Outlining Theoretical Underpinnings of Game Transfer Phenomena

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Abstract. Research has investigated the impact of video game play on cognitive processes and perceptions during and after gaming. These studies have primarily focused on cognitive functions such as perception, attention, working memory, and skill transfer. However, little attention has been paid to the short-term effects of gaming. Research on Game Transfer Phenomena (GTP) has emerged as a comprehensive, multi-modal approach to examining the temporary changes in sensory perception, cognition, and self-agency directly linked to video game experiences. GTP manifestations involve suddenly re-experiencing images, sounds, haptics, and perceptual distortions of surroundings, objects, and the body perception after gaming. These experiences typically happen while being awake and are triggered by internal (thoughts) or external stimuli associated with the game. The prevalence of GTP ranges from 74.8% to 96% (in a 12-month period). However, GTP occurrences are mostly infrequent. Most GTP cases are reported by gamers without a history of substance use or mental disorders. After reviewing the literature on GTP (32 studies, N>8,000) and related phenomena, seven theories were formulated, partially supported by the current knowledge about GTP. The postulated theories were categorized into three groups: 1) Vulnerability factors include susceptibility to cognitive and sensory phenomena, hypersensitivity, low working memory capacity, and tendency to experience mind-wandering. 2) Mechanisms underlying GTP involving priming mechanisms, associative learning, selective attention to game-related cues, predicting errors, disinhibition of visual processors, neurotransmission dysregulations, sensory sensitivity, and neural adaptations. 3) Risk involving GTP due to their potential disruptive nature and its contribution to the symptomatology of gaming disorder.

Keywords. Game transfer phenomena, video games effects, involuntary cognitions

1. Introduction

GTP involve the interplay of physiological, perceptual and cognitive mechanisms. Recent efforts have focused on identifying the underlying processes and potential outcomes by distinguishing between endogenous and exogenous manifestations as well as environmental stimuli acting like triggers [1]. The GTP framework [2] has been supported by cross-cultural validation studies [3-5]. This paper aims to outline theories that can provide a foundation for the future investigation of GTP.

2. Methods

After reviewing the GTP literature and related phenomena, seven theories were formulated as statements regarding vulnerability factors, underlying mechanisms, and the etiology of GTP. Studies on GTP included 32 studies (N>8,000). Most of the studies utilized cross-sectional designs and gathered data through surveys, interviews, diaries, online forums, and experimental tasks.

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3. Results

Individuals who are more susceptible to involuntary cognitive and sensory phenomena, are more likely to experience GTP: GTP are considered involuntary due to their unpredictable and uncontrollable nature [2]. GTP has been placed on the spectrum starting from common experiences up to symptoms of disorders causing distress and impairment. GTP are associated with cognitive phenomena resulting from exposition or encounters with stimuli (e.g., earworms or music imagery) [6] or the resurfacing of involuntary memories such as autobiographical or mind-popping (MP; brief and involuntary recollections of semantic knowledge in the form of words, images, and music), perceptual disturbances (e.g., MUSEQ; CAPS), unusual sleeping experiences [1, 7] and dissociations (e.g., DES) [8].

GTP are of a dissociative nature as they can disrupt the track of thoughts, perception, motor control and body representation: Normal dissociation involves instances of mind-wandering (daydreaming), task-unrelated thoughts, deep absorption in reading or watching a movie, and imaginative play [9]. Dissociation as a disorder imply the disruption in the usual integration of various aspects of consciousness and behavior [10]. GTP has been classified among dissociative phenomena (see review of [11] and has been associated with dissociations [8]. Gamers have also reported corporeal phenomena involved in dissociations (e.g., vestibular adaptations, perceptual changes in physical characteristics [1, 12]. GTP can be dissociative when individuals become deeply engaged in mental imagery and involuntary mental actions while recalling or envisioning gameplay after playing, particularly when feeling sensations of derealization and depersonalization triggered by game-related stimuli [1]. However, GTP usually occur in a non-dissociative manner, allowing episodic game content to emerge without interrupting concurrent activities [6, 13, 14]. Similarly, Hallucinogen Persistent Perception Disorder (HPPD) symptoms which share phenomenological similarities with some sensory experiences in GTP (e.g., retinal sensations) appear to be better explained by shift of focus from exogenous to endogenous phenomena than mimicking the alteration in states of consciousness typically accompanied by the substance use [15]. Although, GTP can also occur during the transition from wakefulness to sleep, resembling hypnagogic phenomena that do not necessarily involve declarative memory systems, as indicated by experiments using games to explore the link between wake states and dreams [16]. Since GTP typically manifests when awake and are elicited by gaming-related stimuli, comprehending the risk of GTP causing disruption is crucial, as distractions can lead to mishaps during engagement in activities that require full attention.

