Beyond the Boundaries of the Game:

The Interplay Between In-game Phenomena, Structural Characteristics of Videogames, and Game Transfer Phenomena

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Abstract

The rewarding nature of video game playing can be observed through transfers in space, inducing not only temporary visual, auditory or kinaesthetic sensations while playing, but resulting in sensorial imprints that can suddenly occur after playing. In studies conducted with over 3,500 participants, gamers have reported involuntary phenomena related to video game content that manifest as altered sensorial perceptions, spontaneous thoughts and actions, and referred to as Game Transfer Phenomena (GTP). The aim of this chapter is to map in-game phenomena with transfer of game experiences with the purpose of stimulating future empirical work for theory testing. This was done by identifying four important factors in video game playing: (i) sensory perceptual stimulation, (ii), high cognitive load, (iii) dissociative states, and (iv) high emotional engagement. Each factor is supported by relevant theory and research. The discussion is illustrated with GTP experiences extracted from gamers' self-reports.

Keywords: Game Transfer Phenomena, video game effects, non-volitional phenomena, video games' structural characteristics, virtual immersion, gamers' experiences, in-game phenomena

Beyond the Boundaries of the Game: The Interplay Between In-game Phenomena, Videogame Structural Characteristics, and Game Transfer Phenomena

The rewarding nature of video game playing can be observed through transfers in space, inducing, not only, temporary visual, auditory or kinaesthetic sensations while playing, but resulting in sensorial imprints that suddenly occur after playing. Furthermore, virtual worlds are becoming more immersive, and games are lived and experienced rather than just being played on the screen. Arguably, there is a tendency among some individuals not to dichotomise between actual and non-actual worlds. We are beginning to witness an integration between the simulation of real world environments, augmented reality games, and use of virtual reality head-sets. Consequently, this challenges our concept of reality for two important reasons: (i) virtuality allows us to live parallel lives in non-actual worlds by adopting virtual identities and materializing fantasies (Ryan, 1999), and (ii) the consequences of virtual immersion are capable of facilitating and/or stimulating post-play phenomena, which manifest as hallucinatory-like experiences such as seeing or hearing elements from the game after playing. This poses challenges to individuals that, even though they are aware that the virtual elements (e.g., sounds, images) are not real, for a split second they find themselves responding intuitively to those elements as if they are in the virtual world. In addition, the consequences of virtual immersion go beyond the virtual space and can influence the way we perceive and interact with the real world (Dill, 2009).

In studies with over 3,500 participants, gamers have reported involuntary phenomena directly related to video game content that manifest as altered sensorial perceptions, spontaneous thoughts, actions, and behaviours, referred to as Game Transfer Phenomena (GTP). The structural characteristics of the game and the nature of the game activity appear to

facilitate transfer effects (Ortiz de Gortari, Aronsson, & Griffiths, 2011; Ortiz de Gortari & Griffiths, 2014a; Ortiz de Gortari & Griffiths, 2014b; Ortiz de Gortari & Griffiths, 2014c; Ortiz de Gortari & Griffiths, 2015).

This chapter is a first attempt to map in-game phenomena and structural characteristics of videogames, with transfers of game experiences manifesting in a number of modalities: Altered perceptions, automatic mental processes, and behaviours with the purpose of stimulating future empirical work for hypothesis testing. This chapter also examines which phenomena, inherent to the video game world and elements in gameplay, appear to contribute to transfer of game experiences.

Game Transfer Phenomena: A Brief Overview

A number of studies by the present authors have investigated the relationship between GTP and playing habits, individual characteristics and motivations for playing, as well as severity levels of GTP. In a sample of over 2,000 gamers, playing habits, particularly (i) the length of the playing sessions (three to six hours sessions), and (ii) individual factors such as having a pre-existing medical condition and playing for immersion, exploration, customization, mechanics and for escape from the real world have been significantly associated with GTP (Ortiz de Gortari & Griffiths, 2015). Those with severe levels of GTP (i.e., experience GTP frequently and several types) were significantly more likely to (i) be students, (ii) be aged 18 to 22 years, (iii) have played videogames every day in sessions of six hours or more, (iv) have played to escape from the real world, (v) have a mental disorder, sleep disorder, or consider themselves as having dysfunctional gaming, and (vi) have experienced distress or dysfunction due to GTP (Ortiz de Gortari, Oldfield & Griffiths, 2016b).

A cross-cultural comparison showed that Spanish-speaking gamers (i.e., a sample with a large percentage of Latin-American participants) were more likely to experience GTP that manifest as external or exogenous phenomena (e.g., involuntary movements of limbs as a

response to external stimuli, verbal outburst, act out a behaviour, change of behaviour, seeing images with open eyes) than English-speaking gamers (Ortiz de Gortari, 2015a).

GTP have also been reported in over 400 unique videogames including old and modern games, in a large variety of video game genres (Ortiz de Gortari, 2015a). Among the most popular video game genres associated with severe levels of GTP are: Massively Multiplayer Online Role Playing Games (MMORPGs), strategy games, simulation games, and fighting games (Ortiz de Gortari, Oldfield & Griffiths, 2016). A higher level of engagement in the narrative has been suggested as being important for the occurrence of biased perceptions and experiences (e.g., thoughts about the game being triggered by physical objects, sounds and/or music) (Poels, Ijsselsteijn, & de Kort, 2014).

No systematic analysis has ever been conducted in relation to the structural characteristics of videogames associated with GTP, but some patterns have been observed among qualitative data (Ortiz de Gortari, 2015a). These are presented below according to each of the GTP modalities/sub-modalities:

- ***Altered visual perceptions.*** After-images of prolonged duration that arise recurrently, usually in the back of the eyelids, have been reported frequently when playing videogames with monotonous patterns and repetitive gameplay. Perceptual neural adaptations to visual effects have been reported in relation to abrupt changes of colours and lights (e.g., eagle vision in *Assassin's Creed*) and visual effects (e.g., slow motion effect in *Crysis*). (In eagle vision mode, all of the environment turns black-ish and relevant objects glow in different colours). Furthermore, motion after-effects have been associated with music/dance videogames and high speed racing videogames. Hallucinations involving the seeing of videogame elements with open eyes or the misinterpretation of videogame images appear to be more related to recurrent feedback

images of specific videogame elements such as maps, heads-up displays, power bars, and menus (Ortiz de Gortari & Griffiths, 2014a).

