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Altered visual perception in Game Transfer Phenomena:

An empirical self-report study

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ABSTRACT

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.

Keywords: *Video game side effects; Game transfer phenomena; Tetris effect; Pseudo-hallucinations; Perceptual adaptation; Intrusive images.*

INTRODUCTION

Today, virtual environments have evolved from highly immersive into fully immersive environments. Therefore it has become more important to know how gaming influence 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.

Game Transfer Phenomena (GTP) comprise the transfer of video game experiences into the real world. GTP manifest as altered sensorial perceptions, as 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 of time.

This paper attempts to raise awareness of VGTP to various stakeholders (e.g., academics, clinicians, video games developers, policy makers 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 pre-game and post-game user

recommendations to encourage safe and healthy gaming. Such aims are challenging because of the interplay between the complexity of human behaviour, video game habits, the diversity of video game software and the multitude of video game platforms.

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 to 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; Viirre & Bush, 2002). Here, re-adaptation 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 afterwards, 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 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 games content (Pan European Game Information), and health warnings to prevent epileptic seizures for 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, 2007) include warnings about motion sickness

and recommendation not to engage in activities such as driving if feeling dizzy or nauseous, as well as warnings about repetitive motion injuries and eyestrain (*Wii* Instruction booklet, *RockBand*, 2008).

Particular altered sensory perceptions associated with the use of digital environments

Different altered sensory perceptions have been reported in association with the exposure to digital environments. For example, the prolonged use of video display terminals that typically use black backgrounds and green characters have been associated with perception of achromatic patterns slightly coloured (Khan, Fitz, Psaltis, & Ide, 1984); this is known as the McCollough effect (Pena, de la Caba, Eceiza, Ruseckaite, & Mondragon, 2010). Few studies have investigated altered sensorial perceptions, particularly in video games. Dyson (2010) reported motion after-effects (MAE), more specifically waterfall after-effects in music video games such as *Guitar Hero* that occur after viewing a moving visual stimulus for a certain period of time (Ibbotson, 2005). Supporting Dyson's findings was a qualitative interview study about GTP conducted with 42 gamers aged between 15 and 21 years old (A. B Ortiz de Gortari, Aronsson, & Griffiths, 2011). Gamers reported that objects appeared to levitate when they stopped playing and looked away from the screen. In the online Urban Dictionary (2012) gamers have defined this visual experience as "dizziness and wavy vision that can occur after playing *Guitar Hero*".

Additionally, visualizations of video game images appearing at some point after playing a video game have been reported in other studies. Researchers interested in demonstrating continuity theory, a theory that supports the idea of continuity between awake activities and dreams, and in understanding the memory consolidation during sleep (Schredl, 2003) have explored visualizations of video game images in sleep onset considering this experience as hypnagogic replays of the game (Kusse, Shaffii-Le Bourdiec, Schrouff,

Matarazzo, & Maquet, 2012; Stickgold, Malia, Maguire, Roddenberry, & O'Connor, 2000; Wamsley, Perry, Djonlagic, Reaven, & Stickgold, 2010) as well as kinaesthetic sensations similar to the symptoms of motion sickness where rocking sensations occur after a prolonged exposure to motion (Golding, 2006) and movements of fingers when playing the game have been reported (Kusse, et al., 2012; Wamsley, et al., 2010). Two of the three experimental studies used the tile-matching puzzle video game (i.e., Tetris, 1984) as the experimental game to induce hypnagogic experiences.

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 (A. B Ortiz de Gortari, et al., 2011). For example, one gamer saw health bars from *World of Warcraft* (2005) above other gamers' heads while playing a football game. Another gamer saw *Guitar Hero* frets in front her eyes when her teacher said the word 'guitar'.

Visualizations of video game elements, or involuntary replay of the game after playing, is 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* (1984) pieces falling, or seeing images of falling *Tetris* (1984) shapes at the edges of the gamers' visual fields or when they close their eyes" (Wikipedia, 2012).

