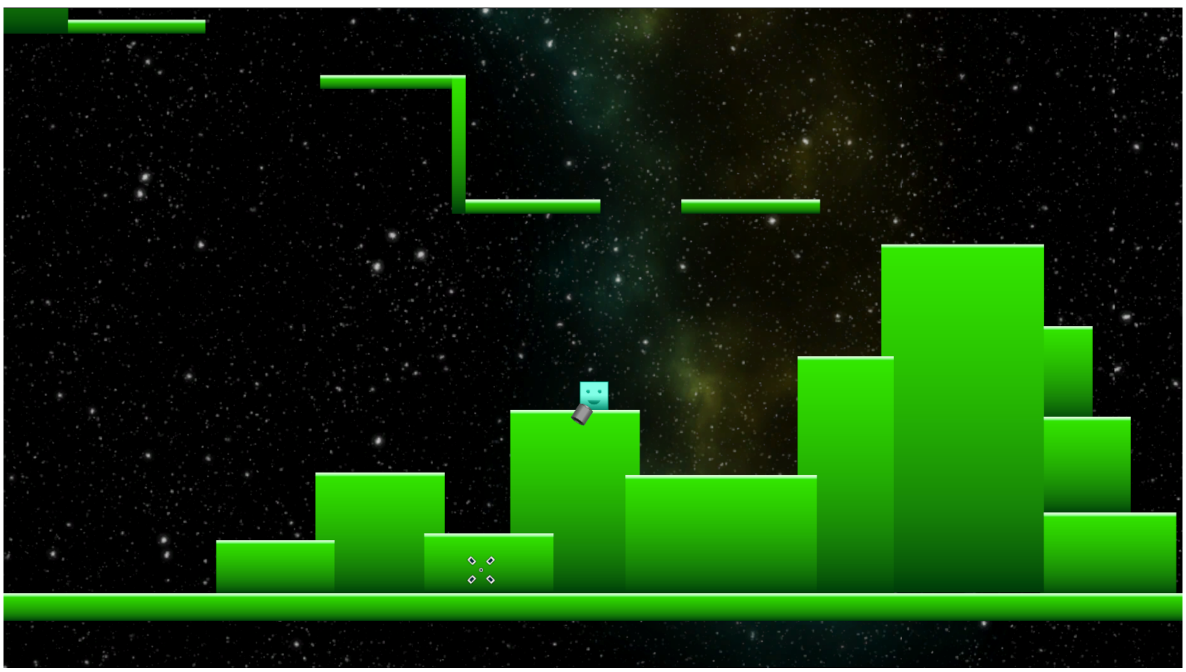
Utrecht University

Department of Information and Computing Sciences

Game and Media Technology Master Thesis

An Embedded Guided Breathing Intervention for Regulating Competence-Related Frustration in Games



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July 3, 2026

Abstract

Video games can elicit strong emotional responses, especially when players repeatedly fail, lose progress, or struggle to overcome challenging gameplay situations. While such experiences can be part of what makes games engaging, they can also give rise to competence-related frustration. Players may not always have effective means to regulate this frustration during play, particularly in fast-paced or performance-driven contexts. This study investigated whether a brief, guided breathing intervention embedded directly into gameplay could support the regulation of competence-related frustration.

To examine this, a custom single-player platformer, *Master Blaster*, was developed. The game was designed around challenging traversal, repeated setbacks, and loss of progress, creating situations in which competence-related frustration could naturally arise. A dynamic triggering system monitored gameplay events and activated the intervention at moments of substantial progress loss. Participants were assigned to either a breathing condition, in which they completed two guided cycles of cyclic sighing, or a control condition, in which they continued gameplay for an equivalent duration. The final sample consisted of $N = 54$ participants. The effects of the intervention were evaluated using measures of need satisfaction and frustration, momentary frustration, affective state, player experience, and gameplay performance.

The results showed that frustration increased substantially over the course of the gameplay session, suggesting that the game successfully elicited the target emotional state. Around the intervention moments, frustration decreased in both groups, but this decrease was significantly larger for participants in the breathing condition. However, this effect was limited to the short-term interval surrounding the intervention moments. No significant difference in momentary frustration was found between groups across the overall gameplay session or after gameplay had concluded. The intervention also did not lead to significant differences in competence or autonomy satisfaction and frustration, affective state, player experience, or gameplay performance. These findings suggest that brief, guided breathing can help reduce momentary frustration following challenging gameplay events, but that this short-term reduction does not necessarily persist or translate into broader changes in player experience or performance. The study contributes an initial exploration of embedded breathing-based emotion regulation support in games, as well as a dynamic gameplay-based approach for identifying suitable moments for intervention.

Contents

1 Introduction

Video games have grown into a globally widespread and mainstream form of interactive entertainment, with over three billion active players worldwide and continued annual growth in both player numbers and industry scale [29, 4]. Their interactive nature makes them capable of eliciting dynamic and emotionally intense experiences [15]. During play, players continuously encounter challenges, evaluate outcomes, and respond to successes and failures. These emotionally salient moments can influence not only in-game performance, but also players' affective state and post-play well-being [74, 13].

One reason games are engaging is their capacity to satisfy basic psychological needs [79]. According to Self-Determination Theory (SDT), the satisfaction of the needs for autonomy, competence, and relatedness supports intrinsic motivation and well-being [80]. In gaming contexts, competence, defined as the need to feel effective and capable of mastering challenges, plays a particularly important role [74, 13]. When players successfully overcome challenges and experience progress that is attributable to their own actions, this can foster feelings of mastery and enjoyment [74].

However, gameplay does not always satisfy these needs. SDT distinguishes between need satisfaction and need frustration: whereas satisfaction supports well-being, need frustration refers to experiences of failure, ineffectiveness, or being thwarted in one's goals [13]. In games, competence need frustration may arise when players repeatedly fail, encounter setbacks that violate expectations, or perceive situations as unfair [13]. Such experiences have been observed across different gaming contexts, including competitive multiplayer environments and challenging single-player games [13, 16].

Importantly, competence need frustration is not only associated with reduced enjoyment. Experimental research has shown that impediments to felt competence during gameplay can lead to short-term increases in aggressive affect, aggressive cognition, and aggressive behavior [74]. In competitive settings, players often describe entering a state of "tilt," in which frustration escalates and performance deteriorates further [98]. Once such a state is reached, it can become difficult to regain composure, potentially reinforcing a cycle of frustration and emotional dysregulation [16].

The challenge, therefore, is not that games elicit strong emotions, as this is central to their appeal, but that players may lack effective means to regulate competence-related frustration at the moment it occurs. While players report using a range of coping strategies during play, including problem-focused, emotion-focused, and avoidance-based approaches, avoidance strategies such as disengagement appear to be frequently used despite being perceived as suboptimal [16]. Fast-paced and performance-driven contexts may limit players' ability to deliberately select and implement cognitively demanding regulation strategies, making in-the-moment support particularly relevant.

At the same time, advances in digital emotion regulation technologies demonstrate that interactive systems can scaffold regulation processes [83]. However, many existing approaches emphasize offline training, reflection, or biofeedback-based systems. Less is known about how brief, explicitly guided interventions can be embedded directly into gameplay to support regulation during emotionally salient moments.

Controlled breathing represents a promising candidate for such in-context support. Slow, structured breathing practices have been shown to reduce stress and anxiety and to improve affective state, even when delivered remotely and in brief sessions [41]. Exhale-focused techniques such as cyclic sighing have demonstrated particularly strong effects on positive affect and reductions in state anxiety [11]. Because breathing directly targets physiological arousal and requires limited cognitive resources, it may be suitable for integration into interactive environments.

This study investigated whether a brief, guided breathing intervention embedded directly into gameplay could support the regulation of competence-related frustration. To this end, a single-player game was developed that incorporated challenging gameplay situations and progression losses intended to elicit competence-related frustration while maintaining player engagement. A dynamic intervention system monitored gameplay events and triggered short breathing interventions at moments of substantial progress loss. The effects of this intervention were evaluated by examining differences between conditions in competence-related frustration, momentary frustration, affective state, player experience, and gameplay performance.

The main contributions of this study are:

1. The design and evaluation of an embedded breathing-based intervention for supporting the regulation of competence-related frustration during gameplay;

2. Empirical insight into the effects of brief, guided breathing interventions on competence-related frustration, affective state, player experience, and gameplay performance; and
3. Exploration of a dynamic, gameplay-based approach for identifying suitable moments to provide emotion regulation support without relying on additional physiological sensors.

2 Background and Related Work

This section reviews relevant prior work. We first discuss literature on the satisfaction and frustration of basic psychological needs in video games and the link between competence need frustration and aggression. This is followed by research on the design of technical emotion regulation interventions. The section then considers breathwork as an emotion regulation technique and finally, examines the coping strategies esports players use to regulate their emotions.

2.1 Need Frustration in Video Games

Games often include elements of challenge, difficulty, and risk of failure [35]. While these elements are part of what makes games engaging, they can also bring about moments of frustration, especially if failure remains unresolved [35]. This may not only diminish the gameplay experience, but can also have various negative effects on the player. Need frustration in particular has been associated with escapist motivations [45, 51], problematic gaming [51], and stress [51]. Moreover, it has been proposed as a potential precursor of toxic behavior [49, 50, 89, 100, 104].

According to a qualitative study by Ballou and Deterding [13], need frustration occurs when the player's needs are not met in game, and this is not in line with their expectations. The remainder of this section discusses the concept of game-related need frustration, its underlying causes, and its effects.

The concept of need frustration is built upon Self-Determination Theory (SDT). While the theory is a broad framework spanning six sub-theories, HCI work has mainly focused on its three basic psychological needs, put forward as key determinants of intrinsic motivation and well-being: autonomy, competence, and relatedness. Autonomy is the need to feel a sense of control and choice in one's actions. Competence refers to the need to feel effective, capable, and able to master challenges. Relatedness is the need to feel a sense of connection and belonging [80]. The satisfaction of these basic needs can be a strong predictor of enjoyment of both interactive and non-interactive media [87]. It is also linked with greater intrinsic motivation and engagement across game genres [3, 89, 69, 87], alongside various positive well-being effects [1, 88, 92]. Need frustration in games specifically may also be associated with aggression [74] and dysregulated gaming [5, 51].

Importantly, need frustration is not simply the absence of need satisfaction. Rather, it is considered a separate concept, with evidence suggesting the two can even coexist to varying degrees [5, 91]. Need frustration refers to experiences in which autonomy, competence, or relatedness are actively undermined, such as feeling pressured or restricted, feeling ineffective or doubtful about one's abilities, or feeling isolated or excluded from others.

According to Ballou and Deterding [13], players bring expectations to a game about the extent to which play will support autonomy, competence, and relatedness. Based on these expectations, players make decisions regarding their play behavior. Need frustration then occurs when a need-thwarting situation arises that is more significant or intense than expected. Over time, these experiences update players' expectations. These new expectations result in changes in play behavior aimed at reducing exposure to need frustration, such as rushing through a particular section, taking breaks, or quitting the game altogether. However, such frustration-reducing adaptations can be inhibited by extrinsic motivations, such as social pressure to continue playing [13].

We will now discuss the different types of gaming-induced need frustration in more detail, starting with autonomy frustration. This refers to feelings of being controlled or coerced [80]. It is further divided into three categories of situations that may give rise to this particular type of need frustration. The first and most common situation is one in which the desired playstyle of the player is constrained. This may occur when they are unable to play a particular character, use certain equipment or abilities, or take preferred in-game decisions. It can be caused by other players, such as when their preferred role is already taken by someone else, or by the game itself, such as when a game forces them to sit through an unskippable storytelling segment that does not interest them. Another form of autonomy frustration occurs when the players' ability to play is constrained. This may be due to constraints on their schedule, hardware availability, finances, or similar circumstances, preventing them from playing a particular game or playing when they want to. Finally, players can face autonomy frustration when they feel compelled to play. This can be caused by social pressures to continue playing or by punishment systems the game has in place for leaving early, such as in competitive multiplayer games like *Counter-Strike 2* [13].

The second form of need frustration observed in video games, and the form that the intervention presented in this study primarily aims to regulate, is competence frustration. Competence frustration relates to feelings of failure and self-doubt and is also divided into three categories. First, stagnation can occur when players are unable to carry out a desired or necessary action, thereby blocking their progression. This often comes with the underlying expectation that progress should be possible in that particular scenario.

Unfair situations can also be the cause of competence frustration. These are situations where players feel like winning or losing is not an expression of their skill, due to external forces that make attaining a particular goal practically impossible. This violates their expectations of being given equal or sufficient means. Examples include playing against significantly stronger opponents, facing an AI opponent with unreasonably strong buffs, or being placed in a team with weaker teammates. In such cases, feelings of frustration are often directed outward, toward other players, the situation they have been dealt, or the game as a whole.

Finally, competence frustration may be the result of in-game actions or choices that are perceived as meaningless. The players' decisions then do not have the expected scale of impact, or, in some cases, no impact at all [13].

The last type of need frustration is relatedness frustration. This refers to feelings of loneliness or exclusion. Within the context of gaming, it comes in three forms. The first occurs when players feel disconnected from other players. This can be because of a disagreement, a skill mismatch, or as a result of in-game harassment. Second are situations in which players feel disconnected from the community at large. An example of this is when there are certain closed groups within the community, such as a set of players with a particularly high rank. The final case is when players feel disconnected from the game's characters or the game world, making them feel alienated, uninterested, or disappointed [13].

Besides acknowledging these three types of need frustration within the gaming community, as well as identifying the underlying categories that give rise to them, Ballou and Deterding [13] also highlight the importance of expectations within their theoretical framework. Expectations are a crucial factor in two ways.

First, players' expectations serve as a point of reference for the extent to which need frustration is experienced as disruptive or annoying. As a result, need frustration often becomes salient only when the play experience violates or negatively deviates from players' expectations, rather than inherently producing negative effects. For example, some players may not anticipate unforgiving game mechanics, such as permanently losing all items upon death. Expectations are often shaped by prior experiences, either through playing other games or through earlier encounters within the same game. When need-frustrating situations are correctly anticipated, expectations can reduce the salience of felt frustration and mitigate its impact on subsequent play behavior [13].

The second way in which expectations are important is that they play a key role in shaping future gaming behavior. A need-frustrating experience does not necessarily lead players to change their behavior right away. Instead, repeated experiences of need frustration shift their expectations for the enjoyment of the game over time. These updated expectations then shape their decision making about future gaming behavior. If the anticipated need frustration outweighs the anticipated enjoyment, players may choose to engage less or play differently. Such behavioral shifts can happen from session to session, but also within a single session, especially for competence frustration [13].

In sum, expectations shape both need frustration and subsequent behavior: experienced frustration emerges when the actual play situation falls short of expectations, while expectations also guide player behavior beyond immediate emotional responses [13].

In response to current and expected future need-frustrating experiences, players might adjust their behavior to reduce or eliminate exposure to such experiences in four different ways. The first is to reduce the emotional intensity of play. For example, this can be done by rushing through a segment that is frustrating them, paying little attention to the situation at hand. Second, players may change their in-game behavior to reduce the prevalence or salience of such events. They might circumvent specific challenges or use exploits to overcome them, move to a different in-game location, or interact with other players in a different way. The third option is for players to disengage from the game to some extent. This can mean taking a break from the game or preferring to play a different game instead. The final way players may alter their behavior to eliminate exposure to particular need-frustrating situations is by simply quitting the game entirely [13].

However, repeated need frustration does not necessarily mean the player will quit playing the game forever. Many players persist regardless, due to pressures or anticipated rewards external to the need-frustrating gameplay that outweigh the anticipated undesirable frustration. There are three such categories of external motivation to keep playing. The first is the desire to see beyond the obstacle in front of them. The game might feature appealing characters, an interesting story, or a beautiful visual design. These positive expectations for future portions of the game can all serve as incentives to push through a frustrating situation. Second, the player might identify as a fan of the game series or the developing team. This can lead to a felt obligation to that identity, where the player must fulfill their duty as a fan and at least finish the game. Lastly, players can be externally motivated by in-game rewards and achievements. Besides these categories, there can be other externally motivating forces at play, but the key takeaway here is that need frustration does not singularly determine play behavior. Rather, play behavior results from a conscious or unconscious weighing of actual current and expected future consequences [13].

In sum, need frustration appears to be a recurring experience that can influence both player experience and behavior. Based on their qualitative analysis, Ballou and Deterding [13] show that, within gaming contexts, autonomy, competence, and relatedness need frustration can be understood as distinct constructs, and that need frustration is analytically separate from need satisfaction. Their findings further suggest that need frustration is an important factor in the selection of games and in-game activities. From a game design perspective, this implies that avoiding need-frustrating situations may be at least as important as affording need-satisfying ones.

For the purposes of the present study, this theoretical framework informed the design of a game in which competence-related frustration could naturally arise. In particular, the game was designed around challenging traversal, repeated setbacks, and the potential loss of progress following mistakes. These elements can impede the player's sense of competence, while still allowing failure to be attributed to the player's own actions rather than to unfair or unpredictable game behavior.

In addition, Ballou and Deterding [13] highlight the role of expectations in shaping player experience. Their analysis suggests that the appraisal of situations involves comparing actual outcomes with expected ones, and that the salience of experienced frustration arises from discrepancies between the two. This insight was relevant to the design of the present study. Rather than deliberately shaping expectations to make the game appear easier than it was, care was taken to provide only limited information about the game's difficulty beforehand. This allowed participants to form expectations more naturally, while limiting the extent to which the experimental instructions themselves influenced the experience of frustration. Despite the potential importance of expectations for user frustration and related experiential processes, this topic has so far received relatively limited attention within HCI research [13].

Finally, Ballou and Deterding note that other forms of frustration may also occur in games. While some of these are captured by the need frustration model, many specific need-frustrating situations do not fully overlap with other conceptualizations of frustration. In particular, need frustration was near-universally experienced as negative, whereas perceiving one's goal-directed action to be impeded without feeling controlled, ineffective, or excluded may set apart the positive, motivating experiences of frustration [35, 70].

2.2 Competence Need Frustration and Aggression

To motivate the focus on competence frustration as an emotional trigger within gameplay, this section reviews the work of Przybylski et al. [74], who examined how interaction-related competence frustration in games predicts short-term shifts in aggressive feelings, accessibility of aggressive thoughts, and aggressive behaviors.

At the time of publication, gaming-related aggression was a hotly debated topic. The results from earlier work in this field varied. Some studies reported consistent links between some forms of gaming and measures of aggression [6], whereas others found unreliable or inconsequential links [30]. The aim of Przybylski et al. [74] was to empirically explore gaming-related aggression through the motivational lens of Self-Determination Theory (SDT) [80]. More specifically, they systematically investigated psychological need thwarting in gaming as a possible source of aggressive feelings, thoughts, and behaviors.

SDT researchers have posited that frustration of the three basic psychological needs can lead to aggression. Initial studies demonstrated higher implicit aggressiveness among children whose need for autonomy was impeded [78]. More recent work has indicated that need-thwarting classroom environments are more likely to foster bullying and interpersonal aggression [77]. Further research has shown that the salience of autonomy-blocking leads to increased accessibility of aggressive thoughts, which, in turn, results in a greater appreciation for hostile forms of humor [97]. In addition, need-thwarting motivation has been linked to aggressive driving and road rage [66], and situations that undermine the need for relatedness have been shown to increase interpersonal aggression [96]. These studies provide preliminary support for the assertion that psychological need thwarting can lead to aggressiveness. However, at the time of publication, competence need frustration had not been explored as extensively. To address this gap in the literature, Przybylski et al. [74] leveraged the interactive nature of video games to conduct their research.

Unlike many other pursuits in life, most people are not motivated to play video games for the sake of extrinsic rewards. Rather, they are intrinsically motivated to engage in play because of the potential need satisfaction gaming offers [79]. In particular, many video games provide ample opportunities for competence need satisfaction due to their carefully graded challenges and detailed, unambiguous performance feedback. Similarly, the opportunity for exploration and high-action gameplay can support the need for autonomy. Finally, the affordance of communication channels and group challenges emphasizing collaboration and competition can satisfy the need for relatedness. As discussed previously, in-game satisfaction of these basic needs can predict preferences for specific games and game enjoyment, along with general well-being.

In previous work, Ryan et al. [79] investigated the motivational aspects of violent games in particular. It was often assumed that the violent nature of some games made them inherently more motivating or immersive, but this was not in line with what they observed in their research. Instead, they highlighted the extent to which such games satisfied the player's basic needs, particularly competence and autonomy, and how this accounted for their appeal independent of the particular content or genre.

As discussed, the frustration of basic psychological needs for autonomy and relatedness had been shown to result in increased feelings of aggression. However, the effects of competence need deprivation had not yet been explored as extensively from an SDT perspective. Video game play provides a useful context for studying the effects of need-thwarting experiences in this regard, as human competence is a central part of what makes games appealing as interactive experiences [79].

One component that plays a significant role in the player's overall sense of competence is their *mastery-of-controls* [79]. This refers to the learned ability to effortlessly use a game's control interface to carry out actions in virtual environments. In their experiments, Przybylski et al. [74] manipulated players' mastery-of-controls in several ways. They then investigated the effects on players' felt competence, enjoyment, and level of aggression. The following paragraphs highlight several findings from the experiments conducted by the authors.

In their first experiment, participants played one of two games. The first game was a first-person shooter with relatively complex controls, while the second was a two-dimensional platform game with far simpler controls. Notably, the game with the more complex controls featured violent content, while the simpler game did not. Both before and after play, participants' level of aggression was measured using a 7-point Likert scale. Mastery-of-controls was measured in a similar manner after play. The results showed that players who felt less competent reported increased feelings of aggression, regardless of whether the game contained violent content. This implied that struggling with feelings of incompetence at the game interface was related to increased levels of aggressive affect [74].

This result was replicated in a more refined version of the experiment. Here, a violent and nonviolent version of the same game were used. This manipulation was verified by also measuring players' perceived level of threat after play. The other measurements remained the same. This study again showed that participants who reported less mastery of the game interface also reported increased levels of aggressive feelings, regardless of violence level [74].

In the third and fourth experiments, a nonviolent gaming context was used. This time, two versions of a puzzle game with varying control interfaces were played, one of which was intended to be significantly less intuitive to the players. The studies used different techniques to measure participants' levels of aggression, and the second study directly measured players' felt competence at the game. Despite these differences, the results were similar. Participants who reported lower mastery-of-controls showed greater accessibility of aggressive thoughts, and those who felt less competent at the game reported more aggressive feelings. These studies also showed that the influence of both interface complexity and mastery-of-controls on short-term shifts in aggressive feelings and player enjoyment was mediated by players' overall level of competence need satisfaction. This means that the complexity of the controls and players' mastery of them only affected aggression and enjoyment to the extent that they influenced players' overall sense of competence [74].

The fifth and sixth studies examined additional mechanisms through which games might influence player competence. The fifth study did so by allowing one group of participants to practice the game for 10 minutes beforehand. As in one of the previous experiments, the authors also used a violent and nonviolent version of the same game, although this is less relevant for the purposes of the present study. Both versions of the game were relatively complex, giving the players who were able to practice an advantage. After the practice phase, during which the other group played a different game, a regular play session of 10 minutes began for both groups. Afterwards, players were able to choose between continuing to play the game for another 10 minutes or freely browsing the internet for the same duration. This was used as a measure of player motivation. In addition, similar measures as before were used to assess aggression, mastery-of-controls, and competence. The results showed that participants who were given time to practice, and therefore had more experience with the game, were able to master the controls better. As a result, they experienced a greater sense of competence. In turn, this level of felt competence influenced participants' feelings of aggression and their motivation to continue playing the game [74].

The sixth experiment influenced player competence by adjusting the game's difficulty. For this, the authors used two versions of *Tetris*, one of which used a block selection algorithm intended to be overly challenging. In a pilot study, it was found that this manipulation of game structure succeeded in influencing players' felt competence need satisfaction, with those playing with the standard algorithm reporting higher levels of competence compared to those using the modified algorithm. Besides measuring players' aggressive feelings before and after play, the experimenters used another method to gauge participants' level of aggression. Before play, participants were asked to perform a behavioral aggression task. During this task, they had to place their hand in a bath of chilled water. They were told that the length of time they had to hold their hand in the chilled water had been selected for them by the preceding participant. In reality, this time period was fixed at 25 seconds for all participants. After play, participants were then asked a simple question: "Based on your experience in the experiment thus far, how long do you believe the next participant should be instructed to put his or her hand in the chilled water?" The results were in line with the authors' hypothesis: participants who played the overly difficult version of the puzzle game not only reported more aggressive feelings, but also showed more aggressive behavior. They tended to assign subsequent participants to nearly four seconds more of the chilled water task than they had experienced themselves, whereas participants who played the regular version of the game assigned nearly three seconds less physical pain than they had endured [74].

The seventh and final experiment was conducted to evaluate the generalizability of the competence-impedance hypothesis across everyday gaming contexts. This was done by interviewing over 300 regular video game players to examine the extent to which their experiences of competence need satisfaction or frustration related to aggressive feelings after play, as well as their game enjoyment. Participants were asked to reflect on their past four weeks of play in their three most played games. They also reported competence, enjoyment, and aggressive feelings after play for these games using 5-point scales. The results indicated that competence was negatively associated with aggressive feelings and positively related to enjoyment. Furthermore, aggressive feelings were negatively related to enjoyment. These findings correspond with the findings from the experimental setups, suggesting generalizability across everyday gaming contexts [74].

In sum, Przybylski et al. [74] used varying games, interface complexities, levels of experience, and underlying algorithms to influence players' felt competence. They found that lower felt competence was related to short-term shifts in aggressive feelings, accessibility of aggressive thoughts, aggressive behavior, and aggressive feelings after play. During this, they controlled for baseline levels of aggression and evaluated links between competence and aggression under conditions where violent game content was experimentally manipulated, absent, and varied by player preference. Overall, the results show consistent support for their need-thwarting hypothesis. They indicate that impediments to player competence satisfaction can increase cognitive, affective, and behavioral aspects of aggression, and that these effects were independent of violent game content [74].