- ***Altered auditory perceptions.*** Recurrent auditory sensations (e.g., earworms) have repeatedly been reported by gamers who play games that use background music. Hallucinatory-like experiences such as suddenly hearing a sound from the videogame or misinterpreting real life sounds have been reported in relation to repetitive sounds associated with fundamental activities within the game. Sounds reported by gamers include high pitch and loud sounds (e.g., bullets, explosions, screams) but also more discrete sounds (e.g., lasers, the spreading of a net). Also, sounds embedded as rewards, alerts, or punishments have been reported. The content of hearing voices include instructions, commands, echoing voices, and whispers (Ortiz de Gortari & Griffiths, 2014b).
- ***Body-related perceptions.*** These experiences have been reported in videogames that use effects of velocity, slow motion, constant, and/or fast movements. Stereotypical body movement such as strafing (i.e., moving side-ways) around corners have been related to playing First-Person Shooter games. Other examples include tactile hallucinations related to the haptic feedback of gamepads (Ortiz de Gortari & M. D. Griffiths, 2014).
- ***Automatic mental processes.*** Repetitive activities in the game (e.g., climbing, jumping, running) and associations between visual and/or auditory cues and activities have manifested as thoughts, urges and/or behaviours when the impulses are not held back. This also includes thoughts about using videogame elements that have a function, such as elements of feedback (e.g., health bars, maps, bionic arms, hook) (Ortiz de Gortari & Griffiths, 2014c).

- ***Automatic Behaviours.*** Automatic behaviours include most videogames that involve the simulation of real life activities (e.g., driving, searching, jumping, climbing buildings) (Ortiz de Gortari & Griffiths, 2014c).

In-game Phenomena Relevant to Game Transfer Phenomena

In addition to the findings of the studies mentioned above, there is a lack of understanding of which in-game phenomena and structural characteristics of the videogame lead to GTP experiences. Four core factors relevant for GTP to occur have been identified by the present authors: (i) Sensory perceptual stimulation, (ii) high cognitive load, (iii) dissociative states, and (iv) high emotional engagement (see Table 1 for overview of the in-game phenomena related to GTP). The factors proposed are based on analysis of gamers' self-reports concerning GTP (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2014a; Ortiz de Gortari & Griffiths, 2014b; Ortiz de Gortari & Griffiths, 2014c) and are supported by review of related literature. However, there they are preliminary in nature and thus warrant further empirical validation.

Table 1. Overview of the in-game phenomena related to GTP

In-game phenomena	GTP	Examples
SENSORY PERCEPTUAL STIMULATION		
Special visual effects	Perceptual adaptations (e.g., perceive objects, environment, time distorted)	Seeing objects pixelated or floating, environments in monochrome colour, intensified colour, objects having a coloured outline or a halo. Feeling time slowing down.
Monotonous gameplay	Hallucinatory-like phenomena (e.g., seeing images, hearing sounds or feeling tactile and kinaesthetic sensations)	Seeing videogame images in the back of the eyelids, tactile feedback of the gamepad, or feeling the pushing of the gamepad button, constant hearing of music, sounds or voices after playing
	Multi-sensory and induced synaesthesia	Movements of fingers when hearing music, or seeing images from the videogame while hearing the music from the game or/and feeling moving of limbs.

Sensory discrepancies	Postural instability and lack of motor flexibility	Un-coordinated motor movements or feeling the body stiffen such as arms moving upwards, automatically strafing (i.e., moving side-ways) around corners after playing First-Person Shooter games.
	Vestibular adaptations	Illusion of body movement as feeling the movement from the videogame when trying to fall asleep.
		Out-of-body-like experiences such as feeling as being in a "zombie state", the "mind getting disconnected from the body", and "like being in a hangover".
HIGH COGNITIVE LOAD		
Pairing between stimuli	Misperceptions	Thinking that birds in real life are fighter planes from a videogame.
	False expectations	Interpreting events and responding to real life objects using the logic of the videogame.
	Misattribution errors	Seeing images from menus in conversations, maps in the corner of their eyes when looking for an address, or seeing tags above peoples' heads.
Engaging in repetitive problem solving	Lack of cognitive flexibility or perseverative mental states	Continued looking for patterns, trying to arrange objects in sets or continued scanning for items from the videogame in real life contexts.
DISSOCIATIVE STATES: Immersion and subjective sense of presence in the virtual world		

Feeling as if the game was real	Automatic associations between both worlds and source monitoring errors	Confusing memories from the videogame with those from real life or confusing videogame characters with real individuals such as thinking that something needs to be done in real life when this actually needs to be done in the videogame.
Simulation of body movements	Automatic motor activation when in real life encountering game-related cues associated with in-game actions	Involuntary movements of fingers or arms when wanting to use videogame, feeling the urge to perform actions or body movements as in the videogame in real life.
Ownership and functionality of videogame elements	Attachment to videogame elements and wanting to use videogame elements in real life	Feeling strange when not having videogame elements in real life such as a bionic arm, thoughts popping up when wanting to resolve situations in real life using videogame elements to extreme cases where experiencing temporal inability to accomplish real life tasks for not having the videogame elements.
	Cognitive failures as slips of actions	Confusing videogame controls and those from real life machinery or vehicles like looking for the R1 button for braking while cycling.
Embodiment of virtual entities that lead to	Depersonalisation-like experiences	Feeling as being the game character such as going to bed thinking being Batman or feeling as the character in the game when travelling in the subway.
	Body-related altered perceptions	Feeling shorter after playing a videogame with a small character in a gigantic world.
HIGH EMOTIONAL ENGAGEMENT		
Rewarding and punitive features	Attention bias and overreaction toward game-relate cues	Trivial stimuli become salient and capturing gamers' attention. Resulting sometimes in overreactions such as ducking when seeing a security camera.
	Change of moods	Feeling relaxed or hyper-vigilant when encountering stimuli related to the videogame.
Accomplishments in the videogame	Feeling empowered and having irrational thoughts related to the videogame	Gamers momentarily thinking they can climb buildings and actually

		trying to do it, or trying to break some object with only a finger.

Sensory Perceptual Stimulation

Virtual immersion is characterized by sensorial stimulation due to the exposure to repetitive or recurrent synthetic stimuli (e.g., visual, aural, and haptic effects). Traditionally, perceptually-related after-effects have been associated with the use of highly immersive technologies such as simulators and head-mounted displays (LaViola, 2000). However, research concerning GTP has found a large variety of perceptual distortions, misperceptions, and hallucinations with videogame content when playing on a computer or TV screen. The main in-game phenomena suggested to be related to GTP concerning sensory perceptual stimulation are: (i) Exposure to specific visual effects which lead to perceptual adaptations such as perceiving objects, environment, time, and/or body as distorted, (ii) monotonous gameplay that leads to hallucinatory-like phenomena when seeing images, hearing sounds, feeling tactile and kinaesthetic sensations, and/or multi-sensorial sensations that induce synaesthesia as day-time or night-time phenomena, and (iii) sensorial discrepancies as precursors for out-of-body-like experiences, illusions of body movement, and uncoordinated body movements.

