Secondary Publication



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Date of secondary publication: 05.11.2026

Version of Record (Published Version), Conferenceobject

Persistent identifier: urn:nbn:de:bvb:473-irb-118007x

Primary publication

Enders, Florian; Xie, Runjie; Fernández Galeote, Daniel; u. a. (2026): How Play Evokes Empathy: Emotional Dynamics in a Perspective-Taking Game about Long COVID, in: Proceedings of the ACM on human-computer interaction, New York, NY: ACM, pp. 1–34, doi: 10.1145/3831342

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How Play Evokes Empathy: Emotional Dynamics in a Perspective-Taking Game about Long COVID

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Long COVID is a debilitating, invisible condition affecting millions worldwide. Patients frequently face skepticism and social isolation due to an empathy gap that scalable interventions have yet to address. While serious games show promise for fostering chronic illness empathy, the emotional mechanisms through which gameplay drives empathy remain poorly understood. We developed *My Pair of Shoes*, a perspective-taking game simulating daily life with long COVID, and conducted an online mixed-methods experiment with 68 participants. Partial least squares structural equation modeling revealed that emotional variability in the control/power dimension positively predicted game-induced empathy ($\beta = 0.477$), while valence variability showed an unexpected negative association ($\beta = -0.361$). Empathy, in turn, predicted personal helping intention ($\beta = 0.564$) and attitude toward structural help ($\beta = 0.373$). An exploratory thematic analysis of player diaries contextualized these findings, revealing responses ranging from deep engagement to defensive minimization. We derive design implications for perspective-taking games that leverage emotional dynamics to foster empathy.

CCS Concepts: • **Applied computing** → **Interactive learning environments**; • **Human-centered computing** → **Empirical studies in HCI**.

Additional Key Words and Phrases: emotion, empathy, attitude, helping, altruism, serious games, game-based learning, long COVID, chronic fatigue, chronic illness

ACM Reference Format:
Florian Enders, Runjie Xie, Daniel Fernández Galeote, and Benedikt Morschheuser. 2026. How Play Evokes Empathy: Emotional Dynamics in a Perspective-Taking Game about Long COVID. *Proc. ACM Hum.-Comput. Interact.* 10, 7, Article GAMES037 (November 2026), 34 pages. https://doi.org/10.1145/3831342

1 Introduction

Long COVID refers to the persistence of illness following SARS-CoV-2 infection, extending beyond the expected acute phase and often causing prolonged health impairments and functional limitations that affect daily activities such as work, learning, caregiving, and leisure [17, 79]. It is a debilitating condition affecting millions worldwide, with an estimated 43–45% of COVID-19 survivors developing persistent symptoms, and up to half meet diagnostic criteria for Myalgic encephalomyelitis/Chronic fatigue syndrome (ME/CFS) [22, 32, 90]. Post Exertional Malaise (PEM), a disproportionate worsening of symptoms following minor exertion, distinguishes these conditions

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ACM 2573-0142/2026/11-ARTGAMES037
https://doi.org/10.1145/3831342

from general fatigue [72, 106]. Beyond physical impairments, these conditions carry a substantial social burden [27, 45, 53]. Their invisibility, variability, and unpredictability pose substantial challenges for outsiders to understand the severity of symptoms and empathize with affected individuals. Consequently, patients frequently encounter skepticism, minimization, and social isolation, often feeling disbelieved by healthcare providers, employers, and even family members [27, 45, 53]. Stigma and the psychologization of symptoms — dismissing them as "all in the head" because no organic causes can be found — expose long COVID patients to prejudices typically associated with psychiatric or mental illness [16, 17]. This further exacerbates workplace discrimination, social exclusion and delays in accessing appropriate care [16, 17, 27, 45, 53, 79]. Such stigma undermines both individual well-being and collective understanding of the condition [17].

Despite the societal implications of this empathy gap, interventions aimed at fostering broader public empathy toward affected individuals remain underdeveloped. Existing research primarily targets patient self-management, provider-patient interactions, and intra-group support, focusing on symptom pacing and care strategies, with empathy development considered only a secondary outcome (such as in [15, 40, 82]). These approaches largely neglect broader societal disbelief and active perspective-taking. Scalable methods to cultivate empathy in everyday audiences are absent, leaving patients without the cognitive and emotional understanding and support of family, friends, colleagues, and even healthcare practitioners. Investigating how empathy can be strengthened toward affected individuals may foster attitudinal change, encourage individual acts of supportive behaviors, and contribute to sustainable structural support for those living with long COVID [18, 80].

As theory underscores the potential of experiential approaches for understanding stigmatized conditions [7, 29, 96], serious games offer a promising avenue to address this empathy gap through their unique capacity for perspective-taking [10, 33, 101]. Research indicates that empathic responses are largely learned through associative processes that can be enhanced through carefully designed interactive experiences [51, 77]. By allowing players to psychologically inhabit another person's circumstances, games can foster both cognitive understanding and emotional resonance [1, 3, 24, 29, 54, 96]. By enabling non-affected individuals to experience the unpredictable realities of chronic illness through interactive simulation, games can potentially contribute to bridging the understanding gap and increase prosocial attitudes and behavior.

Although initial studies have explored the potential of games to foster empathy toward people with chronic illness, this research remains exploratory, often lacks strong theoretical grounding, and reports inconsistent findings [69, 95, 99, 103, 107]. More importantly, there is limited understanding of the underlying mechanisms through which games may systematically promote empathy. In particular, despite theoretical evidence that emotional engagement might drive empathic responding [12, 46, 51, 64, 73], no study to date has yet systematically examined players' emotional experiences during gameplay as a key mechanism of empathy development. This gap is particularly salient in light of emerging evidence that emotional variability, the experience of shifting between different emotional states, may be central to learning and understanding. Research suggests that effective learning involves transitions across emotions rather than the maintenance of a single affective state [46, 64, 104]. However, no studies have systematically examined how emotional variability during gameplay relates to empathy outcomes. Accordingly, this work addresses the following research question:

RQ: How do players' emotional dynamics during gameplay relate to game-induced empathy and prosocial attitudes toward individuals with long COVID?

To address this question, we developed a web-based role-play serious game, as no suitable game existed. Players take the role of the protagonist Lena and experience her journey from a healthy life through acute COVID-19 infection, the onset of severe long COVID symptoms, the challenges

of living with ongoing physiological impairments, and the repeated experience of disbelief and lack of understanding from her social environment, and the process of adapting to life with persistent health challenges. Using this serious game as the intervention, we conducted an experiment with 68 participants. We collected pre- and post-intervention survey data, as well as in-game emotion reports and qualitative diary entries at the end of each in-game day. Emotional experiences were assessed using the Geneva Emotion Wheel, grounded in appraisal theory, which conceptualizes emotions along the dimensions of valence and power. To contextualize and enrich the interpretation of the quantitative model, we additionally conducted an exploratory thematic analysis of players' diary entries and open feedback, examining how players experienced chronic illness through the game's mechanics and narrative and how they related these experiences to their own lives.

The manipulation check indicated that the game intervention increased helping intentions and structural support. The structural equation model showed that power variability positively predicted game-induced empathy, while valence variability negatively predicted it. Empathy predicted personal helping intention and support for structural help. An exploratory thematic analysis contextualized these findings, revealing that players navigated complex emotional terrain between frustration and adaptation, and that responses ranged from deep engagement to defensive minimization.

In sum, this work contributes to the understanding of serious games as empathy interventions in two ways. Theoretically, we identify emotional variability in the control dimension as a mechanism for empathy development, demonstrating that the valence dimension operates differently, and we introduce a method for quantifying players' emotional journeys during gameplay using the Geneva Emotion Wheel's dimensional structure. Practically, we derive design implications for creating perspective-taking games that foster empathy toward individuals with chronic illness such as long COVID.