Thus, competence need frustration is not only common in games [13], but may also be directed externally and associated with cognitive, affective, and behavioral indicators of aggression [74]. These findings suggest that competence-thwarting gameplay experiences can trigger escalating patterns of negative cognitive and affective responses. Although the present study does not directly measure aggression, this work motivates the focus on competence-related frustration as an emotional state worth regulating during gameplay. Intervening at moments of heightened frustration may therefore be particularly valuable, as it could help reduce short-term emotional escalation before it develops into more maladaptive responses.

However, little is known about whether brief, embedded emotion regulation interventions can effectively mitigate competence-related frustration in real time during gameplay. In particular, the extent to which such interventions influence not only momentary frustration, but also players' affective state, psychological need satisfaction and frustration, overall player experience, and gameplay performance, remains underexplored. Addressing this gap constitutes the central aim of the present study.

2.3 Emotion Regulation

Emotion generation, and therefore emotion regulation, are important aspects of video games. To better understand how emotions are generated and how they may be regulated, this section uses Gross' Process Model of Emotion Regulation [38]. This model is widely cited, well-established, and can be generative for the design of emotion regulation technologies [83]. It distinguishes between emotion generation and emotion regulation. According to the process model, emotion generation involves people encountering, attending to, appraising, and responding to situations. Thus, emotion generation begins with the presence of a particular situation. This situation must be attended to and then evaluated in light of the individual's active goals, which forms the appraisal stage. This leads to associated changes in subjective, behavioral, and physiological responses that we perceive as emotion. Emotion regulation can then be broadly understood as the strategies individuals use to increase, maintain, or decrease their affective experience, including the feelings, behaviors, and physiological responses that make up an emotion [39]. Emotion regulation occurs when people evaluate their current emotional state relative to their goals and choose whether or not to modify it. If they decide to modify their state, they have to select a particular regulation strategy, implement it, and monitor its effects. Depending on the outcome, they may repeat this process. Emotions can be evoked both through external and internal situations. Arising from the person-situation interchange, emotions are experiential, situation-dependent, and transient, meaning they change over time [38].

According to the process model [38], emotion regulation occurs when one actively tries to influence their emotion generation by recruiting certain processes. The emotion regulation process is seen as consisting of four main stages, which feed into each other. First, there is the *identification* stage, where one decides that they want to regulate their current emotional state. This leads to the *selection* stage, where one selects one of the five general families of emotion regulation strategies to use. They then arrive at the *implementation* stage, where they have to decide which specific regulatory tactic within the selected emotion regulation family to activate. During all of this, active *monitoring* is required to determine whether to continue or stop regulating, or to switch strategies during implementation. All of these steps require specific skills and knowledge from the person taking them. This is where emotion regulation interventions can take an important role [83].

During the selection stage, one must decide between five general families of emotion regulation strategies. These are *situation selection*, *situation modification*, *attentional deployment*, *cognitive change*, and *response modulation* [38]. These strategies all relate to, and target, a particular stage in the emotion generation process, namely the situation, attention, appraisal, or response stage. Each of these families comprises several emotion regulation strategies, which are discussed in more detail below.

The first family of emotion regulation strategies is situation selection. This strategy tries to change the full emotional experience at the earliest stage, by weighing the potential emotional impact of a situation against its benefits and determining whether or not it is worth engaging with. Examples include avoiding a mean family member at a party or choosing to engage in an uplifting activity.

If avoiding a situation is no longer an option, or if the long-term costs of avoiding something outweigh the short-term benefits, the next option is situation modification. Here, the situation is not avoided entirely, but its external features are changed in order to change its emotional impact. This can involve moving to a quieter room to reduce stress or changing the topic of a tense conversation. A common situation modification strategy is problem-solving, where one consciously tries to change a stressful situation or contain its consequences.

Attentional deployment is when one does not try to change the situation, but rather diverts attention to something else. By shifting attention away from emotionally generative aspects of the situation at a relatively early stage, one can prevent emotional states from gaining full strength. A common strategy here is distraction, where attention is redirected within a given situation or shifted away from the present altogether.

Cognitive change targets emotion generation in the appraisal stage. By shifting how we perceive the situation at hand, whether internal or external, we can alter its emotional impact. A well-researched strategy is reappraisal, which specifically targets the meaning behind a potentially emotion-eliciting situation. If your partner is not responding to your texts, for example, you could tell yourself that this simply means that they are busy, not that they are ignoring you or do not care enough about you. Another well-known cognitive change strategy is non-judgmental acceptance of emotional states.

Finally, response modulation comes down to directly influencing the experiential, behavioral, or physiological components of the emotional response after the emotion is already developed. This can involve using substances such as alcohol or drugs, but also relying on deep breathing or exercise to change one's physiological responses [38]. To summarize, emotion generation results from people encountering a specific situation, attending to it, appraising its assumed impact, and responding to it through changes in perceived emotion. Emotion regulation processes operate on these stages, thereby affecting subsequent emotion generation cycles. Emotion regulation proceeds through four stages: identification, strategy selection, implementation, and monitoring. Finally, the five families of emotion regulation strategies, situation selection, situation modification, attentional deployment, cognitive change, and response modulation, provide common approaches that people can use to up- or down-regulate a particular emotion, each corresponding to a stage in the emotion generation model.

The present study intervenes during the player's emotional response to a frustrating gameplay event. The goal is to help the player down-regulate their emotional response before their frustration escalates or is directed outward, thereby limiting potential negative consequences of the response. This falls under the category of response modulation. One might argue that it may be preferable to address generated emotions at an earlier stage [83], such as by altering the appraisal of the situation or by using attentional deployment, but this can be complicated to embed directly into the gameplay experience. Altering the player's appraisal of a gameplay situation is difficult to achieve during play, as reappraisal requires cognitive resources and reflective processing that may not be available in moments of heightened frustration. Similarly, modifying attentional deployment is challenging, since players' limited attentional capacity is already largely allocated to task-relevant demands in interactive environments. Deliberately redirecting attention away from frustration-eliciting stimuli may therefore interfere with performance itself. In contrast, response-focused strategies such as controlled breathing operate at the level of physiological arousal and may require less complex cognitive restructuring. Although pausing or slowing gameplay to perform a breathing exercise may temporarily influence performance, such response modulation may nevertheless provide a more feasible and immediately actionable form of regulation within fast-paced gaming contexts.

The process model provides a framework for thinking systematically about the approaches one can take to alter an emotional state, along with a set of clear intervention targets and strategies. For this reason, emotion regulation can be understood as an embodied skill, which can therefore be trained [38].

Learning to regulate emotions involves two aspects: knowledge and performance. One must improve their knowledge of the available strategies and when to apply them most effectively. However, they must also be able to enact those strategies in practice [76]. Skills are often split into two categories: intellectual and performative. An intellectual skill is a skill whose goal is predominantly symbolic, such as solving a mathematical problem or playing chess. Performative skills, however, have a nonsymbolic goal, such as playing tennis or football. Symbolic and nonsymbolic skills differ in the way they are commonly trained. For symbolic skills, it is common to use a didactic approach, where one explains the skill or provides a worked example [7]. Nonsymbolic skills, however, often draw heavily on experiential approaches, where one repeatedly attempts something to improve at it [99].

Emotion regulation is hard to fit exclusively into one of these categories. Altering a bodily response to a particular person-situation context is a performative, nonsymbolic skill that requires practice. On the other hand, there are also several elements that rely strongly on cognitive processes, such as knowing the available strategies and constructively applying them. This dual nature of emotion regulation has implications for the process of skill acquisition and influences the way designers should think about providing technology-enabled support [83].

The intervention design used in the present study aimed to provide emotion regulation support in a way that was directly accessible during gameplay. The breathing exercise was initiated by the game itself, meaning that players did not need to decide for themselves when to apply the strategy. In addition, the system provided clear, step-by-step guidance, reducing the procedural demands of performing the exercise correctly. Although this level of scaffolding may limit the transfer of the skill to unassisted gaming situations, it enabled a more controlled evaluation of the intervention component, as the observed effects depended less on differences in players' prior emotion regulation abilities.

2.4 Emotion Regulation Interventions

Emotion regulation, as discussed above, can be understood as an embodied skill that involves both symbolic and non-symbolic processes [83]. However, understanding how regulation unfolds is only one part of the challenge. Designing effective interventions requires translating these theoretical insights into systems that can meaningfully support people in developing and applying regulation strategies [83].

A key difficulty of emotion regulation interventions lies in the nature of emotions themselves. To learn how to regulate an emotion, one must have access to it. Yet emotions are difficult to "re-live" on demand, which complicates intervention design. Systems must therefore either elicit relevant emotional experiences during training or support the application of regulation strategies in the moments when emotions naturally arise. Addressing this tension is central to the design of effective digital emotion regulation interventions [83].

In response to these challenges, Slovak et al. [83] encourage HCI researchers to first consider the *delivery mechanisms* that digital technologies bring into the intervention process. These mechanisms specify *how*, *when*, and *where* a system scaffolds users' learning. The *how* concerns the mode of skill acquisition, distinguishing between didactic approaches, such as instruction-based learning, and experiential approaches, such as learning through guided practice. The *when* and *where* dimensions address the temporal and contextual placement of the intervention, differentiating between *offline* training and *on-the-spot* support.

Offline training refers to deliberate practice contexts in which regulation strategies are developed outside of emotionally intense situations, with the expectation that these skills will later transfer to everyday life. In contrast, on-the-spot interventions aim to provide support during naturally occurring emotional episodes, embedding regulation guidance directly within the lived experience itself.

In their work on designing for emotion regulation, Slovak et al. [83] also performed an extensive scoping review of recent literature. This review had several aims. The first aim was to give an overview of commonly used intervention design components in existing work for each of the delivery mechanisms. This refers to the design choices researchers have made so far to provide experiential, didactic, offline, or on-the-spot support, but also to which ER stages or families of strategies have been supported and which remain understudied. Secondly, they wanted to outline how these individual design components have been combined into actual interventions, meaning which combinations have already been explored and what gaps remain in this regard.

The following paragraphs discuss the delivery mechanisms used in existing research, starting with experiential intervention components. These focus on mediating the first-hand experience of applying a specific emotion regulation strategy, without necessarily providing a verbal description of the actions to be performed [83]. This support can, for example, involve ongoing real-time feedback on the application of a specific ER strategy or guidance through a particular experience.

Among the reviewed articles, the range of mechanisms used in experiential learning components was limited to two main categories [83]. First, there were cases where a learning environment was provided that included structured feedback during a practice application of a given ER strategy, such as embedding biofeedback into games [61, 94]. The second approach was to subtly guide participants toward a target emotional state, such as through vibrotactile patterns [27] or audiovisual cues [37].

The way these two categories of interaction design aimed to support the emotion regulation process differed substantially in how, when, and through which psychological mechanisms this support was provided. The real-time tailored biofeedback components provided the user with information about their current physiological state in a closed biofeedback loop. This supports them in learning emotion regulation through operant conditioning [8, 9]. This was predominantly implemented through video games that map the physiological response of the user to some metaphorical representation in-game, such as by subtly changing particular gameplay mechanics [58] or by using graphic overlays that make the gameplay more difficult if the player is not calm enough. An example of this is from Mandryk et al. [61], who inserted a graphic overlay on top of existing games, such as mud in a racing game, as the player's stress increased.

In contrast, the implicit target feedback components try to nudge the user's emotional state toward a particular target [14, 37]. Such components predominantly use vibrotactile interaction, either as a guide for physiological processes that the user can control, such as their breathing rate, or by shifting the user's attention.

The intervention component developed in the present study can be characterized as experiential, as it guides the player through the active application of a specific emotion regulation strategy during gameplay. Rather than teaching the strategy in an abstract or instructional manner, the system scaffolds the regulation process directly at moments of heightened frustration. However, unlike biofeedback-based systems, the intervention does not rely on real-time physiological monitoring. While biofeedback can strengthen learning through operant conditioning, it is not a necessary prerequisite for the effectiveness of structured breathing exercises, which have been shown to influence affect even when guided solely through instruction [11]. Omitting biofeedback also reduces technical complexity and limits additional performance demands during play.

Furthermore, the intervention does not attempt to implicitly nudge the player's emotional state through subtle sensory cues. Instead, it provides explicit breathing guidance, assuming that clear, structured instructions are sufficient to support response modulation in this context. In this way, the component occupies a distinct position within the experiential design space: it offers direct scaffolding of a regulation strategy without relying on closed-loop physiological feedback or implicit affective guidance.

In contrast to experiential learning approaches, didactic delivery mechanisms focus primarily on the communication of information and the support of its conscious application. Rather than scaffolding the execution of an emotion regulation strategy during the emotional episode itself, these approaches aim to strengthen users' cognitive understanding of how, why, when, and where particular strategies can be applied. The emphasis is therefore on explanation, reflection, and instruction, rather than direct experiential guidance [83].

Several interaction design approaches fall within this category. Reminder-recommender systems provide in-the-moment prompts that suggest the use of a particular ER strategy, sometimes accompanied by brief step-by-step instructions. For example, Smyth et al. [86] delivered semi-random mobile notifications encouraging users to take five mindful breaths if their context allowed for it. Although such prompts occur during daily life, the support remains primarily instructional: users are reminded what to do, but the system does not actively scaffold the regulation process itself.

Other didactic approaches focus on awareness and reflection support. These systems often rely on self-report or biosensing data to help users monitor their emotional states over time, for instance by maintaining mood diaries that enable pattern recognition and reflection [10]. Finally, cognitive model development components provide more extensive psycho-educational material, frequently grounded in cognitive behavioral therapy, to teach users new ER strategies in advance of emotionally charged situations.

While these didactic mechanisms have demonstrated value in fostering knowledge and long-term skill development, they differ from the approach taken in the present study. The intervention used here does not primarily aim to increase conceptual understanding of breathing-based regulation, nor does it merely recommend that the player engage in a strategy. Instead, it guides the player through the breathing exercise itself at a moment of competence-related frustration, thereby shifting the focus from instruction to direct experiential support. In this sense, the current work aligns more closely with experiential delivery, while remaining conceptually distinct from reminder-based breathing prompts such as those described above.

Besides distinguishing between didactic and experiential learning approaches, we can also divide the space into methods that use offline versus on-the-spot intervention components. We start by discussing the offline components.

Offline intervention components primarily aim to support the development of emotion regulation strategies in deliberate training contexts, rather than in the moment where emotions naturally arise. The trained skills are then expected to transfer into everyday situations. These methods can take a number of forms [83].

One common approach is to elicit strong emotions using technology, often through video games, providing a controlled context to practice regulation strategies. In these cases, biofeedback is frequently used to give users insight into their regulation progress [58, 103]. Alternatively, some systems promote ongoing monitoring of tracked emotions across situations, enabling reflection on previously unnoticed patterns and supporting emotional awareness over time [10]. Other offline methods include didactic psycho-education, delivering guidance on when and how specific strategies are useful, typically in non-technologically mediated formats that supplement the main training component [83].

Within these offline approaches, several interaction design patterns can be identified. Some components facilitate both emotion generation and regulation, often by deliberately inducing negative emotions and then supporting regulation, for instance through video games coupled with biofeedback [58]. Others focus purely on relaxation training in neutral states, using technological feedback to deepen relaxation competence [8]. Finally, some methods focus on reflection and awareness by visualizing emotional patterns over time, without actively generating or regulating emotion [10].

As can be seen, offline components mostly aim to train response modulation, either by eliciting emotions and supporting regulation, or by guiding the user toward relaxation. Some also target emotional awareness or cognitive reappraisal through psychoeducational elements [83].

While these offline approaches are similar to the present work in their use of emotionally engaging games or simulations, the current study differs in a key aspect: the intervention occurs directly within the relevant emotional context of gameplay, rather than in a separate training environment. This allows the study to support emotion regulation in the moment, focusing on experiential guidance through a structured breathing exercise without relying on biofeedback or additional implicit cues. In this way, the intervention leverages principles from offline methods, but adapts them to be immediately actionable and embedded within the gameplay experience itself.

Finally, there are the on-the-spot intervention components. Their primary characteristic is that they aim to provide support for emotion regulation strategies during naturally occurring emotional situations. This means the skills practiced are applied immediately, so no further transfer of skills is expected or needed [83].

On-the-spot systems vary in design. Some target specific moments when strong emotions arise, such as while driving through a busy city [14] or during a stressful work situation [64]. Others provide real-time information about the user's current emotional state, enabling awareness when negative emotions occur [63]. Some suggest specific emotion regulation strategies whenever a particular emotional state is detected [86]. Many on-the-spot systems combine these approaches with experiential components, guiding the user through practice in the moment [14, 37]. Didactic prompts, such as reminders or brief instructions, are also occasionally integrated [10, 31].

Interaction design patterns for on-the-spot interventions differ along two key dimensions: the triggering mechanism and the timing or duration of support [83]. Regarding the triggering mechanism, there are three main approaches [83]:

- *User-initiated interventions*, where the user notices the need for regulation and activates the support system, such as the BioFidget interactive fidget spinner [57].
- *System-initiated interventions*, where the system detects the user's emotional state, often via biosensing such as heart rate, breathing, or electrodermal activity, and triggers support automatically [86].
- *Situation-specific interventions*, where the intervention is provided continuously in predetermined contexts deemed likely to be stressful, such as Calm Commute [14], which provides ongoing haptic-guided slow breathing exercises while driving through a modified car-seat cover.

Timing and duration of support also vary. Some systems offer *discrete point components* [86], delivering a single intervention expected to shift the user's emotion regulatory trajectory. Others provide *ongoing support*, guiding the user until the regulation goal is achieved, often through slow breathing [14], cognitive scaffolding [31], or attentional deployment exercises [84]. Certain approaches rely on implicit feedback [25], where users adjust behavior or emotions in response to system-delivered cues, such as haptic interactions [27].

The intervention designed in the present study aligns closely with on-the-spot, experiential approaches. It is triggered by the game itself at moments predicted to be frustrating, guiding the player through a structured breathing exercise. Unlike some prior work, it does not rely on biofeedback or implicit feedback, as the explicit breathing instructions are expected to be sufficient for down-regulating the emotional response. By providing immediate, in-context support, the study assesses the effectiveness of a brief, guided response modulation strategy in reducing momentary frustration and its potential impact on affect, psychological need satisfaction and frustration, player experience, and gameplay performance.

Slovak et al. [83] further observe that existing systems tend to cluster into a small number of recurring design combinations, such as implicit on-the-spot support, biofeedback-based game interventions, and reminder-recommender systems. Importantly, relatively few systems combine on-the-spot support with explicit experiential guidance that does not rely on biofeedback. This highlights an opportunity to explore alternative forms of in-context experiential scaffolding. The present study contributes to this space by embedding a guided breathing intervention directly into gameplay without relying on physiological sensing.

2.5 Breathwork as Emotion Regulation Technique

The breath has long been used as an anchor in well-being practices such as yoga and Tibetan Buddhism, as well as in clinical contexts. More recently, an increasing body of empirical research has examined the potential of slow-paced breathing practices as an emotion regulation strategy [67]. In this section, recent work on breathwork is reviewed, starting with a meta-analysis of randomized controlled trials investigating its effects on stress and mental health [41].

Slow-paced breathing practices have received considerable attention in recent research, with several psychophysiological mechanisms proposed to underlie their effects on emotion regulation [41]. One commonly discussed mechanism concerns modulation of the autonomic nervous system (ANS), particularly through increases in heart rate variability (HRV) [102]. HRV is widely used as an indicator of ANS functioning and is associated with stress resilience and emotional regulation capacity [36]. Breathing exercises, especially those involving slow respiration rates of approximately 5–6 breaths per minute, have been shown to increase HRV, potentially reflecting increased parasympathetic activity [54].

Low HRV and impaired ANS functioning are frequently observed in conditions associated with heightened stress, anxiety, and depression, suggesting that interventions that increase HRV may support more adaptive emotional responses [36]. In addition to these autonomic effects, respiration has been linked to changes in neural activity, with slow-paced breathing associated with increased synchrony in brain oscillations [43], which may facilitate communication between distributed brain regions involved in emotional and cognitive control [44].

The meta-analysis primarily aimed to investigate the effects of breathwork interventions on stress levels. Breathing exercises are considered an easily accessible intervention that can be practiced independently, making them potentially valuable for improving public mental health [41]. The analysis included 12 randomized controlled trials with a total of 785 participants. Overall, breathwork interventions yielded a significant positive effect on stress reduction compared to non-breathwork control conditions. While moderate statistical heterogeneity was observed, this was not considered problematic, supporting the robustness of the findings [41].

Interestingly, the mode of delivery of the breathing intervention did not significantly influence outcomes. Approximately half of the interventions were delivered remotely without the presence of an instructor [41], suggesting that breathwork can be effective even when self-guided. This finding is particularly relevant for digital applications, as it indicates that breathwork may be successfully embedded into interactive systems such as games. Additionally, no significant relationship was found between the minimum duration of the breathing exercises and effect size [41], suggesting that relatively short breathing interventions may already yield measurable benefits.

Taken together, these findings suggest that breathwork constitutes a relatively low-cost and scalable emotion regulation strategy that can be delivered without extensive instruction or supervision. This makes it particularly suitable for embedding into interactive digital environments, such as video games, where interventions must be brief and minimally disruptive.

Another study examined the psychophysiological effects of controlled breathwork compared with mindfulness meditation [11]. This research focuses specifically on brief structured respiration practices, aligning well with the aims of the present work.

The paper highlights that different emotional and cognitive states can alter the depth and frequency of breathing [17, 40]. In turn, this can impact the emotional state [48, 101]. It is also noted how yogic breathing practices have been associated with increased feelings of peacefulness, improved reaction time and problem solving, decreased anxiety, and reductions in mind wandering and intrusive thoughts [21, 20]. A central theme of such practices is the inclusion of deliberate patterns of breathing [11]. Despite the evident benefits of these practices for overall health and well-being [23], it was not yet clear how different types of breathing impacted mood and physiology, and how those effects compared with brief mindfulness meditation practice [11].

During mindfulness meditation, the aim is to be aware of the present moment, often by using the breath as an anchor. During controlled breathing exercises, however, the breath is directly influenced by the individual performing it, rather than simply being observed [11]. This alteration of the respiratory rate may be able to cause more immediate physiological and psychological calming effects by increasing vagal tone [11]. The direct modulation of the physiological state provided by controlled breathing could produce more potent and acute mental and physical relaxation. These relatively fast effects may encourage adherence, suggesting that breathwork could potentially lead to more sustained benefits compared to mindfulness meditation [11].

In the study, three different techniques were used. One of the main differentiators of the techniques was the emphasis on relative duration and intensity of the inhale portion versus the exhale portion of the breath. The first technique was the *physiological sigh*, or *cyclic sighing*. This is a deep inhalation, followed by a second smaller inhalation, before exhaling fully but slowly. The sigh puts an emphasis on the exhale portion of the breath and is associated with psychological relief, shifts in autonomic states, and resetting of the respiratory system [93, 75, 28]. The second technique was *box breathing*, characterized by equal inhale, hold, and exhale ratios. It has been used by the military for stress regulation and performance improvement [28, 81, 18]. The final technique compared in the experiment was *hyperventilation with retention*. In contrast to cyclic sighing, this technique puts an emphasis on inhalations of longer duration and relatively greater intensity than exhales [53].

Notably, the three techniques all differ in what part of the breath they emphasize. By selecting these techniques in particular, the authors sought to explore how inhale-emphasized, exhale-emphasized, and balanced inhale-exhale breathing impact physiology and subjective measures of anxiety. Additionally, the results were compared with a control group that performed mindfulness meditation, meaning the passive observation of natural breathing. All groups were instructed to perform daily sessions of five minutes. To assess the effects of these techniques, the study employed a combination of subjective self-report measures and physiological indicators [11].

The protocol in the study was performed remotely, with participants receiving instructional videos on the correct execution of the exercises. Before and after each session, self-reported positive affect, negative affect, and state anxiety scores were measured. Some additional measurements were also taken using a smart wristband, such as the sleep quality of the participants, heart rate statistics, and their respiratory rate.

The results showed significant reductions in state anxiety and negative affect and increases in positive affect for both the mindfulness meditation and the controlled breathing groups. However, the breathwork group showed a notably higher increase in daily positive affect. Additionally, increases in positive affect were larger for participants who had spent more days on the protocol, suggesting a cumulative effect of adherence over time. Furthermore, the cyclic sighing group had a significantly higher increase in positive affect than the group performing mindfulness meditation. The sighing group also showed a greater reduction in respiratory rate than the other groups. This change was negatively correlated with change in daily positive affect, indicating that greater reductions in respiratory rate were associated with larger increases in positive affect [11].

Overall, the cyclic sighing technique showed the greatest benefits by significantly improving positive affect and reducing state anxiety and negative affect. Moreover, it led to the highest reduction of the respiratory rate [11]. This technique differs from the others in two main ways. First, it includes a double inhalation, which increases the depth of the inhalation. Second, it involves an extended exhalation.

The authors further discuss several potential mechanisms through which controlled breathing may influence affective and physiological states. One proposed pathway involves modulation of vagal function, as indexed by changes in heart rate variability, which has been associated with emotional regulation capacity. In addition, controlled breathing may influence interoceptive processes, potentially increasing awareness and regulation of bodily signals related to stress and arousal. Finally, slow-paced breathing has been suggested to affect cortical and subcortical structures involved in emotional processing, with exhale-emphasized breathing patterns possibly signaling reduced behavioral arousal. While these mechanisms provide a plausible theoretical basis for the observed effects discussed by the authors, a full investigation of their relative contributions falls outside the scope of the present work [11].