Specific sensory effects. The brain tends to easily adapt to the perception it receives (Harris, 1965) including such things as patterns and visual effects, therefore perceptual adaptations can take place when virtual environments alter the person's vision - especially when there is prolonged exposure (LaViola, 2000). Playing videogames can lead to visual after-effects and gamers have reported perceptual distortion of objects or environments (Ortiz de Gortari & Griffiths, 2014a). Such reports include: (i) Seeing objects pixelated or floating, (ii) seeing environments in monochrome colour or intensified colour, and (iii) seeing objects cell-shaded with a coloured outline or with halos.

Playing music or dance games such as *Guitar Hero* or *Rock Band* have been have found to provoke motion after-effects such as waterfall motion effects (Dyson, 2010). Given that the images of the game descend at a certain velocity, when gamers take away their eyes from the screen they continue to see movement. Gamers have reported that their vision become "wavy", and that objects appear to "levitate" or "slowly moves upward" (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2014a). Furthermore, after playing games with high velocities or with slow motion visual effects, gamers perceive time going slowly or moving slowly (Ortiz de Gortari & Griffiths, 2014a). For instance, one gamer explained:

> *"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."* (Ortiz de Gortari & Griffiths, 2014a, p. 102).

Monotonous gameplay. The playing of monotonous videogames has been associated with seeing images, hearing sounds, and having kinaesthetic sensations with videogame content, and has been reported in a variety of circumstances. Various experimental studies have used stereotypical puzzle-tile games such as *Tetris* or *Alpine Racer* (i.e., a downhill skiing simulator) as a visuomotor learning task to investigate how daytime experiences are replayed during sleep-onset (Stickgold, Malia, Maguire, Roddenberry, & O'Connor, 2000).

A number of studies have reported gamers seeing videogame images at sleep-onset (Kusse, Shaffii-Le Bourdiec, Schrouff, Matarazzo, & Maquet, 2012; Ortiz de Gortari & Griffiths, 2014a; Stickgold et al., 2000; Wamsley, Perry, Djonlagic, Reaven, & Stickgold, 2010). The visualizations are characterized by only seeing elements of the gameplay rather than external elements such as screens, keyboard or gamepad (Kusse et al., 2012; Ortiz de

Gortari & Griffiths, 2014a; Stickgold et al., 2000; Wamsley et al., 2010). Furthermore, the lack of emotional content in gamers' experiences at sleep onset suggests the absence of the participation of cerebral structures such as the amygdala and the reward system (Kusse et al., 2012). A large number of these visualizations have been considered to be the result of hypnagogic states (i.e., the transactional period between being awake and falling asleep) (Mavromatis, 2010). This is one of the most common types of hallucination among the non-clinical population (Collerton, Perry, & McKeith, 2005), and are suggested to be mediated by implicit memory since even amnesic patients that do not recall having played the game have reported seeing such images (Stickgold et al., 2000). However, healthy gamers have also been known to incorporate features of previous versions of the same videogame they have played in the construction of the images. This suggests that these experiences are not simply products of automatic replay of recent activity or exposure to sensory stimuli, but are also the result of activation of remote memories (Stickgold et al., 2000).

In a survey concerning GTP (N=2,363), 77% of the gamers reported having visualized or seen videogame images in the back of their eyelids (Ortiz de Gortari & Griffiths, 2016). Seeing such images have been reported both at daytime and night-time. When the images were seen for prolonged periods of time it provoked sleep deprivation (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2014a). For example:

> *"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!"* (Ortiz de Gortari & Griffiths, 2014a, p. 100).*"Lumines, oh God. I play 3 days and I have seen those damn squares everywhere, even when my eyes open"* (Ortiz de Gortari & Griffiths, 2014a; p. 100).

Hypnotic proneness and visuospatial skills have been associated with after-image persistence (Atkinson & Crawford, 1992), therefore the 'hypnotic properties' of the game that

lead to trance states may be enacted (e.g., automatic playing, attention absorption, and flow states). Gamers have also reported multi-sensory experiences when trying to sleep, and they have felt movements of fingers or hearing music from the game while seeing the images (Ortiz de Gortari & Griffiths, 2014a). For instances:

> *"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".* (Ortiz de Gortari & Griffiths, 2014a, p. 101).
>
> Moreover, some gamers have reported synaesthesia like experiences. For instance:
>
> *"Playing so much "Rock Band," some songs make me see green, red, yellow, blue and orange notes in my vision".* (Ortiz de Gortari & Griffiths, 2014a, p. 101).

Additionally, gamers have reported sensations of tactile feedback of the gamepad or they have felt themselves pushing the buttons of the gamepad (Ortiz de Gortari & Griffiths, 2014a). Tactile sensations related to the game were found 41% of the participants in a survey concerning GTP (Ortiz de Gortari & Griffiths, 2016). Other gamers have continued to hear music, sound and/or voices after videogame playing as auditory imagery, inner-speech, and hallucinations (Griffiths & Ortiz de Gortari, 2015; Ortiz de Gortari & Griffiths, 2014b). For instance:

> *"Command & Conquer: Red Alert was an exception. I used to wake up with 'Hell March' in my head for weeks after finishing the game"* (Ortiz de Gortari, 2015b, p. 140).

Sensorial discrepancies. It is well known that motion sickness symptoms (i.e., nausea, eyestrain, and visual discomfort) are the results of neural adaptations due to sensorial discrepancies and disrupted integration between different systems (e.g., vestibular, proprioceptive, tactile and visual). Disruption in multi-sensory integration due to the virtual immersion has been suggested to be responsible for: (i) Postural instability or motor flexibility (Murata, 2004), (ii) vestibular adaptations, and (iii) out-of-body-like experiences (Seifert & Patalano, 1991).

Postural instability and lack of motor flexibility includes uncoordinated body movements such as arms moving upwards automatically and feeling the body stiff, which may be related to neural adaptions when experienced soon after playing (Ortiz de Gortari & Griffiths, 2014c). For instance:

> *"Many times! Quake 2, made me literally strafe my way around corners in real life!"*
>
> *"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"* (Ortiz de Gortari & Griffiths, 2014c, p. 442).

