Can Ordinary Horror Games Reduce Avoidant and Safety Behaviours in Players with Anxiety Disorders?

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Abstract

Since 2010, several studies have highlighted the ability of therapeutic video games to reduce avoidant and safety behaviours in individuals with anxiety disorders (ADs). However, there has been little exploration into whether horror games can have similar effects on these behaviours without incorporating explicit therapeutic design strategies. This paper provides an exploratory heuristic analysis of *Carbon Steel* (Klubnika, 2022), an indie puzzle horror game, to investigate its potential impact on reducing avoidant and safety behaviours in players with ADs. *Carbon Steel* evokes fear and tension, elements that are typically seen as counterproductive in anxiety management, yet it may offer players controlled exposure to fear-inducing events, which are central to therapeutic techniques like cognitive behavioural therapy (CBT), attention bias modification (ABM), and exposure training. The analysis explores how *Carbon Steel*, though not designed as a therapeutic tool, might indirectly provide benefits for players with anxiety disorders. This paper advocates for further research into how ordinary horror games could be adapted to serve as supplementary tools for more accessible and engaging mental health interventions, offering diverse approaches to anxiety management and prevention.

Keywords

Anxiety disorders; anxiety reduction; cognitive-behavioural therapy; mental health intervention; attention bias modification; exposure therapy.

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Introduction

Ordinary horror games provide players with immersive, fear-driven experiences. In the context of this article, "ordinary horror games" refer to those created without the intention of serving as mental health interventions during therapeutic treatment. While therapeutic video games, unlike ordinary games, are designed explicitly to promote physical, mental, or emotional well-being, often by incorporating principles from psychology, ordinary games may still incorporate elements that align with therapeutic goals. Some studies have explored the usefulness of such games in mental health contexts. Shah et al. (2018) investigated the potential of ordinary games in therapy. *The Sims: Life Stories* (Electronic Arts Redwood Shores, Aspyr, & Maxis, 2007) was notably successful in engaging adolescents in emotional regulation (Aventin et al., 2014). However, ordinary video games, and in this context horror games, are not necessarily designed with therapeutic goals in mind. This distinction is important as ordinary horror games may face limitations in their ability to meet criteria for reducing avoidant and safety behaviours in players with anxiety disorders (ADs).

This article aims to explore how ordinary horror games, specifically *Carbon Steel* (Klubnika, 2022), might help reduce avoidant and safety behaviours in players with ADs. Unlike clinical studies that focus on games designed for AD treatment, the article uses a heuristic analysis to evaluate the effectiveness of *Carbon Steel* in addressing these behaviours. To thoroughly explore this subject, the article draws on a literature review regarding anxiety disorder treatment through videogame-based intervention techniques. The unique symptomology of ADs must be understood to assess how interventions, including video games, might assist in symptom mitigation.

ADs are a category of mental health conditions defined by the *DSM-5-TR* (2022) as characterized by excessive fear, anxiety, and related behavioural disturbances. These include avoidance behaviours—actions taken to escape or prevent exposure to anxiety-inducing situations—and safety behaviours, such as reliance on objects or routines to reduce perceived threats. ADs include but are not limited to generalized anxiety disorder, panic disorder, social anxiety disorder, and specific phobias, as outlined by the National Alliance on Mental Illness (NAMI, 2017). These conditions often persist without intervention, significantly impacting daily functioning and quality of life. Both the *DSM-5-TR* and NAMI perspectives on ADs inform this article, ensuring that clinical criteria and shared lived experiences are considered. Avoidance and safety behaviours, while temporarily alleviating distress, perpetuate anxiety by preventing individuals from confronting their fears (Hofmann & Hay, 2018). By defining and contextualizing ADs within this framework, I examine how game mechanics in ordinary horror games like *Carbon*

Steel may interact with AD symptoms by providing controlled exposure to reduce avoidant tendencies and support healthier coping strategies.

Carbon Steel is a first-person puzzle horror game in which the player operates machinery to conduct unethical research in a laboratory setting (see Figure 1). Horror games like *Carbon Steel* evoke feelings of dread and inherently create controlled environments where players confront fear, making them natural candidates for therapeutic applications like exposure therapy. While the game's intention is to elicit fear, which might seem counterintuitive for anxiety disorder treatment, it is crucial to recognize that dread is a fear-based emotion (Berns et al., 2006). Research shows that controlled exposure to "fear events"—situations that provoke fear through negative stimuli—can help individuals with ADs confront avoidance tendencies and practise healthier coping strategies (Birk, 2019). This highlights the potential of horror games, even in their existing form, to address anxiety by reshaping the role of avoidance and safety behaviours in anxiety management, aligning with their innate connection to anxiety and fear responses.