2 Background

2.1 Emotions, Appraisal, and Empathy

Empathy — the capacity to understand and emotionally respond to another person's experiences — is closely linked to prosocial attitudes and helping behavior, particularly toward marginalized or stigmatized groups [7, 9, 29, 35]. Emotions play a central role in empathy development. Appraisal-based theories such as Roseman's appraisal theory [88] and Scherer's component process model [91] conceptualize emotions as adaptive responses that emerge from individuals' evaluations of situations in relation to personal goals, needs, coping potential, responsibility, and situational control. Within these perspectives, emotions arise from dynamic appraisals of whether situations are beneficial or harmful, controllable or uncontrollable, and compatible or incompatible with individual goals and expectations. Appraisal-based perspectives further suggest that empathic responses emerge when individuals evaluate another person's situation along dimensions such as goal relevance, controllability, and need — dimensions central to appraisal theories of emotion [7, 88, 91]. Emotional engagement therefore constitutes a key mechanism through which perspective-taking experiences may foster empathic understanding and prosocial orientation.

Across appraisal-based emotion theories, emotional experiences can be represented along core dimensions, most prominently valence (pleasant–unpleasant) and control/power (high–low coping potential), as operationalized in instruments such as the Geneva Emotion Wheel (GEW) [89]. Valence captures the positive or negative quality of emotional experience, whereas power reflects perceived control, agency, and coping potential in relation to a situation. This dimensional representation enables emotional experiences to be conceptualized and quantified as movement through a multidimensional emotional space. From an empathy perspective, such emotional movement

may be particularly important because perspective-taking experiences involve dynamic shifts in how individuals perceive and respond to another person's circumstances. Appraisal-based perspectives suggest that these dynamic emotional transitions are closely intertwined with cognitive interpretations of situational meaning, controllability, responsibility, and coping potential [88, 91]. Empathy itself is increasingly understood as involving both affective resonance and cognitive perspective-taking processes that enable individuals to understand and emotionally engage with another person's lived experience [30, 31].

If emotional experience is represented as movement through this dimensional space, then the *dynamics* of such movement — how emotions shift and transition over time — may be theoretically meaningful for empathy development. Heyes [51] proposes that automatic emotional contagion arises from learned matching between observed expressions and personal experiences, via mechanisms such as self-stimulation, synchronous emotion, and affect mirroring. This learned-association account implies that novel empathic responses can be forged through repeated experiential learning, and that varied emotional experiences during perspective-taking may create richer associative networks between individuals' emotional states and those of others [77]. Section 2.2 examines how these emotional dynamics operate in learning and game contexts.

2.2 Emotional Variability and its role in Games and Learning

Emotional variability refers to the extent to which an individual's emotional experience changes across time through transitions between distinct emotional states [67]. Rather than reflecting the intensity of a single emotion, emotional variability captures the dynamics of movement through emotional space as individuals continually reappraise changing circumstances. In affective science, emotional variability has frequently been studied as an indicator of affective instability or dysregulation, particularly when emotional fluctuations are frequent, unpredictable, and weakly tied to environmental demands [67]. However, emotional variability is not inherently maladaptive: when emotions fluctuate in response to meaningful events and challenges, such variability may reflect adaptive processes of interpretation, coping, and learning. We argue that this latter perspective is particularly relevant in serious games, where emotional transitions are intentionally elicited through designed experiences, gameplay mechanics, and narrative events.

Research on emotions in learning contexts demonstrates that transitions between emotional states — rather than sustained positive or negative states — support adaptive learning processes. Thus, Kort et al. [64] proposed a four-quadrant model intersecting emotional valence with learning activity, emphasizing that learners naturally cycle through emotional–cognitive configurations as they encounter and resolve challenges, rather than remaining in any single state.

This perspective has been extended to digital and game-based learning environments. Hamrouni and Bendella [46] adapted the four-quadrant framework to serious games and argue that effective gameplay experiences frequently involve movement between beneficial, detrimental, and ambivalent emotional states (see Figure 1). Such transitions could emerge as players encounter obstacles, make decisions, receive feedback, and adapt their strategies. Neuroscientific evidence similarly suggests that positive emotions facilitate learning through enhanced curiosity and working memory, while negative emotions have context-dependent effects that can promote deeper engagement [104].

Collectively, prior research suggests that adaptive learning and engagement emerge not from static emotional states but from structured transitions between emotional conditions. Such transitions constitute a cumulative trajectory through the valence–power emotional space — the player's **emotional journey** — rather than mere fluctuations around a stable baseline. Serious games may therefore foster empathy not merely by eliciting isolated emotions, but by guiding players through

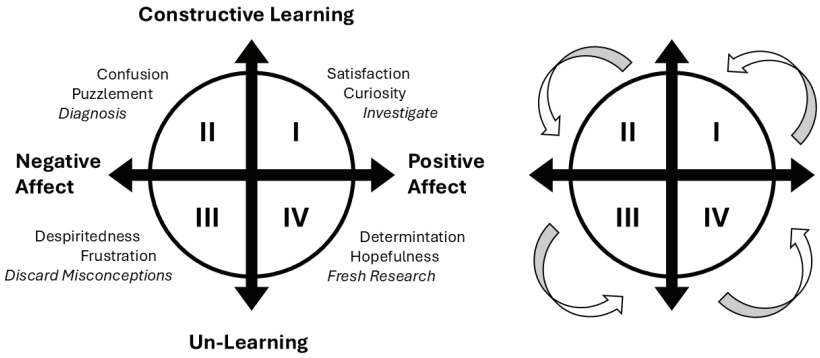


Fig. 1. Hamrouni and Bendella's [46] taxonomy of emotions in serious games, building on Kort et al.'s four-quadrant model [64].

emotionally meaningful trajectories that mirror the instability, uncertainty, and loss of control associated with lived illness experiences.

2.3 Games as Pathways to Empathy

Games offer immersive, experiential pathways to create resonant emotional experiences [10]. Key mechanisms include narrative and roleplay (enabling perspective adoption), meaningful choice (creating emotional investment through consequences), and immersion and presence (providing the psychological foundation for empathic connection). Narrative-driven games with strong character development can evoke meaningful, emotionally moving experiences that support perspective-taking and self-reflection [28, 75], and embodied perspective-taking through immersive media enhances presence and engagement [50].

Empirical evidence demonstrates that games can productively harness emotional variability. Bopp and Mekler [12] found that sadness from in-game loss often coexists with appreciation, and Mariani and Gandolfi [73] showed that negative emotions such as frustration and confusion facilitated learning and attitude change when properly contextualized. Meaningful choices involving moral dilemmas promote reflection and cognitive perspective-taking [54, 78]. However, not all approaches are equally effective: "preachy" designs can create resistance [10, 109], and excessive personal distress can cause self-focused rather than other-oriented empathy [85, 105]. This establishes a boundary condition: emotional variability is productive within a range, but overwhelming negativity backfires. Effective empathy games require careful calibration — sufficient variability to create meaningful engagement, but bounded to avoid self-focused distress.

2.4 From Empathy to Prosocial Action

Batson's empathy-altruism hypothesis posits that empathic concern for another person elicits altruistic motivation to reduce their suffering, even at personal cost [6, 7]. This motivational pathway extends beyond individual acts of helping: empathy-driven moral engagement can activate personal norms that generalize into support for systemic and policy-level interventions [37, 93, 100]. This theoretical chain — from empathic concern, through altruistic motivation, to support for structural change — establishes the pathway through which game-induced empathy may translate into meaningful attitudinal and behavioral outcomes.

2.5 Serious Games for Chronic Illness Empathy: Gap and Contribution

Individuals with chronic illnesses such as long COVID face specific empathy barriers: their conditions are largely invisible, fluctuate in severity, and lack definitive diagnostic markers, leaving affected individuals facing skepticism, minimization, and insufficient support [17, 27, 53]. These characteristics make chronic illness particularly challenging for empathy induction through traditional informational approaches, as outsiders struggle to grasp the lived reality of conditions they cannot directly observe. Serious games may address this gap by enabling experiential understanding through structured perspective-taking.