Vestibular adaptations manifest as *illusions of body movement*, and are related to *out-of-body-like experiences*. During illusions of body movement, the constant movements or haptic perceptions (e.g., flying, bouncing or tumbling in the game) persevere and gamers report that they keep feeling the movement from the game when trying to fall asleep (Ortiz de Gortari & Griffiths, 2014a). This is similar to the feeling sailors have when they keep feeling the movement from the sea due to vestibular adaptation (i.e., Mal de Debarquement Syndrome or

disembarkment syndrome; Cha, 2009). Bodily sensations of movement were reported by over half of all gamers in a recent study (Ortiz de Gortari & Griffiths, 2016). For instance:

> *"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"* (Ortiz de Gortari, 2015b, p. 117).

Researchers have suggested that disrupted sensorial processing (e.g., visual, vestibular, proprioceptive), which are easily stimulated by virtual immersion, and inputs received from various systems, are important precursors of out-of-body experiences and autoscopy (Blanke & Mohr, 2005). Research on GTP experiences reported by gamers include reports of feeling like they are in a "zombie state", like the "mind is disconnect[ing] from the body", and "like being in a hangover" (Ortiz de Gortari, 2010). In a survey with 2,362 gamers almost half reported having perceived time and/or feeling the body differently after playing a videogame and almost one-third felt as though the mind had disconnected from the body after playing (Ortiz de Gortari & Griffiths, 2016).

High cognitive load

Playing a videogame is a highly demanding activity that requires interactivity and involves the processing of visual and auditory stimuli, executive functions, and perceptual and motor skills (Powers, Brooks, Aldrich, Palladino, & Alfieri, 2013). The main in-game phenomena related to GTP in the cognitive load are: (i) Pairing between stimuli that lead to attentional bias and hallucinatory-like experiences explained as misattribution errors, and (ii) engaging in repetitive problem-solving that lead to perseverative mental states.

Pairing between stimuli. The incidentally learned associations via the repetitive pairing between cues and activities in the game (i.e., implicit learning) leads to gamers acquiring schemas or templates that later influence their interpretations of experiences or

responses in the real world. Manifestations include (i) misperceptions, (ii) false expectations, and (iii) misattribution errors.

Misperceptions. Gamers have confused physical objects or sounds with those from the game, such as thinking that birds in real life are fighter planes from a videogame (Ortiz de Gortari et al., 2011; Ortiz de Gortari & Griffiths, 2014a; Ortiz de Gortari & Griffiths, 2014b). In a survey, 46% had misperceived a real life object with something from within a videogame, and 65% had misinterpreted a sound in real life with something from a videogame (Ortiz de Gortari & Griffiths, 2016). For instance:

> *"For minutes I would confuse airplanes in the sky for [unmanned aerial vehicles] in 'Modern Warfare 2'"* (Ortiz de Gortari & Griffiths, 2014a, p. 102).

False expectations. Gamers have expected that something will happen as in the game (Ortiz de Gortari & Griffiths, 2014c). As one gamer explained:

> *"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!'"* (Ortiz de Gortari, 2015b, p. 174).

Other gamers have performed actions expecting to find something from the videogame. There is the extreme case of a gamer that found a barrel in a shopping store and he broke it looking for bananas, as he would typically do when collecting points in the game *Donkey Kong* (Ortiz de Gortari & Griffiths, 2014c).

Misattribution errors. Gamers have perceived internal thoughts as sensorial experiences. For example, gamers have seen menus in conversations, maps in the corner of their eyes when looking for an address, and tags above peoples' heads. Moreover, sometimes sounds or music related to the game have been heard as if coming from external sources (Ortiz de Gortari & Griffiths, 2014b). Some gamers have even checked if they left the console on because the music they heard was very vivid. For instance:

> *"I will wake up sometimes and check if my computer is off because I swear I heard videogame music coming out of my speakers. I need help"* (Ortiz de Gortari, 2015b, p. 140).
>
> *"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"* (Ortiz de Gortari, 2014b, p. 64).

Other gamers have reported hallucinatory-like experiences when hearing sounds from the game in real life conditions that reminded them of the videogame. One gamer heard the sound from the game that indicated that a monster was close by and started to look around and became scared.

Repetitive problem-solving. Engaging in repetitive cognitive operations (e.g., strategies) to solve problems in a videogame facilitates the acquisition of action schemas. Specific tasks can be activated by specific environmental stimuli, since strong associations have been established between stimuli and actions executed by videogame playing (Ridderinkhof, Span, & Van Der Molen, 2002). When gamers are unable to override the action schemas learnt in the game, they continue applying the strategies in real life contexts that share salient features with the videogame showing perseveration or cognitive inflexibility (Ridderinkhof et al., 2002). However, ecological approaches that are strongly against cognitivist perspectives may argue that gamers are discovering specific affordances in real life contexts where they apply learning based on their expertise as gamers (Linderoth, 2012). 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"* (Ortiz de Gortari & Griffiths, 2014c, p. 442).

> *"There is a large football court with some five meter high buildings around it when I then walk out in the football field I try to find all the weaknesses and strong points as well as hiding places then I sometimes wants to shout orders to my friends and start running into cover* (Ortiz de Gortari, Aronsson & Griffiths, 2011, p. 22).

More specifically, performing a highly demanding activity for a prolonged period of time, such as playing a videogame, may lead to mental fatigue where the executive control can become compromised (Van den Linden, Frese, & Meijman, 2003). When the executive control is compromised, the individual responses are often guided by external stimuli even when these responses are inappropriate (Van den Linden et al., 2003). Consequently, this type of cognitive failure may easily manifest as GTP (Ortiz de Gortari & Griffiths, 2014c). In research concerning GTP, gamers have reported perseverative mental states shortly after playing. They perceived physical objects such as *Tetris* pieces, kept looking for patterns, tried to arrange objects in sets, or kept scanning for items from the videogame in real life contexts (Ortiz de Gortari & Griffiths, 2014c). 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"* (Ortiz de Gortari & Griffiths, 2014c, p. 441).