Figure 1. A gameplay screenshot of *Carbon Steel*. Screenshot taken by the author.

A clear understanding of anxiety disorder treatment and the role of therapeutic games is crucial for evaluating *Carbon Steel's* potential to impact avoidant and safety behaviours. However, as this article devotes considerable space to contextual research on therapeutic approaches and therapeutic games such as *MindLight* (GainPlay Studio, 2014), it is important to clarify how this foundational information informs the heuristic analysis. This approach ensures a broader understanding of the principles underpinning effective anxiety interventions before applying them to an ordinary horror game. The next section will outline the contextual research that shaped the heuristics used in this analysis, bridging the gap between established therapeutic methods and their potential application in *Carbon Steel*.

Literature Review

ADs are the earliest form of psychopathology that emerges in childhood and are some of the most frequently diagnosed disorders in youth (Beesdo et al., 2009). Beyond clinical diagnoses, subclinical levels of anxiety symptoms are estimated at 40% in children, which increase the risk for ADs in adulthood (Muris et al., 2000). This highlights the importance of addressing subclinical anxiety to prevent development of more severe symptoms.

Understanding the mechanisms that perpetuate anxiety is crucial to developing effective treatments. Avoidant behaviours are common strategies used to evade or minimise perceived threats. Knaus (2014) explains that avoidance reinforces anxiety by stopping individuals from facing their fears. Safety behaviours are the most common type of avoidant behaviour (Jamil, 2020). Knaus (2014) defines safety behaviours as actions taken to prevent feared outcomes, which can perpetuate ADs. Leahy et al. (2012) explore how safety behaviours offer temporary relief but reinforce anxiety by maintaining the belief that danger still exists unless safety behaviours are exhibited. These behaviours temporarily reduce distress but reinforce anxiety symptoms by hindering exposure to feared stimuli.

Research on therapeutic approaches, such as the use of video games to address mental health disorders, has largely involved controlled environments where participants confront fears, challenge avoidance tendencies, and practice coping strategies (e.g., Fernández-Aranda et al., 2012; Schoneveld et al., 2016; Wols et al., 2018). These studies demonstrate the potential to reshape the role of avoidance and safety behaviours in anxiety management (Birk, 2019). They also commonly integrate established intervention approaches, such as cognitive-behavioural therapy (CBT), into game mechanics designed to reduce reliance on maladaptive coping strategies.

It is crucial to recognise that not all individuals with ADs exhibit reduced levels of avoidant and safety behaviours when playing ordinary or therapeutic video games. According to Quintana et al. (2023), a study involving adults over 18 years of age from Spain and Canada utilized a virtual convenience store environment with tasks such as informal conversations, naming exercises, and assertiveness challenges, which elicited varied responses. Measurements in the study included tools such as the State—Trait Inventory for Cognitive and Somatic Anxiety (STICSA) and the Subjective Units of Disturbance Scale for Anxiety (SUDS-A) to assess anxiety levels. While some individuals with ADs experienced reductions in avoidance and safety behaviours, others maintained or intensified these behaviours, particularly in scenarios requiring significant social interaction or evaluation. As the study focused on adults with generalized social anxiety disorder (SAD), the findings may not be applicable to children or adolescents, who may

exhibit different responses due to developmental and cognitive differences. Nevertheless, this variation in responses suggests the presence of diverse anxiety profiles and coping mechanisms within the AD population, highlighting the need for personalized interventions and treatment methods.

Evidence-Based Video Game Treatment as an Alternative to Cognitive Behavioural Therapy

CBT is a form of psychological treatment that has been demonstrated to be effective for a range of mental health disorders such as anxiety and depression. Treatment involves techniques that include learning to address fears and recognising behavioural patterns. This may be achieved through methods that help a client recognise that distorted thinking is often the root of perceived problems (American Psychological Association, 2017). However, failure to respond well to CBT can result from various factors, including treatment-related issues such as poorly conducted therapy or a low dose of treatment, as well as patient-related issues like low engagement and comorbid disorders (Glenn et al., 2013). This finding is supported by studies on the effectiveness of CBT, such as McManus et al. (2008).