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, 2012b). 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, 2012c).

METHOD

Participants: 2,000 gamers’ experiences identified as GTP experiences in one or more modalities (visual, auditory, automatic thoughts, automatic actions and behaviours) were collected from 60 online video game forums¹ over a period from March to September 2011.

Procedure and data collection: GTP experiences identified as “altered visual perception GTP” (VGTP) were extracted from 54 online gaming forums where gamers congregate and discuss whatever is on their mind. 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. The total data VGTP set comprised 656 experiences from 483 gamers collected from discussion threads relating to game transfer phenomena and experiences. Only 78 gamers reported their age ranging in age 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 in the study. A total of 181 different video game titles were associated with VGTP experiences ranging from tile-matching puzzle games to massively multiplayer online role-playing games. 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 the self-reports contained explicit

¹ Online video game forums included comments to articles on websites, since these are considered discussion platforms.

information, and when the self-reports established clear references or cited previous posts to explain their own experiences.

Data analysis: The data were analyzed using thematic analysis. First, gamers' posts were registered in different tables according to the GTP modality (visual, auditory, automatic thoughts, behaviours), and then a database was created to code and systematically quantify gamers' visual experiences and the characteristics of their experiences. Each gamers' self report included identification information (e.g., name of gamer, forum where the experience was collected, and [if provided] age, and gender), type of GTP (e.g., visual, mental process), GTP sub-categories (e.g., mind visualization), nature of the GTP (e.g., associative or non-associative), number of occurrences (e.g., once, more than once), duration of GTP experience (e.g., seconds, hours), situation in which the GTP manifested (e.g., trying to sleep), gamers' physiological conditions while experiencing GTP (e.g., sleep derivate, under influence of substances), playing habits (e.g., short, long sessions, hours), and gamers' perception of the GTP experience (e.g., positive, neutral, negative).

The data interpretation was informed by a literature review about visual phenomena. However, video game features and characteristics of the actual game play (e.g., game activities, visual effects use by the games) were also taken into consideration (e.g., watching videos about game walkthrough and by playing some of the video games) to understand why certain visual experiences had been associated with particular video games. 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 study were paraphrased to reduce the possibility of gamers' experiences being tracked, and to protect the gamers' identities. Paraphrasing included using synonyms, changing tense, or removing extraneous information.

Categories and definitions: The themes were classified in a descriptive way to preserve the gamers' own words. The way the VGTP manifest may have different psychological implications on gamers. For this reason, the data classification differentiated between: (i) digitally-induced images, (ii) perceptual distortions, (iii) visual misperceptions, and (iv) unspecified visual game transfer phenomena.

Digitally-induced images (DII): 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 multi-sensorial experiences and cross-sensorial experiences, and comprised (i) mind visualizations, (ii) retinal sensations, (iii) seeing video games elements projected in the real world, (iv) multi-sensorial experiences, and (v) across 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. Subcategories were defined as following:

- *Mind visualizations.* These were defined as visualizing video game elements in the mind, flashbacks or picturing video games elements in real life environments (e.g., 'mind', 'head' or 'mind's eye'). They were considered as daydreams if the gamers imagined themselves doing things as in the video game. These daydream experiences were excluded from the data analysis.
- *Retinal sensations.* These were defined as seeing video game elements intermittently or episodically in the back of the eyelids. Indications of eye sensations were required in this category that differ from mind visualizations (e.g., 'in the back of my eyelids').
- *Seeing video game elements projected.* This was defined as seeing video game elements with open eyes or projected 'out there' (e.g., 'corner of the eye', 'in front my eyes', 'with open eyes', 'see them everywhere', 'peripheral vision', 'projected', 'blinking', and 'hallucinations'). This manifested as: (i) seeing video game elements

just floating, 'and/or as (ii) seeing video game elements as superimposed on real life objects and environments.