Dissociative States

Daydreaming, fantasy, and absorption in recreational activities are considered a type of dissociation which are, in essence, a form of non-pathological dissociation, also referred to as 'normative dissociation' (Butler, 2006). Both normative and pathological dissociations are characterized by "telescoping of the attentional field to concentrate on a narrow range of experience and the exclusion of other material (internal or external) from awareness, to some degree, from accessibility, which may result in a temporary lack of reflective consciousness" (Butler, 2006, p. 46). Engaging with entertainment media and intrinsically rewarding activities

involve a variety of normative dissociative phenomena including: (i) Time distortion by losing track of time (Wood, Griffiths, & Parke, 2007); (ii) states of flow which imply hyperfocus as intense focus and concentration in an activity, loss of reflective self-consciousness, sense of personal control or agency over the activity, and distortion of time (Csikszentmihalyi & Csikzentmihaly, 1991); and (iii) absorption by being transported in the fictional story leaving behind the sense of disbelief or judgment and suspending critical evaluations (Dill, 2009). However, two phenomena are characterized exclusively from the involvement in virtual environments: (i) Immersion in a multi-sensory events and (ii) the sense of presence by feeling dislocated or detached from the physical location and feeling "in" the virtual space (Jennett et al., 2008).

Immersion. Higher degrees of immersion or presence in the virtual world implies greater detachment from the objective reality, particularly among individuals with dissociative tendencies or symptoms (Aardema, O'Connor, Côté, & Taillon, 2010). Total immersion in the game has led to derealisation-like experiences when gamers still believe they are in the videogame. This can be exemplified by the following experience:

> *"I played more or less 18 hours 'Alien vs. Predator 2' in darkness. My father came 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"* (Ortiz de Gortari, 2015b, p. 190).
>
> *"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"*(Ortiz de Gortari, 2015b, p. 183).

Presence. The subjective sense of presence requires interaction with the virtual surroundings rather than just looking at images on the screen (Slater & Wilbur, 1997). Presence

is a core component of virtual embodiment including sense of agency and sense of body ownership (Kilteni, Groten, & Slater, 2012). The elements related to the subjective sense of presence in the virtual world that appear to be most relevant for GTP are: (i) Sensory realism that facilitates associations and lead to source monitoring errors, (ii) simulations of body movement that lead to automatic motor activation when in real life encountering game-related cues associated with in-game actions, (iii) ownership and functionality of videogame elements that lead to gamers wanting to use videogame elements in real life, and (iv) embodiment of virtual entities that lead to body-related altered perceptions and depersonalisation-like experiences.

Sensory realism. Memories of events in the virtual world share salient features (e.g., perceptual, spatial, temporal, semantic, and affective information) with those from the real world (Hoffman, Garcia-Palacios, Thomas, & Schmidt, 2001; Johnson, 2007). More specifically, similarities are enhanced by sensory realism (i.e., realistic representations of objects) (Jeong, Biocca, & Bohil, 2012) and perceived realism, when the individual responds to stimuli as if they are real (e.g., suspending disbelief) (Hall, 2006). Sensory realism facilitates automatic associations between videogame elements and real life stimuli and source monitoring errors when confusing memories from the real and the virtual world. For instance, gamers have reported confusing memories from the game with those from real life or confusing game characters with real individuals:

> *"Sometimes get my 'Sims' mixed up with people. 'Remember when you'....oh no, wait, that was my Sim"* (Ortiz de Gortari & Griffiths, 2014, p. 440).

Another gamer found himself in a hardware store, trying to remember why he was there (but actually needed a light bulb in the videogame). One study on GTP among gamers found that 43% had mixed up events from the videogame with actual events in real life (Ortiz de Gortari & Griffiths, 2016).

Simulations of body movement. It is known that observing someone else's actions tends to evoke activation of the observed action's motor pathways (Borroni, Gorini, Riva, Bouchard, & Cerri, 2011). Studies have demonstrated that viewing an avatar picking up an object in a natural way resulted in activation of the mirror neuro-system of the observer (Borroni et al., 2011). Many games involve simulation of body movements (e.g., jumping, running, walking), which in a way awakens the movement they represent, although this may be more relevant in realistic games.

The automatic activation of motor pathways during videogame playing may heighten gamers' experiences related to movements of limbs when they want to use that particular videogame element in real life contexts. For instance, one gamer involuntary moved his arm when he wanted to use a grappling hook to swing under a bridge. Almost half of over 2000 participants in a GTP survey reported reflexive body reactions associated with their videogame playing (Ortiz de Gortari & Griffiths, 2016). Gamers have also expressed urges to perform behaviours or body movements as in the videogame. For instance:

> *"There is a game called Assassin's Creed, in which you move a lot in big crowds of people the method of doing so efficiently is that he kind of gently pushes everyone out of the way. I remember feeling an urge for doing so in a crowded street"* (Ortiz de Gortari et al., 2011, p. 23).

Ortiz de Gortari (2015b) argued elsewhere that since videogame elements (e.g., visual or auditory cues) are paired with activities, game-related cues in real life contexts can trigger a well learned sequence of responses where gamers need to hold back their impulses, and sometimes the encounters with game-related cues activate the visual or auditory cortex leading to gamers seeing or hearing something from the game. In fact, a functional magnetic resonance imaging study showed that encounters with game-related cues showed a larger difference than

a fantasy TV drama-related cues in activations of the brain areas related with control inhibition, particularly motor inhibition (Ahn, Chung, & Kim, 2015).

Other studies have showed that the mirror neuron system becomes activated when hearing sounds is associated with specific movements (Kohler et al., 2002). Gamers also appear to have established associations between body movements used to control rhythm music games and music leading to experiences where they reported automatic movements of fingers or legs when they heard a song related to the game. These experiences appear to be closely related to when pianists experience involuntary movements of their fingers for playing the song they are listening to (Haueisen & Knösche, 2001).

Ownership and functionality of videogame elements. The bodily ownership or illusion of "owning" a rubber or virtual hand (and even someone else's body parts) have been induced experimentally by synchronous multi-sensory stimulation (Kilteni, Normand, Sanchez-Vives, & Slater, 2012; Petkova & Ehrsson, 2008).

Gamers have reported attachment to videogame elements that typically provide a function in the game and that are used repetitively (e.g., health bars, maps, special items), and wanting to use videogame elements in real life. One gamer reported that after having played as a virtual character with a bionic arm he felt strange to not have the bionic arm in real life (Ortiz de Gortari et al., 2011). In addition, it has been reported that thoughts have popped up in gamers' minds when they wanted to resolve situations in real life using videogame elements. For instance, there is the case of the gamer wanting to use the grappling hook mentioned above. In extreme cases, some gamers have experienced temporal inability to accomplish real life tasks due to not having the desired videogame elements. One gamer explained how he got lost going to a friend's house after playing a videogame because he could not find the way without the compass from the game. (Ortiz de Gortari & Griffiths, 2016). In a GTP survey, 72% of

gamers reported having wanted or felt the urge to do something in real life after seeing something that reminded them of the game. For instance:

> *"I got that urge though to climb and explore after I played 'Shadow of the Colossus'. Something that you really want to do, almost as if you must do"*(Ortiz de Gortari, Aronsson & Griffiths, 2011, p. 23).