A randomized controlled trial by Wols et al. (2018), involving children aged 8–12 who played the therapeutic game *MindLight*, highlighted the significance of avoidant and safety behaviours in the maintenance of anxiety. Wols et al. (2018) directly measured players' engagement levels and actively sought to encourage engagement through the game's mechanics. Developed to prevent the escalation of anxiety in at-risk children, *MindLight* is an adventure game aimed at 8–12-year-olds that uses biofeedback to help the player defeat monsters, solve puzzles, and overcome challenges to rescue Grandma from her haunted house. *MindLight* incorporates evidence-based therapeutic techniques as game mechanics in a way that is deemed more engaging and motivating to players than typical treatment methods like CBT. *MindLight* uses the following evidence-based strategies: attention bias modification, relaxation training, and therapeutic exposure techniques. These techniques are embedded in gameplay mechanics to reduce avoidant and safety behaviours in players. Reduced behaviours and increased treatment engagement, such as adherence to advice and consistent session attendance, are predictors of better outcomes for effective anxiety disorder treatments (Glenn et al., 2013). Results from an indicated randomised controlled trial (Schoneveld et al., 2016) showed that after playing five sessions of *MindLight*, participants showed significant reduction in anxiety symptomatology for up to six months and had been proven to be as effective as regular CBT-based prevention programs. However, Wols et. al (2018) stated that it was unclear which mechanics were most important for anxiety reduction as well as if the mechanics themselves were responsible for anxiety reduction.

As a result, Wols et al. examined the effectiveness of specific game mechanics in *MindLight* on reducing anxiety symptoms in children and found that therapeutic exposure techniques were most effective. Increased engagement behaviours, such as exploring fearful game environments, significantly predicted lower anxiety symptoms at a three-month follow-up. Conversely, avoidant or safety behaviours, such as hiding inside chests or using ceiling lights to avoid fear stimuli, were associated with higher anxiety levels over time. These results highlight the importance of exposure-based mechanics in anxiety reduction, demonstrating their potential to teach children effective emotion-regulation strategies through gameplay.

Attention Bias Modification

A well-established alternative to CBT, attention bias modification (ABM) is therapeutic approach to anxiety disorders, grounded in cognitive models of anxiety and supported by experimental evidence demonstrating the role of threat-related attentional biases in maintaining anxiety symptoms. ABM aims to diminish avoidant and safety behaviours by shifting attention from threats onto positive stimuli (Bar-Haim et al. 2010). Current cognitive models of anxiety recognize that early, automatic, and unconscious attention biases play a role in the causation and maintenance of ADs. Research in both animals and humans shows that these anxiety biases are due to functional aspects of subcortical neural circuits that are not available to the conscious mind (e.g., Delgado et al., 2008). However, because standard psychotherapy cannot change these biases and brain activities, certain aspects of anxiety are not addressed by traditional treatment methods like CBT, further underscoring the need for personalised treatment methods.

The use of ABM principles demonstrates a targeted strategy for addressing avoidance and safety behaviours. Figure 2 outlines the approaches used and the behaviours classified as avoidant or safety-related in Wols et al.'s (2018) study.

Evidence-based principle	Game mechanic	In-game play behaviours	
		Engaged	Avoidant/safety
Relaxation	Neurofeedback	Bright mindlight	No mindlight
Exposure	Approach fear events	Exploration	Turn on ceiling light
		Decloak/attack fear events	Hide in chest
		Defeat	Inactivity
Attention bias modification	Attention bias puzzles	Pick up coins Solve puzzle	

Figure 2. Evidence-based principles translated into game mechanics in *MindLight* and the specific in-game play behaviours that are indicative of these mechanics (Wols et al., 2018, p. 656).

Conventional ABM procedures tend to use a modified version of the dot-probe task or a visual search task which have been proven to reduce anxiety symptoms at least short term (Bar-Haim et al., 2011). The dot-probe task is a behavioural paradigm in which individuals view two stimuli—typically one threatening and one neutral—followed by a probe that appears in the location of one of the stimuli; faster responses to probes replacing the threatening (emotional) stimulus indicate an attentional bias (Cisler et al., 2007). In *MindLight*, gaming elements have been added to the main principles of dot-probe training. In the ABM puzzles, the player learns to focus on portraits of happy faces rather than threatening ones. Once the puzzle is completed the lights turn back on in that specific room. As a result, ABM training is performed through these puzzles.

Relaxation Training Through Neurofeedback

Another intervention approach performed is relaxation training through neurofeedback. Neurofeedback teaches self-control of brain functions to people by measuring brain waves and providing a feedback signal (Marzbani et al. 2016). In neurofeedback training, individuals are presented with real time electroencephalogram headset (EEG) recordings from their brain and are guided through relaxation exercises.

