisensory auditory experiences (e.g., hearing music while involuntarily moving the fingers). (See Chapter 5 for further details). The most prevalent altered auditory experience in the survey was hearing re-plays of music, followed by misperception of sounds in real life contexts which were almost equally prevalent as having heard sounds from the video game. Similarly, in the qualitative studies a larger number of self-reports included experience of hearing re-plays of music followed by hearing replays of sounds from the game.

Some experiences appear to resemble typical earworms when people keep hearing replays of music (Liikkanen, 2012a) and verbal auditory hallucinations when gamers heard voices coming from external sources or inner-speech (Jones, et al., 2010) and when hearing

their own thoughts voiced loud in the head. Moreover, there were a few cases that can be understood as auditory neural adaptations. Music from the video game was usually experienced persistently, while sound effects or voices appeared to have occurred more episodically. Some gamers heard auditory cues from the game when trying to sleep, but a number of gamers experienced GTP-AUD when waking up, in their dreams, and/or while doing daily routines. No gamers indicated that they experienced GTP-AUD when playing short sessions. Some gamers reported that they heard the music directly after stopping playing or when triggered by automatic associations. Only 19% of the GTP-AUD experiences occurred via associations between real life stimuli and video game elements.

### *Other altered perceptions (GTP–OAP)*

Experience in this sub-modality include (i) feeling as if the mind disconnected from the body immediately after playing a game, (ii) sensations of body stiffness or perceiving time is going slowly as in games that use visual and haptic effects, (iii) sensations of body movement, (iv) feeling fingers or feet moving involuntarily, (v) tactile sensations of gamepads or keyboard. These experiences were reported in two of the three qualitative studies and in the survey conducted in this thesis (See Chapter 4 to 6 for further details).

Most of these experiences occurred particularly when falling asleep. Involuntary movements of fingers or legs were experienced while hearing, seeing, or visualizing something from the video game. This was the least prevalent experiences in the survey study (although 72.7% reported having experienced some of these phenomena at some point) and the least found among the gamers' self-reports in the qualitative study. The most prevalent type was experiencing body motion sensations as in the video game, followed by altered perceptions of time or body, feeling tactile sensations, and mind disconnecting from the body.

These types of experiences appear to be related to neural adaptations to the illusion of movement in the video game. This results in motion sickness when gamers felt their body in movement or disruptions in multisensory integration (e.g., vestibular, proprioceptive, tactile, visual) (Seifert & Patalano, 1991) when the gamers experienced feeling as if their mind disconnected from their body like out-of-body experiences. Some of these experiences are likely to be related to adaptations to haptic sensations and tactile feedback by the repetitive pushing of buttons that manifest as feeling the limbs move (myoclonic jerking) (Grunewald, et al., 1992) or hypnagogic jerking or myoclonic twitching (Mitchell, 1890) when lying in bed.

These experiences were sometimes accompanied by visualization or sounds from the video games.

### ***Mental processes (GTP-MP)***

According to findings in the qualitative study, gamers' experiences in this modality appear to show how gamers' cognitive control was compromised by video game playing, and how on many occasions external triggers worked as initiators of GTP in the majority of the cases. They appeared to occur episodically and these episodes lasted for a relatively short period of time but could occur recurrently once the associations had gained associational strength.

This modality includes a large variety of experiences and manifest as mainly automatic, although sometimes controlled, mental processes. In this modality thoughts, sensations and impulses and automatic mental actions were included. More specifically, this modality was divided into seven main categories. (i) Thoughts about video game content, (ii) cognitive errors and distortions influenced by video game content, (iii) subjective sensations of unreality, (iv) urges and impulses to do something as in the video game, (v) automatic and involuntary mental actions involving video game content, (vi) carrying out automatic actions, and (vii) behaviours influenced by video game experiences. (See Chapter 6 for further details).

In the survey study, the most prevalent type was slips when trying to use video game elements in real life contexts to resolve real life situations, followed by having felt the urge to do something as in the video game, and getting stuck in the mind-set of the game. Interestingly the same types of GTP were the ones that were more prevalent in the qualitative study. The most prevalent experience in the automatic mental process modality was automatic mental actions which corresponded to experiences of getting stuck in the mind-set of the game, automatic thoughts when trying to use video game elements, and feeling urges or impulses to do something as in the video game. Experiences in this modality appear to be related to intrusive and automatic thoughts, cognitive bias such as jumping to conclusions (Freeman, 2007), source monitoring errors (Johnson, 2007), perseverative mental states (Van den Linden, et al., 2003), attentional bias (Metcalf & Pammer, 2011), lack of awareness/dissociations (Merckelbach, Muris, & Rassin, 1999), subjective sensations of unreality (Aardema, et al., 2010), and mood modification (Baños, et al., 2006). The majority of the experiences occurred episodically, with the exception when gamers could not stop thinking about the video game. The majority of the experiences (85%) were triggered by an association with stimuli in physical contexts.



***Controlled and automatic actions and behaviours (GTP-B)***

This modality comprised two main categories that included a large variety of sub-categories: (i) automatic actions, and (ii) behaviours influenced by video game experiences. These included slips when moving arms looking for gamepads or trying to use video game elements in real life, or when involuntarily saying something with video game content. Also, some gamers overreacted to real life stimuli (e.g., hiding, crouching), approached real life objects with the intention to do something as in the video game, avoided real life objects, performed some behaviour because they felt compelled to do so, or voluntarily got engaged in imitations of video game content etc. (see Chapter 6 for further details).

A variety of involuntary body moments and movements of limbs were identified. For instance, some gamer reported movements of limbs when falling asleep (Chapter 4), when feeling the touch of the gamepad or when voluntarily engaging in imitating repetitive moments from the game. (Chapter 6; Ortiz de Gortari et al., 2011, Ortiz de Gortari, 2010). Involuntary movements induced by technological devices and by the repetitive use of virtual objects has been referred by the author as “Tech induced dyskinesia” (Ortiz de Gortari, October 14).

In the survey study, the most prevalent experience in this modality were verbal outbursts followed by acting differently in RL situations without intention due to previous video game experiences. The qualitative study included many more different types of behaviours but verbal outbursts were not prevalent in that study, but there were many cases where the gamers modified their behaviours due to experiences in the video game. The gamers’ experiences in this modality could be explained by: (i) neural adaptation (e.g., uncoordinated movements, stiffness) (Pressman, Nisky, Karniel, & Mussa-Ivaldi, 2008), (ii) acting out behaviour for failures of control inhibition manifesting as reflexive actions (e.g., moving the arm trying to use a hook), verbal outbursts (e.g., saying something as in the game unintentionally) or performing full sequences of behaviour (Friese & Hofmann, 2009) (e.g., breaking a barrel while for looking for the banana as in a game of *Donkey Kong*), overreactions (e.g., jumping on someone when they come up from behind due to hyper-vigilant mood states), compulsive repetitions (Muris, Merckelbach, & Clavan, 1997) (e.g., repeatedly picking up objects associated with the game), and (iii) voluntary behaviours (Tiffany, 1990) (e.g., using video game content for amusement such as using a phrase in the video game or deliberately imitating video game characters). The majority of the automatic actions and behaviours were triggered by or influenced by stimuli in physical contexts.

## Recommendations and Policy Implications

The implications of this thesis can be summarized as following:

**Social responsibility policies concerning video game use and habits.** GTP were more likely to be experienced soon after stopping playing and for this reason it is particularly important to investigate neural adaptations induced when video games are played on the screen and even more with the upcoming use of virtual augmented accessories. In the current research, the gamers appeared to have experienced lowered flexibility to switch from virtual to real life tasks. This ranged from altered perceptions to perseverative mental states. Understanding how prolonged the effects of GTP are may allow us to create accurate user recommendation guidelines and strategies to reduce side-effects from playing video games. However, it is important to emphasise that GTP can occur recurrently and in many cases are elicited by associations between real life stimuli and video game content.