Taken together, the reviewed evidence suggests that brief, structured breathing practices can produce measurable changes in affective state and physiological arousal, even when delivered remotely and with minimal instruction. However, most existing work has examined breathwork in relatively neutral or controlled contexts, such as daily practice protocols or laboratory settings. Much less is known about how such techniques function when embedded directly into emotionally charged, fast-paced environments, such as digital games, where frustration and arousal arise dynamically. It therefore remains unclear whether brief guided breathing interventions can effectively down-regulate competence-related frustration in real time during gameplay, and how such regulation may influence affective state, need satisfaction and frustration, player experience, and gameplay performance. Addressing this question forms a central focus of the present work.

2.6 Emotion Regulation During Gaming

Emotions play a significant role in the video game play experience. This section discusses what situations may elicit emotions during gameplay, how players tend to regulate their emotions during play, and where there is room for technological interventions to support the emotion regulation process.

To this end, this section examines a systematic review by Beres et al. [16]. In this review, the authors examine the effects of emotions on esports performance, as well as the coping strategies currently employed by players. The term esports stands for electronic sports, referring to professional video game play performed at a competitive level, whereby expert players compete in organized sporting contexts in the presence of spectators [34]. Similar to traditional sports athletes, esports players are under immense pressure to maintain optimal performance, which may elicit a wide range of emotional experiences. These emotions can, in turn, influence their in-game performance, their mood following a match, and their well-being in general [16]. For this reason, it is important for players to develop effective coping strategies if they aim to achieve and maintain optimal performance. The review therefore aimed to identify the current state of the literature concerning the role of emotions in esports performance, as well as strategies for emotion regulation that are currently applied.

The study reviewed a total of 32 papers. Out of these, 15 related to emotion regulation in esports, 13 concerned emotions and their effects on esports performance, and 4 involved emotion-centric technical interventions. Together, these studies illustrate that while emotions and emotion regulation are recognized as critical factors in esports performance, relatively few works have empirically examined interventions that support regulation during gameplay [16].

First, we will discuss what gameplay situations may elicit emotions. The review specifically focused on esports contexts, but many of the findings are also relevant to video game play more broadly.

To start, the findings suggest that the emotions players face may vary throughout the different stages of gameplay [42]. Players may also recall the peak and end of their experience with greater emotional intensity [71]. Furthermore, the outcome of the game has a strong influence on the emotional state of the player. *League of Legends* players reported higher values of depression, anger, and post-game confusion following a loss, while reporting higher values of vigor following a victory. Additionally, pre-game depression was higher when the outcome of the last game was a loss. However, this effect may be attributable to the limited rest players receive between games in the maintained competition format [62]. Similarly, *Counter-Strike: Global Offensive* players typically associate positive emotions with shooting other players, while associating negative emotions with being shot. Furthermore, it was found that feelings of anger and arousal often faded after the game had ended, whereas feelings of happiness were present both during and after the game [82].

Moreover, an inductive thematic analysis of 431 posts on the subreddit of *League of Legends* revealed three emotive factors among players [52]. These emotive factors are types of situations that trigger players' emotional experiences. First, there are achievement-related situations. Negative emotions like anger and frustration may arise when players feel their performance levels did not meet their own expectations, while positive emotions, such as happiness and pride, can be experienced when they execute a skillful play. Second, team-related situations may elicit emotions. They can give way to negative emotions when teammates underperform or engage in toxic behaviors. In particular, breakdowns in teammate communication were identified as a major stressor among professional esports players. In contrast, positive emotions may arise when teammates are in harmony with each other and work together. Lastly, there are game design-related situations, where a design decision by the game developers has an emotional effect on the player. For example, players might experience sadness when their preferred playable character is weakened, or happiness when it is strengthened [52].

These results were echoed in a longitudinal study, where diary entries of six high-level *League of Legends* players were collected over an entire in-game season (87 days). The findings showed that general performance, outcome of games, critical moment performance, and teammate mistakes accounted for the majority of the stressors players faced. Furthermore, the severity of the stressors increased during high-stakes moments of competitive play [73].

Another important aspect impacting the emotional experience of esports players is their performance in general. Mateo-Orcajada et al. [62] found that favorable performance actions were positively correlated with vigor and negatively correlated with tension, depression, anger, fatigue, and confusion. In contrast, when performance actions benefited the opposing team, they were negatively correlated with vigor and positively correlated with negative mood states. In a similar vein, research by Behnke et al. [15] explored which situations within video game play elicit positive and negative emotions among gamers. They analyzed 652 responses from *Counter-Strike: Global Offensive* players to identify situations where players felt amusement, enthusiasm, anger, or sadness. The results showed that amusement was experienced when mindless game mistakes were made during recreational play and enthusiasm was felt when players had successful games in competitive settings, while anger was felt during unfair situations and sadness when losing a game. Furthermore, positive emotions were associated with clutch performances, such as victories and skillful plays, and negative emotions with defeating scenarios, such as poor performance, weak teammates, or unfair behavior by others [15].

In sum, both general gameplay factors and individual player performance play an important role in shaping the player's emotional experience. In terms of general gameplay factors, negative emotions are associated with in-game losses, breakdowns in team communication and performance, and game design-related changes, while positive emotions are associated with favorable gameplay factors, such as winning, securing objectives, or cohesive team performance. In competitive settings, negative emotions arise when an individual's performance falls short of their own expectations, whereas positive emotions emerge when those expectations are met. During recreational play, negative feelings related to player performance may be less likely to emerge, although failure and poor performance can still affect the emotional experience.

Taken together, many of the situations described above appear to overlap with instances of competence need frustration. In particular, performance failures, critical mistakes, unfair situations, and breakdowns in team coordination may undermine players' sense of effectiveness and mastery during gameplay. Especially in competitive settings, where expectations about one's own performance are salient, discrepancies between expected and actual outcomes may intensify emotional responses.

From the perspective of the present work, these findings are relevant because they illustrate how emotionally charged moments can emerge naturally within gameplay. Rather than being rare or artificial events, frustration, anger, and heightened arousal appear to be embedded in many gameplay structures themselves. Such moments may therefore represent meaningful opportunities for providing emotion regulation support directly within the ongoing activity.

Next, we turn to how esports players attempt to regulate their emotions during play. Emotional control is considered an important aspect for maintaining performance in esports [65], and it can be dissected into handling tilt, mental toughness, and dealing with stress.

In the context of video game play, the term *tilt* refers to a prolonged suboptimal state of mind, occurring from a series of failures [98]. Once this state is reached, it can be very difficult to reconcile performance and return to a more beneficial state. It has been found that, compared to traditional athletes, esports competitors engage in less self-talk and have more negative thought patterns, which may contribute to an increased likelihood of experiencing tilt [56]. The way tilt is perceived by players can affect the emotional response it elicits. When tilt is caused by the game itself, players who perceive tilt as something within their own control are more likely to respond with positive strategies than players who do not. However, this does not make a difference if tilt arises from the player's own performance [100]. In this case, it can be particularly difficult to deal with negative emotions in an effective manner [100, 56].

Another aspect influencing emotional control is the mental toughness of the player. In traditional sports, mental toughness has been linked to lower perceived stress and better emotional control [47]. However, this does not directly translate to esports contexts. It was found that esports athletes with higher levels of mental toughness did not report lower stress levels or higher stress control [72]. This difference could be explained by the different types of stressors esports players face compared to traditional athletes, such as technical issues or toxicity [72]. Moreover, in traditional sports, athletes with greater mental toughness are more likely to perceive stressors as a challenge rather than a threat [68]. In esports, findings suggest that players perceive stressors as both a challenge and a threat [72]. The online nature of esports may contribute to uncertainty, as players are often unable to choose their teammates.

Finally, the way players deal with stress also affects their emotional control. Stress has been shown to have a strong negative impact on the psychological well-being of esports players. The highly competitive nature of the scene, combined with tournament formats that allow for limited rest between matches, can induce significant stress levels among players [59]. Moreover, toxicity can add additional challenges [60]. The ability to deal with this stress effectively can therefore shape the emotional experience of the player.

From the perspective of the Process Model of Emotion Regulation introduced earlier, many of these challenges concern difficulties not only in implementing regulation strategies, but also in identifying when regulation is needed and selecting an appropriate strategy under time pressure. Competitive esports contexts are fast-paced and emotionally volatile, which may constrain players' ability to move deliberately through the identification, selection, and implementation stages of regulation. This makes it particularly relevant to examine which strategies are actually used during play and how they map onto established emotion regulation families.

In an effort to regulate their emotional experience during play, esports players have developed several coping strategies. These can be separated into three categories: problem-focused strategies, which aim to directly address the situation eliciting the emotion; emotion-focused strategies, which target the emotional response; and avoidance-focused strategies, which involve disengagement from the stressor. Although players perceive problem-focused and emotion-focused strategies as more helpful [73], they tend to rely on avoidance-focused strategies during competition [55, 85].

Besides these three categories of coping strategies, the ways players regulate their emotions can be divided further. The first way emotion regulation takes form is through self-regulation. This form of emotional self-care consists of internal strategies targeted toward the players' own emotional well-being. A qualitative study on *League of Legends* players [52] found that players utilized various regulation strategies spanning all families of emotion regulation as described in the Process Model. The first strategy observed was situation selection, where players choose which situations they prefer to approach and avoid. Second was situation modification, such as muting players to reduce their negative influence on the emotional experience. Third was attentional deployment, which involves shifting focus to a different in-game goal, such as letting go of the fear of losing. Next was cognitive change, where players reframe the appraisal of the situation using statements such as "it's just a game". Another option was response modulation, which involves managing the response to the stimulus. Finally, social interaction was utilized, meaning players turned to others for emotional support.

This suggests that, at least in principle, players are capable of engaging in regulation attempts across the full emotion-generative trajectory. However, the extent to which these strategies are deliberately selected, effectively implemented, or sustained under pressure remains unclear.

Besides self-regulation, emotion regulation also takes place within team contexts. Freeman and Wohn [34] identified four themes of support within esports teams. The first was emotional support, mediated through forms of friendship or romantic connections with teammates. Next, there was informational support, referring to the transfer of game knowledge. Third was instrumental support, which involves support both within and outside of the game, such as supporting each other's in-game as well as personal goals in real life. Lastly, there was esteem support, relating to attentiveness to the emotional needs of other players within the team. From the perspective of the Process Model, these forms of team-based support can be interpreted as supporting different families of emotion regulation strategies. For example, informational and instrumental support may facilitate situation modification, whereas emotional and esteem support may contribute to cognitive change or response modulation.

However, while such distributed regulation may be relevant in team-based esports contexts, many gameplay experiences, particularly in single-player settings, rely primarily on individual, in-the-moment self-regulation. This places greater demands on the player's ability to implement regulation strategies independently during emotionally salient moments. In such contexts, brief and easily deployable strategies targeting response modulation may be particularly suitable.

In similar research, Smith et al. [85] aimed to identify both the types of stressors faced and the coping styles used by four elite *Counter-Strike: Global Offensive* players. They differentiated between internal and external types of stressors. Internal stressors can be team-based, which may include communication issues, criticism from the leader, lack of confidence in teammates, or the outcomes of losing. They can also come from the individual themselves, such as issues with work-life balance and general difficulty with managing one's lifestyle. External stressors, on the other hand, may include matters such as scrutiny and criticism, as well as issues relating to the competitive event. The study again found a variety of coping styles that players utilized to deal with internal and external stressors. Emotion-focused strategies such as controlled breathing were used, as well as problem-focused strategies such as improving intra-team communication. However, players also reported an overuse of avoidance-focused strategies. This may be due to a lack of effective problem- and emotion-focused coping strategies. Such a lack may stem from insufficient training or from the fast-paced nature of competitive play [85]. Regardless, this indicates the potential of brief emotion-focused regulation strategies as interventions.

The authors of the systematic review move on to discuss how technical interventions may be used to support the emotion regulation process of esports players [16]. They highlight how esports contexts may facilitate richer emotional experiences than traditional sports, particularly due to the continually updating game design as an influencing factor. At the same time, the technological nature of the scene offers potential for creating new technologies that support emotion regulation and skill development. To date, most interventions in the esports domain have focused on providing individualized real-time feedback, which can increase emotional awareness among players and coaches and help identify emotionally salient moments during play. Interventions that directly support response modulation, such as structured breathing methods, are not prominently discussed. However, given that several studies report a lack of effective emotion-focused regulation strategies, a gap appears to exist in this area, although its applicability within competitive esports settings remains to be explored.

Taken together, these findings suggest a mismatch between the emotional demands of gameplay and the strategies currently available to players during play. While players recognize the value of emotion-focused regulation, such strategies are difficult to apply in fast-paced contexts, leading to an overreliance on avoidance. This points to an opportunity for brief, low-effort interventions that can be deployed in situ, without requiring players to independently identify, select, and implement an appropriate strategy. The structured breathing intervention used in the present study addresses this gap by targeting response modulation at moments of heightened frustration during gameplay.

2.7 Research Aim

The literature reviewed above highlights that competence need frustration is a common and consequential experience in video games. Prior work has demonstrated that competence-thwarting gameplay situations can negatively affect player experience and are associated with increased aggressive affect, thoughts, and behavior. At the same time, players often persist in such situations due to external motivations, making competence frustration a recurring and emotionally salient part of gameplay rather than a rare exception.

Despite this, existing research has largely focused on *describing* competence frustration and its outcomes, rather than on designing and evaluating interventions that actively support players in regulating their emotional responses during these moments. In particular, little is known about how competence-related frustration can be mitigated in situ, at the moment it occurs during gameplay.

Research on emotion regulation technologies has proposed a wide range of intervention strategies and delivery mechanisms. However, most existing systems emphasize offline training, reflective support, or biofeedback-based approaches. On-the-spot interventions that provide explicit experiential guidance remain relatively rare, especially in gaming contexts. When such systems do exist, they often rely on physiological sensing or implicit feedback, which increases technical complexity and may interfere with gameplay.

Furthermore, while response modulation strategies such as controlled breathing are well-established as effective emotion regulation techniques, their application within interactive, performance-driven environments has received limited attention. In particular, the effectiveness of brief, guided breathing exercises embedded directly into moments of competence frustration during gameplay remains underexplored. It is unclear whether such interventions can meaningfully reduce felt frustration without undermining player autonomy, engagement, or overall experience.

The present study aims to address these gaps by designing and evaluating an on-the-spot, response-focused emotion regulation intervention embedded into gameplay. Specifically, it investigates whether a brief, guided breathing exercise, triggered at moments of predicted competence frustration, can support players in regulating their emotional response and improve aspects of player experience.

Based on this aim, the study addresses the following research questions:

- **RQ1:** How does embedding a guided breathing intervention into gameplay influence players' experiences of need satisfaction and need frustration compared to gameplay without such an intervention?
- **RQ2:** How does embedding a guided breathing intervention into gameplay influence players' experienced frustration and affective state?
- **RQ3:** How does embedding a guided breathing intervention into gameplay influence broader aspects of player experience?
- **RQ4:** How does embedding a guided breathing intervention into gameplay influence player performance?

Together, these questions seek to contribute empirical insight into the design of on-the-spot emotion regulation interventions in games, and to explore the potential of response modulation strategies as a viable approach for supporting players during emotionally challenging gameplay moments.

Based on prior work on breathing-based emotion regulation and competence-frustrating gameplay experiences, the following hypotheses were formulated:

- **H1:** Participants receiving the guided breathing intervention will report differences in competence and autonomy satisfaction and frustration compared to participants in the control condition.
- **H2:** Participants receiving the guided breathing intervention will report lower levels of momentary frustration and a more positive affective state than participants in the control condition.
- **H3:** Participants receiving the guided breathing intervention will report a more positive overall player experience than participants in the control condition.
- **H4:** Participants receiving the guided breathing intervention will demonstrate improved gameplay performance compared to participants in the control condition.

The following chapter describes the methods used to evaluate these hypotheses.

3 Methodology

In this section, we describe the methodology employed in the present study. We first outline the game designed for the experiment, followed by a description of the intervention component, the experimental setup, and the analysis approach.

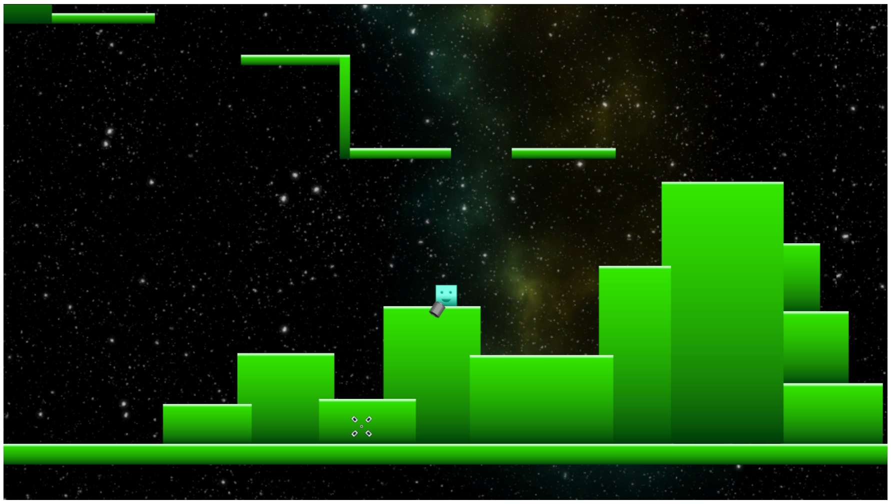


Figure 1: Opening section of the game *Master Blaster*

3.1 The Game

For the purpose of this study, a full game called *Master Blaster* was designed and implemented. The game is a 2D platformer in which players attempt to reach the top of a vertically structured level by navigating platforms and avoiding falls. The opening section of the game is shown in Figure 1. The level was designed to provide a challenging gameplay experience, requiring players to learn and adapt to the movement mechanics while progressing through the environment.

A challenging game experience naturally provides opportunities for frustration to emerge, particularly when players encounter setbacks or lose progress. This was important for the present study, as the intervention component was intended to support players in regulating their emotional responses during such moments. Therefore, the game was designed to include challenging sections that could elicit competence-related frustration, while still providing sufficient engagement to motivate continued play.

Competence was selected as the primary target because it can be readily influenced through gameplay mechanics in a single-player context. By creating situations in which players experience difficulty, mistakes, and progress loss, the game could elicit moments where players' perceived competence was challenged. These moments provided the context in which the effects of the emotion regulation intervention could be evaluated.

3.1.1 Design Considerations

In order to design a game that is both engaging yet frustrating at times, we have taken inspiration from *Getting Over It with Bennett Foddy* [33]. In this punishing climbing game, the player controls a character whose body is stuck inside a cauldron and who must ascend an enormous mountain with only a hammer at their disposal. The game is known for its difficulty and lack of checkpoints, meaning players are likely to lose substantial progress following a single mistake. As players master the controls, they are able to reach greater heights before falling, until eventually reaching the top of the mountain and completing the game.

The controls can be unintuitive at first, and new players often do not expect to lose all their progress following a single mistake. This can lead to moments that may be perceived as highly frustrating. Adding to this is the map design, which not only features high-risk moves that can cause the player to fall, but also forces the player to observe their character falling down the mountain after making a mistake, emphasizing the progress that has been lost. Crucially, despite the game's difficulty and perceived unfairness, failures can generally be attributed to the player's own actions, reinforcing an internal attribution of responsibility for lost progress. Although there is no direct empirical evidence demonstrating that this game induces competence need frustration, the repeated loss of progress and attribution of failure to one's own actions may plausibly contribute to experiences of competence frustration.

Based on these observations, the developed game incorporates several design principles inspired by the gameplay of *Getting Over It with Bennett Foddy.* These aspects include:

- Mechanics that are easy to learn but difficult to master.
- The possibility of losing a substantial portion of progress due to a single mistake.
- A strong sense of personal responsibility for progression loss.
- Forced observation of failure.
- A gameplay experience that is perceived as difficult, but achievable.

These aspects were intended to create a challenging gameplay experience in which moments of competence frustration could naturally emerge and serve as meaningful delivery points for the intervention.

3.1.2 Development Process

The game followed an iterative development process, involving several rounds of prototyping, playtesting, and refinement. While the main gameplay goals were clear from the start, translating these into a playable and engaging game proved less straightforward. Throughout development, player feedback was continuously incorporated to improve both the feel of the game and its suitability for the experimental setup.

The game was built in Unity (version 6000.2.9f1). Before focusing on level design or visual presentation, the basic gameplay mechanics first had to be established, starting with the player movement. As explained in Section 3.1.4, the movement was designed to feel smooth and responsive, ensuring that failures would be attributed to the player's own actions rather than to limitations of the controls. Reaching this point required extensive fine-tuning of parameters such as ground acceleration, air friction, gravity, and jump force.

Once the movement mechanics reached a satisfactory state, development shifted towards the game's main traversal mechanic: blasting. For this mechanic, two different concepts were prototyped and playtested. In the first version, the player used a device that generated a gust of air. The recoil of this blast launched the player in the opposite direction, providing additional mobility. In the second version, the device launched an explosive projectile. Rather than the recoil itself moving the player, the resulting explosion propelled the player away from the point of impact.

Both approaches had advantages and disadvantages. The recoil-based version was simple and intuitive, but because the propulsion force always originated directly from the player's device, there was relatively little variation in how a jump could be performed. The projectile-based version offered more freedom and creativity. Depending on the player's distance from the explosion, the strength of the launch could vary considerably. Furthermore, players had to position themselves relative to walls and surfaces to achieve the desired movement, potentially creating a higher skill ceiling and allowing for more demanding level design. However, this also increased the complexity of the mechanic and introduced additional challenges in ensuring that the resulting movement remained intuitive and consistent.

To determine which version was better suited for the study, separate prototypes were created for both approaches. Each prototype featured a small test level showcasing some of the intended uses of the mechanic. The recoil-based version emphasized longer jumps and mid-air direction changes, while the projectile-based version focused on jumps of varying sizes and the strategic use of nearby walls to gain additional height or distance.

Players then tested both versions and provided feedback. During this initial playtesting phase, both prototypes were generally experienced as cumbersome and overly difficult. Although the basic mechanics were functional, the movement still required further refinement and the blasting mechanics were often perceived as unintuitive. One recurring observation was that players gained the most height by jumping and blasting simultaneously. As a result, the blast often felt less like a distinct gameplay mechanic and more like an additional input required for a regular jump. Despite these issues, most players expressed a preference for the recoil-based version, largely because it felt more predictable and consistent.

Based on this feedback, the recoil-based approach was selected for the final game. Although the projectile-based version may have offered a higher skill ceiling, the consistency and intuitiveness of the recoil-based mechanic were considered more important for the goals of the study. Since participants would only have limited time to become familiar with the game, the design benefited more from mechanics that could be learned quickly than from additional complexity. At the same time, the recoil-based system still provided sufficient depth to create a challenging gameplay experience.

With the core mechanics established, development could shift towards designing the level itself. The main challenge here was creating a level that remained engaging while also providing moments of genuine challenge and potential frustration. Early playtesting revealed that the initial versions were excessively difficult, particularly in the lower sections of the map. Consequently, the level was redesigned to introduce mechanics more gradually and provide a smoother difficulty curve.

The level was built from the ground up, starting with relatively accessible sections and gradually increasing the challenge as the player progressed upwards. Throughout development, several additional playtesting rounds were conducted to assess the difficulty, pacing, and overall feel of the game. After each round, feedback was implemented and the design was iteratively refined until the desired balance between challenge, engagement, and accessibility was achieved.

In addition to the gameplay systems themselves, most visual assets used in the game were created specifically for this project using tools such as *Inkscape* and *Adobe Photoshop*. The only exception was the background texture, which was obtained from an external source.

3.1.3 Gameplay

The final game resulting from this development process is a 2D platformer called *Master Blaster*. In the game, the player controls a character that can move left and right, jump, and blast. The blasting ability is one of the core mechanics of the game, allowing the player to propel themselves in any desired direction. A blast is performed by aiming with the crosshair and clicking the left mouse button. The blasting device then launches a gust of air, propelling the player in the opposite direction of the blast. By combining this blasting mechanic with walking and jumping, the player can traverse the level by moving from platform to platform. The character control while airborne is limited, emphasizing the importance of proper timing and aiming of the blast.

The goal of the game is to reach the top of the level by traversing the floating platforms. The game world consists of several color-coded segments stacked directly above one another (Figure 2). As a result, falling causes the player to drop into one or more lower segments, creating a natural sense of lost progress. The visual distinction between the different segments may further reinforce this experience. During playtesting, several players explicitly expressed disappointment after falling back into the green section, suggesting that the segmented level design effectively emphasized progression loss.

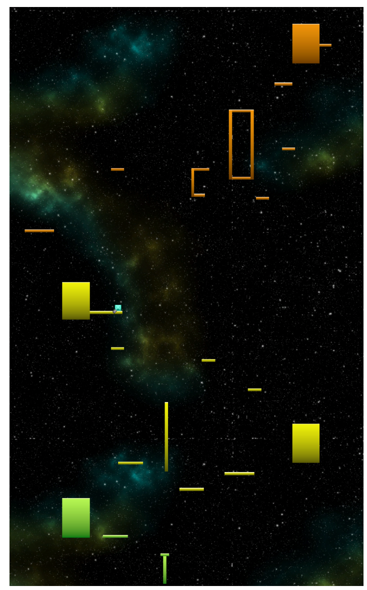


Figure 2: Illustration of several consecutive vertical slices within the level

3.1.4 Movement

The movement mechanics of the game were a crucial element of the game's design. To induce the targeted competence frustration, it was important for players to attribute their failure to their own actions, rather than to the lack of control over their character or unpredictable movement mechanics. To this end, the movement was meticulously designed to feel smooth and responsive, while keeping the mechanics relatively simple and straightforward.