MindLight applies a neurofeedback mechanic in which the player wears an EEG. This ensures that players maintain EEG wave patterns consistent with the established relaxation metrics identified by Price and Budzynski (2009). Data produced from the EEG is fed into the game so that when players are more relaxed the in-game brightness is increased, meaning when players have higher levels of measured relaxation the game becomes easier to complete (Wols et al. 2018). Relaxation is trained through incentivising game progression depending on the player's level of relaxation. In turn, this should result in reduced levels of expressed avoidant and safety behaviours and increased levels of engagement.

Despite prediction, relaxation during gameplay indicated little to no changes in anxiety symptoms. Wols et al. (2018) speculated that this may have occurred because relaxation during gameplay is not as important in comparison to exposure training for players. It is claimed that the contribution of relaxation training to improve anxiety symptomatology in youth is limited. These findings are in line with Glenn et al.'s (2013) research on avoidant/safety in-game behaviours during traditional therapy. However, it is important to note that relaxation training may be effective in higher doses or within a game with different mechanics that are not shared with exposure training.

Exposure Training

The study by Wols et al. (2018) also used therapeutic exposure techniques, rewarding players for confronting fear events through exposure training. Fear events may be described as fearful obstacles

that the player must confront in order to progress through a game. In *MindLight*, for example, fear events are designed as obstacles that players must overcome to progress, such as shining their mindlight on an enemy to dispel it, thereby practicing controlled exposure to anxiety-inducing stimuli. During the study, players who confronted fear events were rewarded with items needed to solve puzzles later in the game. Exploration increased players' exposure to fear events, aiding them in learning how to control their behavioural responses to perceived threats.

Despite players completing multiple play-sessions, play-pattern differences amongst players (i.e., willingness to explore and confront fear events, not evade) meant that the number of opportunities to encounter and confront fear events varied greatly. This occurred when a player chose to hide in a chest or be inactive thus exhibiting avoidant/safety behaviours when confronted with a fear event, as displayed in Figure 2.

Results indicated that therapeutic exposure techniques used led to a reduction in avoidant and safety behaviours. Wols et al. (2018) found that in-game play behaviours representing therapeutic exposure techniques predicted reductions in anxiety symptoms at a 3-month follow-up. More broadly, the study reported that reductions in avoidant and safety behaviours (overall) were sustained for up to six months post-trial. These findings were in line with previous research on avoidant/safety behaviours during traditional therapy like CBT (Morgan and Raffle 1999; Salkovskis et al. 1999). However, it is important to note that children with higher anxiety levels would try to create more lights by turning on ceiling lights and hiding lights inside chests as a way to reduce and/or avoid exposure to fear events. From this, it could be assumed that exposure training may be most effective on children with low to moderate levels of anxiety.

Findings and Limitations of the *MindLight* Study

The study by Wols et al. (2018) explored the potential of *MindLight* to reduce avoidant and safety behaviours. Findings indicated that game mechanics, rather than repeated play, drove treatment success. This suggests that *MindLight* altered how players engaged with the game over time, creating opportunities for sustained anxiety reduction and real-world behavioural changes.

A key outcome was that no in-game behaviours measured during the first session correlated with behaviours in the final session, with one exception: higher levels of exploration early on were associated with fewer fear attempts later in the game. This demonstrates *MindLight's* ability to reshape engagement patterns. In-game behaviours refer to specific actions players take during gameplay that could be regarded as avoidant or safety behaviours. These actions include engaging with or avoiding challenges and reflect how players interact with the game mechanics and therapeutic techniques. The study served as a

foundational effort to identify game mechanics capable of addressing anxiety symptoms, with players showing reduced reliance on avoidant and safety behaviours after gameplay.

However, several limitations were highlighted. While *MindLight* features an attention bias modification mechanic, the in-game behaviours associated with it were not measured. The variability of player behaviours, heavily influenced by specific puzzles and player locations, made reliable comparisons difficult. Furthermore, the effectiveness of ABM itself remains contested in broader research. Studies such as Bar-Haim et al. (2011) have shown ABM's potential to reduce anxiety symptoms, whereas later studies such as Cristea et al. (2015) have refuted its efficacy. Future research could focus on whether *MindLight*'s puzzles successfully modify ABM before linking puzzle-solving behaviours to anxiety symptom reductions.

Another limitation of the study is *MindLight's* inactivity system. Player inactivity appears to be a representation of avoidant and safety behaviours because the player is either avoiding exposure to fear events or not engaging with the game's mechanics. *MindLight's* inactivity code is therefore not able to distinguish differences between active game avoidance or whether the player is just waiting for a research assistant to help them if they are stuck or in fear. Also, when "technical" issues that stop play arise (e.g., the player pauses the game) they are not classified as eliciting avoidant and safety behaviours. To address this issue, future research could endeavour to further classify these behaviours, enabling a clearer examination of their potential relationship with changes in anxiety symptomatology.