Despite this promise, empirical studies of empathy games yield inconsistent results. General empathy game evidence is mixed: Braley et al. [13] found that the game BROKE reduced poverty-related bias, and Gutierrez et al. [43] demonstrated that Fair Play reduced implicit bias. However, van Loon et al. [69] found that VR perspective-taking increased cognitive empathy but did not translate to behavioral changes. For chronic illness specifically, results are even less consistent: Vilches Gonzalez et al. [107] found no significant empathy differences (N=16), Shah [95] reported promising but methodologically limited results (N=12), and Tong et al. [103] found kindness and willingness effects but non-significant overall empathy (N=18). These inconsistent findings highlight methodological gaps: small samples, different measures, and — most critically — no studies on perspective-taking games for chronic illness have systematically examined how players' emotional experiences during gameplay relate to empathy outcomes, despite theoretical suggestions that emotional engagement might drive empathic responding [46, 51, 64, 77].

Beyond academic research, advocacy-driven projects have explored similar design space. The *Long COVID Mode* project[1] implements free modifications for *Elden Ring*, *Minecraft*, and *The Witcher 3* that simulate Long COVID symptoms — reduced speed, post-exertional malaise, brain fog, and memory loss — as gameplay mechanics. While this campaign demonstrates public demand for illness simulation through games, it modifies existing commercial titles rather than designing purpose-built interventions, limiting control over the emotional trajectory, and has not been empirically evaluated for empathy outcomes.

This study addresses both gaps by investigating whether players' **emotional journeys** — operationalized as the cumulative magnitude of emotional transitions along the valence and power dimensions during gameplay — predict empathy and prosocial attitudes toward individuals with long COVID. In doing so, we contribute both a purpose-built perspective-taking game for chronic illness empathy and a mechanistic account of how emotional dynamics during gameplay relate to empathic outcomes.

3 Hypotheses

Based on the framework established above, we examine whether the cumulative magnitude of players' emotional transitions — their **emotional journey** through the game — predicts empathy and prosocial outcomes. The following research model formalizes these predictions.

This section details the research model's (see Figure 2) five hypotheses. First, a key determinant of empathic responding is the perceived controllability of another person's suffering [11]. When suffering is viewed as uncontrollable and not self-caused, observers are more likely to experience empathy toward the affected [11]. This mechanism is rooted in attribution theory, which posits that causal attributions shape emotional and behavioral responses [59, 60]. According to this theory, individuals tend to attribute their own misfortunes to external, uncontrollable factors, while attributing others' misfortunes to internal, controllable causes [71], a fundamental attribution error that fosters victim blaming [48]. When suffering is perceived as self-inflicted or controllable,

[1] https://saint-elmos.com/en/cases/long-covid-mode/

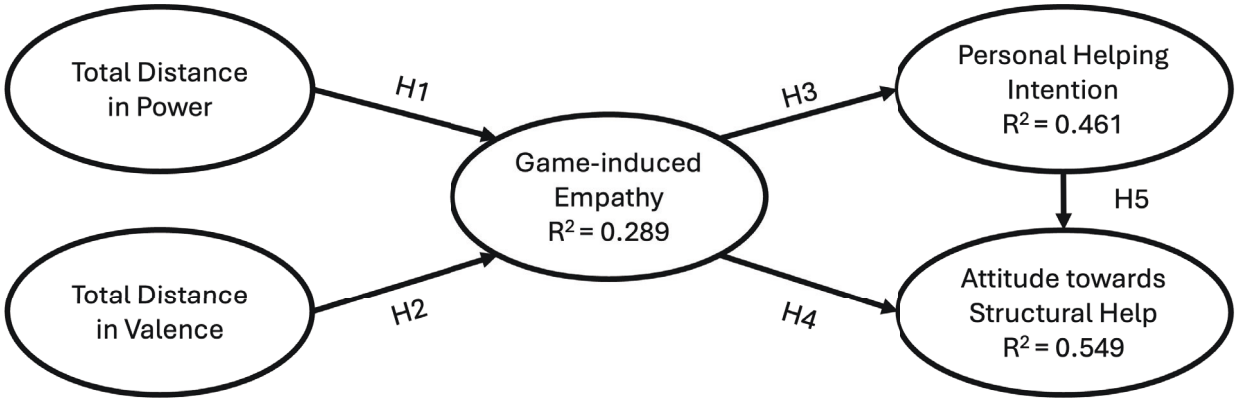


Fig. 2. Proposed research model. Arrows labeled H1–H5 represent the hypothesized paths. TDP = Total Distance of Power (cumulative emotional journey in the control dimension); TDV = Total Distance of Valence (cumulative emotional journey in the valence dimension); GIE = Game-induced Empathy; PHI = Personal Helping Intention; ASH = Attitude towards Structural Help.

observers are less likely to feel empathy and more likely to assign responsibility to the victim. As discussed in Section 2, the control/power dimension is central to appraisal-based emotion theories. We argue that when individuals take the perspective of a suffering person and experience an emotional journey along the control/power dimension, they become more aware of the loss of controllability and more likely to appraise the situation as uncontrollable. This appraisal, in turn, fosters empathy. Thus, we hypothesize that:

- **H1:** A more extensive journey in the control/power dimension during gameplay (measured as total distance of power) is positively associated with empathy toward the sufferer.

Another central determinant of empathic responding is the emotional valence. Negative emotions such as sadness or guilt can increase prosocial behavior when they activate empathic concern — an other-oriented response characterized by compassion and care that motivates helping [19, 25, 57]. According to the attentional focus model [19, 102], adopting the sufferer's perspective shifts cognitive focus outward, transforming negative affect into empathy and altruistic motivation [8]. Importantly, sustained negative emotional states alone are unlikely to foster empathy in a game context, as they may instead lead to disengagement. Rather, it is the dynamic movement across emotional states — the emotional journey in valence — that enables players to recognize contrasts, understand negative affect, and meaningfully relate to the suffering of others. However, as discussed in Section 2, this mechanism has a boundary condition: excessive valence variability may instead trigger self-focused personal distress that suppresses rather than facilitates empathic concern [25, 85]. In other words, appraisal and personal-distress theories suggest a competing possibility: when valence fluctuations become large, self-focused distress may override other-oriented concern, producing a negative rather than positive association. We therefore advance a positive association as our primary prediction while explicitly acknowledging that the data may instead support this boundary-condition alternative. Formally:

- **H2:** A more extensive journey in the valence dimension during gameplay (measured as total distance of valence) is positively associated with empathy toward the sufferer.

As discussed in Section 2, empathy elicits altruistic motivation that translates into prosocial behavior and, through activated moral norms, into support for structural change. This study examines two prosocial outcome constructs: *Personal Helping Intention* (PHI) refers to an individual's willingness to engage in personal, direct actions to support people with long COVID, such as

volunteering time or donating money. *Attitude toward Structural Help* (ASH) refers to an individual's support for systemic, policy-level interventions benefiting people with long COVID, such as government assistance programs for medical care and essential needs. Thus, we propose:

- **H3:** Game-induced Empathy is positively associated with Personal Helping Intention
- **H4:** Game-induced Empathy is positively associated with Attitude towards Structural Help

Sustainable support for long COVID patients requires both individual acts of support and long-term structural change [18, 80]. Norm activation theory [92, 93] and the value-belief-norm theory [100] posit that when individuals internalize personal helping intentions as moral obligations, these activated personal norms generalize into support for broader structural and policy-level change. Based on this reasoning, we propose:

- **H5:** Personal Helping Intention is positively associated with Attitude towards Structural Help

4 Methods

We employed an online experiment using a self-developed serious game as the intervention. Participants adopted the perspective of Lena, a student experiencing long COVID. Quantitative data were analyzed using structural equation modeling (SEM) to test the hypothesized model, while an exploratory qualitative analysis contextualized and enriched the interpretation of findings.