Gamers with low working memory capacity (WMC) and a tendency to mindwandering are more likely to experience GTP: WMC allows maintaining information in memory even when facing distractions [17]. Gamers with a low WMC can easily shift their attention away from their current activity and focus on internal thoughts or external stimuli related to the game. In this context, connections between GTP and mindwandering were found [18]. Research indicates that GTP like daydreaming tend to occur during periods of low cognitive demand as when performing routine tasks (e.g., walking) [14]. Gamers may activate memory representations associated with a previously played game while mind wandering as the focus of attention can be shifted to the most activated memory representation, which can lead to its awareness. The activation of specific hubs of the Brain's Default Mode Network (DMN), particularly the Posterior Cingulate Cortex [19] has been suggested to be associated with GTP [20]. Hyperactivity in the DMN has been observed in individuals experiencing unusual thoughts and hallucinations, such as those diagnosed with schizophrenia or at risk [21]. This increased activity may also be present in gamers who report high frequency of GTP, especially in those exhibiting positive schizotypal traits, as these traits have been found to predict GTP [20].Therefore, examining the relationship between DMN activity and the extent of positive schizotypal traits could offer insights into whether frequent GTP could serve as an early indicator of vulnerability to developing psychosis, as seen in clinical cases [22]. Furthermore, GTP has been linked to cognitive lapses, including those caused by attention errors and low mindfulness [8].

GTP are the result of priming or associative learning leading to reactivity toward game-related cues: Long-term priming mechanisms observed in MP that can be triggered by previous encounters with similar stimuli (repetition priming) or with related content (associative priming) [23] may be involved in GTP [18]. GTP could also be explained by associative learning (classic conditioning) observed in experiments where auditory hallucinations have been induced by pairing visual and auditory stimuli [24]. Through repeated exposure to visual, auditory, and tactile cues in gaming, strong associations can be formed with specific actions, emotions, or states. These enduring connections in the brain could lead to automatic triggers when encountering similar cues outside the gaming environment, potentially resulting in GTP. Studies have found that gamers can recognize objects related to gaming which activates their GTP [12, 14]. The game-related cues may trigger memories of past gaming experiences and stand out due to the expectation of rewards or punishment from games [25]. GTP usually occur shortly after playing but also days, months, or even years later when engaging in an activity related to a particular game [26]. This suggest that repetitive exposure to words, images, and concepts associated with the game may not immediately disappear, but remain active in the mind for some time after playing [18]. Some gamers with poor impulse control seem to struggle to resist impulsive actions toward game-related stimuli and automatically approach objects or raise their arms [2]. Motor impulsivity has been shown associations with GTP [14], and negative correlations have been found in goal maintenance, inhibition, and adjournment [27]. However, no correlations have been found between GTP and the Go/No-Go task [28].

Sensory GTP experiences are explained by prediction errors and neural adaptations involving hypersensitivity: The predictive processing framework supports the idea of the role of top-down processes in hallucinations [29]. The connection between cognitive processes and sensory perception is evident in the context of GTP. The same game has led to GTP for many gamers, although with different manifestations. Some expect to see maps when searching for an address, while others see them in the corner of their eye. Some are taken aback by the non-square shape of trees, unlike the cubic ones in Minecraft, while others perceive trees as distorted.

Engaging in repetitive tasks or prolonged exposure to sensory stimuli can lead to neural adaptations [2] facilitated by fatigue [28]. Seeing game images recurrently resemble afterimages in the retina, but due to their prolonged duration (hours, days) and color preservation, they appear to be positive afterimages indicating involvement of the brain [12]. Some games contain epileptogenic precipitators such as flashing lights and specific figure patterns [30]. Sensory hypersensitivity have correlated with GTP (e.g., sensitivity to bright light, pain, textures) [7]. Symptoms of HPPD, which bear similarities with visual GTP, have been linked to photosensitivity and perceptual disturbances, including sensitivity to tinnitus, migraine with aura, vertigo synesthesia [31].