Additionally, the study did not examine potential mediators or moderators, such as player motivation or enjoyment, which are known to influence treatment outcomes. These factors, along with a broader, more diverse participant sample, should be considered in future research to better understand which players benefit most from video game-based interventions. Fernández-Aranda et al. (2012) also highlight that individual responses to video game interventions vary significantly, with some players experiencing heightened anxiety rather than symptom reduction. This underscores the importance of tailoring interventions to individual needs.

Despite these limitations, the Wols et al. (2018) study is one of very few longitudinal studies, with long-term follow-ups, in the field of applied video games (Girard et al., 2013; Granic et al., 2014). Its results contribute to the growing body of evidence supporting the use of applied video games in mental health treatment. Given the limited findings from the few existing longitudinal studies, it is clear that more research is needed. Future research could explore larger, more diverse populations to evaluate the long-term effectiveness of these interventions and examine their potential as supplementary tools for treating anxiety

disorders. Such studies may provide valuable insights into optimising game mechanics for sustained anxiety reduction while addressing broader mental health challenges.

Method: Heuristic Analysis

To advance this research framework, tools and methodologies that systematically evaluate the effects of video game-based interventions are essential. Heuristic analysis, grounded in usability principles, identifies potential user interaction issues (Nielsen, 1993) by assessing game elements against predefined heuristics. In this study, a priority (severity) matrix was incorporated into the heuristic evaluation to categorise and quantify issues based on their impact on reducing avoidant and safety behaviours in players (see Figure 3). This chart-based approach not only added structure to the evaluation but also helped prioritise areas for improvement. While heuristic analysis provides quick and adaptable solutions for various contexts, it can introduce biases and errors. To mitigate these limitations, other measurement systems could complement heuristic analysis, providing a more comprehensive understanding of specific player experiences.

Severity Rating	Description
None	There are no issues present.
Minor	Resolving this issue is not a central priority to better facilitate the reduction in avoidant and safety behaviours in players with ADs.
Major	The issue is obstructing the reduction of avoidant and safety behaviours in players with ADs.
Severe	The issue is a detriment to reducing avoidant and safety behaviours in players with ADs.

Figure 3. Priority matrix, based on Bromley (2017), evaluating the potential severity of challenges to reducing avoidant and safety behaviours in players with ADs.

For example, the Think Aloud protocol aims to "identify the cognitive processes responsible for a participant's behaviour" (Knoll, 2018, p. 190). However, using the Think Aloud protocol on people with ADs could elicit a cognitive overload as players are expected to play and verbally give feedback, only perpetuating anxiety symptoms further. ADs already disrupt cognitive performance, even before applying cognitively demanding testing methods like Think Aloud (Maloney et al., 2014). In the context of this article, this method could be used to identify areas for improvement such as behavioural changes of players with ADs.

Heuristics have proven to be significantly more effective than informal reviews in identifying problems, suggesting improvements, and highlighting successful aspects of existing game design to achieve specific player experiences (Desurvire & Wixon, 2018). Furthermore, heuristics are widely recommended for analysing commercial digital products, with their demonstrated effectiveness well-documented by Nielsen and Molich (1990) and Rodio et al. (2013).

The analysis applied a set of heuristics to a full playthrough of *Carbon Steel*, where I evaluated its potential to reduce avoidant and safety behaviours in players with ADs. This approach aimed to highlight where *Carbon Steel* aligned with or diverged from established therapeutic approaches, such as CBT, ABM, and exposure training. The heuristics used are abstracted from therapeutic design features in *MindLight*, which successfully integrate anxiety reduction mechanisms based on evidence-based techniques for anxiety treatment (see Figure 4 for the list of heuristics used).

Heuristic	Description	Contextualisation
H1	Fear events incentivise rewards, so players "engage" rather than "avoid" potential threats.	Fear events must be approached to progress, utilizing exposure techniques to reduce avoidant and safety behaviours. Engaging with fear events involves exploration, while avoidance includes fleeing (Wols et al., 2018).
H2	Puzzles divert player attention from negative stimuli.	Negative stimuli refer to in-game threats. ABM training retrains individuals to focus on positive stimuli instead of negative, reducing anxiety symptoms (Wols et al., 2018; Bar-Haim, 2010). Diversion may occur through distractions or mini-games (MacLeod, 2023).
H3	Rising game difficulty increases heart rate variability.	Game difficulty can gradually increase as players learn, motivating self-regulation. Pairing games with biofeedback helps reduce avoidance behaviours in therapy (Rice, 2022). Monitoring HRV, typically low in individuals with anxiety, shows how well games reduce avoidance (Held et al., 2021).
H4	Positive performance	Therapeutic games encourage exploration over avoidance (Barnes

	feedback aids improvement of self-regulating behaviours.	et al., 2018). Positive performance feedback motivates players to improve self-regulation and manage anxiety symptoms.
H5	Relaxation techniques are trained through neurofeedback.	Relaxation training, using neurofeedback, is incorporated in games like *MindLight*. EEG data guides players through relaxation, increasing in-game brightness as relaxation improves (Wols et al., 2018). Neurofeedback reinforces relaxation by providing real-time feedback, training players to manage anxiety.