Re-adaptation strategies such as dual adaptation have been applied to reduce unwanted effects after using virtual environment simulators (Welch, 2002). Some strategies include remaining seated for a certain period of time afterward before engaging in other activities (Kennedy & Fowlkes, 1992), and not driving or flying for 24 hours after the use of the simulator (LaViola, 2000). However, simulator users have reported disturbances and discomfort between 6 and 24 hours after the exposure (e.g., Baltzley, Kennedy, Berbaum, Lilienthal, & Gower, 1989). In the video game playing field, the study of perceptual experiences and neural adaptations and their implications is a new area of research. Current advice about safe video game playing mainly advocates responsible gaming policies focusing on the rating classification on video game content (Pan European Game Information), and health warnings to prevent epileptic seizures due to photosensitivity, along with other recommendations such as taking regular breaks from playing, avoiding playing when feeling fatigued, and playing in a well-lit room. User guides for video games such as *Rock Band* include warnings about motion sickness and the recommendation not to engage in activities such as driving if feeling dizzy or nauseous, as well as warnings about repetitive motion injuries and eyestrain (Quazal Technologies Inc, 1998-2007).

While certain GTP may disappear or reduce due to the repetitive exposure, some GTP experiences appear to disappear after playing the same game several times, as it occurs with motion sickness effects that also tend to disappear after a while due to habituation (Champney, et al., 2007), other GTP may be strengthened by priming mechanisms. Some recommendations to moderate the effects of GTP include: (i) moderating the time invested in playing games, (ii)

not playing video games when tired, sleep deprived, or hungry, (iii) taking breaks to connect with reality during long gaming sessions, and (iv) not playing video games directly before going to sleep (Crawley, 2014, January 24).

**Raising awareness about healthy gaming and preventive measures.** Evidence in this doctoral research suggests that video game habits are relevant for GTP to occur. Therefore, it is important to develop campaigns to inform, educate, and encourage healthy gaming habits, and reading of video game manuals. Moreover, demystifying and informing gamers about GTP can raise awareness, foster self-control, and avoid misinterpretation of GTP that could harm the gamers' psychological stability. "The initial interpretation of an intrusion will determine choice of cognitive and behavioural responses or strategies that will affect the subsequent occurrence of similar intrusions" (Morrison, 2001, p. 264).

**Policies about video game content and video game features.** The relevance of video game features (i.e., visual effects, auditory effects) is important in inducing GTP experiences. This suggests it is imperative to take into consideration particular video game features embedded in the games (e.g., the intensity, the recurrence and the duration of visual and aural effects), rather than only include generalized recommendations in video game playing manuals.

Additionally, simulations of real life objects and events in the video games appear to increase the likelihood that automatic associations end up as GTP, but it is not possible to predict or control what, who, and when an individual will establish automatic associations between real life events and video game experiences. However, a strategy to prevent risks involves embedding realistic elements in the game as they actually function in real life scenarios (e.g., red lights that indicate stop rather than go, jumping from heights that result in at least some injury). It is also recommended that gaming companies strengthen and highlight the information about epilepsy seizures and recommendation of exposure time to certain visual effects used by the most modern video games. This is because some of the visual effects that are considered potentially dangerous as epileptogenic material (e.g., flashing lights, geometric patterns, colour, contrast of colours) (Bureau, et al., 2004) were associated with visual altered perceptions after stopping playing and some gamers' experiences appear to share similarities with warning signs of epileptic seizures (e.g., out of body sensations, feeling detached, "fuzzy" or confused, uncontrolled movements of an arm, leg or body).

## Limitations

Several limitations need to be acknowledged. The studies carried out in this doctoral research are the first step into the understanding of a broad range of subjective gamers' experiences associated with video game playing, therefore the classification of GTP developed is considered a 'work in progress' and may require adjustments in future studies.

In general, little was known about the video gamers' psychological profiles, the role of emotions or immersion, or details about video game genres. These are crucial for increasing our understanding of GTP and their implications. The nature of the research presented here was cross-sectional, therefore we do not know anything about the longitudinal effects of GTP.

In terms of the specific studies, online forums were considered the most appropriate resource to identify, classify and define new phenomena that previously have not been operationalized. This outlet facilitated the collection of thousands of gamers' experiences in an economical way. However, the analysis was very time consuming and the data had some limitations.

First, participants in online forums do not commonly include demographic information in their posts in online forums. The same happened when trying to collect information about general characteristics of GTP.

Second, even though different online video game forums were used to collect the data, the high recurrence of some experiences may be due to that some forums were focused on very specific video games (e.g. *Guitar Hero*, *Tetris*).

Third, classifying experiences exclusively based on gamers' self-reports has important limitations mainly due to the lack of contextual information. Also, the comments collected from online forum posts may have been misunderstood by the researcher. However, the data were coded in a database preserving the gamers' exact words. Furthermore, online self-reports may be more vulnerable to include non-truthful and/or exaggerated claims or participants may influence each other with their posts.

In terms of the online questionnaire, a large variety of online outlets were used to recruit participants for the survey. However, only the gamers with internet availability and probably those more active in online groups were the ones that participated, therefore results in the survey represent only one segment of the population of gamers. Furthermore, it could be the case that gamers who participated in the study may be the ones that recognized GTP

experiences, therefore the high incidence of GTP in the sample should be interpreted cautiously. Future research should try to recruit participants both offline as well as online. Additionally, technical differences were found between the two questionnaires that compromised the comparison of some of the variables. Future studies should include more systematic translation methods and investigate GTP using longitudinal designs.

### **Final Remarks and Future Research**

The research in this PhD thesis has in a novel way investigated non-volitional phenomena important to understand the complex wonders of the mind. Most importantly, the research provided a multimodal and neutral research approach to investigate the effects of video games, and has shown the importance in investigating non-volitional phenomena for understanding the effects of video games. This is central because the playing of video games is distant from the passive reception of images and sound. Playing a video game requires interacting with images and sounds that have been systematically paired with events in the game, and have acquired positive or aversive meanings accordingly with the purpose of the game and the gamers' experiences in the game. Objects and sounds become "evocative objects", therefore encounters with physical objects, hearing sounds associated with the video game, or the sudden manifestation of 'ghost' images or sounds from the game tend to elicit thoughts, emotions, sensations, involuntary movements and/or behaviours as reminisces of the game experience.

In addition, the research in this PhD thesis has demonstrated cross-modal perceptions in a day-to-day context, when virtual objects and in-game activities were associated with sounds and images and resulting in gamers perceiving sounds and images that were not actually there. Further research should be conducted to investigate if the interaction with simulated objects in the game activates visual and auditory cortex paths resulting in these types of GTP experiences.

This present research has demonstrated that as long as automatic associations are established between real and virtual objects and events, video game experiences can lead to positive or potentially dangerous situations. GTP manifest mostly when engaging in automatic activities, therefore, activities such as driving, particularly shortly after stopping playing, where the mind can easily wander toward unrelated concerns (Galéra, Orriols et al. 2012). This, together with the gamers' propensity to selectively attend to stimuli associated with the video

game (Decker & Gay, 2011) and failures in inhibitory control where some gamers respond impulsively to objects associated with the game, raise some concerns.

Findings from this research suggest that the effects of playing video games should be investigated independently of the content of the game (e.g., violence, prosocial) and focus on the actions and simulation of objects in the game that can be more easily transferred to a real life context, as well as paying attention to the effects of the prolonged exposure to video game features.

The GTP framework has demonstrated that it can be useful to identify what and how video game experiences are transferred and their consequent psychosocial effects. Moreover, the research demonstrated how video games are pervasive in gamers' lives and how even old video games can result in GTP that arise without awareness and (in most of the cases) are difficult to control (e.g., altered perceptions, automatic mental processes, involuntary behaviours).