Visual GTP experiences are a result of disinhibition of visual processors and neurological: Analysis of visual experiences via qualitative studies and clinical cases [32, 33] suggests that GTP exhibits clinical features and similarities to Flashbacks (FB or Type I) and Hallucinogen Persisting Perception Disorder (HPPD or type II) derived from the use of psychedelics and consciousness or mind expanding substances. This includes the re-emergence of the perceptual disturbances experienced during substance use, in the absence of the substance (DSM-5-TR) (For review see [10]). Likewise, HPPD patients, those reporting GTP, while not exclusively, re-experienced sensory perceptions in dark conditions, such as when attempting to fall asleep, moving from well-lit environments, or in conditions where ambiguous stimuli allow re-interpretations [12, 33]. The perceived location of these images may be internal, within the mind's eye, or external, overlaying objects associated with the game. The disinhibition hypothesis appears to explain some of the HPPD symptoms (e.g., afterimages, palinopsia, and halos) which may be caused by a lack of inhibitory neurons to control the activity of pyramidal neurons after a visual stimulus [31]. This disinhibition may be linked to dysfunction of cortical serotonergic inhibitory interneurons with GABA-nergic outputs processes that are implicated with sensory filtering mechanisms of unnecessary stimuli in specific and certain brain areas [34]. A faulty sensory gating process could be linked to the

development of visual GTP experiences, enabling the ongoing central processing of visual perceptions after the image has disappeared from the visual field [35].

GTP contributes to symptoms of GD, and can be a sign of GD symptomatology and dysregulation of neurotransmission: GD involves excessive, uncontrollable and dysfunctional gaming, while GTP implies temporal changes in perceptions, cognition, and behaviors [36]. Both GD and GTP have been associated with a range of conditions, including anxiety and depressive disorders, impulsivity, ADHD, OCD, dissociative disorders, and substance use [42, 46-48]. It is noteworthy that while the co-occurrence of GD and mental disorders is common, most gamers with GTP do not have a mental disorder [20]. Nevertheless, having a disorder does increase susceptibility to GTP [37]. An abnormal activity in the release of dopamine has been connected to gaming and GD, hallucinations in schizophrenia and perceptual disturbances in HPPD [34, 38] and may play a role in GTP. Studies have consistently shown that GD can predict GTP [28, 39]. Associations between playing time and GTP has been established, but the findings have not always been substantiated [40, 41]. The individual characteristics appear to play a more significant role in the susceptibility to GTP than excessive playing [20].

GTP could also represent GD symptoms [32]. Specifically, (i) silence symptoms, a peripheral criteria, involves preoccupation for gaming when it dominates thoughts, emotions and behaviors [42]. (ii) The Elaborated Intrusion Theory (EIT) posits that cravings manifest as spontaneous intrusions (cognitive or sensory) that can become desires when elaborated [43]. Addictions are often triggered and sustained by cravings. In patients with both GD and GTP, it has been observed that re-experiencing game content or attempting to induce sensory experiences contributes to the maintenance and relapse of GD symptoms [22, 44]. The cycle of dysfunctional gaming has been posited to be worsened by susceptibility to GTP, including euphoric recall of gaming, cravings, and impulses drive to play, despite negative consequences [33]. (iii) Withdrawal symptoms in GD comprise anxiety, moodiness, sadness, and irritability. There is little evidence about the physiological symptoms of GD compared to other addictions [45]. Withdrawal symptoms in addictions may include perceptual disturbances such as hallucinations, with intact reality testing [46]. Dystonias and dyskinesias (e.g., involuntary muscle movements, twisting and repetitive movements) can be withdrawal symptoms caused by dopamine receptor-blocking agents (neuroleptics). Involuntary movements of fingers have been also observed in repetitive tasks such as playing piano [47]. In GTP involuntary and repetitive finger movements have been observed when trying to sleep and are sometimes triggered by an identifiable game cue [12]. Memory and attention changes, irrational thinking and expectancies may be cognitive features of withdrawal [45]. GTP also involves irrational thinking and false expectations associated with game outcomes in the real world [48].

4. Conclusions

This paper presents theories on GTP to prompt new research avenues. GTP encompasses a broad range of phenomena, from sensory perceptions to high cognitive levels. Consequently, the etiology and underlying mechanisms of the various forms may exhibit differences. The interpretation of studies on GTP appear to offer initial support, although further investigation is necessary to validate or refute the proposed theories.

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