The main movement system consists of walking left and right, combined with small jumps. In addition to this, the player is able to boost themselves into the air by using the blast mechanic. While the player is airborne, they are still able to steer horizontally, but with reduced effectiveness, reflecting the lack of air resistance observed in the real world. This also means players must aim and time their blast carefully to successfully traverse the level. Once the blast has been used, it has a short cooldown of 0.6 seconds before being able to be used again. This prevents players from reaching higher spots by stacking blasts in sequence. Furthermore, the player can only blast twice while airborne, providing them with one grace shot, while still maintaining the punishing nature of the game. Adding to the realism and natural feel of the movement, the player's momentum is preserved to some extent. The player still loses velocity when input is absent, but this deceleration is harsher while grounded compared to when airborne. This means the player can maintain their velocity obtained from a previous blast when jumping shortly after touching the ground, further adding to a smooth and consistent movement experience.

In addition to these basic mobility aspects, some hidden techniques were implemented in the movement system. One of these is a so-called "Coyote Time". This is a game design technique in platformers that allows players to jump for a few frames after walking off a ledge. This ability acts as a grace period to make the controls feel more responsive, forgiving and fair. In a similar manner, jumps before landing are buffered and then acted upon as soon as the player touches the ground, also contributing to a responsive feel.

3.1.5 Level Design

As stated, the goal of the game is to reach the top of the level by traversing the floating platforms. In the design of the level, several factors were considered to ensure it fits the experimental setup.

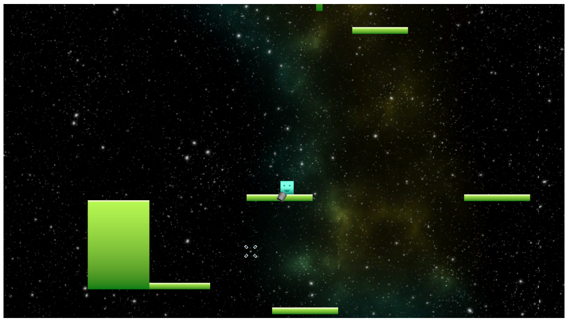
First of all, the level consists of several horizontal slices, stacked on top of each other. At the start of the game, the player is slowly introduced to the various mechanics the game offers. First the gaps are small enough to allow traversal using only small jumps, but shortly after a blast must be utilized to progress further. Then, properly timing the combined use of both a jump and a blast is required to continue climbing, naturally forcing the players to get familiar with the basic mechanics. In addition to this, a ghost-like player object is shown performing some of these unfamiliar jumps in earlier stages of the level, introducing the player to the intended path and proper use of the blast feature.

As the player climbs, the jumps they have to perform become increasingly more difficult. This is done in multiple ways. Rather soon into the level, moving platforms are introduced. If the player stands on top of these, the platform will carry them along. Not only does this require the player to time their jumps correctly, it may also stall them at times, especially in the easier sections of the level where the platforms move relatively slow. This can make falling down even more frustrating. Another way the sections increase in difficulty as the player progresses through the level, is by increasing the gaps between the platforms, ensuring precise movement is required to reach the next platform. In similar fashion, the platforms also decrease in size the higher the player gets. In addition to the gaps themselves leaving less room for error, the player is challenged further by incorporating jumps where timing is key. Examples of such cases are jumps where the player is first required to drop down a platform, before blasting themselves onto the next one, carefully timing their jump to avoid hitting their head along the way. A combination of moving platforms, larger gaps, smaller platforms and precise timing jumps is used to scale the difficulty as the player progresses through the level. Meanwhile the color of the platforms changes to reflect this challenge, shifting from bright green to red, before the platforms eventually turn purple and pink. Figure 3 shows representative jumps from each of these sections, illustrating how the platform layouts and traversal challenges become progressively more demanding. As the player climbs, not only does the difficulty rise, but so do the stakes, as a single mistake may result in the player having to start over from the beginning.

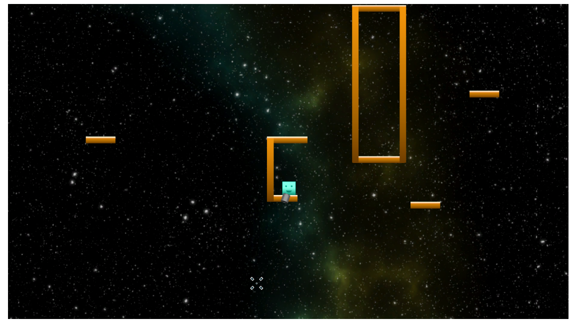
At the apex of the level, the player will reach a rainbow-colored platform, indicating they have conquered all sections along the way and have completed the game. To prevent the completion of the level from influencing the experiment results, the level was designed in such a way that it is very unlikely that any participant was able to beat it within the experiment time frame. We will discuss this in more detail in Section 3.3.3.

3.2 The Intervention Component

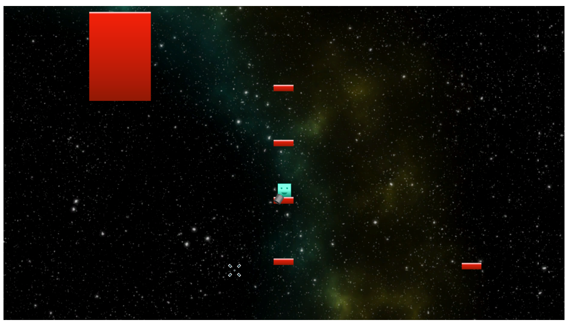
The second key component of the experimental setup was the intervention component. This component was integrated into the game to provide players with a structured breathing exercise intended to down-regulate frustration at appropriate moments. In its design, several important elements were considered. First, there is the delivery mechanism, which relates to the distinction between didactic vs. experiential and offline vs. on-the-spot experiences. Since the intervention directly guided the user through the emotion regulation process, it falls under the experiential category. Second, it was aimed at supporting the user during naturally occurring emotional situations, rather than teaching the user how to regulate within a deliberate training context. As such, it provides on-the-spot support.



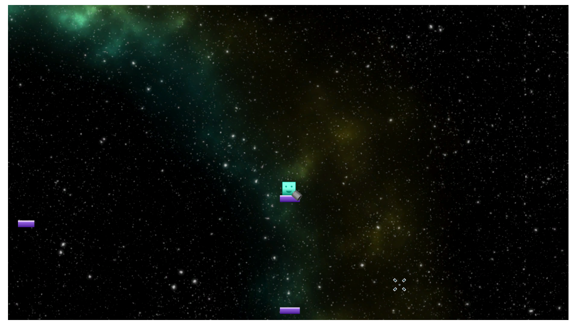
(a) Green section jump



(b) Orange section jump



(c) Red section jump



(d) Purple section jump

Figure 3: Representative jumps from different sections of the level, illustrating the gradual increase in difficulty. (a) The green section introduces the player to the basic movement mechanics using relatively large platforms and forgiving jumps. (b) In the orange section, players are required to first drop below a platform before carefully timing a blast to reach the next platform without colliding with the ceiling above. (c) The red section introduces more constrained platform layouts, requiring players to chain together jumps and blasts while avoiding overhead platforms to reach narrow landing spots. (d) The purple section features the smallest platforms and the largest gaps, demanding highly accurate movement and precise timing to successfully traverse the level.

3.2.1 Triggering System

Another important aspect concerned the triggering system for the delivery of the intervention. Here, a distinction can be made between system-initiated, user-initiated, and situation-specific components. Ideally, the system would intervene when the player reached a certain level of frustration. However, dynamically assessing the player's frustration during gameplay is difficult. For this reason, a heuristic approach was adopted to determine when the intervention should be deployed, leveraging the structure of the game.

The player's progress was reflected by their current position along the ascent. This made loss of height a useful gameplay-based proxy for moments in which the player's progress had been meaningfully interrupted. Rather than estimating frustration directly, the triggering system therefore used substantial progress loss as an indicator that an intervention moment might be relevant.

To trigger the intervention at relevant moments during gameplay, a multi-level triggering system was designed to ensure comparable intervention timing across participants. This system prioritized the most direct indicators of progress disruption, while including additional fallback triggers to ensure that the intervention would still be activated if such moments did not occur in time.

The gameplay phase of the experiment lasted 10 minutes. During play, the triggering system aimed to activate the intervention at two separate moments. This number was chosen as a design compromise, allowing for repeated exposure to the intervention while limiting potential disruption to the gameplay experience.

During the first two minutes of play, the intervention could not yet be triggered. This allowed participants to familiarize themselves with the controls and make initial progress in the game, increasing the likelihood that the intervention would be triggered following a meaningful loss of progress rather than an early minor setback. After this initial phase, the first level of the triggering system was activated.

The triggering system consisted of the following four levels:

- **Level 1: Fall from high score.**
  This first level prioritized triggers that were most likely to induce frustration, namely a substantial loss of progress near the player's highest reached position. The intervention was triggered when the player was within a predefined threshold of their highest attained position (measured along the vertical axis) and subsequently fell a significant distance.

  This distance was considered significant if it exceeded either an absolute threshold (i.e., a fixed vertical distance) or a relative threshold (i.e., a percentage of the player's current progress). This ensured that the intervention could be triggered both at lower and higher stages of progression within the level.

  The absolute threshold was set to 45 units, while the relative threshold was defined as a loss of 40% of the player's current progress.

- **Level 2: General fall.**
  The second level functioned similarly to the first, but without the requirement that the player had fallen from near their highest attained position. In this case, falling a significant distance alone was sufficient to trigger the intervention component. This level therefore acted as a lower-priority alternative to Level 1, capturing substantial mistakes regardless of the player's overall progress.

- **Level 3: Repeated failure in a local region.**
  The third level focused on players getting stuck on a particular section of the map, without losing an amount of progress large enough to trigger the first two levels. It employed a lower threshold for what constituted a fall and tracked all fall events within a 60-second window. If three of these falls occurred within a similar section of the level, this was taken as an indication that the player was struggling to progress past that area, and the intervention was triggered.

- **Level 4: Fallback trigger.**
  The fourth level functioned as a final fallback, intended to trigger only in cases where no substantial triggering events occurred within the preferred time frame. In these cases, a single fall exceeding 12 units was sufficient to activate the intervention.

The different triggering levels were not active simultaneously from the start of gameplay, but were progressively unlocked over time. At any given moment, only the levels that had been unlocked up to that point could trigger the intervention. This ensured that early gameplay remained uninterrupted, while increasing the likelihood of intervention delivery later in the session. The exact timeline of the 10-minute gameplay phase can be seen in Figure 4.

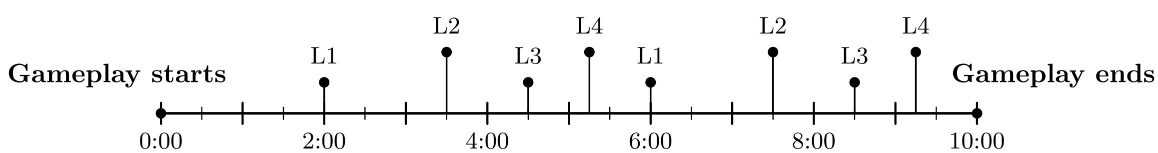


Figure 4: Timeline of the 10-minute gameplay phase with progressive level unlocks for intervention opportunities. Major ticks represent 1-minute intervals and minor ticks represent 30-second intervals. Familiarization phase lasted from 0:00 to 2:00. Intervention opportunity 1 was active from 2:00 to 10:00, and intervention opportunity 2 from 6:00 to 10:00. Unlock timestamps were L1/L2/L3/L4 at 2:00/3:30/4:30/5:15 and 6:00/7:30/8:30/9:15, respectively.

Once an event satisfied the conditions of one of the currently unlocked levels, the intervention was not triggered immediately. Instead, the system entered a short pending state. During or shortly after a fall, players may still be in a panicked state, making additional mistakes in quick succession. As the goal was to trigger the intervention at a moment of peak frustration, the system therefore delayed activation to account for this.

If the player fell further during this pending state, which lasted approximately 2 seconds, the additional fall was incorporated into the original event and treated as part of a single, larger fall. This prevented the intervention from being triggered prematurely. Furthermore, once the pending state ended and the intervention was confirmed to trigger, it was only activated when the player reached a grounded state. This ensured that the timing of the intervention itself did not interfere with the player's ongoing action or artificially influence their level of frustration.

The designed intervention component can be characterized as a hybrid between a system-initiated and situation-specific approach. While the system initiated the intervention automatically, it did not rely on bio-sensing to determine timing. Instead, a heuristic based on gameplay events was used to identify situations that were likely to be perceived as frustrating.

3.2.2 The Breathing Exercise

The intervention itself consisted of a brief, structured breathing exercise based on the cyclic sigh technique. A cyclic sigh involves a deep inhalation through the nose, followed by a second shorter inhalation, and a slow, extended exhalation through the mouth.

During the intervention, players were guided through a series of cyclic sighs via on-screen instructions. Before play, participants in the breathing group were familiarized with the breathing exercise and the instructional animations, to ensure correct execution of the exercise once the intervention was triggered during gameplay.

Evidence suggests that visual breathing cues outperform audio-only instructions in helping users follow a breathing pattern, with visualizations showing both improved breathing depth and higher user preference [24]. Seeing the breathing pattern helps users match the target breathing rhythm more easily. More recent work comparing four common breathing visualization styles used in mobile applications found that a *donut chart* visualization scored highly both in breathing synchronization and in user preference and usability ratings [26]. Based on these findings, and considering the asymmetric and relatively unusual structure of the cyclic sigh breathing pattern, a donut chart style visualization was selected for the guided breathing instructions provided during the intervention.

The donut chart visualization technique offers several advantages in this context. It clearly communicates the timing and progression of the different phases of the exercise through a segmented circular progress indicator. Furthermore, it makes transitions between breathing phases predictable and easy to anticipate by continuously displaying both the current phase and the phases that follow next. The segmented ring structure also lends itself naturally to the three-phase structure of cyclic sighing, which may be more difficult to represent clearly using alternative visualization techniques.

For the purpose of this study, a custom donut chart style breathing visualization was designed and implemented to guide players through the cyclic sighing exercise. The visualization displayed the various breathing phases, the progression through the current breathing cycle, and the number of remaining cycles. An example of the visualization used in-game can be seen in Figure 5.

The breathing exercise itself consisted of two consecutive cyclic sighs. Each cycle contained a 2 second primary inhalation, followed by a 1 second secondary inhalation, and concluded with a slow 6 second exhalation. The extended exhalation was chosen in line with prior work on cyclic sighing and exhale-emphasized breathing patterns, which are associated with reductions in physiological arousal and increases in positive affect [11]. The decision to limit the intervention to two breathing cycles was primarily motivated by the pacing of the gameplay experience. While a longer intervention may potentially produce stronger regulatory effects, extending the duration further was expected to disrupt gameplay flow to a greater extent.

Some prior work has incorporated biofeedback into breathing interventions by adapting the visualization based on the user's real breathing pattern. Such approaches may improve synchronization between target and performed breathing, and can increase feelings of presence and engagement during the exercise [32]. However, beginner users may initially experience the exercise as less relaxing due to the additional attentional demands associated with actively matching their breathing to the visualization [32]. Given the short duration of the intervention in the present work, as well as the preference for conducting the experiment fully remotely, biofeedback was not incorporated into the breathing exercise. This reduced the setup requirements for participants and lowered the barrier to participation, while also simplifying the interaction during emotionally heightened gameplay moments.

In terms of delivery, the intervention provided experiential, on-the-spot support, as it guided the player directly through the emotion regulation process during naturally occurring gameplay situations.

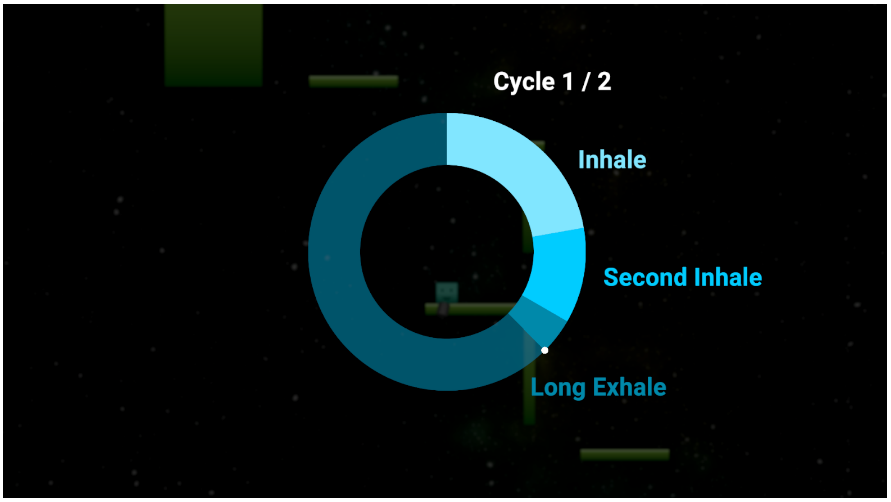


Figure 5: In-game visualization of the guided breathing exercise, showing the donut-shaped breathing indicator with distinct phases of the breathing cycle. The filled portion represents the elapsed time within the current cycle, while the unfilled portion represents the remaining duration. The marker indicates the player's current position within the cycle and moves along the visualization as the exercise progresses

Furthermore, the system provided ongoing support rather than a single prompt, scaffolding the player throughout the execution of the regulation strategy.

3.3 Experimental Setup

The experimental setup of the study is described in the following sections. First, the overall study design and participants are introduced, followed by a description of the experimental procedure. Finally, the measures used to assess the effects of the intervention are discussed.

3.3.1 Study Design

For this study, a between-subjects design was used, with participants being assigned to either the breathing or control condition. This design choice was made primarily due to the dynamic nature of the gameplay experience and the expected influence of prior experience with the game.

First of all, the player's experience is expected to differ substantially when playing the game for the first time compared to subsequent playthroughs. Part of the challenge of the game lies in becoming familiar with the controls and gradually developing mastery over the movement mechanics. As players become more proficient, they may experience fewer failures and approach challenging sections of the level differently. This could influence not only their frustration levels, but also their perceived competence, player experience, and gameplay performance. Furthermore, the extent to which players adapt to the mechanics is likely to vary between individuals, making it difficult to account for these effects by simply counterbalancing the order of conditions.

In addition to the effects of familiarity and learning, the heuristic approach used to determine intervention timing further complicates a within-subjects design. Ideally, intervention moments should occur at comparable levels of frustration across participants. However, even if a participant were to encounter the same gameplay situation in a second playthrough, their previous experience with similar failures and progression losses could influence their emotional response. This could make it difficult to determine whether differences between conditions are caused by the intervention itself or by changes in the player's interaction with the game.

Furthermore, implementing two gameplay sessions would either substantially increase the total duration of the experiment or require reducing the duration of each individual gameplay session. The former could increase the barrier for participation, particularly given the fully remote nature of the experiment, while the latter could reduce the amount of gameplay required for participants to become sufficiently engaged with the mechanics of the game. It could also limit the extent to which participants were able to build up meaningful progress within the level, reducing the likelihood that subsequent setbacks would be experienced as substantial or frustrating losses of progress. Although counterbalancing the order of conditions could mitigate some of these concerns, the combination of skill development, changing expectations, and dynamic gameplay interactions makes a between-subjects design more suitable for the current study.

Throughout the experiment, both repeated and single-point measurements were collected. Repeated measurements were used to assess changes over time, including momentary frustration before and after intervention moments, as well as frustration and affect before and after the gameplay session. In addition, several post-game measures were collected to assess broader effects of the intervention on psychological needs and player experience, while gameplay statistics were recorded throughout the session to examine player performance.

3.3.2 Participants

Participants were recruited through convenience sampling. They were drawn from the researcher's personal networks, including fellow students, friends, family members, online gaming communities, and online forums. Participation was voluntary and entirely remote. The minimum age for participation was set at 18 years, with no maximum age restriction.

A total of 58 participants completed the study. During data cleaning, four participants were excluded from the analysis. This included participants who did not progress sufficiently through the game to experience both intervention moments, as well as participants who were inactive for a substantial portion of the experiment. The final sample therefore consisted of $N = 54$ participants, of whom 26 were assigned to the breathing condition and 28 to the control condition.

To better contextualize the participant sample and gameplay experience, demographic information was collected regarding age, gender, region of residence, general gaming frequency, and familiarity with platformer games. Participants ranged in age from 18 to 74 years ($M = 28.24$, $SD = 13.00$). The sample consisted of 49 participants who identified as men and 5 participants who identified as women. Most participants resided in the Netherlands (79.6%), with the remaining participants living elsewhere in Europe (9.3%), North America (9.3%), and Asia (1.9%).

As shown in Figure 6, most participants reported moderate to high gaming frequency. The largest group indicated that they played video games one to two times per week, followed by participants who played daily and those who played one to three times per month. Relatively few participants reported gaming less than once per month, suggesting that the sample was generally familiar with video games.

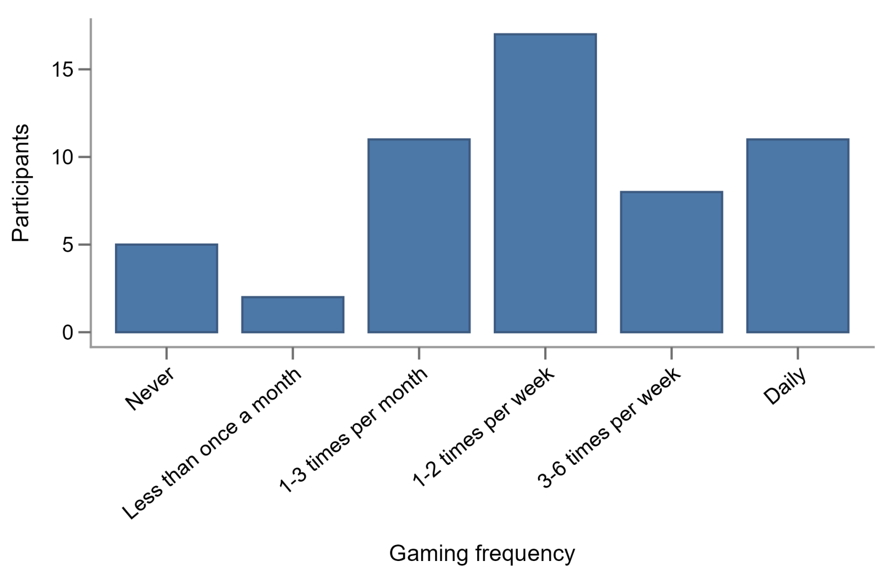


Figure 6: Distribution of self-reported gaming frequency across all participants

Participants were also asked to rate their familiarity with platformer games, as prior experience with this genre may influence gameplay performance and experienced frustration. Figure 7 shows that the sample was generally familiar with platformer games. The largest group reported being moderately familiar, followed by participants who were slightly familiar and very familiar. Fewer participants indicated no familiarity, while only a small number reported being extremely familiar.

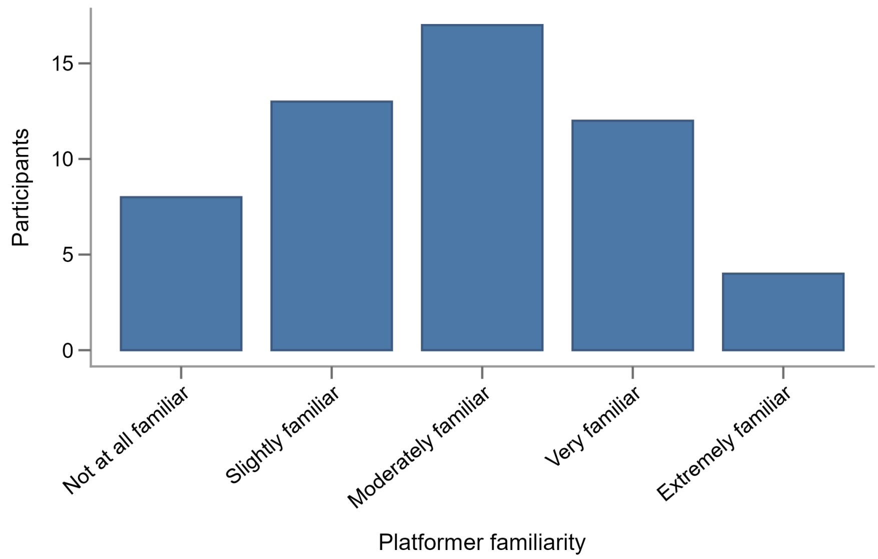


Figure 7: Distribution of self-reported familiarity with platformer games across all participants

3.3.3 Procedure

The experiment was conducted fully remotely. Participants accessed the game through a web browser using a provided link and were informed that a mouse and keyboard were required to play the game as intended. Data collection was integrated into the game itself, with both gameplay statistics and questionnaire responses being stored automatically throughout the experiment.