4.1 Materials

The serious game *My Pair of Shoes* was developed in Godot 4.4 and is hosted on itch.io (accessible via this link: https://flox86-64.itch.io/my-pair-of-shoes). It simulates the daily life of Lena, a 24-year-old undergraduate student experiencing long COVID symptoms through a visual novel format. Players assume Lena's perspective and face decisions about activities, social interactions, and health management. The game provides an immersive experience lasting 1–2 hours and spans 18 in-game days plus an epilogue shaped by players' choices. The narrative progresses from a healthy baseline (days 1–3) through an acute COVID-19 infection (day 4), a one-month time skip showing severe persistent symptoms, and the main storyline (days 5–18) depicting life with long COVID. Players navigate key life tasks such as academic deadlines (e.g., studying for exams and completing the final thesis), part-time work to cover living costs, maintaining social relationships (e.g., spending time with partner and friends, attending events, or preparing birthday gifts), and managing mental and physical health (e.g., resting, eating, personal hygiene, cleaning, recreation, and medical appointments).

The game was developed primarily by the first author over approximately one year, including initial research and paper prototyping phases. Colleagues contributed to story refinement and user interface design in later stages. The game engine Godot was chosen because it is lightweight, open-source, and offers the Dialogic plugin for visual novel functionality. In the final 1–2 months of development, 12 pilot testing sessions were conducted leading to bug fixes, story adjustments, and mechanical refinements. The developed game was reviewed by a state-funded public initiative in accordance with the German Entertainment Software Self-Regulation Body (USK) and was rated suitable for players aged 12 and above.

The resource constraints faced by people with long COVID are reflected in the game through energy, time, and money, deliberately restricting player agency (see Figure 3 for a screenshot of general gameplay). The game contains an energy system and each action consumes energy and time. Energy can be regained through short rests during the day. Players begin in a healthy state with the maximum energy capacity, which resets daily to simulate full recovery from sleep. After COVID-19 infection and the onset of long COVID symptoms, maximum energy capacity decreases

and daily starting energy fluctuates, reflecting the unpredictability of chronic fatigue. Action costs also vary slightly, reinforcing this uncertainty. Moreover, to model post-exertional malaise (PEM), a core symptom of long COVID, overexertion pushes players into a "negative energy" state, reducing maximum energy and extending recovery over subsequent days. These energy constraints require players to prioritize activities, as their daily available actions become increasingly limited. In addition to managing energy, players must handle finances, balancing income from work against daily expenses (e.g., purchasing groceries). Together, these mechanics create cycles of loss and adaptation, allowing players to experience reduced agency and the challenges of living with chronic illness.

Players use an in-game smartphone interface to track key tasks, urgent deadlines, and their available budget (see Figure 4). At the end of each in-game day, players completed a diary noting their most prominent emotion and could add optional free-text reflections (see Figure 5).

The protagonist's social environment is represented by various non-player characters, each illustrating different relationships and reactions to long COVID. Example interactions with the friend Emily and the dismissive doctor are shown in Figures 6 and 7.

The game deliberately combines narrative, mechanics, and aesthetics to foster empathy through both cognitive and emotional engagement, offering meaningful choices with genuine trade-offs without being preachy or didactic, which will be explained in more detail in the following.



Fig. 3. Gameplay environment showing the energy meter (bottom left) and dynamic needs tracker (top left), core mechanics simulating the unpredictability of living with chronic illness.

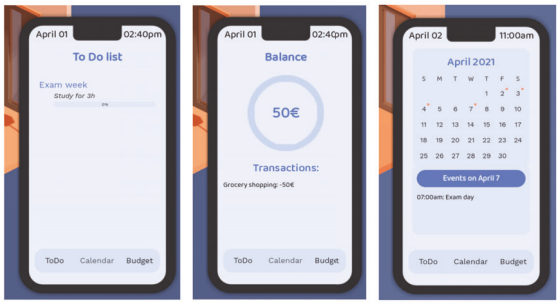


Fig. 4. In-game smartphone interface showing task management, financial decisions, and calendar events, through which players navigate daily trade-offs between energy and obligations.

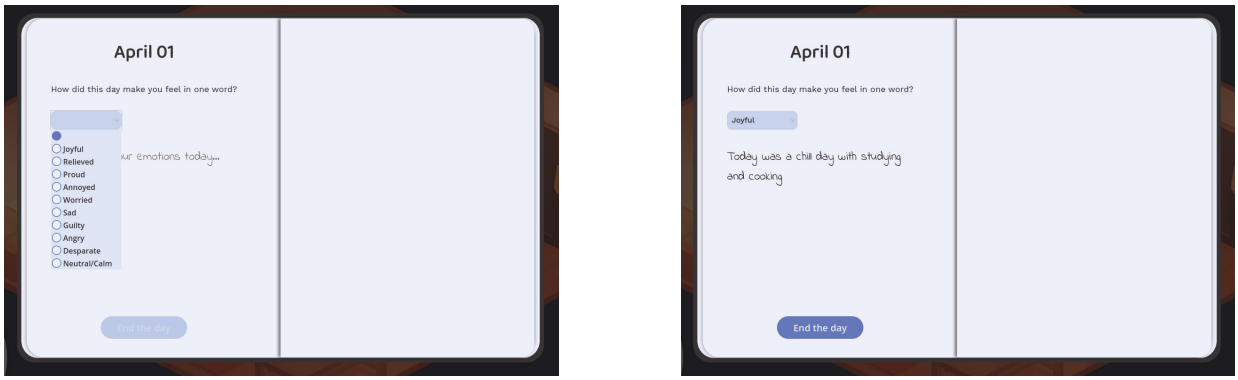


Fig. 5. In-game journal where players select their current emotion from a dropdown and optionally describe their experience in free text, collected after each game day.



Fig. 6. Dialogue interaction with Emily, Lena's supportive friend, representing the social support dimension of living with chronic illness.



Fig. 7. Dialogue with a dismissive doctor, depicting medical epistemic injustice as experienced by the protagonist Lena.

4.1.1 Design Rationale. The narrative structure of *My Pair of Shoes* facilitates perspective-taking through an "active construction" approach [33], where players construct understanding through gameplay rather than passive reception. The temporal structure intentionally mirrors emotional variability cycles, alternating between capability and limitation: an introductory healthy baseline (days 1–3) establishes normalcy through routine activities, followed by acute disruption (days 4–7) and an extended adaptation phase (days 8–16). Positive support moments, particularly interactions with Emily and Alex, introduce mixed emotions—hope and gratitude amid sadness for example. Negative encounters, such as dismissive medical professionals and Ryan's well-meaning but invalidating behavior, generate parallel empathy through perceived injustice. NPCs were designed following Belman and Flanagan's [10] principles: empathy is deepened when similarity and perspective-taking coexist with emotional challenge.

The core mechanics simulate illness unpredictability through deliberate constraints on agency, consistent with an "Outside-In" design approach [101] where empathy arises from doing as the character does. The energy system, with its finite resources, fluctuating costs, and PEM mechanic, enforces cycles of loss and adaptation. Daily maintenance needs—cooking, cleaning, personal hygiene—compete with health management and social obligations, operationalizing the experience of chronic illness where ordinary tasks gain disproportionate weight. These constraints generate meaningful but ambiguous choices: attending social events versus conserving energy, pushing through symptoms versus risking relational disappointment. Such dilemmas exemplify non-preachy design [109], presenting players with genuine trade-offs rather than didactic lessons. The epilogue reveals consequences without external moralizing, and the game gradually scaffolds players from health to decline, mirroring pedagogical progression [1].

Each NPC illustrates a distinct societal reaction to chronic illness, targeting different empathy dimensions per Belman and Flanagan's [10] framework. Emily, the supportive friend, demonstrates the value of social support while also illustrating the demands it places on the person with chronic illness. Ryan, a well-meaning but dismissive friend, illustrates unintentional invalidation—his gestures of care (e.g., buying concert tickets) paradoxically underscore his failure to understand the illness. Alex, the boyfriend, shows the relational strain that chronic illness introduces even in strong relationships. The professor and doctor represent institutional ambivalence and medical gaslighting, respectively, exposing systemic failures in recognizing invisible conditions. Together, these characters were designed to engage cognitive, affective, and associative empathy dimensions, ensuring that players encounter a range of empathic triggers throughout the experience.