Figure 4. List of heuristics used, their descriptions and contextualisation of clinical studies, and research to warrant investigation.

While *MindLight* and other therapeutic games such as *SPARX* (SPARX Ltd., 2014) are explicitly designed for mental health management, *Carbon Steel* offers an alternative approach through its fear events, puzzles, and horror atmosphere. By situating *Carbon Steel's* mechanics within this broader context, the analysis identified areas where its design elements could be enhanced. These recommendations served to provide game designers with the insight to make their games not only more effective at reducing anxiety but also usable as supplementary tools to AD interventions.

During playtesting, *Carbon Steel's* performance against the heuristics was assessed to determine how well each criterion had been met. Recommendations focused not only on improving *Carbon Steel's* alignment with therapeutic heuristics but also on drawn comparisons to designs from therapeutic games like *MindLight*. These insights guided how *Carbon Steel* could be refined to more effectively support anxiety reduction while maintaining its core identity as a horror game.

Findings

The puzzle horror game *Carbon Steel* meets several heuristics. Despite this, there are still significant gaps in addressing avoidant and safety behaviours in players with ADs. A significant concern is the imbalance in dynamic game difficulty (H3), impacting potential improvements in Heart Rate Variability (HRV) for players with ADs. While H5 poses a severe issue, implementing suggested changes may not be financially feasible (see Figure 3 for severity matrix). Despite partial adherence to H1 and H2, *Carbon Steel* could benefit from further development to better support the reduction of avoidant and safety behaviours in players with ADs. See Figure 5 for a summary of the findings from analysis.

Heuristic	Notes	Severity Rating
H1 Fear events incentivise rewards, so players "engage" rather than "avoid" potential threats	*Carbon Steel* starts by reducing immediate threats, allowing players to face fear events without overwhelming them (e.g., creatures in cages). Dream sequences foreshadow upcoming fear, creating curiosity. Timed challenges (like making anaesthesia) force players to engage with fear mechanics rather than avoid them. However, no explicit rewards are given, which reduces long-term engagement with these fear events.	Minor
H2 Puzzles divert player attention from negative stimuli	Hints in computer logs direct focus away from threats and toward puzzle-solving. The repetition of puzzles over in-game days creates a safe routine, reducing anxiety. However, current puzzles are too simple and predictable, limiting sustained engagement with positive stimuli.	Minor
H3 Rising game difficulty increases heart rate variability	The final day introduces a significant spike in difficulty, potentially causing avoidance behaviours in players with anxiety. Predictable early puzzles create pre-emptive fear, discouraging players from completing the final, more difficult puzzles. The lack of positive performance feedback contributes to this issue.	Severe
H4 Positive performance feedback aids improvement of self-regulating behaviours	*Carbon Steel* lacks performance feedback, with no recognition of player success across its three endings. This omission discourages engagement, particularly for players with anxiety disorders who may benefit from reinforcement. Without rewards for engaging with fear events, the game's difficulty may dissuade players from continuing.	Moderate
H5 Relaxation techniques are	*Carbon Steel* does not include relaxation training, and implementing neurofeedback may be impractical and unsuitable for an indie game. Simpler alternatives,	Severe

trained through neurofeedback	like microphone-based relaxation mechanics, could allow players to manage in-game stress through verbal input, enhancing the horror atmosphere without high development costs.	

Figure 5. Heuristic analysis summary of *Carbon Steel*.

Comparing *Carbon Steel'*s mechanics with those of *MindLight*, a game explicitly designed to address anxiety behaviours, highlights several potential opportunities for enhancement. In *MindLight*, fear events are structured to encourage players to confront anxiety-inducing stimuli by offering rewards and progression. Players who tackle challenges are rewarded with tools that help them advance, which incentivizes engagement over avoidance. In contrast, *Carbon Steel* relies solely on intrinsic motivation for progression and does not offer rewards beyond this for facing fear-inducing events (H1). The lack of external incentives may discourage players with ADs from engaging with challenges. As Flanagan (2009) emphasizes, critical play does not necessarily require external rewards but can embed meaning into the gameplay itself. As a result, H1 is not met and may lack the potential to reduce avoidant and safety behaviours due to *Carbon Steel*'s intentional narrative design of punishing players, even when they successfully complete tasks required for progression.