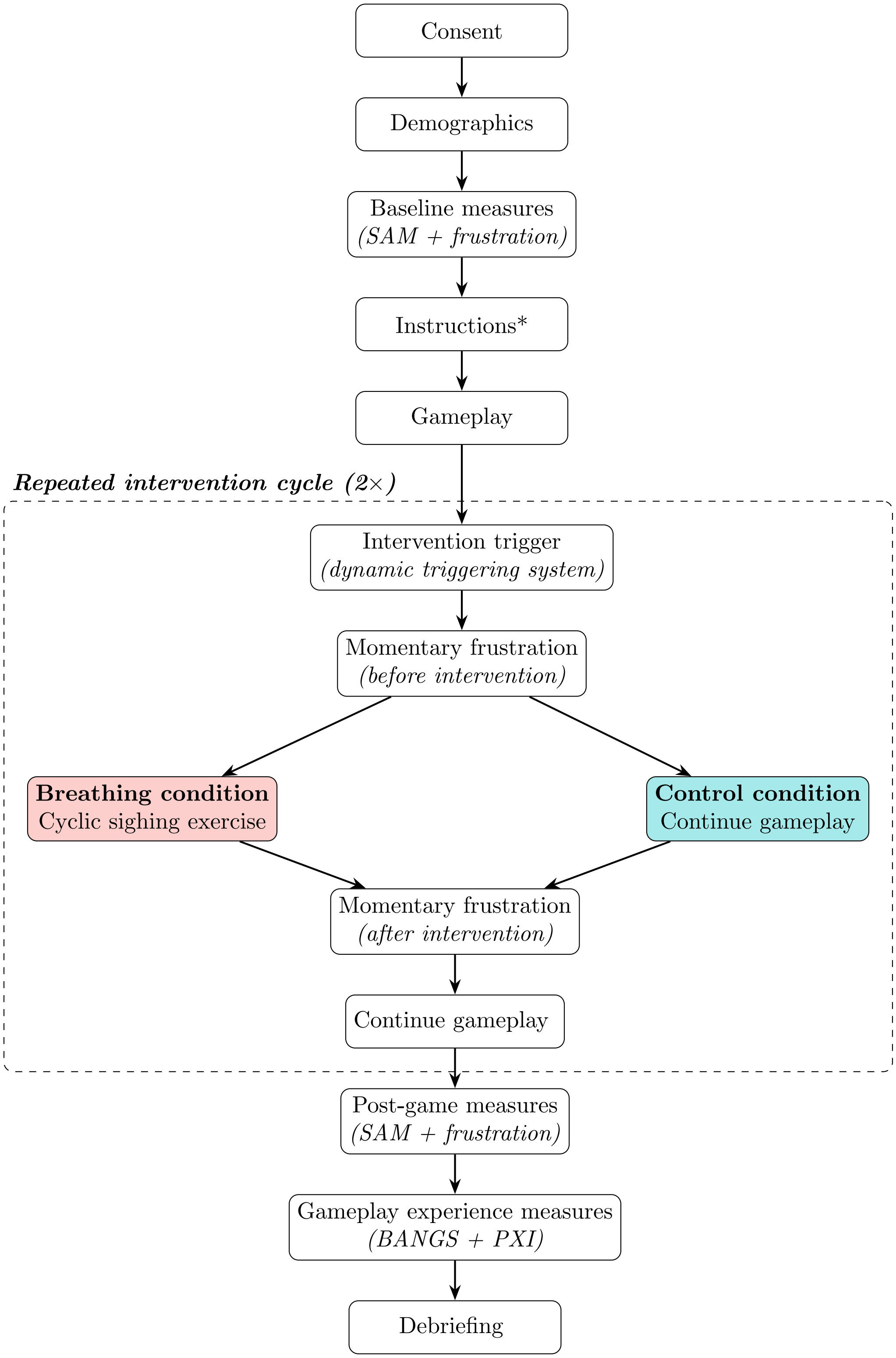
Participants were assigned to one of two groups using an automated balancing procedure. To keep group sizes balanced, each new participant was assigned to the group with the fewest fully completed sessions, meaning sessions in which all final questionnaires had been completed. The first group was the breathing group, in which participants were guided through the breathing exercise whenever the intervention system was triggered. The second group was the control group. For this group, the same intervention triggering system was used, but instead of performing the breathing exercise, participants continued gameplay for the duration of the intervention period. Both groups completed the momentary frustration assessment immediately before and after these intervention moments.

The procedure consisted of three phases, namely before, during, and after gameplay. Figure 8 provides an overview of the full experimental procedure, after which each phase is discussed in more detail.

Before Play

Several steps were completed before participants started playing the game and interacting with the intervention component. First, participants were asked to sign a consent form to ensure they were voluntarily taking part in the experiment and were informed of their right to withdraw at any time without penalty. Next, demographic information was collected to contextualize the participant sample and gameplay experience. Finally, baseline measurements of affect and frustration were collected using the Self-Assessment Manikin and a single-item frustration measure.

After the baseline measurements were completed, the breathing group was introduced to the breathing exercise. First, a general overview of the cyclic sighing technique was provided, after which participants were required to watch the animation of a single cycle at least once. At this point, they did not have to actively follow the exercise yet, but were instructed to get a feel for the timing of the different phases. In the next instructional panel, participants were asked to perform two full cycles of the exercise, following the on-screen guidance. The instructions were presented in the same format as during the gameplay phase, supporting correct execution during the experiment. After completing the two cycles, participants could choose to repeat the practice session by returning to the previous panel,



** The breathing group received additional instructions and practice for the breathing exercise before gameplay, whereas the control group received only the gameplay instructions.*

Figure 8: Overview of the experimental procedure. After providing consent, participants completed demographic questions and baseline measurements before receiving gameplay instructions. During gameplay, the dynamic intervention system was activated and the intervention cycle occurred twice. Depending on the assigned condition, participants either completed the cyclic sighing exercise or continued gameplay for an equivalent duration between the pre- and post-intervention frustration assessments. After completing the gameplay phase, participants completed post-game measures assessing affect, frustration, and gameplay experience, followed by a debriefing.

or proceed if they felt comfortable with the exercise. The breathing instructions were not provided to the control group.

This familiarization phase in the breathing group may have influenced participants' affective state outside of the gaming context. Although this may have introduced a small difference between groups, introducing the exercise for the first time during gameplay was not considered appropriate, as correct adherence to the breathing pattern was essential. To limit the impact of the instructions on the baseline measurements, affect and frustration were assessed prior to the breathing instruction and practice phase. This allowed for a more comparable baseline between the breathing and control groups.

Before participants started playing the game, they were given brief instructions regarding the objective of the game and the in-game controls.

Since need frustration is exacerbated when experienced difficulty deviates from a player's expectations, care was taken to avoid shaping expectations about the game's difficulty during this phase. To this end, only minimal information about the challenging nature of the game was provided, and a full debriefing was given after the gameplay phase was completed.

During Play

After the questionnaires were completed and the participant had read the introductory instructions, the gameplay phase began. During the first two minutes of gameplay, no intervention could be triggered yet, allowing the player to become familiar with the controls and game mechanics. After this initial familiarization period, the intervention triggering system became active. Over time, if the player did not lose substantial progress, additional triggering levels were progressively unlocked. A more detailed description of the triggering logic and activation levels is provided in Section 3.2.1.

Ideally, each participant would experience exactly two intervention moments during gameplay. However, due to differences in player skill, pacing, and the dynamic nature of movement throughout the level, this could not be guaranteed in practice. Even so, the fourth triggering level, i.e., the fallback trigger requiring only a relatively small fall, made it highly likely that participants would receive at least one intervention during the session.

Since the level was handcrafted, the vertically stacked gameplay sections did not extend infinitely. This meant that participants could theoretically reach the end of the level within the experiment time frame. However, through extensive playtesting and iterative balancing of the level design, the game was made sufficiently extensive and difficult to make this highly unlikely in practice. This prevented completion of the game from influencing the player's affective state in ways unrelated to the intervention component. Indeed, none of the participants completed the entire level within their first 10 minutes of play.

At moments of intervention, both groups first completed the single-item frustration measure, capturing the participant's frustration level immediately before the intervention period. Participants in the breathing group were then guided through two cycles of the cyclic sighing breathing exercise. In the control group, participants instead continued gameplay for an equivalent duration. After either the breathing exercise or the equivalent gameplay period had concluded, all participants completed the momentary frustration assessment once more. By measuring perceived frustration immediately before and after the intervention period, the study could directly examine short-term changes in frustration between the two groups.

For the control group, allowing participants to continue gameplay between the two frustration assessments was not a trivial design decision. Alternative options, such as displaying a blank screen or showing a passive waiting period, were also considered. However, since the aim was to compare the breathing exercise against a baseline condition without an explicit regulation strategy, allowing participants to simply continue playing was considered the most appropriate comparison. While gameplay events occurring during this period could influence participants' frustration levels, this approach more closely resembles typical gameplay behavior, where players generally continue attempting to overcome challenges after failure [46].

After Play

After the gameplay phase had concluded, participants completed the post-gameplay measurements, consisting of assessments of affect, frustration, psychological need satisfaction and frustration, and overall player experience.

After all questionnaires had been completed, the experiment concluded. Participants then received a short debriefing statement explaining that the game had intentionally been designed to be highly challenging and potentially frustrating for the purposes of the study. Furthermore, participants were informed that they were free to either close the game or continue playing from where they had left off.

3.3.4 Measures

Several measures have been taken before, during, and after gameplay. Together, these measures are intended to capture both short-term changes elicited by the intervention and broader experiential outcomes of the gameplay session. The timing of these measurements throughout the experiment has been described in Section 3.3.3. The measures themselves are discussed below.

Need Satisfaction and Frustration

The present study is grounded in Basic Psychological Needs Theory (BPNT), a core component of Self-Determination Theory, which proposes that the satisfaction and frustration of the needs for autonomy, competence, and relatedness play a central role in motivation, well-being, and maladaptive outcomes [80]. Of particular relevance to this work is competence need frustration, which has been linked to negative affect, aggression, and maladaptive behavior in gaming contexts [74].

To assess psychological need satisfaction and frustration in gameplay contexts, the Basic Needs in Games Scale (BANGS) provides a context-specific alternative to more general need satisfaction and frustration measures. The BANGS was developed to capture both positive and negative game-related experiences through the lens of Self-Determination Theory, explicitly measuring need satisfaction and need frustration as related but distinct constructs [12]. This distinction aligns with prior work within Self-Determination Theory, which argues that need frustration is not merely the absence of need satisfaction, but reflects the active thwarting of psychological needs associated with distinct motivational and emotional consequences [22, 90, 95].

The validity of the BANGS has been demonstrated across multiple studies, showing reliable measurement of need satisfaction and frustration constructs and a factor structure that aligns with the theoretical distinctions proposed within Self-Determination Theory [12]. By grounding item wording directly in gameplay experiences, the scale is well suited to capturing variations in need satisfaction and frustration that arise during play, compared to more general-purpose instruments such as the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) [22]. As such, the BANGS has been proposed as a suitable measure for investigating need-based experiences in games, including competence-related frustration during challenging or failure-prone gameplay situations [12].

Moreover, the BANGS has been used to examine differences in need satisfaction and frustration across gameplay experiences and game designs, suggesting it is suitable for assessing competence frustration within experimental gameplay contexts [12]. This aligns well with the aims of the present study, which investigates emotion regulation in response to frustration elicited during gameplay.

In the context of the present work, competence need frustration was of particular relevance, as the challenging nature of the game could give rise to competence-impeding situations. At such moments, the intervention aimed to support regulation of the player's emotional response and mitigate experienced frustration.

The original BANGS consists of 18 items covering autonomy, competence, and relatedness satisfaction and frustration. However, for the purpose of the present study, the relatedness items were omitted, resulting in a reduced 12-item version of the scale. This decision was made because the game used in the experiment was entirely single-player, making the relatedness items less applicable to the gameplay experience and potentially confusing for participants.

The remaining items consisted of statements relating to autonomy and competence experiences during play, such as "I felt I made progress while playing the game", or "I felt forced to take certain actions in the game". Participants responded using a 7-point Likert scale ranging from 'Strongly disagree' (1) to 'Strongly agree' (7). Each item represented either satisfaction or frustration of a particular psychological need, with construct scores calculated by combining the relevant items.

Momentary Frustration

Besides the need satisfaction and frustration measures, a separate single-item frustration measure was included to more directly assess participants' immediate subjective frustration levels throughout the experiment. This measure is referred to as the momentary frustration measure throughout this thesis. In contrast to competence need frustration, which reflects the thwarting of a psychological need, this measure focused specifically on the participant's consciously experienced feeling of frustration at a given moment in time.

The measure was used repeatedly across the experiment to capture fluctuations in frustration before gameplay, surrounding the intervention moments during gameplay, and after the gameplay session. In particular, it was intended to assess more immediate changes in frustration surrounding the intervention moments, allowing for examination of the short-term effects of the breathing exercise.

No validated single-item measure specifically targeting momentary frustration was identified in the reviewed literature. For this reason, a straightforward self-report question was designed with the aim of minimizing interpretive ambiguity and bias. Participants were asked the question "How frustrated do you feel right now?", and responded using a 7-point Likert scale ranging from "Not at all" (1) to "Extremely" (7).

Affect

Besides frustration and need frustration, the present study also assessed the players' affective state. Prior work has shown that affective responses during gameplay are closely related to competence-related experiences, with competence-impeding situations associated with more negative affective states [74]. Since the intervention in the present work aimed to down-regulate emotional responses following frustrating gameplay events, affect formed an important outcome measure alongside competence frustration and momentary frustration.

To assess affective state, the Self-Assessment Manikin (SAM) [19] was used. The SAM is a non-verbal pictorial assessment technique designed to measure emotional responses along three affective dimensions: valence, arousal, and dominance. Valence reflects how pleasant or unpleasant an emotional state is experienced, arousal reflects the degree of physiological or emotional activation, and dominance reflects the extent to which a person feels in control versus overwhelmed by the situation.

The SAM was administered before and after the gameplay phase of the experiment, rather than during gameplay. This allowed for a pre-post comparison of the overall affective state associated with the game session and the intervention, without interrupting the gameplay experience itself. In this context, the measure primarily captured more stable changes in affect across the experimental session rather than moment-to-moment fluctuations.

Compared to questionnaire-based affect measures, the SAM is particularly suitable for brief assessments of emotional state, as it can be completed quickly while imposing relatively low cognitive load on participants [19]. This made it appropriate for use at the boundaries of the gameplay phase, where it could be administered alongside the other post-gameplay measures without adding excessive burden or making the post-experiment questionnaire set overly long.

Another advantage of the SAM is that it measures affect dimensionally rather than focusing on discrete emotions. This aligns well with the goals of the present work, where the aim was not to identify specific emotions individually, but rather to examine broader shifts in emotional state following frustrating gameplay situations and the breathing intervention.

The SAM was implemented using a 7-point scale for each of the three affective dimensions. Participants selected the figure that best matched how they felt at that moment in time, resulting in separate scores for valence, arousal, and dominance.

Player Experience

In addition to measuring need frustration and affect, it was also important to examine the overall player experience, as it provides insight into how engaging, enjoyable, or challenging the gameplay is perceived to be. Player experience encompasses both cognitive and emotional responses to game mechanics, challenge, and interface design, and can help indicate the effects of the intervention component on not just the player's need frustration and affective state, but also on their general gameplay experience.

To assess player experience, the Player Experience Inventory (PXI) was used. The PXI offers a comprehensive framework for capturing multiple dimensions of gameplay, including challenge, competence, immersion, affective engagement, and flow-related experiences. The scale was designed to assess both immediate, functional consequences of gameplay (e.g., ease of control) and higher-order psychosocial outcomes (e.g., immersion and mastery), with construct validity and reliability supported across multiple studies and populations [2].

In the context of the present study, the PXI was used to capture participants' overall evaluation of the gameplay experience. Since several other measures focused on more immediate emotional responses, including the PXI provided a broader assessment of the gameplay experience, allowing the effects of the intervention to be examined beyond need satisfaction, frustration, and affect. The full version of the PXI was used instead of the abbreviated variant. Although this increased the length of the post-game questionnaire slightly, the overall questionnaire burden remained acceptable due to the relatively brief state assessments and reduced BANGS questionnaire.

The PXI measures player experience at both the level of functional consequences, i.e. the immediate, tangible consequences, experienced as a result of game design choices, and the level of psychosocial consequences, i.e. the emotional experiences, as a second-order response to game design choices. The inventory consists of 11 constructs, measured by 3 items each. The constructs are ease of control, goals and rules, challenge, progress feedback, audiovisual appeal, meaning, curiosity, mastery, immersion, autonomy, and enjoyment. Each construct is measured via a 7-point Likert scale, ranging from 'strongly disagree' (-3) to 'strongly agree' ($+3$).

Performance

Besides the self-report measures collected throughout the experiment, several gameplay statistics were recorded automatically. Whereas the questionnaires captured participants' subjective experiences during and after gameplay, these gameplay statistics provide a more objective indication of player performance within the game.

The primary performance measures consisted of the greatest height reached during the gameplay session, the total number of falls, the average distance climbed between falls, and the percentage of falls that occurred from the player's highest attained position. Together, these measures capture different aspects of player progression and failure throughout the game, allowing the performance of the breathing and control groups to be compared from multiple perspectives.

Furthermore, all gameplay was logged as a sequence of game states, allowing gameplay sessions to be replayed afterwards. A custom replay viewer was developed for this purpose, making it possible to inspect gameplay sessions and identify invalid sessions for exclusion without requiring participants to record their screens during the fully remote experiment.

4 Results

In this section, the results of the experiment are presented. As the analyses were based on valid sessions in which participants received both intervention moments, four of the 58 completed sessions were excluded. The reported analyses are therefore based on the final sample of $N = 54$ participants.

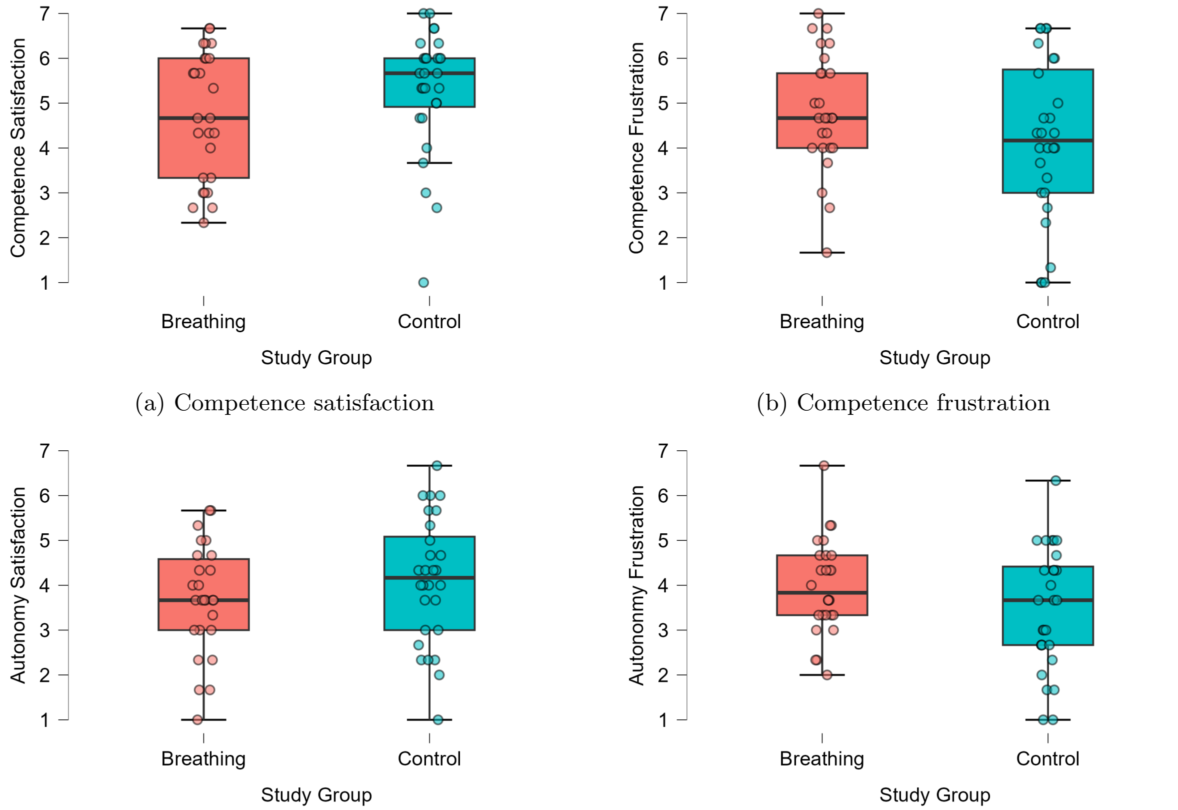
The results are presented in the following order. First, need satisfaction and frustration are examined. Next, momentary frustration and affect are analyzed, followed by the evaluation of overall player experience. Finally, player performance is analyzed.

4.1 Need Satisfaction and Frustration

Need satisfaction and frustration were measured at the end of the gameplay phase for the needs of competence and autonomy. Figure 9 shows the distribution of construct scores, and Table 1 reports descriptive statistics. Visually, the boxplots suggest slightly higher competence satisfaction and lower competence frustration in the control group compared to the breathing group. In contrast, autonomy satisfaction and frustration appear more similar between groups. More generally, substantial overlap can be observed across all construct score distributions.

Competence satisfaction scores were relatively high for both groups, whereas competence frustration was also reported at a moderate to relatively high level. Compared to the breathing group, the control group appeared to report somewhat higher competence satisfaction and lower competence frustration. Autonomy satisfaction and frustration were both reported around moderate levels and appeared more comparable between groups, with only modest differences in the descriptive statistics.

A Shapiro-Wilk test of normality indicated that competence satisfaction and competence frustration deviated significantly from a normal distribution, with $p = .008$ and $p = .048$, respectively. Based on these assumption checks, Mann-Whitney U tests were used to examine differences between the breathing and control groups on the post-game need scores (see Table 2). The results did not show any significant differences for competence satisfaction, competence frustration, autonomy satisfaction, or autonomy frustration. These null results are consistent with the boxplots and descriptive statistics, which show substantial overlap between the groups. The rank-biserial correlations are small and do not indicate a meaningful group effect.



(a) Competence satisfaction

(b) Competence frustration

(c) Autonomy satisfaction

(d) Autonomy frustration

Figure 9: Boxplots showing the distribution of BANGS construct scores for (a) competence satisfaction, (b) competence frustration, (c) autonomy satisfaction, and (d) autonomy frustration across the breathing and control group, with individual participant scores overlaid as jittered points

4.2 Momentary Frustration

Perceived frustration over time formed one of the primary outcome measures of the present study. In total, frustration was assessed at six measurement points. First, a baseline measurement was taken before gameplay. During gameplay, frustration was measured immediately before and after each intervention moment, resulting in four additional measurements. Finally, frustration was assessed once more after the gameplay phase had concluded. Figure 10 illustrates the progression of perceived frustration over time, while descriptive statistics for each measurement point are reported in Table 3.

Visually, the measurements appear to show an overall increase in frustration over time. Frustration levels rose substantially from the pre-game baseline to the first intervention moment, after which a decrease can be observed following the intervention. A similar pattern appears for the second intervention, with frustration levels again increasing leading up to the intervention and decreasing afterwards. Despite these temporary decreases, post-game frustration levels remained notably higher than the pre-game baseline for both groups, suggesting an overall upward trend in perceived frustration across the gameplay phase.

Table 1: Descriptive statistics of BANGS construct scores for competence and autonomy satisfaction and frustration across study groups

	Autonomy satisfaction		Competence satisfaction		Autonomy frustration		Competence frustration	
	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control
N	26	28	26	28	26	28	26	28
M	3.69	4.11	4.71	5.29	3.96	3.49	4.81	4.16
SD	1.23	1.41	1.43	1.38	1.07	1.36	1.30	1.80

Table 2: Mann-Whitney U tests comparing study groups

Measure	U	p	r_{rb}
Competence satisfaction	279.5	.144	0.232
Competence frustration	444.5	.164	-0.221
Autonomy satisfaction	295.0	.234	0.190
Autonomy frustration	435.0	.220	-0.195

Note. Mann-Whitney U tests compare the Breathing and Control groups. p values are two-tailed. Effect sizes are rank-biserial correlations (r_{rb}). The standard error for r_{rb} (estimated from $n_1 = 26$, $n_2 = 28$) is 0.157 for all tests.

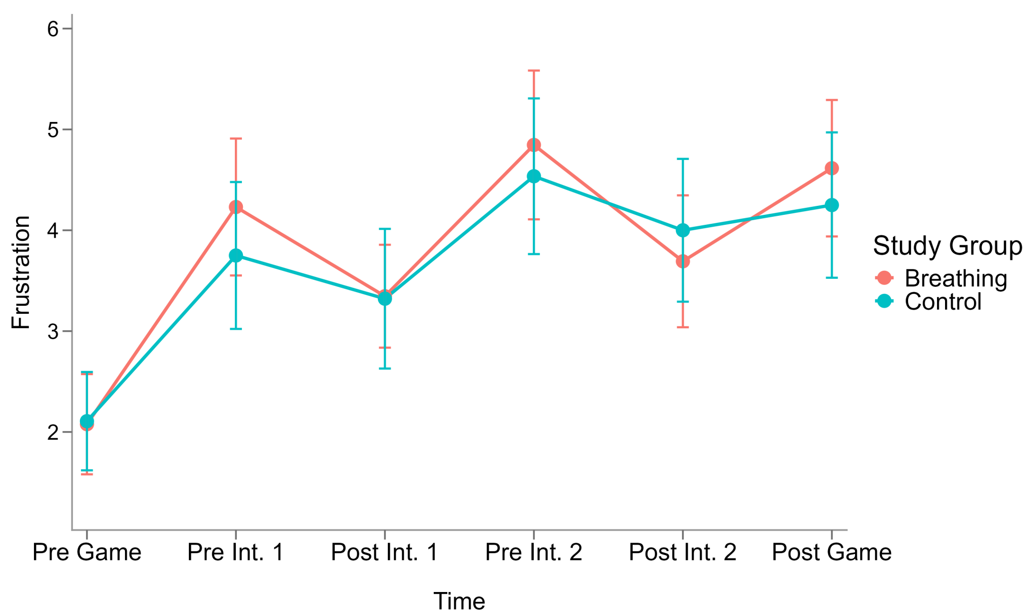


Figure 10: Mean frustration over time by study group with 95% confidence interval error bars

Table 3: Descriptive statistics of momentary frustration scores across the six measurement time points

	Pre game		Pre int. 1		Post int. 1		Pre int. 2		Post int. 2		Post game	
	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control
N	26	28	26	28	26	28	26	28	26	28	26	28
M	2.08	2.11	4.23	3.75	3.35	3.32	4.85	4.54	3.69	4.00	4.62	4.25
SD	1.23	1.26	1.68	1.88	1.26	1.79	1.83	1.99	1.62	1.83	1.68	1.86

A mixed ANOVA was conducted to examine frustration across the intervention moments, using a $2 \times 2 \times 2$ mixed design with *pre/post intervention* (pre, post) and *intervention moment* (intervention 1, intervention 2) as within-subjects factors, and *study group* (breathing, control) as a between-subjects factor. For this analysis, only the frustration measurements surrounding the interventions were included, corresponding to measurement points 2–5 in Figure 10 (see Table 4).