GTP tell us about cognitive abilities and automatic mental processes, physiological and perceptual mechanisms, however these studies invite us to reflect about the challenges that the human mind affront due to the use of virtual technologies.

Finally, this research suggests that resemblance between virtual and physical objects appears to facilitate the transfer of experiences. These effects may be strengthened with the development of more advanced technologies. Knowing about particular video game features and their effect on perceptions, cognitions, emotion and behaviour may contribute to taking more informed decisions regarding the psychological, cognitive, physiological and social effects of video games and the augmented technologies that are still to come.

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# Appendix I

## Declaration of Collaborative Work

### Qualitative Studies (Chapters 4 to 7)

Ortiz de Gortari, A. B., & Griffiths, M.D. (2014). Auditory experiences in Game Transfer Phenomena: An empirical self-report study. *International Journal of Cyber Behavior, Psychology and Learning*, 4(1), 59-75. (Chapter 5).

Ortiz de Gortari, A.B, & Griffiths, M.D. (2014). Automatic Mental Processes, Automatic Actions and Behaviours in Game Transfer Phenomena: An Empirical Self-Report Study Using Online Forum Data. *International Journal of Mental Health and Addiction*, 1-21. (Chapter 6).

Ortiz de Gortari, A.B., & Griffiths, M.D. (2014). Altered Visual Perception in Game Transfer Phenomena: An Empirical Self-Report Study. *International Journal of Human-Computer Interaction*, 30(2), 95-105. (Chapter 4).

### Contribution of first author (Angelica B. Ortiz de Gortari)

(i) Origination of research idea, (ii) development of main ideas, (iii) development of data base to code the data, (iv) data collection, (iv) classification, analysis and interpretation of the data, (v) implementation of supervisor's feedback about data categories, (vi) write-up, (vii) implementation of supervisor's feedback.

### Literature review (Chapter 2)

Ortiz de Gortari, A.B., & Griffiths, M.D. (2012). An introduction to Game Transfer Phenomena in video game playing. In J. Gackenbach (Ed.), *Video Game Play and Consciousness*. NY: Nova Science.

### Contribution of first author (Angelica B. Ortiz de Gortari)

(i) origination of the review, (ii) development of main ideas, (iii) literature collection, (iv) write-up, (v) implementation of supervisor's feedback.

### **Online questionnaire Study (Chapter 7)**

Ortiz de Gortari, A. B., & Griffiths, M. D. (2015). Game Transfer Phenomena and its associated factors: An exploratory empirical online survey study. *Computers in Human Behavior*. (in press).

Ortiz de Gortari AB, Griffiths MD. (2015) Prevalence and characteristics of Game Transfer Phenomena: A descriptive survey study (manuscript under review).

### **Contribution of first author** (Angelica B. Ortiz de Gortari)

(i) origination of the review, (ii) development of main ideas, (iii) development of the questionnaire protocol to investigate GTP, (iv) recruiting participants, (v) data cleaning and data analysis, (vi) implementation of supervisors' feedback in terms of the statistical analysis, (vii) write-up, (viii) implementation of supervisors' feedback.

## Appendix II

### Published chapters, conference papers and posters

Ortiz de Gortari, A. B., & Griffiths, M.D. (2014). Auditory experiences in Game Transfer Phenomena: An empirical self-report study. *International Journal of Cyber Behavior, Psychology and Learning*, 4(1), 59-75. (Chapter 5).

Ortiz de Gortari, A.B, & Griffiths, M.D. (2014). Automatic Mental Processes, Automatic Actions and Behaviours in Game Transfer Phenomena: An Empirical Self-Report Study Using Online Forum Data. *International Journal of Mental Health and Addiction*, 1-21. (Chapter 6).

Ortiz de Gortari, A.B., & Griffiths, M.D. (2014). Altered Visual Perception in Game Transfer Phenomena: An Empirical Self-Report Study. *International Journal of Human-Computer Interaction*, 30(2), 95-105. (Chapter 4).

Ortiz de Gortari, A.B., & Griffiths, M.D. (2012). An introduction to Game Transfer Phenomena in video game playing. In J. Gackenbach (Ed.), *Video Game Play and Consciousness*. NY: Nova Science. (Chapter 2).

### Conference proceedings

Ortiz de Gortari, A. B., & Griffiths, M. D. (2012). The Relevance of Game Transfer Phenomena When Addressing Problematic Gaming. *Proceedings of the 17th annual CyberPsychology & CyberTherapy Conference* (Vol. 5, pp. 72). Brussels, Belgium: The Virtual Reality Medical Institute. (Chapter 8).

### Posters

Ortiz de Gortari, A.B (October, 2014). *Game Transfer Phenomena Adventures: Using cartoons to explain video games' effects*. Poster presented at the ITAG: Interactive Technologies and Games - Education, Health and Disability. Nottingham, UK. (Chapter 4 to 6).

Ortiz de Gortari, A.B., & Griffiths, M.D. (September, 2012). *The relevance of Game Transfer Phenomena in Problematic Gaming*. Poster presented at the 17<sup>th</sup> Annual CyberPsychology & Cyber Therapy Conference, Brussels, Belgium. (Chapter 8).

Ortiz de Gortari, A.B. (May, 2012). *Game Transfer Phenomena: Digitally Induced Altered Visual Perceptions*. Poster presented at the Postgraduate Spring Conference 2012. Nottingham Trent University, Nottingham, UK. (Chapter 4).

# Auditory Experiences in Game Transfer Phenomena: An Empirical Self-Report Study

Angelica B. Ortiz de Gortari, Nottingham Trent University, Nottingham, UK

Mark D. Griffiths, Nottingham Trent University, Nottingham, UK

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## ABSTRACT

*This study investigated gamers' auditory experiences as after effects of playing. This was done by classifying, quantifying, and analysing 192 experiences from 155 gamers collected from online videogame forums. The gamers' experiences were classified as: (i) involuntary auditory imagery (e.g., hearing the music, sounds or voices from the game), (ii) inner speech (e.g., completing phrases in the mind), (iii) auditory misperceptions (e.g., confusing real life sounds with videogame sounds), and (iv) multisensorial auditory experiences (e.g., hearing music while involuntarily moving the fingers). Gamers heard auditory cues from the game in their heads, in their ears, but also coming from external sources. Occasionally, the vividness of the sound evoked thoughts and emotions that resulted in behaviours and copying strategies. The psychosocial implications of the gamers' auditory experiences are discussed. This study contributes to the understanding of the effects of auditory features in videogames, and to the phenomenology of non-volitional auditory experiences.*

**Keywords:** *Auditory Verbal Hallucinations, Effects of Priming, Game Transfer Phenomena, Implicity Memory, Involuntary Auditory Imagery, Neural Adaptations, Self-Monitoring Failures, Videogame Effects, Videogames' Auditory Cues*

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## INTRODUCTION

Modern videogames are rich in sensory cues. Auditory effects are crucial for enhancing the playing experience by increasing the awareness of surroundings, capturing the attention, and eliciting emotions in combination to visual cues (Nacke, Grimshaw, & Lindley, 2010). Auditory cues in videogames include theme songs, background sounds, and ambient sounds, spoken

narrations and dialogue, and even spectral silence. Furthermore, sounds are used as rewards, punishment, and as feedback in response to gamer actions. The psychological and physiological effects of auditory stimuli and music are well known (Polkosky & Lewis, 2002). In fact, music is one of the most effective ways to induce mood in experimental psychology studies (Kenealy, 1988). A considerable amount of literature has been published on the effects of

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## Automatic Mental Processes, Automatic Actions and Behaviours in Game Transfer Phenomena: An Empirical Self-Report Study Using Online Forum Data

Angelica B. Ortiz de Gortari · Mark D. Griffiths

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**Abstract** Previous studies have demonstrated that the playing of videogames can have both intended and unintended effects. The purpose of this study was to investigate the influence of videogames on players' mental processes and behaviours in day-to-day settings. A total of 1,022 self-reports from 762 gamers collected from online videogame forums were classified, quantified, described and explained. The data include automatic thoughts, sensations and impulses, automatic mental replays of the game in real life, and voluntary/involuntary behaviours with videogame content. Many gamers reported that they had responded—at least sometimes—to real life stimuli as if they were still playing videogames. This included overreactions, avoidances, and involuntary movements of limbs. These experiences lasted relatively short periods of time and some gamers experienced them recurrently. The gamers' experiences appeared to be enhanced by virtual embodiment, repetitive manipulation of game controls, and their gaming habits. However, similar phenomena may also occur when doing other non-gaming activities. The implications of these game transfer experiences are discussed.