- *Multi-sensorial experiences.* These manifested when visualizations were accompanied by sensations in other sensorial modalities (e.g., seeing video game elements while feeling body movements or hearing the music from the video game).
- *Across sensorial experiences.* These manifested when gamers had seen with closed or open eyes, or visualized in the mind, video game images triggered by a stimulus in a different sensory modality (e.g., auditory). These experiences were considered as induced synaesthesia (e.g., seeing images while listening to music).

Perceptual distortions: These were defined as distorted perceptions of real life environments, or objects directly associated with video game content. This category also included gamers' experiences of alteration of time perception due to visual effects of velocity.

Visual Misperceptions: These were defined as perceiving a real life object as something from a video game. This included experiences where gamers confused real life stimuli or had thought they saw a video game element, as well as, when they saw video game elements in ambiguous real life stimuli such as clouds or dots. It also included when gamers stated they saw everything in terms of blocks or had made analogies between real life stimuli and video game elements.

Unspecified VGTP: This category included experiences about altered visual perceptions but here the gamers' posts did not include enough information to classify them in any or a new category.

RESULTS

The results are divided in two main sections: (i) general characteristics of VGTP, (ii) types of VGTP identified. VGTP experiences were in most of the cases not triggered by association with an external stimulus as commonly occurred within other modalities of GTP (e.g.,

automatic mental processes). Only 21% of the total VGTP experiences occurred by association between real life (RL) stimuli and video game elements.

General characteristics of VGTP

Very few posts included detailed information to explain the general characteristics of VGTP. For this reason, these data are only presented qualitatively with just the total number of experiences within each category being quantified.

Duration of the VGTP experiences (n=75): In relation to length of VGTP 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 minority also said 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 VGTP occurrence (n= 656): The majority of the gamers in the total sample mentioned that VGTP happened only once or they only reported one experience, but there were also gamers that experienced VGTP on several or more occasions.

Hours played per session when having VGTP (n=192): In most of the cases, the posts included details indicating that gamers played long sessions (e.g., 3½ hours) or very long sessions (e.g., "all the day", "17 hours straight"). A total of 78 of the gamers' posts indicated explicitly that they were playing excessively (e.g., "too long", "hardcore", "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 VGTP occurred (n=50): Some gamers' experienced VGTP 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 VGTP (n=199): A larger number of posts mentioned that VGTP happened when they were trying to sleep, but in general the VGTP occurred while doing daily activities. The activities that were mentioned by the gamers when they experienced VGTP 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, making food.

Physiological conditions (n=25): Only a few posts mentioned under what physiological conditions the gamers were when they experienced VGTP 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 VGTP 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 VGTP as normal (e.g., "it is not unpleasant", "no big deal") or positive (e.g., "entertainment", "fun", "creative"). Some gamers qualified VGTP as "strange", "crazy", "trippy", descriptions that could arguably be perceived as either positive or negative.

Types of VGTP identified

A variety of VGTP experiences were reported (see Table 1). The largest numbers of experiences were identified as digitally induced images. The second most predominant category was perceptual distortions, followed by misperceptions. These are briefly described in turn.

Digitally Induced Images (n=474)

These types of experiences manifested as retinal sensations when gamers see video game images in the back of the eyelids, seeing video games projected “out there”, or visualizing video game elements in the mind and picturing video game elements in real life environments. Video game images or elements could appear static or in motion.