There was a significant main effect of pre/post intervention, $F(1, 52) = 36.77$, $p < .001$, $\eta_p^2 = .414$, indicating that frustration decreased from pre to post intervention overall. There was also a significant pre/post intervention × study group interaction, $F(1, 52) = 4.71$, $p = .035$, $\eta_p^2 = .083$, suggesting that the pre/post change differed between study groups. Based on Figure 10 and the descriptive statistics in Table 3, this interaction suggests a larger pre- to post-intervention decrease in frustration for the breathing group compared to the control group. In addition, there was a significant main effect of intervention 1 versus intervention 2, $F(1, 52) = 23.19$, $p < .001$, $\eta_p^2 = .308$, indicating that frustration levels differed between the first and second intervention moments. The descriptive statistics in Table 3 suggest that frustration levels were higher before and after the second intervention compared to the first intervention, indicating that participants experienced increasing frustration as gameplay progressed. However, there was no significant intervention × study group interaction, $F(1, 52) = 1.00$, $p = .323$, $\eta_p^2 = .019$. The pre/post × intervention interaction was not significant, $F(1, 52) = 1.13$, $p = .292$, $\eta_p^2 = .021$, and the three-way interaction between pre/post intervention, intervention 1/2, and study group was also not significant, $F(1, 52) = 0.21$, $p = .649$, $\eta_p^2 = .004$.

The between-subjects test showed no overall difference between study groups, $F(1, 52) = 0.086$, $p < .771$, $\eta_p^2 = .002$, indicating that averaged across time points the breathing and control groups did not differ in frustration.

Table 4: Within- and between-subjects effects on frustration before and after each intervention

Effect	Sum of Squares	df	Mean Square	F	p	η_p^2
Within-subjects effects						
Pre/post intervention	30.390	1	30.390	36.770	$< .001$	.414
Pre/post intervention × Study group	3.889	1	3.889	4.705	.035	.083
Error	42.980	52	0.827			
Intervention	19.830	1	19.830	23.190	$< .001$	.308
Intervention × Study group	0.852	1	0.852	0.996	.323	.019
Error	44.480	52	0.855			
Pre/post intervention × Intervention	0.477	1	0.477	1.131	.292	.021
Pre/post intervention × Intervention × Study group	0.089	1	0.089	0.210	.649	.004
Error	21.950	52	0.422			
Between-subjects effects						
Study group	0.871	1	0.871	0.086	.771	.002
Error	528.300	52	10.160			

Note. Type III sums of squares.

Furthermore, a mixed ANOVA was conducted to examine changes in frustration across all six measurement points, using measurement time point as a within-subjects factor and study group as a between-subjects factor (see Table 5). Because Mauchly's test indicated that the sphericity assumption was violated for the repeated-measures factor, Greenhouse-Geisser corrected degrees of freedom were used for the within-subjects effects. The analysis showed a significant main effect of time, $F(3.768, 195.9) = 50.58$, $p < .001$, $\eta_p^2 = .493$, indicating that frustration changed substantially over the course of the session. However, the interaction between time and study group was not significant, $F(3.768, 195.9) = 1.279$, $p = .281$, $\eta_p^2 = .024$, suggesting that the overall time course of frustration did not differ reliably between the breathing and control groups. The between-subjects effect of study group was also not significant, $F(1, 52) = 0.130$, $p = .720$, $\eta_p^2 = .002$, indicating no overall difference in frustration between groups.

To examine the shape of the frustration trajectory in more detail, polynomial contrasts were computed for the repeated-measures factor (see Table 6). Significant linear, quadratic, cubic, and quintic components indicated that the change in frustration was not simply monotonic, but instead followed a more complex non-linear pattern across the session. Based on the observed time course, frustration increased sharply from the pre-game baseline to the first intervention period, decreased after the first intervention, rose again before the second intervention, decreased again after the second intervention, and then increased toward the post-game measurement. This pattern suggests an overall upward tendency in frustration across the session, overlaid with alternating peaks and troughs around the intervention phases. The quartic trend was not significant, indicating that this specific component did not contribute meaningfully to the overall shape of the trajectory.

Table 5: Mixed ANOVA effects on frustration across six time points and study group

Effect	Sum of Squares	df	Mean Square	F	p	η_p^2
Within-subjects effects						
Time	234.0	3.768	62.09	50.58	$< .001$	.493
Time × Study Group	5.914	3.768	1.570	1.279	.281	.024
Error	240.5	195.9	1.228			
Between-subjects effects						
Study Group	1.598	1	1.598	0.130	.720	.002
Error	641.2	52	12.33			

Note. Type III sums of squares. Greenhouse-Geisser correction was applied because the sphericity assumption was violated for the repeated-measures factor.

Table 6: Polynomial contrasts for the time effect on frustration, averaged over study group

Contrast	Estimate	SE	df	t	p
Linear	1.509	0.159	52	9.485	$< .001$
Quadratic	-0.798	0.140	52	-5.706	$< .001$
Cubic	0.543	0.124	52	4.367	$< .001$
Quartic	-0.177	0.095	52	-1.862	.068
Quintic	1.048	0.128	52	8.175	$< .001$

Note. Results are averaged over the levels of: study group.

To complement the six-point repeated-measures analysis and directly assess whether frustration changed from immediately before to immediately after gameplay, a separate 2×2 mixed ANOVA was conducted, with *time* (pre-game, post-game) as a within-subjects factor and *study group* (breathing, control) as a between-subjects factor. This analysis showed a significant main effect of time, $F(1, 52) = 105.3$, $p < .001$, $\eta_p^2 = .669$, indicating that frustration significantly increased from pre- to post-game. However, the interaction between time and study group was not significant, $F(1, 52) = 0.752$, $p = .390$, $\eta_p^2 = .014$, suggesting that this increase did not differ reliably between the breathing and control groups. The main effect of study group was also not significant, $F(1, 52) = 0.230$, $p = .633$, $\eta_p^2 = .004$, indicating no overall difference in frustration between groups.

4.3 Affect

Before and after gameplay, participants self-assessed their levels of valence, arousal, and dominance by selecting a figure for each affective dimension on the SAM scale. Figure 11 illustrates the reported values, while Table 8 presents the corresponding descriptive statistics.

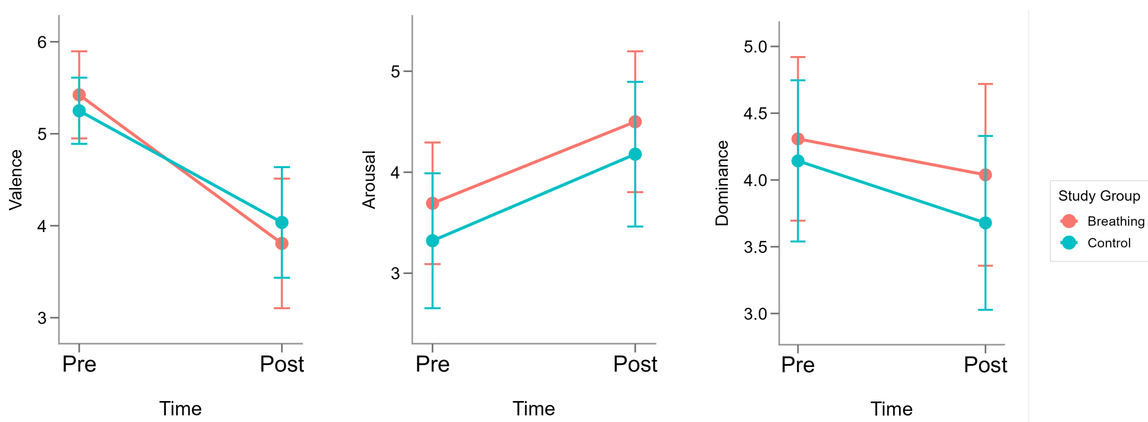
Valence levels were relatively high before play for both groups and decreased by more than one point on average on the 7-point scale after gameplay. Arousal levels were moderate before play and appear to have increased following gameplay. Dominance levels were also moderate before play and appear to have decreased slightly after gameplay, although the change was relatively small.

To assess whether changes over time and differences between groups were significant, mixed repeated-measures ANOVAs were conducted for valence, arousal, and dominance. As noted above, valence was high before play and dropped by more than a full point on the 7-point scale after play. For valence (see Table 9), there was a significant main effect of Time, $F(1, 52) = 24.74$, $p < .001$, $\eta_p^2 = .322$,

Table 7: Mixed ANOVA effects on frustration before and after gameplay

Effect	Sum of Squares	df	Mean Square	F	p	η_p^2
Within-subjects effects						
Time	147.7	1	147.7	105.3	$<.001$	.669
Time $\times$ Study Group	1.055	1	1.055	0.752	.390	.014
Error	72.95	52	1.403			
Between-subjects effects						
Study Group	0.757	1	0.757	0.230	.633	.004
Error	171.0	52	3.288			

Note. Type III sums of squares.



(a) Valence (b) Arousal (c) Dominance

Figure 11: Self-Assessment Manikin (SAM) scores before and after gameplay by study group for (a) valence, (b) arousal, and (c) dominance, with points representing group means and error bars representing 95% confidence intervals

Table 8: Descriptive statistics for SAM by time and group

	Valence (Pre)		Valence (Post)		Arousal (Pre)		Arousal (Post)		Dominance (Pre)		Dominance (Post)	
	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control
N	26	28	26	28	26	28	26	28	26	28	26	28
M	5.42	5.25	3.81	4.04	3.69	3.32	4.50	4.18	4.31	4.14	4.04	3.68
SD	1.17	0.93	1.74	1.55	1.49	1.72	1.73	1.85	1.52	1.56	1.69	1.68

indicating a reliable decrease from pre- to post-game. The main effect of Study Group was not significant, $F(1, 52) = 0.012$, $p = .912$, $\eta_p^2 < .001$, and the Time $\times$ Study Group interaction was also not significant, $F(1, 52) = 0.497$, $p = .484$, $\eta_p^2 = .009$, suggesting the decrease in valence was similar across groups.

Table 9: Mixed ANOVA effects on valence before and after gameplay

Effect	Sum of Squares	df	Mean Square	F	p	η_p^2
Within-subjects effects						
Time	53.97	1	53.97	24.74	$< .001$	0.322
Time $\times$ Study Group	1.084	1	1.084	0.497	.484	0.009
Error	113.4	52	2.181			
Between-subjects effects						
Study Group	0.020	1	0.020	0.012	.912	2.39×10^{-4}
Error	85.16	52	1.638			

Note. Type III sums of squares.

For arousal (see Table 10), there was a significant main effect of Time, $F(1, 52) = 8.394$, $p = .005$, $\eta_p^2 = .139$, indicating higher arousal after play. The main effect of Study Group was not significant, $F(1, 52) = 0.901$, $p = .347$, $\eta_p^2 = .017$, and the Time $\times$ Study Group interaction was not significant, $F(1, 52) = 0.007$, $p = .932$, $\eta_p^2 < .001$, suggesting similar pre-post increases across groups.

Table 10: Mixed ANOVA effects on arousal before and after gameplay

Effect	Sum of Squares	df	Mean Square	F	p	η_p^2
Within-subjects effects						
Time	18.68	1	18.68	8.394	.005	0.139
Time $\times$ Study Group	0.016	1	0.016	0.007	.932	1.42×10^{-4}
Error	115.7	52	2.226			
Between-subjects effects						
Study Group	3.231	1	3.231	0.901	.347	0.017
Error	186.5	52	3.587			

Note. Type III sums of squares.

For dominance (see Table 11), there was no significant main effect of Time, $F(1, 52) = 1.386$, $p = .244$, $\eta_p^2 = .026$. The main effect of Study Group was also not significant, $F(1, 52) = 0.720$, $p = .400$, $\eta_p^2 = .014$, and the Time $\times$ Study Group interaction was not significant, $F(1, 52) = 0.098$, $p = .755$, $\eta_p^2 = .002$. This suggests dominance remained relatively stable over time and did not differ between groups.

Table 11: Mixed ANOVA effects on dominance before and after gameplay

Effect	Sum of Squares	df	Mean Square	F	p	η_p^2
Within-subjects effects						
Time	3.627	1	3.627	1.386	.244	0.026
Time $\times$ Study Group	0.256	1	0.256	0.098	.755	0.002
Error	136.0	52	2.616			
Between-subjects effects						
Study Group	1.856	1	1.856	0.720	.400	0.014
Error	134.0	52	2.577			

Note. Type III sums of squares.

During the experiment, informal observations suggested that some participants found the dominance dimension more difficult to interpret than the other SAM dimensions. Specifically, some participants asked for clarification regarding the distinction between feeling controlled versus dominant. As these observations were not systematically collected, they were not analyzed quantitatively and are only considered as a potential interpretation issue.

4.4 Player Experience

Player experience was assessed at the end of the gameplay phase using the Player Experience Inventory. Figure 12 shows the distribution of construct scores, and Table 12 reports descriptive statistics across both study groups.

Overall, several constructs appear to be rated at slightly positive levels, in particular immersion, curiosity, ease of control, and clarity of goals. Other constructs, such as meaning and autonomy, appear closer to neutral or slightly negative values on average, indicating more mixed evaluations across participants. Considerable variability can be observed across constructs, as reflected in the relatively large standard deviations.

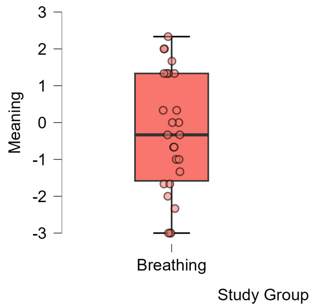
Comparing the two study groups, the control group generally shows slightly higher mean scores across most constructs, most notably for mastery, clarity of goals, progress feedback, and audiovisual appeal. However, for many constructs the differences between groups appear relatively small, and the distributions show substantial overlap. Overall, both groups exhibit a broadly similar pattern of player experience across the different PXI dimensions.

Table 12: Descriptive Statistics for Player Experience Inventory Constructs

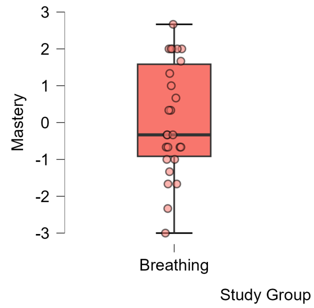
Construct	Group	N	M	SD
Meaning	Breathing	26	-0.308	1.649
	Control	28	0.024	1.437
Mastery	Breathing	26	0.090	1.536
	Control	28	0.750	1.509
Immersion	Breathing	26	1.205	0.838
	Control	28	1.333	1.129
Autonomy	Breathing	26	-0.372	1.595
	Control	28	0.048	1.410
Curiosity	Breathing	26	1.321	1.593
	Control	28	1.560	1.180
Ease of Control	Breathing	26	1.128	1.303
	Control	28	1.214	1.228
Challenge	Breathing	26	0.436	1.478
	Control	28	0.548	1.231
Progress Feedback	Breathing	26	0.449	1.749
	Control	28	0.762	1.490
Audiovisual Appeal	Breathing	26	0.513	1.452
	Control	28	0.869	1.347
Clarity of Goals	Breathing	26	1.782	1.591
	Control	28	2.131	0.867
Enjoyment	Breathing	26	0.885	1.720
	Control	28	1.107	1.483

To compare the breathing and control groups on the Player Experience Inventory constructs, Mann-Whitney U tests were conducted (Table 13). None of the constructs showed statistically significant

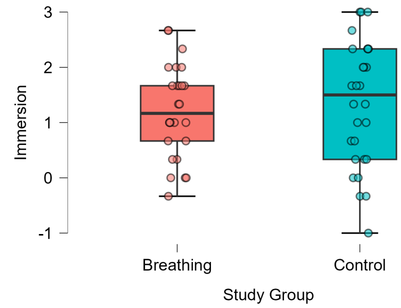
Figure 12: Boxplots of Player Experience Inventory constructs by study group



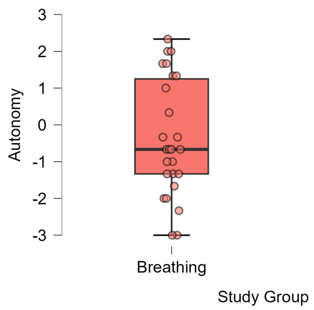
(a) Meaning



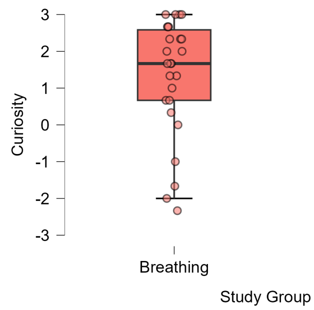
(b) Mastery



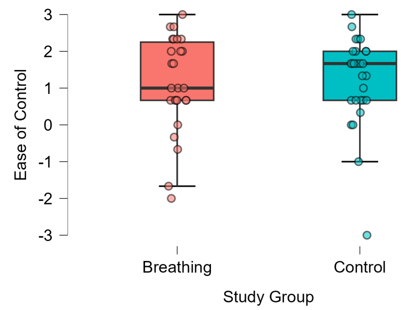
(c) Immersion



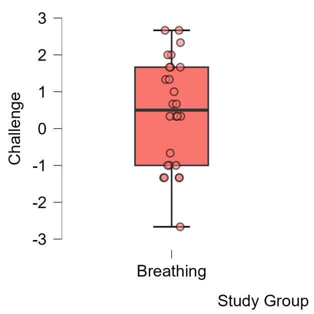
(d) Autonomy



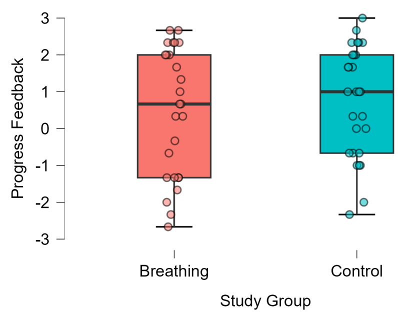
(e) Curiosity



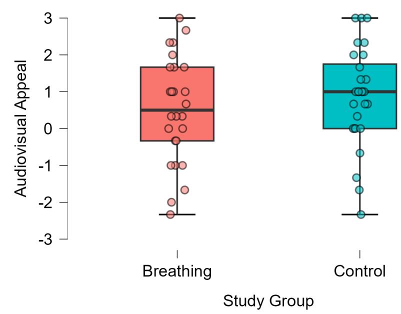
(f) Ease of control



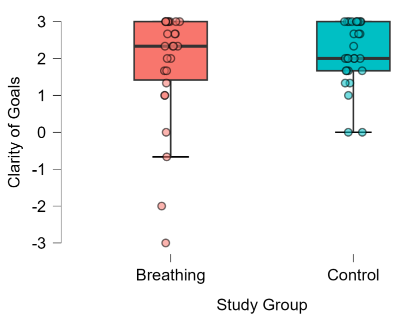
(g) Challenge



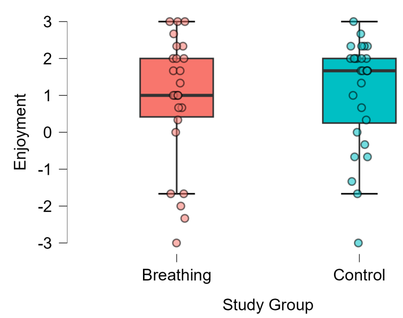
(h) Progress feedback



(i) Audiovisual appeal



(j) Clarity of goals



(k) Enjoyment

Each panel shows the distribution of one Player Experience Inventory construct for the breathing and control groups.

group differences (all $p \geq .162$). Effect sizes were uniformly small (rank-biserial $r_{\mathrm{rb}} \leq 0.223$), with the largest differences observed for mastery ($r_{\mathrm{rb}} = 0.223$) and autonomy ($r_{\mathrm{rb}} = 0.170$). Overall, these results indicate similar PXI need satisfaction and frustration scores across the two groups.

Table 13: Mann-Whitney U tests for Player Experience Inventory constructs

Measure	U	p	r_{rb}
Meaning	324.5	.498	0.109
Mastery	283.0	.162	0.223
Immersion	330.0	.560	0.093
Autonomy	302.0	.286	0.170
Curiosity	352.5	.848	0.032
Ease of control	359.0	.937	0.014
Challenge	355.0	.883	0.025
Progress feedback	330.5	.566	0.092
Audiovisual appeal	311.0	.361	0.146
Clarity of goals	350.5	.818	0.037
Enjoyment	335.5	.626	0.078

Note. Mann-Whitney U tests compare the Breathing and Control groups. p values are two-tailed. Effect sizes are rank-biserial correlations (r_{rb}). The standard error for r_{rb} (estimated from $n_1 = 26$, $n_2 = 28$) is 0.157 for all tests.

4.5 Performance

Throughout the gameplay phase, a range of performance statistics was recorded. From these, four primary metrics were selected for analysis: the greatest height reached during the play session, the total number of falls, the average distance climbed between falls, and the percentage of falls that occurred from the player's highest attained position. Figure 13 shows the distributions of these metrics, while Table 14 reports the corresponding descriptive statistics.

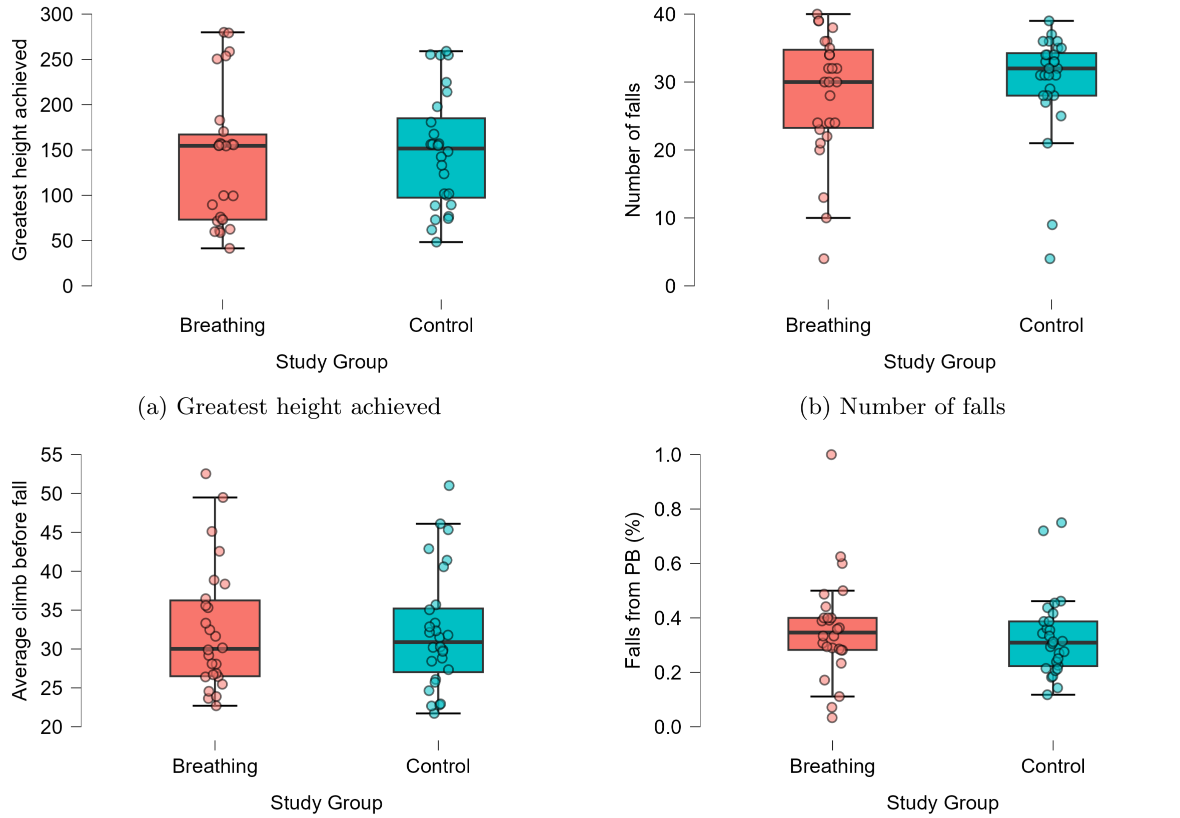
The boxplots suggest broadly similar distributions across the breathing and control groups for all four performance metrics. This observation is consistent with the descriptive statistics reported in Table 14, where the group means differ only slightly and the variability within groups, as reflected by the standard deviations, is generally comparable. No clear visual indication of substantial performance differences between groups is apparent.

Table 14: Descriptive statistics of primary performance measures across study groups

	Greatest height achieved		Number of falls		Average climb before fall		Falls from PB (%)	
	Breathing	Control	Breathing	Control	Breathing	Control	Breathing	Control
N	26	28	26	28	26	28	26	28
M	139.70	148.30	28.08	30.07	32.45	32.26	36.09	32.69
SD	75.15	63.54	9.26	7.75	8.06	7.68	19.20	14.77

Note. Falls from PB values are reported as percentages.

Shapiro-Wilk tests indicated significant departures from normality for all four performance measures. Consequently, Mann-Whitney U tests were used to compare the breathing and control groups on each metric (see Table 15). No significant group differences were found for greatest height achieved, number of falls, average climb before falling, or the percentage of falls that occurred from the player's highest attained position. These null results are consistent with the boxplots and descriptive statistics, which show substantial overlap between the groups. The observed effect sizes were small across all comparisons, indicating no meaningful differences in gameplay performance between the breathing and control groups.



(a) Greatest height achieved

(b) Number of falls

(c) Average climb before fall

(d) Falls from PB (%)

Figure 13: Boxplots showing the distribution of the primary performance measures across the breathing and control groups, with individual participant scores overlaid as jittered points. Panels show (a) greatest height achieved, (b) number of falls, (c) average climb before fall, and (d) percentage of falls that occurred from the player's highest attained position.