**Keywords** Game Transfer Phenomena · Videogame effects · Priming effects · Behavioural conditioning · Cognitive distortions · Neural adaptations

The psychosocial and physiological effects of media engagement have been debated for many decades. Studies have demonstrated that the playing of videogames can have both intended (Brown et al. 1997) and unintended effects (Anderson and Dill 2000; Beullens et al. 2008). Scholars had speculated that transfer effects may be more pronounced if virtual reality mechanisms become more realistic (e.g., Persky and Blascovich 2008; Tamborini et al. 2004), and immersive (Segovia and Bailenson 2009). According to Johnson et al. (1993), memories from virtual experiences are similar to real world memories because they are rich in perceptual detail (e.g., visual and auditory cues) and that facilitate their recall. The use of realistic cues is now commonplace in many videogames and this may aid associations between

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## Altered Visual Perception in Game Transfer Phenomena: An Empirical Self-Report Study

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The aim of this study was to identify, classify, and explain gamers' perceptual experiences referred to as *Visual Game Transfer Phenomena* (VGTP) to contribute to the understanding of the effects of post-video-game playing and encourage healthy and safe gaming. A total of 656 experiences from 483 gamers were collected from 54 online gaming forums. The findings suggest that intensive playing can result in misperceptions and visual distortions of real-life objects and environments, stereotypical visual experiences that arise from mind visualization, and pseudo-hallucinatory experiences with video game content. Gamers' experiences can be explained by the interplay of physiological, perceptual, and cognitive mechanisms. Observation of video game features suggests that in most cases a relationship between the games' structural characteristics, gamers' VGTP experiences, and gamers' playing habits appeared relevant. VGTP can occur while gaming, immediately after stopping play, or after some delay. Further VGTP characteristics and their psychosocial implications are discussed.

### 1. INTRODUCTION

Today, virtual environments have evolved from highly immersive into fully immersive environments. Therefore it has become more important to know how gaming influences gamers' cognitions, behaviours, mood states, and perceptions (Lee & Tsai, 2010; Nagygyörgy et al., 2013). Particularly when dealing with gamers' perceptions, video games usually use visual and auditory effects to enhance the game experience, which alters the human perception, inducing inadvertent sensorial adaptations that sometimes results in side effects such as motion sickness (Merhi, Faugloire, Flanagan, & Stoffregen, 2007). The purpose of this study was to contribute to the understanding of post-video game playing effects by identifying, classifying, and explaining gamers' perceptual experiences referred to as Visual Game Transfer Phenomena (VGTP). More specifically, the study examined these altered perceptions associated with video game playing and examined what effects these gamers' experiences have in real life.

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Game Transfer Phenomena (GTP) comprise the transfer of video game experiences into the real world. GTP manifest as altered sensorial perceptions, automatic mental process, automatic actions, and behaviours. GTP occur spontaneously and usually without gamers' control. They can occur while gaming, immediately after stopping play, or after some delay. GTP are explained by physiological, perceptual, and cognitive mechanism that results from the exposure to a virtual environment for certain periods.

This paper attempts to raise awareness of VGTP to various stakeholders (e.g., academics, clinicians, video games developers, policymakers, and gamers) and encourage strategies that predict, prevent, and/or reduce certain post-video game playing effects, and systematically evaluate, if necessary, the implementation of pregame and postgame user recommendations to encourage safe and healthy gaming. Such aims are challenging because of the interplay between the complexity of human behavior, video game habits, the diversity of video game software, and the multitude of video game platforms.

#### 1.1. Perceptual Adaptations and Strategies to Ensure Safe Use of Virtual Environments

Perceptual adaptation can occur after short- or long-term exposure to a particular stimuli (Wade & Verstraten, 2002), but when the exposure is prolonged as usually happens with the use of virtual environments, the visual after-effects may be strengthened. A large number of studies have been conducted that explore post-effects of the exposure to virtual environment simulators such as symptoms of motion sickness (e.g., eyestrain, headache, disorientation, vertigo) mainly in the military or aerospace domain (e.g., Lawson, Graeber, Mead, & Muth, 2002; Stanney & Salvendy, 1998; Viire & Bush, 2002). Here, readaptation strategies such as dual adaptation have been applied to reduce unwanted effects (Welch, 2002). Some strategies to ensure the safety of virtual simulator users include remaining seated for a certain period of time afterward, before engaging in other activities (Kennedy & Fowlkes, 1992), and not driving or flying for 24 hr after the use of the simulator (LaViola, 2000). However, simulator users have reported disturbances

*Chapter*

## **AN INTRODUCTION TO GAME TRANSFER PHENOMENA IN VIDEO GAME PLAYING**

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### **ABSTRACT**

The study of Game Transfer Phenomena is in its infancy. GTP have been conceptualized as a new area of research into video games' effects. Research into GTP attempts to understand how video game experiences are transferred to the real world and the consequential psychosocial, cognitive and physiological effects by exploring players' mental processes, sensory perceptions, and behaviours. This chapter introduces and overviews Game Transfer Phenomena (GTP) studies and examines how the GTP may contribute to the understanding of the most undiscovered places of the human mind. A number of key questions are answered in this chapter. What are GTP? What types of GTP have been identified and how do GTP seem to work? What games have been associated with GTP? What benefits and potential venues do the GTP studies offer? The authors' conclusions and hypotheses to explain GTP experiences are supported by a review of literature, and by examples of

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#### Abstract

Together with other VR medical devices [1 ; 2], Pablo is a new method that can be used for objective evaluation and sensitive, motor and functional rehabilitation for hand deficits resulting from central (stroke, Parkinson) or peripheral (traumatic, post-surgical) neurologic pathology. Pablo system consists in a special device with sensors that allows accurate measurement of all kind of prehension and grips and of all ROM of shoulder/elbow/fist/fingers, with computerized evaluation and graphic evaluation during recovery process [1 ; 2]. This system offers the possibility of interactive games based on Virtual Reality concept with application in occupational therapy programs, that may be performed at home by the patient himself as a continuation of the classic ergotherapy performed under supervision at the Hand Rehabilitation Center.

#### The Relevance of Game Transfer Phenomena When Addressing Problematic Gaming

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#### Abstract

Game Transfer Phenomena (GTP) comprise the transfer of videogame experiences into the real world. These experiences can be triggered by the association between real life stimuli and video game elements, resulting in the subsequent alteration of mental processes, sensory perception, impulses or reflexes, automatic behaviors, and/or players' actions based on the content of videogames. GTP studies are in their infancy and at present it is unclear as to which players are susceptible to experiencing GTP. However, empirical data indicate that different individuals have similar experiences when playing the same videogames. Furthermore, findings in two studies suggest that GTP are associated with excessive videogame playing. The first study was based on interviews with 42 Swedish frequent video

game players between 15 and 21 years old. Here, some players reported felt the urge to climb buildings, push buttons in the air when something happened in real life, and/or saw text boxes hovering over peoples' heads. In a second study, secondary data analysis of 635 experiences from 463 players collected from online videogame forums found stereotypical mind visualizations, pseudo-hallucinations, and recurrent images in the back of their eyelids of videogame elements. Players also experienced alterations of perception that are considered to be perceptual adaptations, misinterpretation of real life stimuli, and synaesthesia-type of experiences with videogame contents. This paper argues that GTP can contribute to the prevalence of symptoms in gaming addiction, and proposes taking GTP into consideration when addressing problematic gaming.