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 after-images. According to the descriptions of some gamers, these images were of higher fidelity and were seen either as positive after-images, since the images preserved the colours from the game, or as negative after-images in opposite colours as the ones perceived in the game. 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 these experiences in conjunction with when they were trying to sleep (and provoking sleep deprivation). 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 state² (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 elements projected (n=131): In this category, gamers actually saw video game images projected “out there” with open eyes. In a few cases, this occurred immediately after stopping playing and was triggered by blinking, similar to after-images. For instance:

“Lumines, oh god. I play 3 days and I have seen those damn squares everywhere, even when my eyes open...” (Ethan07)

In fact, some gamers got distracted and were not able to concentrate because they kept seeing the video game images. Furthermore, in some cases, it was found that these types of experiences were triggered by contextual associations. Two conditions were identified: (i) similarities between real life stimuli and video game elements, and (ii) association of video game elements with the gamers’ activities or events in real life settings. Associations between real life stimuli that resembled the video game elements appeared to have triggered these experiences. In some cases the images appear superimposed in real life objects. For instance:

² Hypnagogic states are considered transitional states between being awake and asleep and it has been reported in different sensory modalities (e.g., visual, auditory, olfactory, gustatory and tactile). However, a single event can also include different sensory modalities (e.g., visual and auditory, visual and tactile (Mavromatis, 2010).

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

Also, gamers saw video game images while driving. This appeared to being triggered by the association of the road and the table that held the notes in games like *Guitar Hero*. This may have been facilitated by driving on monotonous roads (such as motorways) where driving often becomes automatic. Studies have demonstrated that driving without awareness can lead to micro-sleeps (Briest, Karrer, & Schleicher, 2006). Additionally, some gamers reported seeing video game images triggered by doing daily activities. The activities included: searching for things, wanting to enquire for some type of feedback, having a conversation and selecting among talk/reply options in a menu. 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)

On different occasions, the actual video game characteristics were preserved and the video game images were seen in the same place where gamers saw it in the game. For instance:

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

Mind visualizations (n=136): In this category, gamers reported that video game elements had popped up in their “mind’s eye”. This category includes: (i) stereotypical visualizations of video game images, and (ii) picturing video game elements in real life environments. This type of experience appears to be more stereotypical than when the gamers created their own fantasies with video game content. Stereotypical visualization of video game images share similarities with seeing video game images in the back of the eyelids. For example, stereotypical visualizations with movement have been experienced when the gamers closed their eyes or zoned out. 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)

Another type of mind visualizations occurred when gamers pictured video game elements in their real life. This meant that the gamers were not actually seeing the video game elements but they pictured or visualized them in specific real life events. Sometimes, these experiences were triggered by contextual associations. For instance:

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

Multisensory experiences (n=10): This category included actually seeing video game images with open eyes, in the back of one’s eyelids or as mind visualizations. This was mainly reported 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 had multi-sensory experiences when images of the game were accompanied by kinaesthetic sensations such as feeling the fingers twitching as when pushing buttons on the gamepad or feet moving. This is known as *myoclonic jerking* (Grunewald, Chroni, & Panayiotopoulos, 1992), *hypnagogic jerk* or *myoclonic twitch* (Mitchell, 1890). 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. Synaesthesia occurs when stimulation in one sensory modality automatically triggers a perception in a second modality (Ward, 2010). For instance:

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

Perceptual Distortions

In this category, the gamers reported perceived objects and environments distorted in a variety of ways associated with video games’ visual effects. In most of the cases, perceptual distortions occurred immediately after stopping playing. However, occasionally the gamers’ experiences were triggered by an association between real life stimuli and video game elements. Also, in a few cases, the gamers indicated that they could induce the phenomena.

Perceptual distortions were explained in most of the cases as sensorial adaptations that result in visual after-effects, but some gamers' self-reports suggest the interplay of higher cognitive process and associative mechanisms.