4.1.2 Intended Emotional Trajectories. The game was designed to produce four distinct emotional phases across the 18 in-game days. During the *healthy baseline* (days 1–3), players experience high

power and positive valence through routine activities, establishing an emotional reference point. The *acute disruption* phase (days 4 and 5, along with the time skip) produces a sharp decline in both dimensions as symptoms emerge, energy constraints take effect, and medical validation fails. The *adaptation and struggle* phase (days 6–16) generates maximum emotional variability: power fluctuates through cycles of pacing, setbacks, and small victories, while valence alternates between negative states (guilt from unmet obligations, worry about illness progression) and positive spikes from supportive NPC interactions that prevent sustained negativity. Finally, the *resolution* phase (days 17–18) produces complex, outcome-dependent emotions from the final medical encounter and relationship climax. Power shifts were designed to be large (healthy to ill to adaptation) to foster recognition of uncontrollability, while valence shifts were designed to include positive moments to avoid self-focused distress [85]. Unlike the power/control dimension, whose variability is driven directly by gameplay mechanics such as the energy and post-exertional malaise systems, valence was intended to be shaped more indirectly: through narrative framing and NPC interactions (e.g., supportive versus dismissive characters), through the frustration and guilt induced by resource limitation and unmet obligations, and through an audio design intended to reinforce the affective tone of each scene.

4.2 Procedure

The study was accessible online on the itch.io website via a web browser and could be completed remotely. To ensure technical consistency, participation was restricted to desktop computers and laptops. After accessing the study website and loading the game, participants received detailed information about the study and data collection procedures. Participants were informed that the minimum age for participation was 16 years. Participation was voluntary, and participants were informed (via popup and in the game's description on itch.io) that if they felt uncomfortable in any way, they could choose to stop playing at any time without consequences. They were informed about their rights under the General Data Protection Regulation (GDPR), including the right to request complete data deletion during or after the study. Informed consent was required before proceeding.

Participants first completed a pre-survey assessing demographic information (age, gender, employment status, gaming frequency, and long COVID experience). A trigger warning was displayed to individuals who indicated that they have or have had long COVID, advising them to carefully consider whether to participate, as the game's content closely mirrors their lived experience and may therefore cause distress. The pre-survey further measured personal helping intention toward individuals affected by long COVID and attitudes toward structural support. Afterward, participants received a short introduction to the game narrative and a tutorial covering core gameplay mechanics. After each of the 18 in-game days, participants were asked to select the emotion that best described their experience of that day and could optionally provide a free-text journal entry. Gameplay lasted approximately 1-2 hours. Upon completion, participants completed a post-survey measuring game-induced empathy, personal helping intention, and attitudes toward structural support for individuals affected by long COVID. They could also provide general feedback in a free-text response. As compensation, participants could enter a raffle to win one of three Amazon vouchers.

The study complied with the GDPR and German data protection laws. All data were collected anonymously via secure, GDPR-compliant servers, and no personally identifiable information was stored with the research data. No data from individuals under the age of 16 was collected. Email addresses for the optional raffle were stored separately from research data. The data collection procedure was approved by the university's data protection officer.

To improve the game after initial development, a one-month period of intense user testing was conducted. A total of twelve sessions have been carried out, where either a participant was left alone to play to provide feedback afterwards or the first author sat next to the participant to record notes about bugs, problems and general play behavior. Based on the feedback and notes, the game and study were adapted and improved iteratively.

4.3 Measurements

The emotional journey is operationalized as the sum of absolute day-to-day differences in diary-reported emotions across 18 in-game days. To this end, we computed the measures total distance of power (TDP) and total distance of valence (TDV). Each emotion selected at the end of the 18 in-game days was mapped to corresponding power and valence values based on the Geneva Emotion Wheel [89], with the mapping presented in Table 1. Both measures were calculated as the sum of absolute day-to-day differences across all 18 days. For example, if a participant went from ”joyful” (valence = 0.96, power = 0.62) to ”worried” (valence = -0.84, power = -0.1) and back to ”joyful” in the span of three days, the total distance would be abs(0.96 - (-0.84)) + abs(-0.84 - 0.96) = 3.60 for valence and abs(0.62 - (-0.1)) + abs(-0.1 - 0.62) = 1.44 for power. Participants with missing emotion entries for two or more days were excluded from the dataset. Four participants who completed the game but had a single missing emotion entry were retained, and the missing value was imputed using the participant’s mean day-to-day transition value.

We chose this operationalization because it best aligns with the theoretical framework and study context. Alternative measures such as absolute values or emotional range were considered but deemed less suitable, as they capture peak intensity rather than the emotional journey (i.e., cumulative emotional experience) that is central to our research. Although prior research in affective and clinical psychology has operationalized emotional variability as the standard deviation of emotions across time [67], this approach is used to capture spontaneous, weakly structured emotional fluctuations often interpreted as affective instability or dysregulation [67, 86]. In contrast, our study examines emotionally structured experiences within a digital game context, where affective transitions are intentionally elicited through gameplay mechanisms and events such as challenge, failure, reward, uncertainty, and progression. Rather than reflecting uncontrolled oscillations around a stable baseline general mood, our context follows a contingency-based perspective on emotion, in which emotional responses are shaped by and contingent on environmental events, in this case, the game environment. Furthermore, because players can actively influence the storyline through in-game decisions, assuming a meaningful global mean is not appropriate, as individual emotional trajectories may differ systematically depending on gameplay choices. Moreover, our cumulative approach captures both the frequency and magnitude of emotional transitions, thereby reflecting the theoretical proposition that repeated exposure to diverse emotional states facilitates associative learning and empathy development [64].

Game-induced empathy (GIE) was measured after the game-based intervention using the 12-item State Empathy Scale by Shen [96], which assesses cognitive (perspective-taking and understanding), affective (emotional connection and responsiveness), and associative (immersion and identification) dimensions. As the original scale was developed for message processing contexts, all items were adapted to refer to the game experience and the main character Lena, whom participants embodied during gameplay. Personal Helping Intention (PHI) was assessed with four items. Three items were adapted from Lee et al. [68] and one additional item was included to assess direct monetary donation intention, as it represents a common form of personal helping behavior that involves personal cost and the sacrifice of personal benefit [58], in line with prior research [41, 47, 50]. Attitude toward structural help (ASH) was measured using three items adapted from Phelan et al. [81]. As the original items were developed in the context of attitudes toward homelessness, we