Cognitive failures such as slips of actions (Norman, 1981) due to the repetitive use of videogame elements to resolve problems in the videogame have also been reported. For instance:

> *"After playing too much 'Grant Thief 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"* (Ortiz de Gortari & Griffiths, 2014c, p. 443) .

Embodiment of virtual entities. The embodied virtual entity is the representation of the gamer. This representation socializes, achieves, or fails, and as a consequence, emotions become attached to it (Li, Liau, & Khoo, 2013). There are different processes that take place during virtual embodiment. These include: (i) Monadic identification with the game character or avatar creating the feeling for the gamer that he/she is the virtual entity, usually referred to as "I". This is different from the dyadic identification with traditional media that is more external or dualistic, where the viewer is observing an autonomous entity (Hefner, Klimmt, & Vorderer, 2007); (ii) character attachment as "feelings of friendship and identification with a videogame character when an individual is willing to suspend disbelief, feels responsible for the game character and feels in control of the game character's actions" (Lewis, Weber, & Bowman, 2008, p. 516); (iii) vicarious learning by imitating an attractive and rewarding model (Bandura, 1986); and (iv) the Proteus Effect based on the self-perception theory (i.e., the observation of one's own appearance in the virtual world can lead to behavioural changes (Yee

& Bailenson, 2009, p. 196). The GTP research concerning the embodiment of virtual entities appears to have contributed to: (i) Depersonalisation-like experiences, and (ii) altered perceptions of body.

Depersonalization-like experiences. In extreme cases, case studies have been reported where gamers have lost contact with reality and personified videogame characters. Forsyth, Harland and Edward (2001) reported the case of a man who were transferred from prison to a psychiatric unit because he thought he was the videogame character. He was stealing vehicles and assaulting the owners with weapons. In GTP research (Ortiz de Gortari & Griffiths, 2014c), gamers have reported feeling as being the videogame character. For instance, one gamer said he went to bed thinking he was Batman. Another said he felt like the character in the videogame:

> *"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"* (Ortiz de Gortari, 2015, p. 183).

Altered perceptions of body. Even when the user topology, geometry (i.e., body shape, size, and symmetry) and social role do not match the virtual entity, the virtual embodiment can influence the gamer's perception of the self, thoughts, and behaviours (Biocca, 1999). Experimental studies have demonstrated how embodying a character with a big belly or enlarged arm leads to the self-perception of having a bigger belly (Normand, Giannopoulos, Spanlang, & Slater, 2011) or a larger arm (Kilteni et al., 2012). Moreover, playing with a young character leads to overestimating the size of objects and identification with child-related images when using the Implicit Association Test (IAT) (Banakou, Groten, & Slater, 2013). In GTP studies, gamers have reported body-related altered perceptions (Ortiz de Gortari & Griffiths, 2014a). For example, one gamer reported having felt shorter after playing a game

with a small character in a gigantic world. A GTP survey of over 2,000 gamers showed that 49% had perceived time and/or felt their body differently after having played a videogame.

High emotional engagement

Events in the videogames tend to elicit the most primitive instincts such as survival and aggression, although they also include more subtle mechanisms of empathy, nurturing, and creativity (Freeman, 2003). Emotional responses reported by gamers when playing include joy, relaxation, anger, fear, and depression (Ravaja et al., 2004). Research on violent videogames have shown how affect can be temporarily modified leading to decreases in empathy (Anderson, Gentile, & Buckley, 2007) or increases in hostility and anger (Arriaga, Esteves, Carneiro, & Monteiro, 2008; Barlett, Branch, Rodeheffer, & Harris, 2009). Some videogames are able to provoke physiological arousal and certain degrees of sadness according to how proficient the person plays videogames (Ivarsson, Anderson, Åkerstedt, & Lindblad, 2013). Transfer of game experiences related to emotions are observed along the different manifestations of GTP, but the most important ones relating to high emotional engagement appear to be: (i) Rewarding and punitive videogame features that lead to attention bias, overreaction and change of moods, sometimes elicited by game-relate cues, and (ii) accomplishments in-game that lead to feeling empowered.

Rewarding and punitive features. Activities in videogames are usually rewarded with points, sound effects, level progression, or punished with the reduction of points, lives, and progression. Videogames are designed as sequences of events that provide a schedule of series of reinforcements and punishments to achieve the goals in the game, creating the perfect conditions for conditioning behaviour (Dill & Dill, 1999). Firstly, this has led to attentional bias and overreactions given that physical objects simulated in the game acquire new or different properties, rewarding or aversive properties that are generalized to the original objects, via classical conditioning (Ortiz de Gortari & Griffiths, 2014c). In a GTP survey, almost half of the gamers had unintentionally acted differently in real life situations because of something they had experienced in a videogame (Ortiz de Gortari & Griffiths, 2016). For instance, gamers have ducked down when they saw a security camera. More specifically:

> *"I ducked at helicopter after playing lots of 'Call of Duty 4'"* (Ortiz de Gortari & Griffiths, 2014c, p. 444).

Secondly, it has led to change of moods**,** triggered by game-related cues. 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"* (Ortiz de Gortari & Griffiths, 2014c, p. 445).

Hyper-vigilant mood states have also been observed when gamers expect something to occur as would happen as in the game and acted based on it. For instance:

> *"I was walking in the woods near my home and I just wanted to walk on the path because then its less likely to get attacked my mobs*" (Ortiz de Gortari et al., 2011, p. 27).

Accomplishments in the videogame. Gamers have reported feeling empowered and stronger after playing to the degree that it has led to irrational thoughts. For example some gamers thought for a moment that they could climb buildings and actually tried to do it, or tried to break an object using only their finger (Ortiz de Gortari, 2010). More specifically as one gamer explained:

> *"If I go out after like playing 'Assassin's Creed' for six hours. I can look at the walls and building and thinking oh maybe I can climb there because when I am in the video game I can run in the roof and climb and it follows me to the real life"* (Ortiz de Gortari, Aronsson & Griffiths, 2011, p. 20).