Visual motion (n=75): These experiences 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 after-effect (Goldstein, 2002). Gamers also reported seeing things as “warped”, “wavy” and “expanding”. Usually, these experiences lasted for a short period of time, but some gamers reported that the effect lasted for hours or more, while some experienced it episodically. For instance:

“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)

Some types of long-lasting motion after-effect were also reported. For instance:

“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)

Other visual distortions (n=50): Other gamers' experiences included colour after-effects, shape and pattern after-effects, perceiving static objects as moving, trail after-effects, and contrast after-effects. In some cases, visual distortions occurred while playing. 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)

Other examples included when gamers reported experiencing colour distortions of full environments. This manifested as: seeing real life environments as more colourful or only in the colour of the game, and seeing the world in monochrome or opposed colour as *colour*

after-effects (Gibson, 1937). 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)

Additionally, an altered perception of colour could also be triggered by an association between stimuli. For instance, every time one gamer saw a yellow ‘Y’ in real life settings he experienced a visual distortion. In fact, a yellow ‘Y’ is also present on the game pad of the *Xbox 360*. This can probably be explained by the conditioning of the letter ‘Y’ in yellow with eagle vision effect perceived in the game. Additionally, some gamers performed an action guided by their visual experiences. 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)

Other gamers saw certain real life stimulus as being pixelated. This visual distortion appeared to be similar to ‘visual snow’ where people see television-like static in their visual fields that manifest as a symptom of migraine aura (Curioso, Kepka, Cabello, Segura, & Kurth, 2010) or epilepsy (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)

Furthermore, one gamer reported seeing a screenshot from the game that suddenly started floating as in the game. This visual distortion is known as *Kinetopsia* and it is used to denote a visually perceived illusory movement (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)

Perceptual distortions of time and slow motion sensation (n=7): These types of experiences included altered body sensations and altered perception of time mainly associated with visual and haptic video game effects (e.g., velocity, slow motion). In some cases, gamers perceived the environment in slow motion. For instance:

“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)

Visual misperceptions (n=43)

This category included making erroneous perceptual judgements such as misperceiving one object for another. This is common in individuals with normal vision, especially in poorly illuminated settings or when feeling anxious or stressed (Summerfield, Egner, Mangels, & Hirsch, 2006). Among the gamers' experiences, it appeared that the interpretation of real life stimuli had been affected by previous experiences of video game playing. Sometimes it was difficult to be sure if the gamers' misperceptions were experienced as a thought, or if the gamers actually experienced perceptual distortions. This category included the gamers' claiming a real life object was misperceived as a video game element. The brain constantly tries to make sense of ambiguous stimuli (Summerfield, et al., 2006) and sometimes gamers interpreted ambiguous stimuli based on video games experiences. 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)

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

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

Moreover, some gamers made erroneous judgements based on their expectations, when they thought that they had seen a video game element for a few moments (*“I thought I have seen landmines on the road on many times after Warhawk binges”*, Dannette). Additionally, 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)

Finally, some gamers established analogies between real life stimuli and video game experiences, emphasizing that real life elements “look like” or were similar to that in the game.

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. 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)

DISCUSSION

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 VGTP suggests in the most of the cases a relationship between the video games' visual effects and the gamers' altered visual perceptions.

The gamers' experiences can be explained by the interplay of physiological, perceptual and cognitive mechanism. Gamers' visual experiences were explained similar as visual phenomena experienced by the non-clinical population (e.g., perceptual adaptation, pseudo-hallucinations). However, gamers experiences appear to share broad similarities with *positive visual phenomena*³ (Ffytche & Howard, 1999) presented as symptoms of pathologies such as, photosensitivity epilepsy (Bigal, Lipton, Cohen, & Silberstein, 2003), migraine aura (Podoll & Robinson, 2001), schizophrenia (e.g., hallucinations) (Collerton, Perry, & McKeith, 2005) and side-effects of drug use (e.g., *Hallucinogen persisting perception disorder [HPPD]* in the *Diagnostic and Statistical Manual of Mental Disorders*) (Pichot, Lopéz-Ibor Aliño, & Valéz,

³ Positive visual phenomena are related to increased functions, exaggerated or distorted perceptions of the real world.

1996). For this reason, one of the major contributions of this study is to demystify VGTP since the experiences can in many cases be misunderstood and pathologized. However, the relation with symptoms of pathologies should be investigated further. The data suggest that in most of the cases, the gamers were aware of the unreality of the video game images. This is important when comparing VGTP experiences to pathological hallucinations that imply delusion (Elliott, Joyce, & Shorvon, 2009). However, there are exceptions where a few gamers have taken action when seeing video game images projected or when confusing real life objects from the ones in video games.