Table 15: Mann-Whitney U tests comparing study groups on the primary performance measures

Measure	U	p	r_{rb}
Greatest height achieved	320.0	.455	0.121
Number of falls	319.5	.445	0.122
Average climb before fall	361.0	.966	0.008
Falls from PB (%)	422.5	.315	-0.161

Note. Mann-Whitney U tests compare the Breathing and Control groups. p values are two-tailed. Effect sizes are rank-biserial correlations (r_{rb}). The standard error for r_{rb} (estimated from $n_1 = 26$, $n_2 = 28$) is 0.157 for all tests.

5 Discussion

This chapter discusses the findings of the study in relation to the research questions and hypotheses presented in Section 2.7. First, the results regarding need satisfaction and frustration are examined, followed by momentary frustration, affect, player experience, and gameplay performance. The chapter then reflects on the limitations of the study and concludes with directions for future research.

Overall, the findings suggest that the guided breathing intervention was effective in reducing momentary frustration following intervention moments, but did not result in significant differences in need satisfaction and frustration, affective state, player experience, or gameplay performance. The following sections explore these findings in greater detail and discuss possible explanations for these outcomes, as well as their relevance for future research on emotion regulation interventions in games.

5.1 Need Satisfaction and Frustration

From the results of the reduced BANGS, no significant differences between study groups were found for competence and autonomy satisfaction or frustration. Since the game was designed as a challenging platformer in which setbacks and progress loss could occur, one aim of the intervention was to support players in regulating their responses during moments where their perceived competence was challenged. The moderate to relatively high levels of competence frustration reported in the control group may indicate that the game successfully created situations in which players experienced difficulty and setbacks. However, similar levels were reported for the breathing group, suggesting that the breathing exercise did not meaningfully influence competence frustration as measured after the gameplay phase had concluded.

Interestingly, relatively high levels of competence satisfaction were also observed for both groups. This may indicate that participants experienced the game as frustrating, while still feeling some sense of capability or improvement during play. Although the game was intentionally challenging, players may have gradually become more familiar with the controls and movement system over the course of the session. Even if they continued to fall or lose progress, moments of successful movement, reaching higher sections, or understanding how to recover from mistakes may have contributed to feelings of competence. This does not necessarily imply that participants experienced strong overall mastery of the game, but rather that the game could provide both competence-supporting and competence-impeding experiences. The finding that competence satisfaction and frustration were both reported at moderate to high levels further supports the view that need satisfaction and need frustration should be treated as related but distinct constructs, rather than opposite ends of a single dimension, in line with prior work [5, 91].

For autonomy, both satisfaction and frustration were reported at moderate levels for the two study groups, and no significant differences were found. One expectation was that interrupting gameplay with a mandatory breathing exercise might negatively influence participants' perceived sense of autonomy, as it temporarily restricted player agency. However, no evidence for such an effect was found. This may indicate that the intervention was not experienced as particularly autonomy-thwarting, or that the interruption introduced by the momentary frustration assessments and experimental procedure was comparable between groups. At the same time, the absence of an effect should be interpreted cautiously, as more subtle differences may have gone undetected within the current sample. Together, these findings provide no support for H1, as the guided breathing intervention did not result in differences in competence or autonomy satisfaction and frustration compared to the control condition.

5.2 Momentary Frustration

The results show a clear increase in self-assessed frustration across the duration of the experiment. Not only did frustration increase from before to after gameplay, but frustration levels also increased between the first and second intervention moments. This suggests that the game design was successful in eliciting the target frustration state among participants. However, no significant difference was observed in frustration levels pre- and post-gameplay between groups, suggesting that both groups experienced a comparable overall increase in frustration across the gameplay session.

When examining the effects of the intervention moments, several findings stand out. First, frustration levels decreased following the intervention interval for both the breathing and control group. In the breathing group, this means participants reported lower frustration after completing the breathing exercise. Interestingly, participants in the control group, who simply continued playing during the same time interval, also reported lower frustration afterward.

A likely explanation for this decrease in both groups lies in the way the intervention timing was designed. The triggering system aimed to activate the intervention after moments of substantial progress loss, when frustration was expected to be relatively high. Following such events, participants often found themselves at lower sections of the level, where both the potential fall distance and gameplay difficulty tended to be lower. As a result, the period immediately after a triggering event may naturally have involved fewer severe mistakes and a gradual recovery from peak frustration, even in the absence of a regulation strategy. Furthermore, frustration may not necessarily be a long-lasting emotional state, meaning that a decrease over time could be expected even without an explicit regulation strategy. In other words, the control group may have experienced a natural recovery from a temporary frustration peak, while the breathing group received additional support in facilitating this recovery.

Although frustration decreased in both groups, the magnitude of this decrease differed. Participants in the breathing group showed a significantly stronger reduction in frustration following intervention moments compared to the control group. This suggests that the breathing exercise contributed to a greater short-term reduction in perceived frustration beyond the decrease that occurred through gameplay continuation alone. At the same time, no overall difference between groups was observed when considering frustration across all six measurement points, suggesting that these short-term effects did not translate into broader differences in frustration throughout the gameplay session. These findings provide partial support for H2: while the guided breathing intervention was associated with a stronger reduction in momentary frustration following frustrating gameplay events, no evidence was found that it resulted in lower overall frustration levels across the entire gameplay session.

5.3 Affect

The SAM results provide insight into how participants' affective state changed throughout the gameplay experience. Before gameplay, valence levels were relatively high for both groups. This may indicate that participants felt positively inclined or interested in the upcoming gameplay experience. The significant decrease in valence from pre- to post-gameplay may reflect several factors. It may partly be explained by participants becoming more accustomed to the game after initial anticipation had worn off. At the same time, the challenging and frustrating nature of the gameplay may also have contributed to lower valence levels. For example, repeated failure, loss of progress, or being unable to complete the level within the allotted time may have negatively influenced participants' affective state. It is likely that multiple of these factors jointly contributed to the observed decrease in valence. However, no significant difference in valence was found between study groups, suggesting that the type of intervention did not meaningfully influence valence at the end of the gameplay phase.

Arousal levels started at moderate levels and increased significantly after gameplay. This may indicate that the challenging gameplay experience increased alertness and engagement, although heightened stress or tension may also have contributed to this effect. Again, no significant difference was found between study groups, suggesting that the breathing exercise and continuation of gameplay resulted in comparable post-gameplay arousal levels.

For dominance, pre-gameplay measures indicated moderate levels of perceived control. Although dominance appeared to decrease slightly after gameplay, this difference was not significant. Likewise, no significant difference was observed between study groups. Overall, dominance levels remained relatively stable over time and did not differ meaningfully between groups. One possible explanation is that this dimension may have been more difficult for some participants to interpret compared to the other SAM dimensions. Informal observations during pilot sessions and live observation of participants suggested that some participants were uncertain about the distinction between feeling controlled versus dominant. However, as these observations were anecdotal and not systematically collected, this interpretation should be treated with caution.

Overall, the findings provide no evidence that the guided breathing intervention resulted in a more positive affective state compared to the control condition. Therefore, the affect-related part of H2 is not supported, as no differences between groups were found in the pre- to post-gameplay changes in valence, arousal, or dominance.

5.4 Player Experience

Several player experience constructs received positive ratings, most notably immersion, curiosity, ease of control, and clarity of goals. This suggests that the game was successful in capturing the players' attention, encouraging them to explore what lay ahead, while at the same time providing clear objectives and intuitive controls. From the perspective of the present study, this is encouraging, as it suggests that the frustration experienced by participants was less likely to stem from confusion regarding the controls or objectives of the game and more likely to originate from the intended gameplay challenge itself.

Other constructs, such as meaning and autonomy, received scores that were generally neutral or slightly negative. Thus, although the objective of the game was clear, namely reaching the top of the level, the purpose behind this objective may have been less apparent to participants. The game could potentially have benefited from a small narrative framing or backstory, providing additional context and meaning to the player's actions. The somewhat lower autonomy scores may be explained by the relatively linear nature of the gameplay, which constrained players to a largely predefined route through the level. The intervention component may also have contributed to this perception, as both the breathing exercise and the momentary frustration assessments temporarily interrupted the player's ongoing activity.

Although the PXI constructs provide valuable insight into the overall gameplay experience, no significant differences between groups were found for any of the measured constructs. This does not support the expectation stated in H3 that the breathing intervention would lead to a more positive overall player experience compared to the control condition. Instead, the results suggest that embedding the breathing exercise into gameplay did not have a measurable impact on the broader player experience.

Although no significant group differences were found, some differences in effect sizes provide potential directions for further exploration. Of the eleven PXI constructs, mastery showed the largest effect size, although it remained small and did not approach statistical significance. Mean mastery scores were somewhat higher in the control group than in the breathing group. One possible explanation is that participants in the control group may have attributed their progress entirely to their own actions, whereas participants in the breathing group may have perceived the emotion regulation support as partially contributing to their performance. However, this interpretation remains speculative, and further research would be required to determine whether the use of an intervention component can influence players' sense of mastery in this way.

5.5 Performance

Four primary metrics were selected to assess player performance: the greatest height reached during the play session, the total number of falls, the average distance climbed between falls, and the percentage of falls that occurred from the player's highest attained position. The statistical analyses revealed no significant differences between groups for any of these measures, providing no support for H4 that the guided breathing intervention would positively influence gameplay performance.

The absence of performance differences suggests that although the breathing intervention resulted in a stronger short-term reduction in frustration following intervention moments, this did not translate into measurable changes in gameplay behavior. One possible explanation is that reducing frustration does not necessarily improve performance directly, particularly in a challenging platforming context where success may depend more strongly on factors such as prior gaming experience, familiarity with the controls, and individual differences in motor skill. Additionally, the relatively short gameplay duration may have limited the opportunity for emotional regulation effects to influence longer-term performance development.

Another possibility is that the intervention was primarily effective in regulating the emotional response to challenging events rather than changing how participants interacted with the game. In this case, players may have felt less frustrated after difficult moments without necessarily making fewer mistakes or progressing further through the level. This interpretation is consistent with the observed distributions, which showed substantial overlap between groups across all performance measures and no clear trends favoring either condition. Future research with longer gameplay sessions or repeated exposure to the intervention could provide further insight into whether emotion regulation strategies can influence gameplay performance over time.

5.6 Implications

The findings have several implications for the design of embedded emotion regulation interventions in games. Most importantly, the results suggest that brief guided breathing can support short-term recovery after frustrating gameplay events. Participants in the breathing group showed a stronger decrease in momentary frustration after intervention moments than participants in the control group. This indicates that even a short breathing exercise, embedded directly into gameplay, can have a measurable effect on players' immediate emotional experience.

At the same time, the results also show the limits of such an intervention. The breathing exercise did not lead to lower overall frustration across the full gameplay session, nor did it produce significant differences in psychological need satisfaction and frustration, affective state, player experience, or gameplay performance. This suggests that reducing frustration in the moment is not necessarily sufficient to change how players evaluate the broader gameplay experience or how they perform in the game. For designers, this means that embedded breathing exercises may be most useful when the goal is to help players recover from specific moments of frustration, rather than when the goal is to produce broader changes in outcomes such as enjoyment, perceived competence, or performance.

This distinction is important because the breathing intervention primarily targeted response modulation. It aimed to reduce participants' immediate emotional and physiological response after a frustrating gameplay event, but it did not directly change how players interpreted failure, setbacks, or their own performance. This may help explain why the intervention reduced momentary frustration after intervention moments, but did not lead to lower overall frustration across the full gameplay session. After returning to gameplay, players could still experience later falls as equally competence-impeding or discouraging. In that case, each new setback may again produce frustration, even if the previous frustration peak was reduced. The intervention may therefore have helped players recover from individual moments of frustration, without changing the broader appraisal process through which repeated setbacks became frustrating in the first place.

This points to a useful distinction for future game-based emotion regulation design. Interventions that target response modulation, such as breathing exercises, may be particularly suitable when the goal is to provide brief support during or directly after emotionally intense moments. However, when the aim is to reduce frustration across a longer gameplay session, it may be necessary to combine such strategies with interventions that target cognitive change, such as reappraisal. For example, a game could help players reinterpret setbacks as part of learning or experimentation, rather than as evidence of poor performance. Such strategies may be more likely to influence how later failures are experienced, although this remains to be tested in future work.

Another implication concerns the timing of emotion regulation support. The present study used a dynamic gameplay-based triggering system rather than physiological sensing or player self-initiation. The results suggest that such an approach can identify meaningful moments for intervention, at least in a game where frustration is closely tied to observable events such as substantial progress loss. This is practically relevant because gameplay-based triggering is easier to implement than systems that require additional sensors, and it may be less demanding for players than asking them to recognize and initiate regulation strategies themselves.

However, the suitability of such interventions likely depends on the gameplay context. In a single-player platformer, a brief interruption after a large setback may be acceptable, because the player is already temporarily removed from the flow of progress. In other contexts, such as fast-paced multiplayer games, interruptions may be more disruptive, socially visible, or even disadvantageous. In those cases, emotion regulation support may need to be integrated in a less intrusive way, for example through optional prompts, between-round exercises, or mechanics that allow players to regulate while continuing to interact with the game.

Finally, the study raises questions about whether embedded interventions should only support immediate regulation, or whether they should also help players develop emotion regulation skills over time. The breathing exercise in the present study was fully guided and system-initiated, meaning that participants did not need to decide when or how to regulate their frustration. This may be useful for short-term support, but it may not help players learn to apply regulation strategies independently. Future designs could therefore explore more scaffolded approaches, in which guidance is gradually reduced or players are encouraged to recognize suitable moments for regulation themselves. Such approaches may be especially relevant if the goal is not only to reduce frustration during a single session, but also to support longer-term emotion regulation skills in gaming contexts.

5.7 Limitations

Several limitations should be considered when interpreting the results of this study.

First, the study relied primarily on self-report measures. This was appropriate given that frustration, affect, and player experience are subjective experiences, but it also means that the results may have been influenced by response biases. For example, participants may have guessed that frustration was an important part of the study, may have tried to give answers that seemed helpful, or may have been hesitant to report how frustrated they were with a game that was clearly made for the experiment. This risk was likely increased by the repeated frustration question. Because participants were asked about frustration before gameplay and again during the session, they may have become more aware of their own frustration than they would have been otherwise. This is difficult to avoid in a study that aims to measure frustration during gameplay, but it should be kept in mind when interpreting the results.

A second limitation concerns the timing of the measurements. Momentary frustration was measured directly before and after each intervention moment, but competence and autonomy satisfaction and frustration were only measured once, after gameplay had ended. Affect was also only measured before and after gameplay. As a result, the study cannot show how these needs or affective states changed throughout gameplay, or whether they changed directly after specific competence-impeding events. This was a deliberate trade-off, since adding more questions during gameplay would have made the experience more disruptive. However, future work could examine whether measuring need satisfaction, need frustration, or affect closer to the moments where these experiences occur provides a more detailed understanding of how emotion regulation interventions affect players during play.

Another limitation concerns the breathing intervention itself. Although participants were guided through the exercise, the remote setup made it impossible to verify whether they actually performed the breathing exercise as instructed. Some participants may have followed the guidance closely, while others may have only partially engaged with it or skipped parts of the exercise mentally. As a result, the actual exposure to the intervention may have differed between participants, even though the same guidance was presented to everyone in the breathing condition.

The dynamic nature of the game also introduced variability that was difficult to control. The triggering system was designed to activate after substantial progress loss, but participants moved through the level at different speeds, made different mistakes, and encountered frustrating moments in different parts of the level. This variability was part of the intended gameplay experience, but it also means that the intervention moments were not identical across participants. In addition, participants in the control group continued playing during the intervention interval. Events occurring during this period may therefore have influenced their frustration levels independently of the absence of the breathing exercise. Gameplay statistics were recorded to make further inspection of these intervals possible, but fully controlling for this variation remains challenging.

The sample size of the study was also relatively modest. While the study was able to detect some effects, smaller effects may have remained undetected. This is particularly relevant for outcomes such as player experience, psychological need satisfaction and frustration, and gameplay performance, where several differences between the breathing and control groups were small and non-significant.

The composition of the sample also limits the generalizability of the findings. Most participants identified as men, with 49 participants identifying as men and 5 identifying as women. As a result, the findings may not fully generalize to more gender-balanced samples. Future studies should aim to recruit a more diverse participant sample to examine whether similar effects are observed across different groups of players.

Furthermore, no qualitative data were collected. This was done to keep participation time limited and to reduce participant burden in the remote study setup. Nevertheless, even a short open-ended question at the end of the experiment could have provided useful additional insight. For example, participants could have described how they experienced the breathing exercise, whether the timing felt appropriate, or how they perceived the difficulty and frustration of the game.

Finally, the findings should be understood in relation to the specific game and intervention design used in this study. The intervention was evaluated in a custom-designed, highly challenging platformer, where frustration could arise through repeated setbacks and loss of progress. It remains unclear whether similar effects would be found in other genres, in games with different pacing, or with other forms of emotion regulation support. Future work is therefore needed to examine how well these findings generalize beyond the current experimental context.

5.8 Future Work

The present study provides an initial exploration of guided breathing as an embedded emotion regulation intervention in games. Several opportunities for future research emerge from the findings.

First, future studies could further investigate the relationship between emotion regulation interventions and psychological need satisfaction and frustration. Although no significant differences were found for competence or autonomy satisfaction and frustration, this does not necessarily imply that such effects do not exist. Replicating the study with a larger sample size may help determine whether more subtle effects of the intervention on psychological needs can be detected.

Relatedly, future work could examine need satisfaction and frustration at multiple moments throughout gameplay rather than only after the gameplay session has concluded. Assessing competence satisfaction and frustration closer to competence-impeding events may provide a more detailed understanding of how emotion regulation interventions influence players' experiences in the moment.

The results also raise interesting questions regarding player experience, particularly the mastery construct. Although no significant differences were observed, mastery showed the largest effect size of all PXI constructs. Future research could investigate whether emotion regulation interventions influence how players attribute success and failure during gameplay. For example, players may differ in the extent to which they perceive their progress as resulting from their own abilities versus external support provided by the game.

Another promising direction concerns gameplay performance. While no significant performance differences were observed in the present study, future work could investigate whether performance-related effects emerge over longer gameplay sessions or across multiple play sessions. It is possible that short-term reductions in frustration require more time to influence learning, adaptation, and performance outcomes.

The timing and integration of the intervention itself also warrant further investigation. In the present study, interventions were triggered dynamically based on gameplay events that were expected to correspond to elevated frustration, such as substantial losses of progress. While this approach proved effective in identifying moments at which frustration was likely to be high, future work could explore more advanced player modeling approaches that estimate frustration directly from player behavior. Such systems could potentially adapt intervention timing more precisely to individual players and may prove particularly valuable when applying emotion regulation interventions to game genres where frustration is less closely tied to observable gameplay events.

In addition, future studies could explore alternative ways of embedding breathing exercises into gameplay. Rather than temporarily interrupting gameplay, it may be possible to design mechanics that encourage paced breathing while allowing players to continue interacting with the game. Such an approach could reduce disruption and potentially alleviate concerns regarding autonomy or interruptions to the gameplay experience.

Another direction for future work is to compare interventions that target different stages of the emotion regulation process. The breathing intervention used in the present study primarily targeted response modulation, as it aimed to reduce participants' immediate emotional and physiological response after frustrating gameplay events. However, it did not directly alter how players interpreted failure, setbacks, or their own performance. This may help explain why the intervention reduced momentary frustration following intervention moments, but did not lead to lower overall frustration across the full gameplay session. Future research could therefore compare breathing-based response modulation with strategies that more directly target cognitive change, such as reappraisal. Such work could help determine whether changing how players interpret repeated setbacks produces more sustained reductions in gameplay-related frustration.

Future work could also incorporate qualitative feedback alongside quantitative measures. Even brief open-ended responses could help clarify how players experienced the intervention, whether the timing felt appropriate, and whether the breathing exercise was perceived as supportive or disruptive. Such feedback would be particularly useful for interpreting why the intervention reduced momentary frustration, but did not affect broader measures of need satisfaction, affect, player experience, or performance.

Finally, the present study focused on a single emotion regulation strategy in a custom-designed platforming game. Future research could investigate the effectiveness of embedded emotion regulation interventions across a broader range of game genres and gameplay contexts. This is important because different games may give rise to different emotional experiences and may place different constraints on when and how regulation support can be provided. For example, frustration in a single-player platformer may primarily arise from repeated failure and loss of progress, whereas frustration in fast-paced multiplayer games may be shaped more strongly by social pressure, team dependence, competition, or perceived unfairness. These contexts may also differ in the suitability of different interventions. A brief interruption may be acceptable in a single-player game, but could be disruptive or impractical during real-time multiplayer gameplay. Future work should therefore examine not only whether embedded emotion regulation interventions are effective, but also how their timing, format, and degree of disruption should be adapted to different gameplay situations.

6 Conclusion

This thesis investigated whether a brief, guided breathing intervention embedded directly into gameplay could support the regulation of competence-related frustration in games. To this end, a custom single-player platformer was developed in which players were repeatedly exposed to challenging traversal situations, setbacks, and loss of progress. A dynamic triggering system was used to identify moments during gameplay that were expected to correspond to heightened frustration, after which participants either completed a guided cyclic sighing exercise or continued gameplay for an equivalent duration.

Overall, the results suggest that the intervention was effective in reducing momentary frustration directly after intervention moments. Although frustration decreased in both the breathing and control groups, the decrease was significantly larger for participants who completed the breathing exercise. This provides partial support for the idea that brief, guided breathing can help players down-regulate frustration in the moment, even when the intervention is delivered remotely and without physiological sensing.

At the same time, this effect appeared to be temporary. No significant difference between groups was found when considering frustration across the full gameplay session, and both groups showed a comparable increase in frustration from before to after gameplay. In other words, the breathing exercise seemed to support short-term recovery after frustrating events, but this did not result in lower overall frustration by the end of the gameplay phase.

The effects of the intervention were also limited in scope. No significant differences were found between the breathing and control groups for competence or autonomy satisfaction and frustration, affective state, broader player experience, or gameplay performance. This suggests that while the intervention may have helped players recover emotionally after specific frustrating gameplay events, this did not translate into measurable changes in how they evaluated the overall gameplay experience or how they performed in the game. The findings therefore provide support for the short-term regulatory potential of the breathing exercise, but not for broader effects on psychological needs, affect, player experience, or performance within the current study design.

The study contributes to research on emotion regulation in games in several ways. First, it presents the design and evaluation of an embedded breathing-based intervention for supporting players during frustrating gameplay moments. Second, it provides empirical evidence that such an intervention can reduce momentary frustration following competence-impeding events, even if this reduction does not appear to persist across the full gameplay session. Third, it explores a dynamic, gameplay-based approach for identifying suitable intervention moments without relying on physiological sensors. This is relevant because many emotion regulation systems depend on biofeedback or offline training, while the present work shows that simpler, gameplay-based triggering can still identify emotionally meaningful moments during play.

Several limitations should be kept in mind when interpreting these findings. The study relied primarily on self-report measures, and not all constructs were measured repeatedly during gameplay. The remote setup also made it impossible to verify whether participants performed the breathing exercise exactly as instructed. Furthermore, the intervention was evaluated in a single custom platforming game, which limits the extent to which the results can be generalized to other genres or gameplay contexts.

Future work could build on these findings by measuring psychological needs and affect closer to the moments where frustration occurs, by incorporating qualitative feedback, and by testing similar interventions across different types of games. It may also be valuable to explore alternative ways of integrating breathing exercises into gameplay, for example by allowing players to continue interacting with the game while regulating their breathing. More advanced player modeling could further improve the timing of interventions by estimating frustration more directly from gameplay behavior.

In conclusion, this thesis shows that a brief guided breathing exercise can provide meaningful short-term support during frustrating gameplay moments. Although the intervention did not reduce overall frustration by the end of the gameplay session or affect broader player experience and performance outcomes, it did reduce momentary frustration following dynamically triggered intervention events. These findings suggest that embedded, low-complexity emotion regulation support may be a useful direction for future game design and HCI research, especially in contexts where players encounter frustration but may not have the time or attention available to select and apply regulation strategies on their own.

References

[1] *Video games and well-being: Press start*. Video games and well-being: Press start. Palgrave Macmillan/Springer Nature. Pages: xvii, 166.

[2] Vero Vanden Abeele, Katta Spiel, Lennart Nacke, Daniel Johnson, and Kathrin Gerling. Development and validation of the player experience inventory: A scale to measure player experiences at the level of functional and psychosocial consequences. 135:102370.

[3] Sonam Adinolf and Selen Türkay. Differences in player experiences of need satisfaction across four games. In *Proceedings of DiGRA 2019 Conference: Game, Play and the Emerging Ludo-Mix*.

[4] Ali. Gaming statistics 2025: Mobile, PC, console trends. Section: Statistics.

[5] Johnie J. Allen and Craig A. Anderson. Satisfaction and frustration of basic psychological needs in the real world and in video games predict internet gaming disorder scores and well-being. 84:220–229.

[6] Craig A. Anderson and Brad J. Bushman. Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. 12(5):353–359.

[7] John R. Anderson. Acquisition of cognitive skill. 89(4):369–406.

[8] Alissa N. Antle, Leslie Chesick, and Elgin-Skye Mclaren. Opening up the design space of neurofeedback brain–computer interfaces for children. 24(6):38:1–38:33.

[9] Alissa N. Antle, Elgin Skye McLaren, Holly Fiedler, and Naomi Johnson. Design for mental health: How socio-technological processes mediate outcome measures in a field study of a wearable anxiety app. In *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction*, TEI '19, pages 87–96. Association for Computing Machinery.

[10] David Bakker and Nikki Rickard. Engagement in mobile phone app for self-monitoring of emotional wellbeing predicts changes in mental health: MoodPrism. 227:432–442.