#### Movement and Activity Assessed with the Kinect in Sitting Children, and the Influence of Hyperactivity

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#### Abstract

Movement and activity are major components of patients with Attention Deficit-Hyperactivity Disorder, ADHD. However, studies on movement patterns are still rare. Therefore, we tested the Kinect system for measuring body movements in children with ADHD and controls sitting in front of an immersive projection display (Powerwall) during a rest period. Results showed that patients and healthy controls differed in their movement characteristics, especially regarding right arm movements and movements of the lower body which were more pronounced in ADHD patients. Additionally, ADHD patients showed faster leg movements. Movement speed was more irregular with respect to the right arm and the lower body as compared to controls. In addition, results verify that the Kinect system can be used to collect movement data of most body parts. The study could indicate specific movement patterns in ADHD patient. In the long run, results will help to develop diagnostic tools differentiating ADHD patients from healthy con-

## **Appendix III**

### **Questionnaire protocol English and Spanish language**

# Game Transfer Phenomena Exploratory Survey

## Welcome to the Game Transfer Phenomena - Explorative Survey

### ABOUT THE GTP PROJECT

The purpose of the GTP project is to clarify and demystify players' phenomenological experiences in order to maximize the benefits of interactive media, as well as to understand automatic mental, physiological and behaviour processes that can be relevant in different areas of the sciences.

### ABOUT THIS SURVEY

The purpose of this survey is to explore what types of Game Transfer Phenomena (GTP) are more common among gamers and to find out about the general characteristics of GTP.

### WHAT ARE GAME TRANSFER PHENOMENA (GTP)

GTP comprise the transfer of video game experiences into the real world. These experiences can be triggered by the association between real life stimuli and video game elements.

GTP can manifest visually, auditory, in automatic thoughts, and behaviors due to previous video game experiences.

GTP include what is popularly known as the "Tetris effect".

### HOW LONG DOES IT TAKE TO COMPLETE THE SURVEY?

It takes approximately 10 minutes to complete the survey.

The survey is divided in four sections:

- I. Game habits
- II. GTP experiences
- III. GTP characteristics
- IV. Demographic information

We are looking for video game players aged 18 years or above.

### YOUR RIGHTS AS PARTICIPANT

Your responses will be kept completely confidential. You are free to choose your nickname. Your IP address will NOT be tracked.

Your information will be used for research purposes only.

The possible outlets of distribution of the results of this study will be in a PhD thesis, conferences and on the Internet.

In case you change your mind and want to withdraw from this study after you have submitted please provide a unique identifier (e.g. a nickname) at the beginning of the survey.

If you have any questions or concerns about your participation in this research you can send us an email.

By clicking the "Next" button to enter the survey, you indicate your willingness to voluntarily take part in the study and that you have understood the above information.

You are welcome to visit my blog:

[http://GTP\\_players\\_experiences/](http://GTP_players_experiences/)

## Game Transfer Phenomena Exploratory Survey

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### I. Video game habits

#### \* 1. Choose a nick name

#### 2. How long are your usual video game playing sessions?

- Less than 1 hour
- 1 hour to 2 hours 59 minutes
- 3 hours to 5 hours 59 minutes
- 6 hours to 7 hours 59 minutes
- More than 8 hours

#### 3. How often do you play video games?

- Less than once a week
- Once a week
- 2-4 times a week
- 5-6 times a week
- Every day

#### 4. What type of player do you consider yourself?

- Newbie
- Casual gamer
- Hardcore gamer
- Professional gamer

## Game Transfer Phenomena Exploratory Survey

### 5. Choose the statements that best describe you as a player (you may choose more than one option)

- I like to finish the game as fast as possible
- I like to know as much as possible about the game rules and game mechanics
- I like to improved my own scored and/or compete with others
- I like to socialize when I am playing
- I like to find different routes, secret areas or rare items in the game
- I like to become immersed in the game
- I like to customize my character / vehicle / home base
- I play to get excited
- I play games to escape from the real world
- Other

Other (please specify)

### 6. How often do you recall your dreams? (dream while sleeping)

- Always
- Very Often
- Sometimes
- Rarely
- Never

II. GTP experiences

## Game Transfer Phenomena Exploratory Survey

### 7. Have you ever experienced visual GTP?

|   | All the time             | Many times               | A few times              | Once                     | Never                    |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| I have visualized video game images in my mind or seen them with closed eyes when I was not playing   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have seen video game images with my eyes open when I am not playing (e.g., seeing health bars above peoples' heads or maps in the corner of your eye)                             | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have seen distorted real life environments and/or objects due to my video game playing (e.g., seeing real life environments in slow motion or tinted with some color from a game) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 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 Modern Warfare 2)                               | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Do you want to share any other experiences/comments?

## Game Transfer Phenomena Exploratory Survey

### 8. Have you ever experienced body sensations GTP?

|  | All the time             | Many times               | A few times              | Once                     | Never                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 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)     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 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)  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have perceived time and/or my body feeling differently after playing a game (e.g., experiencing time going slowly or feeling bigger or shorter than I actually am) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have felt as though my mind has disconnected from my body after playing a game (e.g., experiencing an out-of-body experience)                                      | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Do you want to share any other experiences/comments?

### 9. Have you ever experienced auditory GTP?

|   | All the time             | Many times               | A few times              | Once                     | Never                    |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| I have heard the music from a game when I was not playing                 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have heard sound effects from a game when I was not playing             | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have heard a character's voice from a game when I was not playing       | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have misinterpreted a sound in real life as something from a video game | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Do you want to share any other experiences/comments?

## Game Transfer Phenomena Exploratory Survey

### 10. Have you ever experienced automatic thoughts GTP?

|  | All the time             | Many times               | A few times              | Once                     | Never                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| I have wanted or felt the urge to do something in real life after seeing something that reminded 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). | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have experienced still being in the 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 playing the game Portal).                                    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 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)   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 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)  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Do you want to share any other experiences/comments?



# Game Transfer Phenomena Exploratory Survey

## 11. Have you ever experienced behaviour GTP?

|  | All the time             | Many times               | A few times              | Once                     | Never                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 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)                               | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have sang, shouted or said something from a video game in real life without intending to do so   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have acted out a behaviour or performed an activity influenced by a video game (e.g., climbed on top of a roof after playing Mirrors' Edge)  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 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) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Do you want to share any other experiences/comments?

## \*12. Did you answer affirmatively (i.e. Once, A few times, Many times, or All the time) to one or more of the questions on this page?

- Yes
- No

### III. GTP characteristics

In this part you should try to think back about your GTP experiences answered in the previous section.