Furthermore, *MindLight* uses puzzles to retrain players' focus from negative to positive stimuli (H2). By focusing on tasks like identifying happy faces, players shift attention away from fear triggers. While *Carbon Steel* uses puzzles to divert attention from the threat of the creature's escape, they are often too simple and predictable, limiting their ability to sustain attention and reduce anxiety. Therefore, H2 is noted as having a minor impact on the ability to reduce avoidant and safety behaviours as hints in computer logs direct focus away from threats and toward puzzle-solving. The repetition of puzzles over in-game days creates a safe routine, reducing anxiety. However, current puzzles are too simple and predictable, limiting sustained engagement with positive stimuli.

Positive feedback also plays a critical role in anxiety management and self-regulation (H4). In *MindLight,* players receive rewards for confronting anxiety-inducing situations, which helps build resilience. However, *Carbon Steel* lacks this feedback. Players receive no rewards or recognition for progress, missing an opportunity to reinforce positive behaviours. Sicart (2014) argues that play is an ethical activity, and feedback should be integrated to help players feel that their in-game actions matter not just to the game, but also to their personal growth. Consequently, H4 is not met in any capacity. Considering *Carbon Steel*'s classification as a horror game, the probability of players receiving positive performance feedback is notably diminished. Despite players'

attempts to extract information and survive, the game concludes with three endings, none of which allow the player to escape. The consistently formal in-game dialogue offers no acknowledgment of player success.

Lastly, *MindLight* incorporates neurofeedback to help players manage anxiety by training relaxation techniques (H5). As a result, H5 is not met and could pose a large threat to reducing avoidant and safety behaviours. While *Carbon Steel* does not provide direct feedback on player stress or anxiety levels, there are alternative, lower-cost methods to encourage relaxation. One suggestion is to reward players for demonstrating calm behaviours during tense moments, such as staying composed during a fear event.

Discussion

Despite its challenges, *Carbon Steel* presents a unique opportunity to supplement AD treatment. It demonstrates how ordinary horror games can be adapted to incorporate features aligned with therapeutic practices. By subtly integrating these elements, *Carbon Steel* could maintain its appeal as an engaging horror game while providing supplementary benefits for players with ADs. Adapting familiar, well-received video games like *Carbon Steel* may offer a more accessible and engaging alternative to traditional therapeutic games, enabling players to experience anxiety reduction in a familiar context.

To explore this potential, one suggestion to better train higher HRV in players with ADs would be to incorporate dynamic game difficulty. Drawing from Sicart's (2014) concept of play as a moral and emotional practice in *Play Matters*, exploring ways to increase game difficulty based on the player's ability may better support resilience against challenges and maintain player motivation. Sicart (2014) emphasizes that play should allow room for failure, reflection, and growth, turning the challenge into an opportunity for personal development, which in turn could help players engage more deeply and authentically with the game's demands. Exploring the use of dynamic difficulty adjustment could improve autonomic regulation, as players might achieve a state of flow when the challenge level matches their skills, potentially enhancing HRV and reducing stress levels. Adopting this approach in *Carbon Steel* could increase engagement for players with ADs, helping them persevere rather than avoid being overwhelmed by difficulty spikes (H3).

Regarding H1, *Carbon Steel* could explore tools or rewards not as simple motivators but as symbolic markers of progress that reflect the player's growing ability to manage stress or fear. Introducing rewards, such as puzzle-solving tools, could encourage players to engage with fear events and reduce avoidance.

According to Sicart, puzzles should engage players intellectually and emotionally, transforming the act of solving into a process of emotional learning (Sicart, 2014). Furthermore, exploring ways to increase the complexity and unpredictability of puzzles in *Carbon Steel* might better engage players in problem-solving, mirroring *MindLight*'s approach to reducing anxiety through engagement (H2).

A recommendation for implementing positive performance feedback (H4) involves incentivizing players who demonstrate reduced avoidance and safety behaviours, simulating enhanced self-regulation in the face of fear or challenge. Offering visual cues, such as a tick when a task is finished, would motivate players to continue engaging with anxiety-inducing scenarios. Flanagan (2009) notes that feedback can serve as a tool for reflecting on one's actions within the context of a game's message. In this case, feedback in *Carbon Steel* could act as an ironic tool, reinforcing player agency while maintaining the game's horror narrative. It is crucial to balance the feedback with the narrative, ensuring that players are not punished with an overtly negative ending despite exhibiting improved self-regulatory behaviours or perfect game performance, as this could discourage further engagement, unless this is deemed a pivotal thematic choice for *Carbon Steel*.