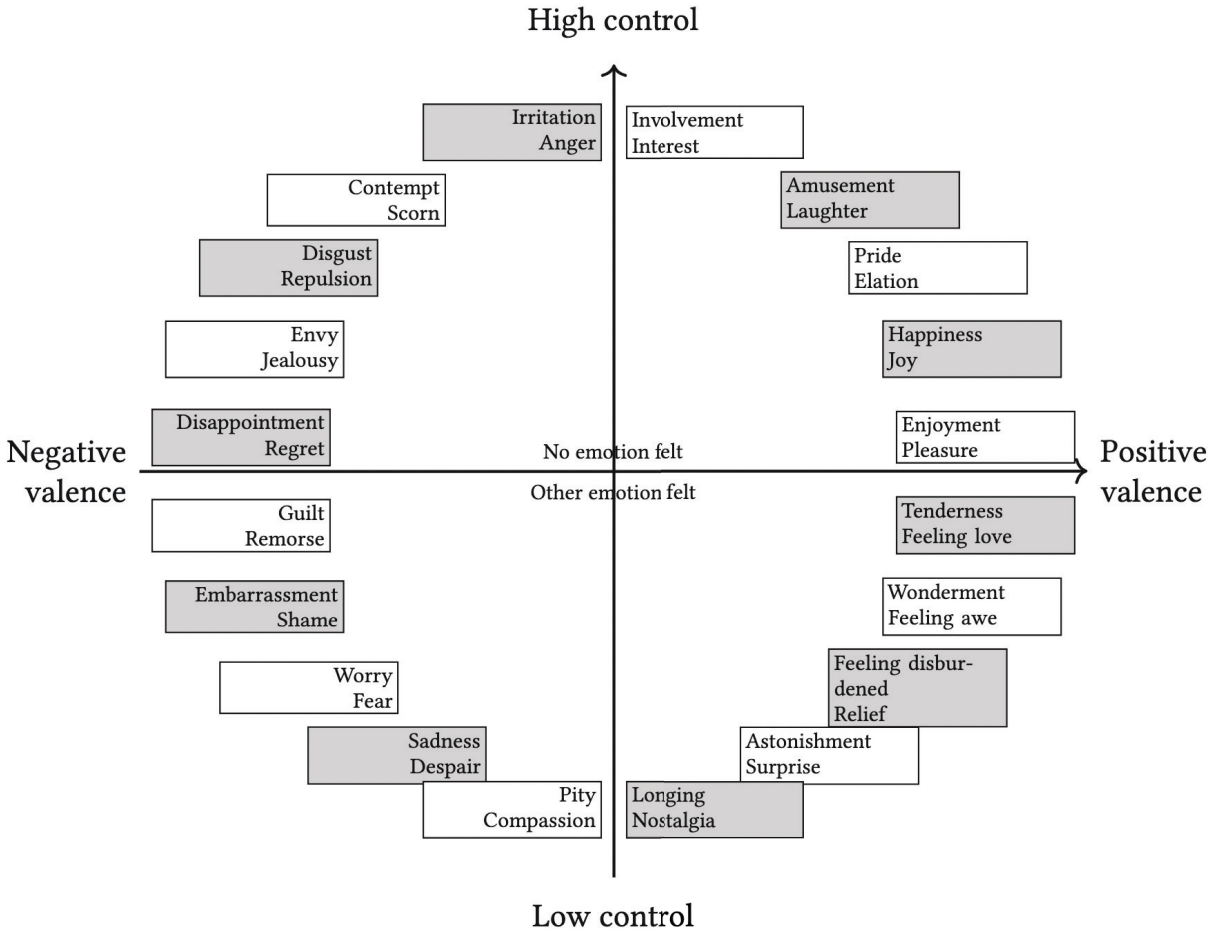


Fig. 8. The Geneva Emotion Wheel (GEW) adapted from [89].

Table 1. Geneva Emotion Wheel (GEW) emotion mapping

Emotion (from GEW)	Valence value	Control/Power value
Joyful	0.96	0.62
Relieved	0.84	0.04
Proud	0.70	0.30
Worried	-0.84	-0.10
Sad	-0.86	-0.40
Annoyed	-0.76	-0.02
Angry	-0.82	-0.04
Guilty	-0.92	-0.22
Desperate	-0.92	-0.62
Neutral/Calm	0.00	0.00

adapted all items to fit the long COVID patient context. To determine the effect of the game, both PHI and ASH were measured before and after the game-based intervention. All items were rated on five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). See all questions for GIE, PHI and ASH in Table 2. As control variables, we included single-item measures for age, gender, employment status, gaming frequency, and long COVID experience.

Table 2. Survey Constructs, Codes, Items, and Sources

Construct	Code	Item	Source
Game-induced Empathy (GIE)	GIE1	I could see Lena's (main character) point of view.	Shen [96]
	GIE2	I understand Lena's (main character) situational challenges.	
	GIE3	I can understand what Lena (main character) was going through in the game.	
	GIE4	I understand Lena (main character).	
	GIE5	The emotions I experienced during the game felt authentic and genuine.	
	GIE6	I felt emotionally connected to the experiences portrayed in the game.	
	GIE7	The game evoked strong emotional responses in me.	
	GIE8	I was emotionally affected by the situations in the game.	
	GIE9	When playing the game, I was fully absorbed.	
	GIE10	The experiences in the game felt personally meaningful to me.	
	GIE11	I felt as though I was experiencing the challenges shown in the game firsthand.	
	GIE12	Playing the game made me feel connected to the experience of living with chronic illness.	
Attitude toward Structural Help (ASH)	ASH1	People with long COVID deserve help from society.	Phelan et al. [81]
	ASH2	People with long COVID should be given government assistance to cover essential needs such as food, clothing, and shelter.	
	ASH3	People with long COVID should be given government assistance for medical care.	
Personal Helping Intention (PHI)	PHI1	I would be willing to pay higher taxes to support people with long COVID (e.g., funding research or providing basic care).	Lee et al. [68]
	PHI2	I would be willing to volunteer to support people with long COVID.	
	PHI3	I would be willing to donate money to support people with long COVID (e.g., funding research or providing basic care).	Herrera et al. [50], Frechette et al. [41], Hargrove et al. [47]
	PHI4	I would be willing to accept higher health insurance contributions to improve medical care for people with long COVID.	Lee et al. [68]

4.4 Participants

Participants were recruited through both offline and online channels. Offline recruitment involved announcing the study in well-attended university lectures and distributing physical flyers at the university and at regional game-related events. Online recruitment was conducted via various digital channels, including university mailing lists and posts on social media platforms such as Reddit forums, Discord servers, and LinkedIn. A total of 68 participants completed the full game experience and post-intervention questionnaire.

The average participant age was 29 years (mean = 29.2, SD = 9.64). The gender distribution was fairly balanced, with 45.6% identifying as male and 44.1% as female. Slightly more than half of the participants were students (52.9%). 69.1% of the participants spent more than 2 hours on video games and can be categorized as regular or frequent gamer. Half of the participants (50%) reported having experience with long COVID, either personally or through someone they know. Detailed participant demographics are presented in Table 3.

Table 3. Participant Demographics

Category	**Characteristics**						
Age	16–20	21–25	26–30	31–35	36–40	>41	NA
	7 (10.3%)	23 (33.8%)	10 (14.7%)	11 (16.2%)	6 (8.8%)	8 (11.8%)	4 (5.9%)
Gender	Male	Female	Diverse	NA			
	31 (45.6%)	30 (44.1%)	6 (8.8%)	1 (1.5%)			
Employment Status	Student	Employed	Self-employed	Unemployed	NA		
	36 (52.9%)	15 (22.1%)	5 (7.4%)	11 (16.2%)	1 (1.5%)		
Gaming Frequency	0–2 hrs	2–5 hrs	5–10 hrs	10–15 hrs	>15 hrs		
	21 (30.9%)	14 (20.6%)	10 (14.7%)	11 (16.2%)	12 (17.6%)		
Long COVID Experience	No	Personal	Know someone				
	34 (50.0%)	12 (17.6%)	22 (32.4%)				

4.5 Data Analysis Methods

4.5.1 Statistical analyses. For quantitative analysis, jamovi 2.7.12 [55] and SmartPLS 4 [87] were employed. First, a manipulation check was conducted using pairwise tests of pre- and post-measures of PHI and ASH to verify the effect of our serious game intervention. Subsequently, partial least squares structural equation modeling (PLS-SEM) was applied to evaluate the research model. PLS-SEM was chosen for its ability to analyze complex relationships between observed and latent variables, its robustness with non-normally distributed data, and its appropriateness for smaller sample sizes [44, 49]. Compared to traditional regression methods, SEM is better suited for theory-driven research models involving multiple interconnected and multifaceted constructs [44]. Our model examines constructs such as empathy, attitudes, and behavioral intentions, which are measured through multi-item scales adapted from validated literature. While traditional regression typically analyzes observed variables directly and focuses on isolated relationships, SEM enables the modeling of latent constructs through multiple indicators [44]. In addition, SEM allows the simultaneous assessment of mediation and indirect effects within a single theoretical model, avoiding the need for multiple separate regression analyses and repeated p-value adjustments. Sample adequacy was assessed using both the inverse square root and gamma-exponential methods [44, 63] using WarpPLS [62], and the measurement model's content, structural, convergent, and discriminant validity was confirmed. To ensure appropriateness, we tested for common method bias and verified the reliability of our statistical conclusions. Hypotheses were then tested using PLS-SEM, with constructs modeled as latent variables and items as observed indicators. PLS-SEM is widely used to extend established theories and is particularly suitable for exploring complex models with multiple

independent and dependent variables, including chains of causal and indirect effects. Finally, bootstrapping was used to assess the statistical significance of the path coefficients in the structural model.