You can choose different answers in case you have experienced GTP at different times or under different circumstances

## Game Transfer Phenomena Exploratory Survey

### 13. With what genre of games have you experienced GTP? (You may choose more than one type of game)

- Action
- Adventure
- First person shooter
- Racing
- Fighting
- Puzzle
- Music/Dance
- Educational
- MMORPG (Massively Multiplayer Online Role Playing Game)
- RPG (Role Playing Game)
- Simulation
- Strategy
- Sports
- Other

(please specify)

### 14. Name of the game(s) (Optional)

### 15. On average how many hours did you play per week when the GTP happened?

- 10 hours or less
- 11 to 20 hours
- 21 to 30 hours
- 31 to 40 hours
- 41 to 50 hours
- 51 hours or more
- I don't remember

## Game Transfer Phenomena Exploratory Survey

### 16. On average how long were your video game playing sessions when the GTP occurred?

- Less than 1 hour
- 1 hour to 2 hours 59 minutes
- 3 hours to 5 hours 59 minutes
- 6 hours to 7 hours 59 minutes
- More than 8 hours
- I don't remember

### 17. On average how long did your GTP experiences usually last?

- Seconds
- Minutes
- Hours
- Days
- Weeks
- Months or years
- I have it all the time
- Other

Please specify

### 18. Have some GTP occurred recurrently or episodically for a period of time? (e.g. everytime you encounter something in real life, everytime you blinked or closed your eyes)

- Always
- Very Often
- Sometimes
- Rarely
- Never
- I don't remember

## Game Transfer Phenomena Exploratory Survey

**19. Remember: You can choose different answers in case you have experienced GTP at different times or under different circumstances.**

### When did you usually experience GTP?

- While playing
- Directly after playing
- Hours after playing
- Days after playing
- Weeks or more after playing
- Other

please specify

### 20. What were you doing when the GTP occurred?

- I just lay down in bed and closed my eyes to sleep
- I was falling asleep
- I just woke up
- I was waking up
- While doing any other activity except falling asleep or waking up
- Other

Do you want to specify what you were doing?

### 21. What was the impact of the experiences on you?

- Had no special feelings
- It felt unpleasant
- Felt the experiences was pleasant
- Felt the experience had lasting effects on me
- Felt confused
- I want it to happen again

Other (please specify)

## Game Transfer Phenomena Exploratory Survey

### **22. Have your GTP experiences ever distressed or affected you socially, occupationally or in other areas of day-to-day functioning?**

- Always
- Very Often
- Sometimes
- Rarely
- Never
- I don't remember

### **23. Were you under the influence of any medication, alcohol or drug when the GTP happened?**

- All the time
- Many times
- A few times
- Once
- Never
- Other

Please specify

You are almost done. The following part is the last section.

#### IV. Demographic information

### **\*24. What is your gender?**

- Male
- Female
- No answer

# Game Transfer Phenomena Exploratory Survey

## Welcome to the Game Transfer Phenomena - Explorative Survey

### ABOUT THE GTP PROJECT

The purpose of the GTP project is to clarify and demystify players' phenomenological experiences in order to maximize the benefits of interactive media, as well as to understand automatic mental, physiological and behaviour processes that can be relevant in different areas of the sciences.

### ABOUT THIS SURVEY

The purpose of this survey is to explore what types of Game Transfer Phenomena (GTP) are more common among gamers and to find out about the general characteristics of GTP.

### WHAT ARE GAME TRANSFER PHENOMENA (GTP)

GTP comprise the transfer of video game experiences into the real world. These experiences can be triggered by the association between real life stimuli and video game elements.

GTP can manifest visually, auditory, in automatic thoughts, and behaviors due to previous video game experiences.

GTP include what is popularly known as the "Tetris effect".

### HOW LONG DOES IT TAKE TO COMPLETE THE SURVEY?

It takes approximately 10 minutes to complete the survey.

The survey is divided in four sections:

- I. Game habits
- II. GTP experiences
- III. GTP characteristics
- IV. Demographic information

We are looking for video game players aged 18 years or above.

### YOUR RIGHTS AS PARTICIPANT

Your responses will be kept completely confidential. You are free to choose your nickname. Your IP address will NOT be tracked.

Your information will be used for research purposes only.

The possible outlets of distribution of the results of this study will be in a PhD thesis, conferences and on the Internet.

In case you change your mind and want to withdraw from this study after you have submitted please provide a unique identifier (e.g. a nickname) at the beginning of the survey.

If you have any questions or concerns about your participation in this research you can send us an email.

By clicking the "Next" button to enter the survey, you indicate your willingness to voluntarily take part in the study and that you have understood the above information.

You are welcome to visit my blog:

[http://GTP\\_players\\_experiences/](http://GTP_players_experiences/)

## Game Transfer Phenomena Exploratory Survey

### \*28. Do you have any of these conditions?

- None
- Epilepsy
- Visual disorder (excluding short-sightedness/long sightedness)
- Hearing disorder
- Sleeping disorder (excluding insomnia provoked by the visualization of video games images)
- Mental disorder
- Problematic gaming or Gaming addiction
- No answer
- Other chronic medical condition?

Other (please specify)

### 29. Have you ever taken illicit drugs (e.g. LSD, ecstasy, cannabis)?

- All the time
- Many times
- A few times
- Once
- Never

### 30. Have you ever experienced flashbacks because of your drug use? (Re-experienced visual effects similar to the ones you had when you were under the effects of the drug, long after the drug has worn off)

- All the time
- Many times
- A few times
- Once
- Never
- I don't remember

## Game Transfer Phenomena Exploratory Survey

THANK YOU for your participation in the GTP project!

If you have friends that could also participate in the survey, please share this link:  
[www.gametransferphenomena.com/survey.html](http://www.gametransferphenomena.com/survey.html)

The results will be publish in my blog

Please submit your answers.

### 31. Select if you are agree

- I want to receive information about the GTP project
- I want to participate in futher researches about GTP

Write your email address

### 32. Here you can write your additional comments/suggestions, etc.



## Game Transfer Phenomena Exploratory Survey

### **THANK YOU for your participation in the GTP project!**

The main objective of this study is to investigate what types of Game Transfer Phenomena (GTP) are more common among video game players and the general characteristics of the GTP.

My goal with the GTP project is to maximize the psychological and social benefits of interactive virtual technologies while reducing the risks or dangers it can present to some individuals.

GTP experiences have been previously reported by a number of players as consequences of intensive playing. Some have experienced the GTP as fun, while others have experienced it as extraordinary experiences and have become concerned.

This is a relatively new area of research and we do not currently know if there are any long term effects.

Your participation in this research is important because by investigating GTP we can understand human behavior and primarily, we will be able to provide information to gamers about these phenomena to avoid misinterpretations.

If your Game Transfer Phenomena experiences have disturbed you and you would like to talk with someone that can give you support, I will be glad to provide you with contact information for a specialized centre in your locality.

Should you have any questions/comments/concerns about this study please do not hesitate to contact me.

If you want to know more about GTP you are very welcome to visit [www.gametransterphenomena.com](http://www.gametransterphenomena.com)

You are also welcome to join the Facebook group "Game Transfer Phenomena" where you can share your thoughts about GTP or visit "Game transfer phenomena in video games" in Facebook.

Angelica Ortiz de Gortari

International Gaming Research Unit, Nottingham Trent University  
[angelica.ortizdegortari2010@my.ntu.ac.uk](mailto:angelica.ortizdegortari2010@my.ntu.ac.uk)

## El fenomeno de transferencia del juego - El GTP

### Bienvenido al cuestionario Fenomeno de transferencia del juego

#### CUAL ES LA META DEL PROYECTO DEL GAME TRANSFER PHENOMENA?

La meta es clarificar, normalizar e informar acerca de estas experiencias que han sido reportadas por algunos jugadores de video juegos con el fin de maximizar los beneficios del uso de los medios interactivos. Y a la mismo tiempo comprender procesos mental automaticos, reaciones fisiologicas y comportamientos que pueden resultar beneficiosos para diferentes areas de la ciencia.

#### EN QUE CONSISTE ESTE CUESTIONARIO?

El principal objetivo de este estudio es el investigar que tipos de Game Transfer Phenomena (GTP)(Fenomenos de transferencia del juego en español) son mas comunes entre los jugadores y sus características.

#### QUE EL GAME TRANSFER PHENOMENA (GTP)

El GTP consisten en la transferencia de experiencias del mundo virtual al mundo real. Estas experiencias pueden ocurrir por la asociacion entre objetos o eventos de la vida real y elementos usados por los videojuegos.