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 majority of the experiences were not contextually triggered as have been observed in other types of GTP (e.g., automatic mental process) (A. B Ortiz de Gortari, et al., 2011). However, in different cases, the gamers' visual experiences were triggered by the associations between real life stimuli and events, and between video game elements and activities. For instance, in a previous GTP study (A. B Ortiz de Gortari, et al., 2011) gamers reported seeing video game images above peoples' heads. Some gamers have also perceived real life environments distorted through pairing between different stimuli. Behavioral (classical) conditioning theory argues that associations can be established between different stimuli resulting in a specific response (Pavlov, 1927 cited in De Houwer, Thomas & Baeyens, 2001).

Only a few self-reports contained further information about the characteristics of VGTP. Based on a small number of posts in comparison with the total data, evidence suggests that many gamers experienced VGTP when playing long and excessive video game sessions (e.g., six hours straight, a full day). This suggests that video game playing habits are important. In fact, physiological mechanisms can explain the causes of some of the gamers'

experiences. Some gamers reported that they experienced VGTP when being sleep-deprived or fatigued after playing for many hours, being sick or, being under the influence of psychoactive substances. Sleep deprivation, sensorial deprivation, starvation and consumption of psychoactive substances are important factors that contribute to experience visual distortions and hallucinations (Mahowald, Woods, & Schenck, 1998) and epileptic seizures (Bigal, et al., 2003) in non-clinical populations. However, it is important to point out that physiological states appear to cause the VGTP not only during play but also after playing has stopped sometimes when triggered by associations between real life stimuli and video game elements and events. Furthermore, findings in a previous GTP study (A. B Ortiz de Gortari, et al., 2011) suggested that situations of arousal, anxiety, fatigue and stress can result in gamers seeing video game images projected as an escape or homeostatic mechanism when in social situations. Previous experimental studies have reported visualizations of video game images in sleep onset (Kusse, et al., 2012; Stickgold, et al., 2000; Wamsley, et al., 2010) and while doing daily activities (A. B Ortiz de Gortari, et al., 2011).

In many cases, the VGTP episodes lasted seconds or minutes, but there were specific types such as *recurrent eye sensations*, that arose when gamers saw stereotypical video game images in the back of their eyelids episodically, lasting a day or even longer. There were also cases where the experiences lasted a full night, causing sleep deprivation. Also, some gamers reported seeing video game images that did not allow them to concentrate on other activities for a while. In these cases, some gamers perceived VGTP as counter-productive. These were the type of VGTP considered more intrusive and annoying. Also, an experimental study conducted specifically with violent video game found that the quality of sleep is affected when playing violent video games for more than two hours before bed (Kwan et al., 2010).

VGTP were considered either positively or negatively. Some gamers enjoyed the experience and even tried to induce it or wanted to induce it, whereas others gamers got

scared and worried. In general, Game Transfer Phenomena can happen while playing, immediately after stopping playing, or be delayed by hours or more. Two types of condition have been identified where gamers experienced GTP. These were (i) where the *gamers were exposed to no (or limited) external stimulus*, specifically when lying in bed and (ii) when the *gamers were in a normal daily context* (A.B. Ortiz de Gortari & Griffiths, 2012). In this study, more gamers reported experienced VGTP when doing normal day-to-day activities. It is speculated that altered state of consciousness, fostered by the gamers' relatively passive and automatic activities, facilitated the VGTP.

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 VGTP. Nor is it known why some gamers experienced VGTP with certain games while 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 VGTP. VGTP were reported when playing console games but also when playing in mobile devices. In a few cases the gamers mentioned that similar experiences to VGTP 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 after-images 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' structural characteristics, it is interesting to note that once again when exploring Game Transfer Phenomena, different individuals reported similar phenomena in the same games (A. B Ortiz de Gortari, et al., 2011). This demonstrates that video games' structural

characteristics are relevant although video game playing habits clearly play an important additional role.