[11] Melis Yilmaz Balban, Eric Neri, Manuela M. Kogon, Lara Weed, Bita Nouriani, Booil Jo, Gary Holl, Jamie M. Zeitzer, David Spiegel, and Andrew D. Huberman. Brief structured respiration practices enhance mood and reduce physiological arousal. 4(1):100895.

[12] Nick Ballou, Alena Denisova, Richard Ryan, C. Scott Rigby, and Sebastian Deterding. The basic needs in games scale (BANGS): A new tool for investigating positive and negative video game experiences. 188:103289.

[13] Nick Ballou and Sebastian Deterding. 'i just wanted to get it over and done with': A grounded theory of psychological need frustration in video games. 7:382:217–382:236.

[14] Stephanie Balters, Matthew L. Mauriello, So Yeon Park, James A. Landay, and Pablo E. Paredes. Calm commute: Guided slow breathing for daily stress management in drivers. 4(1):38:1–38:19.

[15] Maciej Behnke, Patrycja Chwiłkowska, and Lukasz D. Kaczmarek. What makes male gamers angry, sad, amused, and enthusiastic while playing violent video games? 37:100397.

[16] Nicole A. Beres, Madison Klarkowski, and Regan L. Mandryk. Playing with emotions: A systematic review examining emotions and emotion regulation in esports performance. 7:395:558–395:587.

[17] Frans A. Boiten, Nico H. Frijda, and Cornelis J. E. Wientjes. Emotions and respiratory patterns: review and critical analysis. 17(2):103–128.

[18] Stéphane Bouchard, François Bernier, Éric Boivin, Brian Morin, and Geneviève Robillard. Using biofeedback while immersed in a stressful videogame increases the effectiveness of stress management skills in soldiers.

[19] Margaret M. Bradley and Peter J. Lang. Measuring emotion: The self-assessment manikin and the semantic differential. 25(1):49–59.

[20] Richard P. Brown and Patricia L. Gerbarg. Yoga breathing, meditation, and longevity. 1172(1):54–62. _eprint: https://nyaspubs.onlinelibrary.wiley.com/doi/pdf/10.1111/j.1749-6632.2009.04394.x.

[21] Stephany Campanelli, Adriano Bretanha Lopes Tort, and Bruno Lobão-Soares. Pranayamas and their neurophysiological effects : International journal of yoga.

[22] Beiwen Chen, Maarten Vansteenkiste, Wim Beyers, Liesbet Boone, Edward Deci, Jolene van der Kaap-Deeder, Bart Duriez, Willy Lens, Lennia Matos, Athanasios Mouratidis, Richard Ryan, Kennon Sheldon, Bart Soenens, Stijn Van Petegem, and Joke Verstuyf. Basic psychological need satisfaction, need frustration, and need strength across four cultures. 39:216–236.

[23] Tsai-Ling Chen, Shu-Chen Chang, Hsiu-Fen Hsieh, Chin-Yi Huang, Jui-Hsiang Chuang, and Hsiu-Hung Wang. Effects of mindfulness-based stress reduction on sleep quality and mental health for insomnia patients: A meta-analysis. 135:110144.

[24] Luca Chittaro and Riccardo Sioni. Evaluating mobile apps for breathing training: The effectiveness of visualization. 40:56–63.

[25] Kyung Yun Choi and Hiroshi Ishii. ambienBeat: Wrist-worn mobile tactile biofeedback for heart rate rhythmic regulation. In *Proceedings of the Fourteenth International Conference on Tangible, Embedded, and Embodied Interaction*, TEI '20, pages 17–30. Association for Computing Machinery.

[26] Tee Chuanromanee and Ronald Metoyer. Evaluation and comparison of four mobile breathing training visualizations. pages 1–12.

[27] Jean Costa, François Guimbretière, Malte F. Jung, and Tanzeem Choudhury. BoostMeUp: Improving cognitive performance in the moment by unobtrusively regulating emotions with a smartwatch. 3(2):40:1–40:23.

[28] Christopher A. Del Negro, Gregory D. Funk, and Jack L. Feldman. Breathing matters. 19(6):351–367.

[29] Fabio Duarte. How many gamers are there? (new 2026 statistics).

[30] Malte Elson and Christopher J. Ferguson. Twenty-five years of research on violence in digital games and aggression: Empirical evidence, perspectives, and a debate gone astray. 19(1):33–46.

[31] Charles Fage, Charles Consel, Kattalin Etchegoyhen, Anouck Amestoy, Manuel Bouvard, Cécile Mazon, and Hélène Sauzéon. An emotion regulation app for school inclusion of children with ASD: Design principles and evaluation. 131:1–21.

[32] Corinna Anna Faust-Christmann, Bertram Taetz, Gregor Zolynski, Tobias Zimmermann, and Gabriele Bleser. A biofeedback app to instruct abdominal breathing (breathing-mentor): Pilot experiment. 7(9):e13703.

[33] Bennett Foddy. Getting over it with bennett foddy, 2017. Video game.

[34] Guo Freeman and Donghee Yvette Wohn. eSports as an emerging research context at CHI: Diverse perspectives on definitions. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, CHI EA '17, pages 1601–1608. Association for Computing Machinery.

[35] Julian Frommel, Madison Klarkowski, and Regan L. Mandryk. The struggle is spiel: On failure and success in games. In *Proceedings of the 16th International Conference on the Foundations of Digital Games*, FDG '21, pages 1–12. Association for Computing Machinery.

[36] Patricia L. Gerbarg, Richard P. Brown, Chris C. Streeter, Martin Katzman, and Monica Vermani. Breath practices for survivor and caregiver stress, depression, and post-traumatic stress disorder: Connection, co-regulation, compassion. 4(3):1–31.

[37] Asma Ghandeharioun and Rosalind Picard. BrightBeat: Effortlessly influencing breathing for cultivating calmness and focus. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, CHI EA '17, pages 1624–1631. Association for Computing Machinery.

[38] James J. Gross. The emerging field of emotion regulation: An integrative review. 2(3):271–299.

[39] J.J. Gross and Ross Thompson. Handbook of emotion regulation. pages 3–26.

[40] Amélie J. A. A. Guyon, Rosamaria Cannavò, Regina K. Studer, Horst Hildebrandt, Brigitta Danuser, Elke Vlemincx, and Patrick Gomez. Frontiers | respiratory variability, sighing, anxiety, and breathing symptoms in low- and high-anxious music students before and after performing.

[41] Fincham Gw, Strauss C, Montero-Marin J, and Cavanagh K. Effect of breathwork on stress and mental health: A meta-analysis of randomised-controlled trials.

[42] Muhammad Fikri Haekal, Boy Nurtjahyo Moch, and Erlinda Muslim. Stress emotion evaluation in battle royale game by using electroencephalogram. In *Proceedings of the 2020 International Conference on Engineering and Information Technology for Sustainable Industry*, ICONETSI '20, pages 1–5. Association for Computing Machinery.

[43] Shen-Mou Hsu, Chih-Hsin Tseng, Chao-Hsien Hsieh, and Chang-Wei Hsieh. Slow-paced inspiration regularizes alpha phase dynamics in the human brain. 123(1):289–299.

[44] Friedhelm Hummel and Christian Gerloff. Larger interregional synchrony is associated with greater behavioral success in a complex sensory integration task in humans. 15(5):670–678.

[45] Hannu Jouhki, Iina Savolainen, Heli Hagfors, Ilkka Vuorinen, and Atte Oksanen. What are escapists made of, and what does it have to do with excessive gambling and gaming? pages 1–18.

[46] Jesper Juul. *The Art of Failure: An Essay on the Pain of playing Video Games*. Playful Thinking. MIT Press.

[47] Mariana Kaiseler, Remco Polman, and Adam Nicholls. Mental toughness, stress, stress appraisal, coping and coping effectiveness in sport. 47(7):728–733.

[48] Sahib S. Khalsa, Justin S. Feinstein, Wei Li, Jamie D. Feusner, Ralph Adolphs, and Rene Hurlemann. Panic anxiety in humans with bilateral amygdala lesions: Pharmacological induction via cardiorespiratory interoceptive pathways. 36(12):3559–3566.

[49] Bastian Kordyaka, Katharina Jahn, and Bjoern Niehaves. Towards a unified theory of toxic behavior in video games. 30(4):1081–1102.

[50] Bastian Kordyaka, Michael Klesel, and Katharina Jahn. Perpetrators in league of legends: Scale development and validation of toxic behavior.

[51] Mehmet Kosa and Ahmet Uysal. Need frustration in online video games. 41(11):2415–2426. _eprint: https://doi.org/10.1080/0144929X.2021.1928753.

[52] Yubo Kou and Xinning Gui. Emotion regulation in eSports gaming: A qualitative study of league of legends. 4:158:1–158:25.

[53] Matthijs Kox, Lucas T. van Eijk, Jelle Zwaag, Joanne van den Wildenberg, Fred C. G. J. Sweep, Johannes G. van der Hoeven, and Peter Pickkers. Voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans. 111(20):7379–7384.

[54] Paul Lehrer, Karenjot Kaur, Agratta Sharma, Khushbu Shah, Robert Huseby, Jay Bhavsar, Phillip Sgobba, and Yingting Zhang. Heart rate variability biofeedback improves emotional and physical health and performance: A systematic review and meta analysis. 45(3):109–129.

[55] Oliver Leis, Franziska Lautenbach, Phil DJ Birch, and Anne-Marie Elbe. Stressors, associated responses, and coping strategies in professional esports players: A qualitative study. 3(3).

[56] Eric Joseph LeNorgant. Sport-related anxiety and self-talk between traditional sports and ESports - ProQuest.

[57] Rong-Hao Liang, Bin Yu, Mengru Xue, Jun Hu, and Loe M. G. Feijs. BioFidget: Biofeedback for respiration training using an augmented fidget spinner. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 1–12. Association for Computing Machinery.

[58] Adam Lobel, Marientina Gotsis, Erin Reynolds, Michael Annetta, Rutger C.M.E. Engels, and Isabela Granic. Designing and utilizing biofeedback games for emotion regulation: The case of nevermind. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, CHI EA '16, pages 1945–1951. Association for Computing Machinery.

[59] Daniel Madden and Casper Harteveld. "constant pressure of having to perform": Exploring player health concerns in esports. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, CHI '21, pages 1–14. Association for Computing Machinery.

[60] Daniel Madden, Yuxuan Liu, Haowei Yu, Mustafa Feyyaz Sonbudak, Giovanni M Troiano, and Casper Harteveld. "why are you playing games? you are a girl!": Exploring gender biases in esports. pages 1–15. Conference Name: CHI '21: CHI Conference on Human Factors in Computing Systems ISBN: 9781450380966.

[61] Regan L. Mandryk, Shane Dielschneider, Michael R. Kalyn, Christopher P. Bertram, Michael Gaetz, Andre Doucette, Brett A. Taylor, Alison Pritchard Orr, and Kathy Keiver. Games as neurofeedback training for children with FASD. In *Proceedings of the 12th International Conference on Interaction Design and Children*, IDC '13, pages 165–172. Association for Computing Machinery.

[62] Adrián Mateo-Orcajada, Lucía Abenza-Cano, and Raquel Vaquero-Cristóbal. Analyzing the changes in the psychological profile of professional league of legends players during competition. 126:107030.

[63] Neema Moraveji, Athman Adiseshan, and Takehiro Hagiwara. BreathTray: augmenting respiration self-regulation without cognitive deficit. In *CHI '12 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '12, pages 2405–2410. Association for Computing Machinery.

[64] Neema Moraveji, Ben Olson, Truc Nguyen, Mahmoud Saadat, Yaser Khalighi, Roy Pea, and Jeffrey Heer. Peripheral paced respiration: influencing user physiology during information work. In *Proceedings of the 24th annual ACM symposium on User interface software and technology*, UIST '11, pages 423–428. Association for Computing Machinery.

[65] Eugen Nagorsky and Josef Wiemeyer. The structure of performance and training in esports.

[66] Clayton Neighbors, Nathaniel A. Vietor, and C. Raymond Knee. A motivational model of driving anger and aggression. 28(3):324–335.

[67] James Nestor. *Breath: The New Science of a Lost Art.*

[68] Adam R. Nicholls, Remco C. J. Polman, and Andrew R. Levy. A path analysis of stress appraisals, emotions, coping, and performance satisfaction among athletes. 13(3):263–270.

[69] Mary Beth Oliver, Nicholas David Bowman, Julia K. Woolley, Ryan Rogers, Brett I. Sherrick, and Mun-Young Chung. Video games as meaningful entertainment experiences. 5(4):390–405. Place: US.

[70] Serge Petralito, Florian Brühlmann, Glena Iten, Elisa D. Mekler, and Klaus Opwis. A good reason to die: How avatar death and high challenges enable positive experiences. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, CHI '17, pages 5087–5097. Association for Computing Machinery.

[71] Agner Piton, Paris Mavromoustakos Blom, and Pieter Spronck. Exploring peak-end effects in player affect through hearthstone.

[72] Dylan Poulus, Tristan J. Coulter, Michael G. Trotter, and Remco Polman. Stress and coping in esports and the influence of mental toughness.

[73] Dylan R. Poulus, Tristan J. Coulter, Michael G. Trotter, and Remco Polman. Longitudinal analysis of stressors, stress, coping and coping effectiveness in elite esports athletes. 60:102093.

[74] Andrew K. Przybylski, Edward L. Deci, C. Scott Rigby, and Richard M. Ryan. Competence-impeding electronic games and players' aggressive feelings, thoughts, and behaviors. 106(3):441–457. Place: US.

[75] Jan-Marino Ramirez. The integrative role of the sigh in psychology, physiology, pathology, and neurobiology.

[76] David A. Rosenbaum, Richard A. Carlson, and Rick O. Gilmore. Acquisition of intellectual and perceptual-motor skills.

[77] Guy Roth, Yaniv Kanat-Maymon, and Uri Bibi. Prevention of school bullying: The important role of autonomy-supportive teaching and internalization of pro-social values. 81(4):654–666. _eprint: https://bpspsychub.onlinelibrary.wiley.com/doi/pdf/10.1348/2044-8279.002003.

[78] Richard M. Ryan and Wendy S. Grolnick. Origins and pawns in the classroom: Self-report and projective assessments of individual differences in children's perceptions. 50(3):550–558.

[79] Richard M. Ryan, C. Scott Rigby, and Andrew Przybylski. The motivational pull of video games: A self-determination theory approach. 30(4):344–360.

[80] R.M. Ryan and E.L. Deci. Self-determination theory. basic psychological needs in motivation, development and wellness. new york, NY : Guilford press. 38:231.

[81] Stefan Röttger, Dominique A. Theobald, Johanna Abendroth, and Thomas Jacobsen. The effectiveness of combat tactical breathing as compared with prolonged exhalation. 46(1):19–28.

[82] Mirim Shin, Rob Heard, Chao Suo, and Chin Moi Chow. Positive emotions associated with "counter-strike" game playing. 1(5):342–347.

[83] Petr Slovak, Alissa Antle, Nikki Theofanopoulou, Claudia Daudén Roquet, James Gross, and Katherine Isbister. Designing for emotion regulation interventions: An agenda for HCI theory and research. 30(1):13:1–13:51.

[84] Petr Slovak, Katie Salen, Stephanie Ta, and Geraldine Fitzpatrick. Mediating conflicts in minecraft: Empowering learning in online multiplayer games. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 1–13. Association for Computing Machinery.

[85] Matthew J. Smith, Phil D. J. Birch, and Dave Bright. Identifying stressors and coping strategies of elite esports competitors.

[86] Smyth and Heron. Is providing mobile interventions "just-in-time" helpful? an experimental proof of concept study of just-in-time intervention for stress management. In *2016 IEEE Wireless Health (WH)*, pages 1–7.

[87] Ron Tamborini, Matthew Grizzard, Nicholas David Bowman, Leonard Reinecke, Robert J. Lewis, and Allison Eden. Media enjoyment as need satisfaction: The contribution of hedonic and nonhedonic needs. 61(6):1025–1042.

[88] April Tyack and Peta Wyeth. "the small decisions are what makes it interesting": Autonomy, control, and restoration in player experience. 5:282:1–282:26.

[89] Selen Türkay, Jessica Formosa, Sonam Adinolf, Robert Cuthbert, and Roger Altizer. See no evil, hear no evil, speak no evil: How collegiate players define, experience and cope with toxicity. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI '20, pages 1–13. Association for Computing Machinery.

[90] Maarten Vansteenkiste and Richard M. Ryan. On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. 23(3):263–280.

[91] Maarten Vansteenkiste, Richard M. Ryan, and Bart Soenens. Basic psychological need theory: Advancements, critical themes, and future directions. 44(1):1–31.

[92] Kellie Vella, Daniel Johnson, and Leanne Hides. Playing alone, playing with others: Differences in player experience and indicators of wellbeing. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, CHI PLAY '15, pages 3–12. Association for Computing Machinery.

[93] Elke Vlemincx, Ilse Van Diest, and Omer Van den Bergh. A sigh of relief or a sigh to relieve: The psychological and physiological relief effect of deep breaths. 165:127–135.

[94] Zelun Wang, Avinash Parnandi, and Ricardo Gutierrez-Osuna. BioPad: Leveraging off-the-shelf video games for stress self-regulation. 22(1):47–55.

[95] Victoria E. Warburton, John C. K. Wang, Kimberley J. Bartholomew, Rebecca L. Tuff, and Krystal C. M. Bishop. Need satisfaction and need frustration as distinct and potentially co-occurring constructs: Need profiles examined in physical education and sport. 44(1):54–66.

[96] Netta Weinstein. Interest-taking and carry-over effects of incidental rejection emotions.

[97] Netta Weinstein, Holley S. Hodgins, and Elin Ostvik-White. Humor as aggression: Effects of motivation on hostility expressed in humor appreciation. 100(6):1043–1055.

[98] Alfonso White and Daniela Romano. Scalable psychological momentum forecasting in esports.

[99] Daniel M. Wolpert, Jörn Diedrichsen, and J. Randall Flanagan. Principles of sensorimotor learning. 12(12):739–751.

[100] Minerva Wu, Je Seok Lee, and Constance Steinkuehler. Understanding tilt in esports: A study on young league of legends players. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, CHI '21, pages 1–9. Association for Computing Machinery.

[101] Kevin Yackle, Lindsay A. Schwarz, Kaiwen Kam, Jordan M. Sorokin, John R. Huguenard, Jack L. Feldman, Liqun Luo, and Mark A. Krasnow. Breathing control center neurons that promote arousal in mice. 355(6332):1411–1415.

[102] Andrea Zaccaro, Andrea Piarulli, Marco Laurino, Erika Garbella, Danilo Menicucci, Bruno Neri, and Angelo Gemignani. Frontiers | how breath-control can change your life: A systematic review on psycho-physiological correlates of slow breathing.

[103] M. Abdullah Zafar, Beena Ahmed, and Ricardo Gutierrez-Osuna. Playing with and without biofeedback. In *2017 IEEE 5th International Conference on Serious Games and Applications for Health (SeGAH)*, pages 1–7.

[104] Zinan Zhang, Sam Moradzadeh, Andrew Woan, and Yubo Kou. Toxicity by game design: How players perceive the influence of game design on toxicity. 8:345:1–345:31.

Appendix A: Ethics and Privacy Quick Scan

Response Summary:

Section 1. Research projects involving human participants

P1. Does your project involve human participants? This includes for example use of observation, (online) surveys, interviews, tests, focus groups, and workshops where human participants provide information or data to inform the research. If you are only using existing data sets or publicly available data (e.g. from X, Reddit) without directly recruiting participants, please answer no.

- Yes

Recruitment

P2. Does your project involve participants younger than 16 years of age?

- No

P3. Does your project involve participants with learning or communication difficulties of a severity that may impact their ability to provide informed consent?

- No

P4. Is your project likely to involve participants engaging in illegal activities?

- No

P5. Does your project involve patients?

- No

P6. Does your project involve participants belonging to a vulnerable group, other than those listed above?

- No

P8. Does your project involve participants with whom you have, or are likely to have, a working or professional relationship: for instance, staff or students of the university, professional colleagues, or clients?

- Yes

P9. Is it made clear to potential participants that not participating will in no way impact them (e.g. it will not directly impact their grade in a class)?

- Yes

Informed consent

PC1. Do you have set procedures that you will use for obtaining informed consent prior to collecting data from all participants, including (where appropriate) parental consent for children or consent from legally authorized representatives? (See suggestions for information sheets and consent forms on the website.)

- Yes

PC2. Will you tell participants that their participation is voluntary?

- Yes

PC3. Will you obtain explicit consent for participation?

- Yes

PC4. Will you obtain explicit consent for any sensor readings, eye tracking, photos, audio, and/or video recordings?

- Yes

PC5. Will you tell participants that they may withdraw from the research at any time and for any reason?

- Yes

PC6. Will you give potential participants time to consider participation?

- Yes

PC7. Will you provide participants with an opportunity to ask questions about the research before consenting to take part (e.g. by providing your contact details)?

- Yes

PC8. Does your project involve concealment or deliberate misleading of participants?

- Yes

Ethics Warning. **As you plan to use concealment or misleading (yes to PC8), and this may impact participants' rights to informed consent, a fuller ethical review is required.** **Please provide more information on the concealment/misleading here:**

The participants will not be aware of the aim of the study whilst participating in the experiment. Before the experiment, they will receive a introductory text, stating that they will be playing a game. For the sake of the study, this text will suggest the game will be rather easy, but in reality it is designed to be quite difficult. This is to create a mismatch between the participants expectations and their actual performance.

Section 2. Data protection, handling, and storage

The General Data Protection Regulation imposes several obligations for the use of **personal data** (defined as any information relating to an identified or identifiable living person) or including the use of personal data in research.

D1. Are you gathering or using personal data (defined as any information relating to an identified or identifiable living person)?

- No

Section 3. Research that may cause harm

Research may cause harm to participants, researchers, the university, or society. This includes when technology has dual-use, and you investigate an innocent use, but your results could be used by others in a harmful way. If you are unsure regarding possible harm to the university or society, please discuss your concerns with the Research Support Office.

H1. Does your project give rise to a realistic risk to the national security of any country?

- No

H2. Does your project give rise to a realistic risk of aiding human rights abuses in any country?

- No

H3. Does your project (and its data) give rise to a realistic risk of damaging the University's reputation? (E.g., bad press coverage, public protest.)

- No

H4. Does your project (and in particular its data) give rise to an increased risk of attack (cyber- or otherwise) against the University? (E.g., from pressure groups.)

- No

H5. Is the data likely to contain material that is indecent, offensive, defamatory, threatening, discriminatory, or extremist?

- No

H6. Does your project give rise to a realistic risk of harm to the researchers?

- No

H7. Is there a realistic risk of any participant experiencing physical or psychological harm or discomfort?

- Yes

H8. Is there a realistic risk of any participant experiencing a detriment to their interests as a result of participation?

- No

H9. Is there a realistic risk of other types of negative externalities?

- No

Ethics Warning. **As you replied yes to one (or more) of H1-H9, a fuller ethical review is required.**
Please provide more detail here on the potential harm, and how you will minimize risk and impact:

The aim of the study is to evaluate the effectiveness of an embedded guided breathing intervention in a game that is intended to induce (competence need) frustration. This means the participants will likely be slightly frustrated or stressed during play.

Section 4. Conflicts of interest

C1. Is there any potential conflict of interest (e.g. between research funder and researchers or participants and researchers) that may potentially affect the research outcome or the dissemination of research findings?

- No

C2. Is there a direct hierarchical relationship between researchers and participants?

- No

Section 5. Your information.

This last section collects data about you and your project so that we can register that you completed the Ethics and Privacy Quick Scan, sent you (and your supervisor/course coordinator) a summary of what you filled out, and follow up where a fuller ethics review and/or privacy assessment is needed. For details of our legal basis for using personal data and the rights you have over your data please see the University's privacy information. Please see the guidance on the ICS Ethics and Privacy website on what happens on submission.

Z0. Which is your main department?

- Information and Computing Science

Z1. Your full name:

Adrianus Cornelis Klaver

Z2. Your email address:

a.c.klaver@students.uu.nl

Z3. In what context will you conduct this research?

- As a student for my master thesis, supervised by::
  Julian Frommel

Z5. Master programme for which you are doing the thesis

- Game and Media Technology

Z6. Email of the course coordinator or supervisor (so that we can inform them that you filled this out and provide them with a summary):

j.frommel@uu.nl

Z7. Email of the moderator (if you are studying a programme from Information and Computing Sciences, please leave the value provided, otherwise change this to the moderator as provided by the coordinator of your thesis project):

ics-ethics@uu.nl

Z8. Title of the research project/study for which you filled out this Quick Scan:

The Impact of Embedded Emotion Regulation Techniques in Games on Player Mood and Experience

Z9. Summary of what you intend to investigate and how you will investigate this (200 words max):

This study investigates whether a brief, guided breathing exercise embedded directly into gameplay can support the regulation of competence-related frustration. Participants will play a custom-designed single-player digital game intended to induce moderate levels of competence frustration through challenging tasks and repeated failure scenarios.

To experimentally elicit competence frustration, participants will receive introductory information that frames the game's difficulty in a way that may create expectations about their likely performance. The actual difficulty of the game may not fully match these expectations, thereby creating a mismatch between anticipated and experienced performance. This manipulation is intended to induce competence-related frustration in a controlled manner.

Participants in the experimental condition will be prompted at predefined moments to perform a short, structured breathing exercise integrated into gameplay. Participants in the control condition will play the same game without the breathing intervention.

Self-report questionnaires will assess perceived competence frustration, affective state, and player experience. No physiological data will be collected. The use of expectation framing will be fully disclosed during debriefing.

Participation is voluntary and may be discontinued at any time. All data will be anonymized and stored securely in accordance with university guidelines.

Z10. In case you encountered warnings in the survey, does supervisor already have ethical approval for a research line that fully covers your project?

- No

Scoring

- Privacy: 0
- Ethics: 2