El GTP se puede manifestar en diferentes modalidades: visualmente, auditivamente, con sensaciones corporales o tactiles, pensamientos automaticos, acciones y comportamientos como resultado del juego de videojuegos.

#### CUANTO TIEMPO TOMA EL CONTESTAR EL CUESTIONARIO?

Aproximadamente de 10 minutos.

El cuestionario esta dividido en 4 partes:

1. Habitos de juego
2. Tipos de GTP
3. Características del GTP
4. Informacion demografica

Estamos buscando jugadores de 18 años en adelante.

#### TUS DERECHOS COMO PARTICIPANTE

Tus respuestas son 100% confidenciales. Tu puedes elegir libremente un seudonimo. Tu direccion de IP no sera rastreada.

Tu informacion sera unicamente utilizada para investigacion.

Los resultados de esta investigacion seran publicados en mi tesis de doctorado, en conferencias y en internet.

Si acaso llegaras a cambiar de idea y quieres que tus respuestas sean removidas de este estudio solo tienes que enviar un correo con el seudonimo que proporcionaste al inicio del cuestionario y tus respuestas seran borradas.

Si tienes comentarios, preguntas acerca de tu participacion en este estudio no dudes en contactarme.

Al presionar el boton "siguiente" indicas que haz entendido lo leído anteriormente y que esta de acuerdo en voluntariamente participar y contestar este cuestionario.

Eres bienvenido a visitar my blog:

#### **\*1. Elige tu nickname o seudonimo**

I. Habitos de juego

## El fenomeno de transferencia del juego - El GTP

### 2. Cuanto generalmente duran tus sesiones de juego?

- Menos de una hora
- 1 hora a 2 horas 59 minutos
- 3 horas a 5 horas 59 minutos
- 6 horas a 7 horas 59 minutos
- Mas de 8 horas

### 3. Que tan frecuente juegas?

- Menos de una vez por semana
- 1 vez por semana
- 2 - 4 veces por semana
- 5 - 6 veces por semana
- Todos los dias

### 4. Que tipo de jugador te consideras?

- Newbie (no mucha experiencia en video juegos)
- Jugador casual
- Jugador Hardcore (e.g jugar intensamente pero no a nivel profesional)
- Jugador profesional

### 5. Selecciona la opcion que mejor te describa como jugador (Puedes elegir varias opciones)

- Me gusta termina el juego lo mas rapido posible
- Me gusta saber lo mas posible acerca de las reglas del juego y sus mecanismos
- Me gusta competir conmigo mismo y con otros jugadores
- Me gusta socializar cuando estoy jugando
- Me gusta encontrar diferentes rutas, areas secretas y extraños objetos
- Me gusta sumergirme en el juego
- Me gusta personalizar mi caracter, vehiculo u otro
- Juego para emocionarme
- Me gusta jugar para escapar del mundo real

Other (please specify)

## El fenomeno de transferencia del juego - El GTP

### 6. Que tan frecuentemente recuerdas tus sueños? (sueños cuando duermes)

- Siempre
- Muy frecuentemente
- Algunas veces
- Raramente
- Nunca

#### 2. Experiencias de GTP

### 7. Alguna vez haz experimentado algun GTP visual?

|  | Todo el tiempo           | Muchas veces             | Pocas veces              | Una sola vez             | Nunca                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| He visualizado en mi mente o visto elementos de videojuegos con mis ojos cerrados cuando no estoy jugando (Ejemplo: ver imagenes del juego Guitar Hero atras de los parpados cuando cierro mis ojos) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He visto imagenes de los videojuegos con los ojos abiertos cuando no estoy jugando (Ejemplo: ver barras de salud arriba de las cabezas de otras personas)  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He visto ambientes u objetos distorsionados ambientes debido a mi juego de videojuegos (Ejemplo: ver ambientes del mundo real en camara lenta o tintados de algun color del juego)                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He malinterpretado algun objeto de la vida real por algo de los videojuegos (Ejemplo: ver un avion y pensar que es una nave de Moder Warfare 2)  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Quieres compartir alguna otra experiencia?

## El fenomeno de transferencia del juego - El GTP

### 8. Haz experimentado alguna sensacion de cuerpo identificada en el GTP?

|  | Todo el tiempo           | Muchas veces             | Pocas veces              | Solo una vez             | Nunca                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| He experimentado sentir mi cuerpo en movimiento como si estuviera en el videojuego (Ejemplo: estar acostado en la cama y sentir estar en movimiento o sentir el movimiento de algunas partes de tu cuerpo) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He sentido una sensacion tactil (tacto) asociada con el juego cuando no estas jugando (Ejemplo: sentir la sensacion de presionar los botones del control del juego cuando no estas jugando)                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He percibido el tiempo y/o mi cuerpo diferente despues de haber jugado (Ejemplo: sentir que el tiempo avanza muy lento o sentirte mas grande o bajo de como eres en realidad)                              | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He sentido que mi mente se desconecta de mi cuerpo despues de jugar algun videojuego (Ejemplo: ver tu cuerpo como observador, como flotando fuera de tu cuerpo -Experiencia extracorporal-)                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Quieres compartir alguna otra experiencia?

## El fenomeno de transferencia del juego - El GTP

### 9. Alguna vez haz experimentado algun GTP auditivo?

|  | Todo el tiempo           | Muchas veces             | Pocas veces              | Una sola vez             | Nunca                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| He escuchado musica del videojuego cuando no estoy jugando                       | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He escuchado efectos sonoros de los videojuego cuando no estoy jugando           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He escuchado voz de los caracteres del videojuego cuando no estoy jugando        | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He mal interpretado algun sonido de la vida real con algun sonido del videojuego | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Quieres compartir alguna otra experiencia?

## El fenomeno de transferencia del juego - El GTP

### 10. Alguna vez haz experimentado algun pensamiento automatic identificado en el GTP?

|   | Todo el tiempo           | Muchas veces             | Pocas veces              | Una sola vez             | Nunca                    |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| He querido o sentido el ansia de hacer cosas en la vida real como en el videojuego cuando no estoy jugando (Ejemplo: ver puertas rojas y sentir querer abrirse el paso despues de haber jugado Mirror's Edge o sentir la ansiedad de escalar edificios despues de jugar Assassin's Creed) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He experimentado no poder desconectarme mentalmente del juego (Ejemplo: hacer combinaciones automaticamente de objetos en la vida real como si estuvieras jugando el juego)   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Me he encontrado pensando en usar algo del videojuego en la vida real (Ejemplo: querer usar el zoom del rifle para ver cosas que estan lejos)   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Momentariamente he mezclado eventos de los videojuegos con eventos ocurridos en la vida real (Ejemplo: Preguntarte si la puerta esta cerrada para que los moustros no puedan entrar)  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Quieres compartir alguna otra experiencia?

## El fenomeno de transferencia del juego - El GTP

### 11. Haz experimentado alguna accion o comportamiento identificado en el GTP?

|  | Todo el tiempo           | Muchas veces             | Pocas veces              | Una sola vez             | Nunca                    |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| He hecho algun movimiento involuntariamente o como reflejo asociado con mi juego cuando no estoy jugando (Ejemplo: mover los dedos o brazos buscando el control del videojuego como reflejo o reacion)                           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Sin querer he cantado, gritado o dicho algo que he escuchado antes en el videojuego  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He hecho alguna accion o actividad influido por el videojuego (Ejemplo: subirte al techo despues de jugar Mirror's Edge)   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| He actuado diferente en alguna situacion de la vida real debido a alguna experiencia en el videojuego (Ejemplo: analizar o explorar campos abiertos como si fuera en el juego o agacharte cuando ves alguna camara de seguridad) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Quieres compartir alguna otra experiencia?

### \*12. Haz contestado afirmativamente a una o algunas de las preguntas anteriores en esta pagina (Todo el tiempo, muchas veces, pocas veces, una sola vez)?