4.5.2 Thematic analysis. At the end of each in-game day, players had to select an emotion from a list and, in addition, had a text field to leave an optional comment. 28 participants wrote at least one diary entry (*M*: 3.68; *Md*: 0; *SD*: 6.01). The number of diary entries submitted per in-game day decreased as the game progressed, with a maximum of 23 on the second day and a minimum of 4 on the last day, while the average length of an entry (in words) remained more stable across in-game days (*M*: 104; *Md*: 98; *SD*: 38.79) and the quality of the messages from those who remained engaged did not seem to diminish. The final survey included a field for open feedback as well, which 20 participants used. In total, 13 participants wrote at least one diary entry and provided final feedback; 22 contributed either; and 33 did not provide qualitative data at all.

To contextualize and enrich the quantitative findings and understand the phenomenology underlying the measured constructs, we conducted a reflexive thematic analysis (TA) on the participants' diary entries and final feedback, following Braun and Clarke's six-step process [14]. This exploratory analysis addressed the complementary question of *what* the gameplay experience looked like from the player's perspective — specifically, how players experienced chronic illness through the game's mechanics and narrative, and how they related these experiences to their own lives and perspectives. The analysis was not designed to test theoretical predictions but rather to enrich interpretation of the quantitative model by providing grounded descriptions of the experience that the model's latent constructs represent. Discrete player inputs were treated as information units for the purposes of the thematic analysis. However, for some aspects additional consideration was given to how individual players manifested their views at different times, e.g., to establish how their in-game experiences with energy management and with others around them may have affected their identity construction process.

Two authors participated in the thematic analysis process: the third author familiarized himself with the data, generated initial codes, and did an initial categorization into themes. These first three steps were informed by a guiding question, namely how participants expressed themselves in terms of emotions, empathy, and attitude. Then, the first author entered the process, reviewing the themes and proposing a refined categorization that was more data-driven. Together, they did a final review of the themes and defined and named them, leading to a result informed by the goals of the research but which evolved significantly during the analysis and thus "maps onto the inductive approach" [14, p. 84].

4.5.3 Positionality. Regarding positionality, the first author is a 28-year-old white man from Germany whose personal experience living with long COVID for four years directly motivated this study. The game draws primarily on his experiences, which inevitably imbues it with a subjective perspective. His lived experience allows for increased understanding but may also lead to interpreting participants' responses through the lens of his recovery journey.

The second author is a 27-year-old Asian man, born in China and living in Germany since childhood. He experienced long COVID symptoms for over six months and has lived with chronic illness since childhood, giving him understanding of the challenges of living with and supporting others with chronic conditions.

The third author, who did not participate in the game's design, is a 33-year-old white man from Spain living in Finland. He has been diagnosed with multiple chronic illnesses, though these have not significantly impacted his quality of life in recent years. His belief that access to quality healthcare should be a universal right was identified and taken into account during the analysis.

The fourth author is a 40-year-old white male scholar from Germany who has investigated the positive potentials of games across diverse contexts for approximately 15 years. While this commitment positively influences the project's orientation, it may also shape how the broader societal implications of the findings are interpreted.

To account for these positionalities during analysis, the coding process was structured so that Author 3 — who was not involved in the game's design — led the initial thematic coding independently, with Author 1 subsequently providing critical review and proposing refinements, as detailed in Section 4.5.2.

5 Quantitative Results

5.1 Manipulation Check

To verify that our game-based intervention produced an effect, we conducted paired-sample analyses for the constructs PHI and ASH, which were measured both before and after the intervention. These analyses served as a manipulation check to assess whether the game induced improvements in the targeted constructs. For each construct, composite scores were calculated by averaging the corresponding items for each participant. Descriptive statistics for all constructs are reported in Table 4. Prior to conducting the paired-sample tests, we assessed the normality of the distributions using the Shapiro-Wilk test. The results indicated that neither ASH ($W = 0.891$, $p < 0.001$) nor PHI ($W = 0.914$, $p < 0.001$) was normally distributed. Accordingly, Wilcoxon signed-rank tests were used. The results revealed a significant difference in ASH scores before and after the game-based intervention ($W = 221$, $p = 0.018$), as well as a significant difference in PHI scores ($W = 199$, $p < 0.001$), indicating that the intervention had a measurable effect on both constructs. Effect sizes were calculated using the rank-biserial correlation. The effect size for Personal Helping Intention was large ($r_{rb} = 0.66$), while the effect for Attitude toward Structural Help was moderate ($r_{rb} = 0.44$).

Table 4. Descriptive Statistics for ASH and PHI

Construct	Mean	Standard Deviation	Median	Standard Error
ASH pre	4.14	0.827	4.33	0.100
ASH post	4.30	0.853	4.67	0.103
PHI pre	3.02	1.061	3.00	0.129
PHI post	3.27	1.113	3.50	0.135

To assess whether the game successfully manipulated emotional variability along power and valence dimensions and created a coherent emotional journey, we averaged participant ratings for each of the 18 in-game days and plotted them. As intended by the design (see Section 4.1.2), participants began with relatively high control and valence values at a healthy baseline. These values decreased following acute COVID-19 infection and the onset of persistent symptoms and then fluctuated over the rest of the game.

5.2 Partial Least Squares Structural Equation Modeling

We evaluated our research model using PLS-SEM with SmartPLS 4 [87]. To ensure sufficient sample size, we applied the inverse square root method and gamma-exponential method [44, 63] in WarpPLS [62], using standard research parameters (power = 0.8, alpha = 0.05). These approaches yielded minimum required sample sizes of 59 and 45, respectively, both of which were satisfied.

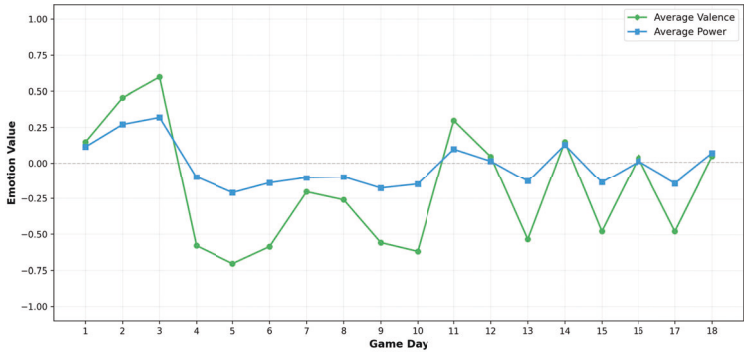


Fig. 9. Average player valence and power across the 18 game days, showing the intended shift toward negative valence during the acute disruption phase (days 3-4) and subsequent fluctuations in valence and power.

5.2.1 Measurement Model. We assessed the reliability, convergent validity, discriminant validity, and content validity of the measurement model. For reliability (see Table 5), all Cronbach's alpha (CA), composite reliability (CR) and average variance extracted (AVE) values met their recommended criteria of 0.7 and 0.5, respectively [39, 44]. All indicator loadings exceeded the recommended threshold of 0.7 [44], except for the empathy items GIE1 and GIE3. These items were retained, as they originate from a previously validated scale [96]. Factor loadings below the threshold are not uncommon, and such items should be considered for removal if doing so would push the AVE or CR values above the recommended levels and not detract from content validity [44]. Moreover, loadings above 0.6 can be considered acceptable [4], particularly if there are additional items in the block for comparison basis [23].

Discriminant validity was confirmed through three methods. First, cross-loadings confirmed that items loaded higher on their corresponding constructs than other constructs [44]. Second, the Fornell-Larcker criterion (see Table 6) showed that the square root of each construct's AVE on the diagonal was notably greater than its inter-construct correlations. Third, all heterotrait-monotrait ratio of correlations (HTMT) values ranged from 0.09 to 0.708 (see Table 7), well below the recommended threshold of 0.85 [49]. Jointly, these results indicate good reliability, convergent validity, and discriminant validity [44].