Conclusion

Virtual experiences have proven to be pervasive in many gamers' lives. The interplay of physiological, perceptual, and cognitive processes is evident among the different manifestation of GTP experiences. Studies have investigated individual factors and motivations for playing associated with GTP (Ortiz de Gortari & Griffiths, 2015; Ortiz de Gortari & Griffiths, 2016; Ortiz de Gortari, Oldfield & Griffiths, 2016), but the present chapter is the first that has explicitly mapped in-game factors and in-game phenomena to transfer of game experiences.

The factors and sub-components proposed in this chapter are preliminary in nature, but their identification opens new paths for interdisciplinary research. Greater understanding of the proposed factors may contribute to the identification of the precipitators of involuntary phenomena with videogame content. This is particularly important with the progressive introduction of highly immersive technologies (e.g., virtual reality glasses such as *Oculus Rift*) that are expected to strengthen the effects of GTP (Ortiz de Gortari, 2015b). Perhaps if specific Game Transfer Phenomena can be identified that are uncomfortable and lead to potentially negative outcomes, gamers can reduce or avoid the risks while at the same time identifying

factors that can be used to develop videogames that are more engaging and that can be used for therapeutic or learning purposes.

References

Aardema F., O'Connor K., Côté S., & Taillon A. (2010). Virtual Reality induces dissociation and lowers sense of presence in objective reality. *CyberPsychology, Behavior and Social Networking, 13*(4), 429-435.

Ahn H. M., Chung H. J., & Kim S. H. (2015). Altered Brain Reactivity to Game Cues After Gaming Experience. *Cyberpsychology, Behavior, and Social Networking, 18*(8), 474-479.

Anderson C. A., Gentile D. A., & Buckley K. E. (2007). *Violent video game effects on children and adolescents: Theory, research, and public policy*. Oxford: Oxford University Press.

Arriaga P., Esteves F., Carneiro P., & Monteiro M. B. (2008). Are the effects of unreal violent video games pronounced when playing with a virtual reality system? *Aggressive Behavior, 34*(5), 521-538.

Atkinson R. P., & Crawford H. J. (1992). Individual differences in afterimage persistence: relationships to hypnotic susceptibility and visuospatial skills. *American Journal of Psychology, 105*(4), 527-539.

Banakou D., Groten R., & Slater M. (2013). Illusory ownership of a virtual child body causes overestimation of object sizes and implicit attitude changes. *Proceedings of the National Academy of Sciences, 110*(31), 12846-12851.

Bandura A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs ; London: Prentice-Hall.

Barlett C., Branch O., Rodeheffer C., & Harris R. (2009). How long do the short-term violent video game effects last? *Aggressive Behavior, 35*(3), 225-236.

Biocca F. (1999). The Cyborg's Dilemma: Progressive embodiment in virtual environments. *Human Factors in Information Technology, 13*(113-144).

Blanke, O., & Mohr, C. (2005). Out-of-body experience, heautoscopy, and autoscopic hallucination of neurological origin: Implications for neurocognitive mechanisms of corporeal awareness and self-consciousness. *Brain Research Reviews*, 50(1), 184-199.

Borroni P., Gorini A., Riva G., Bouchard S., & Cerri G. (2011). Mirroring avatars: dissociation of action and intention in human motor resonance. *European Journal of Neuroscience, 34*(4), 662-669.

Butler L. D. (2006). Normative dissociation. *Psychiatric Clinics of North America, 29*(1), 45-62.

Cha Y.-H. (2009). Mal de Debarquement. *Seminars in Neurology, 29*(5), 520-527.

Collerton D., Perry E., & McKeith I. (2005). Why people see things that are not there: A novel perception and attention deficit model for recurrent complex visual hallucinations. *Behavioral and Brain Sciences, 28*(6), 737-757.

Csikszentmihalyi M., & Csikzentmihaly M. (1991). *Flow: The psychology of optimal experience* (Vol. 41). New York: HarperPerennial

Dill K. E. (2009). *How fantasy becomes reality: Seeing through media influence*. Oxford: Oxford University Press.

Dill K. E., & Dill J. C. (1999). Video game violence: A review of the empirical literature. *Aggression and Violent Behavior, 3*(4), 407-428.

Dyson B. J. (2010). She's a waterfall: Motion aftereffect and perceptual design in video games involving virtual musicianship. *Perception, 39*(1), 131-132.

Forsyth R., Harland R., & Edwards T. (2001). Computer game delusions. *Journal of the Royal Society of Medicine, 94*, 184-185.

Freeman D. (2003). *Creating emotions in games: The craft and art of emotioneering*. Indianapolis: New Riders Publishing.

Griffiths, M. D. & Ortiz de Gortari, A. B. (2015). Musical hallucinations: Review of treatment effects. *Frontiers in Psychology, 6,* 1885. doi: 10.3389/fpsyg.2015.01885

Hall A. (2006). Viewers' perceptions of reality programs. *Communication Quarterly, 54*(2), 191-211.

Harris C. S. (1965). Perceptual adaptation to inverted, reversed, and displaced vision. *Psychological Review, 72*(6), 419-444.

Haueisen J., & Knösche T. R. (2001). Involuntary motor activity in pianists evoked by music perception. *Journal of Cognitive Neuroscience, 13*(6), 786-792.

Hefner D., Klimmt C., & Vorderer P. (2007). Identification with the player character as determinant of video game enjoyment. In M. L, M. Rauterberg & R. Nakatsu (Eds.), *Entertainment computing. International Conference of Entertainment Computing* (pp. 39-48). Berlin: Springer.

Hoffman H. G., Garcia-Palacios A., Thomas A. K., & Schmidt A. (2001). Virtual reality monitoring: Phenomenal characteristics of real, virtual, and false memories. *CyberPsychology & Behavior, 4*(5), 565-572.

Ivarsson M., Anderson M., Åkerstedt T., & Lindblad F. (2013). The effect of violent and nonviolent video games on heart rate variability, sleep, and emotions in adolescents with different violent gaming habits. *Psychosomatic Medicine, 75*(4), 390-396.

Jennett C., Cox A. L., Cairns P., Dhoparee S., Epps A., Tijs T., & Walton A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies, 66*(9), 641-661.

Jeong E. J., Biocca F. A., & Bohil C. J. (2012). Sensory realism and mediated aggression in video games. *Computers in Human Behavior, 28*(5), 1840-1848.

Johnson M. K. (2007). Reality monitoring and the media. *Applied Cognitive Psychology, 21*(8), 981-993.

Kilteni K., Groten R., & Slater M. (2012). The sense of embodiment in virtual reality. *Presence: Teleoperators and Virtual Environments, 21*(4), 373-387.