Additionally, *Carbon Steel* could embed critical play by offering subtle acknowledgments of player choices throughout the game, even if the endings remain bleak. Flanagan (2009) suggests that subversive play can come through the structure of endings themselves. Incorporating subtle feedback mechanisms could reinforce player engagement and reduce avoidant behaviours without conflicting with the game's dark tone.

Lastly, pertaining to H5, microphone-based interactions could allow players to experiment with voice input, connecting relaxation with in-game outcomes. Players could receive positive reinforcement in-game for verbalizing words associated with relaxation, creating a simpler, cost-effective biofeedback mechanism.

While these recommendations may initially seem to conflict with the inquiry into whether ordinary horror games can achieve similar reductions in AD behaviours as games designed with evidence-based strategies, they serve a different purpose. These adjustments do not intend to turn *Carbon Steel* into a therapeutic game but rather explore how critical play, a concept introduced by Flanagan (2009), can offer subtle, non-invasive design changes that support therapeutic outcomes while preserving the game's horror identity. Flanagan (2009) states that critical play encourages designers to question conventional game mechanics and narratives to subvert expectations. By doing so, *Carbon Steel* can retain its horror identity while subtly engaging in therapeutic practices. This bridges the gap between traditional game design and

therapeutic applications, offering insights for developers without fundamentally altering the nature of the game.

Conclusion

The purpose of this article was to explore how ordinary horror games like *Carbon Steel* can be enhanced to supplement AD treatment by incorporating therapeutic features found in games like *MindLight* and *SPARX*. By evaluating the potential of ordinary horror games to reduce avoidant and safety behaviours in players with ADs, this article bridges the gap between serious, therapeutic games and the casual games we play for fun. The findings suggest that adapting familiar games could offer a more accessible and engaging alternative to traditional therapeutic games, allowing players to experience anxiety reduction within a familiar context.

Although research on commercial off-the-shelf video games and their ability to reduce stress and anxiety is emerging, current studies suggest that various game genres—such as action, puzzle, and augmented reality—can have therapeutic benefits. These studies have shown that even short or single sessions of gameplay can help reduce anxiety symptoms. However, while these initial findings are promising, there remains a significant gap in understanding how to systematically adapt ordinary horror games for long-term therapeutic use, especially when compared to therapeutic games like *MindLight*. This article emphasizes the need for more empirical studies to explore their therapeutic potential in depth and across various anxiety profiles and age groups.

Ordinary horror games like *Carbon Steel* provide an opportunity to build a bridge between familiarity and therapy. Through subtle, non-invasive design changes, ordinary horror games could integrate therapeutic elements that reduce anxiety without losing their entertainment appeal. This approach could offer both leisure and treatment benefits, providing a more natural and engaging experience for players with ADs, especially those who may not engage with traditional therapeutic games due to their explicit clinical focus.

The heuristic analysis of *Carbon Steel* shows that there are still significant gaps in addressing avoidant and safety behaviours in players with ADs. While some heuristics were met, the game lacks the depth of therapeutic mechanics seen in games like *MindLight* or *SPARX*. Future developments could focus on refining game mechanics to better meet the needs of players with ADs, such as the implementation of positive feedback and exposure techniques. Moreover, the inclusion of more complex puzzles and dynamic difficulty adjustments could further engage players, helping them persevere through anxiety-inducing moments rather than disengage. These changes would allow games like *Carbon Steel* to better train players in anxiety management strategies while preserving their horror identity.

It is important to acknowledge the limitations of the research presented in this article. Heuristic analysis, while useful, is inherently subjective, and further empirical studies are necessary to build on the findings discussed here. Future research could focus on long-term studies that examine how ordinary horror games, when adapted with therapeutic features, impact anxiety symptomatology over time. Additionally, collaborative efforts between game developers, mental health professionals, and researchers could prove valuable in creating games that are not only engaging but also meet the therapeutic needs of individuals with ADs.

In conclusion, *Carbon Steel*, though not fully meeting all therapeutic heuristics, shows promise in addressing anxiety. Exploring how therapeutic elements could complement familiar ordinary games may provide valuable insights into creating more accessible and engaging treatments. This approach could enhance the reach and effectiveness of anxiety management strategies. *Carbon Steel* exemplifies the potential for ordinary horror games to contribute meaningfully to mental health interventions, offering a bridge between traditional entertainment and therapeutic gaming.

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