- Si  
 No

### III. Caracteristicas del GTP

En esta parte te pedimos tratar de pensar en tus experiencias de GTP que haz respondido en la sesion anterior.

Aqui puedes elegir varias opciones si acaso haz experimentado diversos GTP en diferentes tiempos y condiciones.



## El fenomeno de transferencia del juego - El GTP

### 13. Con que genero de video juego haz experimentado el GTP (Puedes elegir varias opciones)

- Accion
- Aventura
- Jugador en primera persona
- juego de carreras
- Juego de luchas
- Rompecabezas
- Musica/baile
- Educativo
- Juego masivo de roles (ex. MMORPG)
- Juego de roles (RPG)
- Juego de simulacion
- Juego de estrategia
- juego de deportes
- Otro

Por favor especifica

### 14. Nombre de juego o de los juegos?

### 15. En promedio, cuantas horas jugaste a la semana cuando experimentaste el GTP?

- 10 horas o menos
- 11 -20 horas
- 21-30 horas
- 31- 40 horas
- 41-50 horas
- 51 horas o mas
- No me acuerdo

## El fenomeno de transferencia del juego - El GTP

### 16. En promedio cual fue la duracion de tus sesiones de juego cuando ocurrio el GTP?

- Menos de una hora
- 1 hora a 2 horas 59 minutos
- 3 horas a 5 horas 59 minutos
- 6 horas a 7 horas 59 minutos
- Mas de 8 horas

Recuerda que en estas preguntas puedes elegir varias opciones si acaso haz experimentado diversos GTP en diferentes tiempos y condiciones.

### 17. En promedio, cuanto han durado tus experiencias de GTP?

- Segundos
- Minutos
- Horas
- Dias
- Semanas
- Meses o años
- Me pasa todo el tiempo

### 18. Haz experimentado algun tipo de GTP de forma recurrente o episodicamente durante algun periodo de tiempo (Ejemplo: cada vez que te encuentras algo en el mundo real, cada vez que parpadeas o cierras los ojos)

- Siempre
- Muy frecuentemente
- Algunas veces
- Rara vez
- Nunca
- No recuerdo

## El fenomeno de transferencia del juego - El GTP

### 19. Cuando experimentaste el GTP?

- Cuando estaba jugando
- Cuando acababa de jugar
- Horas despues de jugar
- Dias despues de jugar
- Semanas o despues de mas tiempo de jugar
- Otra

Especifica por favor

### 20. Que estabas haciendo cuando experimentaste el GTP?

- Me acababa de costar para dormir
- Me estaba quedando dormido
- Me estaba despertando
- Me acababa de despertar
- Estaba haciendo otra actividad
- Otra

Quieres especificar que estabas haciendo

### 21. Que impacto a tenido en ti tu experiencia de GTP?

- No tengo sentimientos especiales
- Lo he experimentado como displacentero
- Lo he experimentado como placentero
- La experiencia ha tenido un efecto a largo plazo en mi
- Me he sentido confundido (a)
- Quisiera que pasara de nuevo
- Otra

Especifica por favor

## El fenomeno de transferencia del juego - El GTP

**22. Tus experiencias de GTP te han causado angustia o te han afectado socialmente, en tus actividades ocupacionales u otras areas de tu vida diaria?**

- Siempre
- Muy frecuentemente
- Algunas veces
- Raramente
- Nunca

Tienes algun comentario?

**23. Te encontrabas baja la influencia de algun medicamento, alcohol o droga cuando te paso el GTP?**

- Siempre
- Muy frecuentemente
- Algunas veces
- Rara vez
- Nunca

Tienes algun comentario?

Ya estas en la recta final. La siguiente session es la ultima!

## IV. Informacion demografica

**\*24. Cual es tu genero?**

- Hombre
- Mujer
- No responder

## El fenomeno de transferencia del juego - El GTP

### \*25. Que edad tienes?

- 18-22 años
- 23-27 años
- 28-32 años
- 33-38 años
- 39-43
- 44-48 años
- 49-53 años
- 54 años o mayor
- No responder

### 26. Cual es tu principal pais de residencia?

### 27. Cual es tu actual situacion profesional

- Empleado de tiempo completo
- Empleado de medio tiempo
- Trabajo independiente/negocio propio
- Desempleado
- Ama de casa
- Estudiante
- Jubilado
- Incapacitado para trabajar
- Otro

Especifica por favor

## El fenomeno de transferencia del juego - El GTP

### \*28. Presentas alguna de estas condiciones?

- Ninguna
- Epilepsia
- Desorden visual (no incluyen problemas para ver de lejos o ver de cerca -miopia o astigmatismo-)
- Desorden auditivo
- Desordenes del sueño (excluyendo insomnio asociado con los video juegos)
- Desorden mental
- Juego problematico o adiccion al juego
- No responder
- Alguna otra condicion medica?

Por favor especifica

### 29. Alguna vez haz usado drogas? (LSD, ecstasy, cannabis)?

- Todo el tiempo
- Muchas veces
- Pocas veces
- Solo una vez
- Nunca

### 30. Alguna vez haz experimentado flashbacks debido a tu uso de drogas? (Re-experimentar efectos visuales o sensorceptivos similares a los que experimentaste cuando te encontrabas bajo los efectos de la droga tiempo despues que el efecto de la droga ha desaparecido)

- Todo el tiempo
- Muchas veces
- Pocas veces
- Una sola vez
- Nunca

Tienes algun comentario?

**Gracias por participar en el proyecto del GTP**

## El fenomeno de transferencia del juego - El GTP

Si crees que algun amigo quisiera ayudarnos contestando este cuestionario por favor enviale el link.

[www.gametransferphenomena.com/survey\\_espanol.html](http://www.gametransferphenomena.com/survey_espanol.html)

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Supervisor: Professor Mark Griffiths ([mark.griffiths@ntu.ac.uk](mailto:mark.griffiths@ntu.ac.uk))

### 31. Selecciona si estas de acuerdo

- Quisiera recibir informacion acerca del proyecto del GTP
- Quisiera participar en otras investigaciones del GTP

Escribe tu correo electronico

### 32. Aqui puedes escribir tus comentarios, sugerencias, etc acerca de esta encuesta o del proyecto del GTP

## Game Transfer Phenomena Exploratory Survey

### Gracias por participar en el proyecto del GTP!

El principal objetivo de este estudio es investigar que tipos de GTP son más comunes en los jugadores y sus principales características.

Mi objetivo con el estudio del GTP es maximizar los beneficios del uso de las tecnologías interactivas, al mismo tiempo que ayudar aquellos individuos que lo llegaran a necesitar.

Las experiencias del GTP anteriormente han sido reportado por jugadores. Algunos las han experimentado como algo extraordinario y se han llegado a preocupar.

Esta área de investigación es relativamente nueva y no sabemos si existe algún efecto a largo plazo relacionado con el GTP.

Tu participación en esta investigación es muy importante porque gracias a tu colaboración podremos entender parte del comportamiento humano y principalmente distribuirla entre jugadores para evitar la mala interpretación de las experiencias del GTP.

Si acaso tus experiencias del GTP te han incomodado de alguna manera y quisieras hablar con alguien en tu comunidad al respecto, te podemos proporcionar información de algún centro especializado en tu localidad.

Si tienes alguna pregunta, comentario o inquietud al respecto de este cuestionario no dudes en contactarme.

Para saber más del GTP puedes visitar la página [www.gametransferphenomena.com](http://www.gametransferphenomena.com)

También eres bienvenido a mi grupo del GTP en Facebook o a visitar mi página "Game transfer phenomena in video games" in Facebook.

Si crees que algún amigo nos puede ayudar contestando este cuestionario por favor envíale este link

[www.gametransferphenomena.com/survey\\_espanol.html](http://www.gametransferphenomena.com/survey_espanol.html)

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