Kilteni K., Normand J.-M., Sanchez-Vives M. V., & Slater M. (2012). Extending body space in immersive virtual reality: a very long arm illusion. *PloS ONE, 7*(7), e40867.

Kohler E., Keysers C., Umilta M. A., Fogassi L., Gallese V., & Rizzolatti G. (2002). Hearing sounds, understanding actions: Action representation in mirror neurons. *Science, 297*(5582), 846-848.

Kusse C., Shaffii-Le Bourdiec A., Schrouff J., Matarazzo L., & Maquet P. (2012). Experience-dependent induction of hypnagogic images during daytime naps: A combined behavioural and EEG study. *Journal of Sleep Research, 21*(1), 10-20.

LaViola J. A. (2000). Discussion of cybersickness in virtual environments. *SIGCHI Bulletin, 32*(1), 47-56.

Lewis M. L., Weber R., & Bowman N. D. (2008). "They may be pixels, but they're MY pixels:" Developing a metric of character attachment in role-playing video games. *CyberPsychology & Behavior, 11*(4), 515-518.

Li D. D., Liau A. K., & Khoo A. (2013). Player–avatar identification in video gaming: Concept and measurement. *Computers in Human Behavior, 29*(1), 257-263.

Linderoth J. (2012). Why gamers don't learn more: An ecological approach to games as learning environments. *Journal of Gaming & Virtual Worlds, 4*(1), 45-62.

Mavromatis A. (2010). *Hypnagogia: The unique state of consciousness between wakefulness and sleep*. London: Thyrsos Press.

Murata A. (2004). Effects of Duration of Immersion in a Virtual Reality Environment on Postural Stability. *International Journal of Human-Computer Interaction, 17*(4), 463-477.

Norman D. A. (1981). Categorization of action slips. *Psychological Review, 88*(1), 1-15.

Normand J.-M., Giannopoulos E., Spanlang B., & Slater M. (2011). Multisensory stimulation can induce an illusion of larger belly size in immersive virtual reality. *PloS ONE, 6*(1), e16128.

Ortiz de Gortari A. B. (2010). *Targeting the Real life Impact of Virtual interactions: The Game Transfer Phenomenon 42 video games players' experiences (Master thesis).* Stockholm University. Retrieved from DiVA database: 59225.

Ortiz de Gortari A. B. (2015a). What can Game Transfer Phenomena tell us about the impact of highly immersive gaming technologies? *2015 International Conference on Interactive Technologies and Games* (pp. 84-89). Nottingham: IEEExplore.

Ortiz de Gortari A. B. (2015b). Exploring Game Transfer Phenomena: A multimodal research approach for investigating video games' effects (unpublished doctoral dissertation). Nottingham Trent University, Nottingham, UK.

Ortiz de Gortari A. B., Aronsson K., & Griffiths M. D. (2011). Game Transfer Phenomena in video game playing: A qualitative interview study. *International Journal of Cyber Behavior, Psychology and Learning, 1*(3), 15-33.

Ortiz de Gortari A. B., & Griffiths M. D. (2014a). Altered visual perception in Game Transfer Phenomena: An empirical self-report study. *International Journal of Human-Computer Interaction, 30*(2), 95-105.

Ortiz de Gortari A. B., & Griffiths M. D. (2014b). Auditory experiences in Game Transfer Phenomena: An empirical self-report study. *International Journal of Cyber Behavior, Psychology and Learning, 4*(1), 59-75.

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

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

Ortiz de Gortari A. B., & Griffiths M. D. (2016). Prevalence and characteristics of Game Transfer Phenomena: A descriptive survey study. *International Journal of Human-Computer Interaction*. 32(6), 470-480.

Ortiz de Gortari A. B., Oldfield B, & Griffiths M. D. (2016). An empirical examination of factors associated with Game Transfer Phenomena severity. Manuscript under review.

Petkova V. I., & Ehrsson H. H. (2008). If I were you: Perceptual illusion of body swapping. *PloS ONE, 3*(12), e3832.

Poels K., Ijsselsteijn W. A., & de Kort Y. (2014). World of Warcraft, the aftermath: How game elements transfer into perceptions, associations and (day)dreams in the everyday life of massively multiplayer online role-playing game players. *New Media & Society, 16*, 1-17.

Powers K. L., Brooks P. J., Aldrich N. J., Palladino M. A., & Alfieri L. (2013). Effects of video-game play on information processing: a meta-analytic investigation. *Psychonomic Bulletin & Review, 20*(6), 1055-1079.

Ravaja, N., Saari, T., Salminen, M., Laarni, J., Holopainen, J., & Järvinen, A. (2004). Emotional response patterns and sense of presence during video games: Potential criterion variables for game design. In A. Hyrskykari (Ed.), Proceedings of the NordiCHI 2004 (pp. 339-347). New York: ACM Press.

Ryan, M. L. (1999). Immersion vs. interactivity: Virtual reality and literary theory. *SubStance,* 28(2), 110-137.

Ridderinkhof K. R., Span M. M., & Van Der Molen M. W. (2002). Perseverative behavior and adaptive control in older adults: Performance monitoring, rule induction, and set shifting. *Brain and Cognition, 49*(3), 382-401.

Seifert C. M., & Patalano A. L. (1991). Memory for incomplete tasks: A re-examination of the Zeigarnik effect *Proceedings of the Thirteenth Annual Cognitive Science Society* (pp. 114-119). Chicago, IL: Erlbaum.

Slater M., & Wilbur S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence: Teleoperators and Virtual Environments, 6*(6), 603-616.

Stickgold R., Malia A., Maguire D., Roddenberry D., & O'Connor M. (2000). Replaying the Game: Hypnagogic images in normals and amnesics. *Science, 290*(5490), 350-353.

Van den Linden D., Frese M., & Meijman T. F. (2003). Mental fatigue and the control of cognitive processes: effects on perseveration and planning. *Acta Psychologica, 113*(1), 45-65.

Wamsley E. J., Perry K., Djonlagic I., Reaven L. B., & Stickgold R. (2010). Cognitive replay of visuomotor learning at sleep onset: Temporal dynamics and relationship to task performance. *Sleep, 1*(33), 59-68.

Wood R. T., Griffiths M. D., & Parke A. (2007). Experiences of time loss among videogame players: an empirical study. *CyberPsychology & Behavior, 10*(1), 38-44.

Yee N., & Bailenson J. N. (2009). The difference between being and seeing: The relative contribution of self-perception and priming to behavioral changes via digital self-representation. *Media Psychology, 12*(2), 195-209.