On one hand, some gamers' experiences provide insights into the abilities of the human mind. The gamers did not just imagine or visualize images but actually saw images projected with video game content triggered by automatic associations. This shows the potential of using automatic associations in video games to enhance learning. On the other hand, VGTP experiences are sometimes of an intrusive nature since they could occur without the gamers' control and premeditation, and in some cases were triggered by the similarity of real life context and video game environments. This raises some concerns, especially about the circumstance where the experiences occur, as impulsive or automatic reactions in some cases may have unforeseen impacts (e.g., seeing video game images while driving). The implications of VGTP while engaged in daily activities such as driving therefore require further investigation.

Furthermore, the importance of cognitive misinterpretation have been exemplified in studies about panic disorders where a misinterpretation of stimulus ended up increasing the levels of automatic arousal, and anticipation of threat, therefore causing increased levels of anxiety that eventually caused panic attacks (Ehlers, 1989). Demystifying GTP experiences appears to be relevant to help gamers to interpret their own mental health, and stops gamers' thinking it is a sign of psychological dysfunction. Instead it encourages self-control, awareness and healthy gaming. The psychosocial implications of the VGTP on gamers may vary from individual to individual and may depend on different factors.

Visual experiences reported by the gamers in this study suggest that it is important to conduct further research to better understand these phenomena and systematically evaluate if the implementation of pre-game and post-game user recommendations to encourage safe and healthy gaming is necessary. The VGTP have been identified within interactive environments

that include both old and modern video games, but due to the advances in technology, the highly interactive environments will become more fully immersive environments and it is not known what physiological and cognitive consequences of these neural adaptations will culminate in over time.

This is the first study (to the authors' knowledge) that has examined altered perception among a large number of video game players. However, there are a number of limitations. First, 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.

This paper has set a benchmark for future research concerning *altered perceptions induced by digital media*. Future studies should investigate VGTP and the possible psychosocial, cognitive and physiological implications that it might have on gamers. The use of quantitative research methods will allow specific variables and correlations to be addressed and established. A systematic analysis of video game content is also needed. It is also important to know how prevalent VGTP are among the video game playing population and what makes gamers more susceptible to experience VGTP.

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Table 1

VGTP categories and sub-categories

Type of VGTP	Number of experiences	VGTP type (%)	VGTP category (%)
Digitally Induced Images			
Retinal sensations with video games elements	140	30	
See videogames elements projected	131	28	
See videogames elements unspecified			
(open/closed eyes)	16	3	
Recurrent mind visualizations	112	23	
Picture videogames elements	24	5	
Multi-sensorial experiences	10	2	
Cross-sensorial modalities	14	3	
Seeing /visualizing video game elements	27		

(unspecified)		5	
Subtotal	474		72
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Perceptual Distortions			
Motion after-effect	75	6	
Coloured altered perception	10	8	
Float/spin	2	2	
See the world as in the video game	10	8	
Changes in shapes	9	7	
Patterns (e.g., grid, pixelated)	4	3	
3D - depth	1	1	
Motion sickness	3	2	
Slow motion/time perception	7	6	
Perceive things smaller	1	1	
Visual experiences not directly associated with particular videogames' visual effects (e.g., sleep paralysis, tunnel vision, prodrome-epilepsy)	3	2	
Subtotal	125		19
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Visual Misperceptions			
See videogames in ambiguous real life stimuli	8	19	
Confuse RL stimulus with videogame elements	8	19	
Thought to have seen a videogame element in RL	5	11	

Make analogies between RL stimuli and		
video games experiences	7	16
See things as blocks	15	35
Subtotal	43	7
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Unspecified VGTP	14	2
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Total	656	
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