We then assessed multicollinearity by calculating the variance inflation factors (VIF) (see Table 8). All values, ranging from 1.000 to 1.650, were below the threshold of 3.3 [61], indicating that multicollinearity is less of an issue. Moreover, we assessed common method bias, which refers to systematic variance in responses attributable to the data collection method rather than to the constructs being measured [83]. To mitigate this risk a priori, the order of questionnaire items was randomized to reduce potential response patterns [20]. To assess the common method bias in the data, we applied Harman's single-factor test [83]. The first factor accounted for 34.4% of the variance (see Table 9), which is below the 50% threshold, suggesting common method bias is less of a concern in this study.

5.2.2 Structural Model. A bootstrapping analysis with 5,000 resamples was conducted to evaluate the structural model. The evaluation focused on path coefficients (β) and their significance levels (p), explained variance (R^2), effect sizes (f^2), t-values, and the lower (LO) and upper (HI) bounds of the 95% confidence intervals (CI). The results of the structural model are depicted in Figure 10 and the validation of the hypotheses in Table 10.

The structural model analysis revealed the following relationships between our constructs: The total distance of power was positively associated with game-induced empathy ($\beta = 0.477$, $p < 0.01$), supporting H1. In contrast, the total distance of valence was negatively associated with

Table 5. Psychometric properties of Items

	CA	CR	AVE	Items	GIE	ASH	PHI	TDP	TDV
GIE	0.942	0.950	0.617	GIE1	**0.662**	0.594	0.435	0.048	-0.137
				GIE2	**0.781**	0.700	0.484	0.064	-0.021
				GIE3	**0.656**	0.482	0.422	0.017	-0.073
				GIE4	**0.830**	0.512	0.415	0.066	-0.129
				GIE5	**0.877**	0.459	0.430	0.266	-0.087
				GIE6	**0.872**	0.464	0.500	0.227	-0.013
				GIE7	**0.820**	0.451	0.450	0.221	-0.113
				GIE8	**0.863**	0.453	0.488	0.318	-0.003
				GIE9	**0.768**	0.456	0.526	0.329	-0.026
				GIE10	**0.730**	0.383	0.443	0.374	0.135
				GIE11	**0.734**	0.385	0.350	0.291	-0.060
				GIE12	**0.794**	0.529	0.510	0.328	-0.023
ASH	0.867	0.919	0.790	ASH1	0.583	**0.862**	0.562	0.067	-0.046
				ASH2	0.529	**0.872**	0.560	-0.107	-0.190
				ASH3	0.564	**0.930**	0.554	-0.066	-0.185
PHI	0.891	0.924	0.753	PHI1	0.466	0.664	**0.888**	0.018	-0.102
				PHI2	0.568	0.538	**0.861**	0.142	-0.058
				PHI3	0.480	0.445	**0.817**	0.137	-0.096
				PHI4	0.517	0.515	**0.904**	0.131	0.046
				TDP	0.271	-0.036	0.118	**1.000**	0.554
				TDV	-0.058	-0.155	-0.060	0.554	**1.000**

Table 6. Fornell-Larcker Criterion

Construct	TDP	TDV	GIE	ASH	PHI
TDP	**1.000**				
TDV	0.554	**1.000**			
GIE	0.271	-0.058	**0.786**		
ASH	-0.036	-0.155	0.630	**0.889**	
PHI	0.118	-0.060	0.584	0.630	**0.868**

Table 7. HTMT Values of each Construct

Construct	TDP	TDV	GIE	ASH	PHI
TDP					
TDV	0.554				
GIE	0.280	0.090			
ASH	0.097	0.170	0.690		
PHI	0.130	0.092	0.636	0.708	

Table 8. VIF Values for each Path

H	Relationship	VIF
H1	TDP → GIE	1.448
H2	TDV → GIE	1.448
H3	GIE → ASH	1.520
H4	GIE → PHI	1.000
H5	PHI → ASH	1.520

Table 9. Total Variance Explained for Verification of Common Method Bias

Component	Extraction Sums	% of variance	Cumulative %
1	7.20	34.29	34.4
2	3.90	18.57	52.9
3	1.73	8.25	61.1

game-induced empathy ($\beta = -0.361$, $p < 0.01$); contrary to our primary prediction but consistent with the personal-distress boundary condition anticipated in the hypothesis development, H2 is therefore not supported. Game-induced empathy was positively associated with both Personal Helping Intention ($\beta = 0.564$, $p < 0.001$) and Attitude toward Structural Help ($\beta = 0.373$, $p < 0.01$),

supporting H3 and H4. Additionally, Personal Helping Intention was positively associated with Attitude towards Structural Help ($\beta = 0.325$, $p < 0.01$), supporting H5.

Table 10. Results of the Structural Model

H	Relationship	β	p	f^2	t-value	95% CI_{LO}	95% CI_{HI}	Decision
H1	TDP → GIE	0.477	0.000	0.213	3.632	0.246	0.708	Supported
H2	TDV → GIE	-0.361	0.005	0.117	2.819	-0.560	-0.133	Not supported
H3	GIE → PHI	0.564	0.000	0.513	5.001	0.346	0.779	Supported
H4	GIE → ASH	0.373	0.005	0.177	2.785	0.105	0.641	Supported
H5	PHI → ASH	0.325	0.009	0.126	2.612	0.099	0.551	Supported

The R^2 values are the explained variances for the latent variables and are typically used to describe the model's explanatory power [44]. Overall, the R^2 values reveal that the proposed model explains 28.9% of the variance of empathy, 46.1% of the variance of personal helping intention, and 54.9% of the variance of attitude toward structural help. According to Cohen [26], f^2 values above 0.02 indicate small effects, above 0.15 medium effects, and above 0.35 large effects. In the proposed structural model, a large effect was found between Game-Induced Empathy and Personal Helping Intention ($f^2 = 0.513$). Medium effects were identified between Total Distance of Power and Game-Induced Empathy ($f^2 = 0.213$) as well as between Game-Induced Empathy and Attitude toward Structural Help ($f^2 = 0.177$). Small-to-medium effects were observed between Personal Helping Intention and Attitude toward Structural Help ($f^2 = 0.126$) and between Total Distance of Valence and Game-Induced Empathy ($f^2 = 0.117$). Analysis of control variables revealed that personal experience with long COVID significantly predicted both personal helping intention ($\beta = 0.616$, $p < 0.01$) and attitude toward structural help ($\beta = 0.398$, $p < 0.05$), but not game-induced empathy ($\beta = 0.271$, $p > 0.05$). Gaming frequency was negatively associated with game-induced empathy ($\beta = -0.303$, $p < 0.05$), suggesting that more experienced gamers developed less empathy toward the character. Age and gender had no significant effects on any endogenous construct, indicating that the serious game intervention might be effective across diverse demographics.

6 Qualitative Results

The exploratory thematic analysis resulted in two themes, focusing on the experience of chronic illness in the game (1) and the players' expressed relationship to chronic illness (2). Notably, the game was generally well-received, with players praising the mechanics as intuitive, the writing as impressive, and the audiovisual design as engaging. Only one player expressed discontent based on the perception that characters had been generated through AI. This suggests that the game was perceived as well-crafted, ruling out poor game quality as an alternative explanation for weak effects. This section aims to provide a more nuanced perspective on the emotional palette of the game, contextualizing emotions beyond their default tags; not to restate what players felt, but to indicate the targets and circumstances of their feelings.

6.1 Theme 1. Experiencing chronic illness in the game

This theme describes how participants experienced chronic illness through the game's avatar and the events that she went through. A first important aspect of the experience was *energy management*. Since the illness caused physical and mental exhaustion that was quantified in the game, energy was perceived as a precious resource that was difficult to preserve and which hindered normal

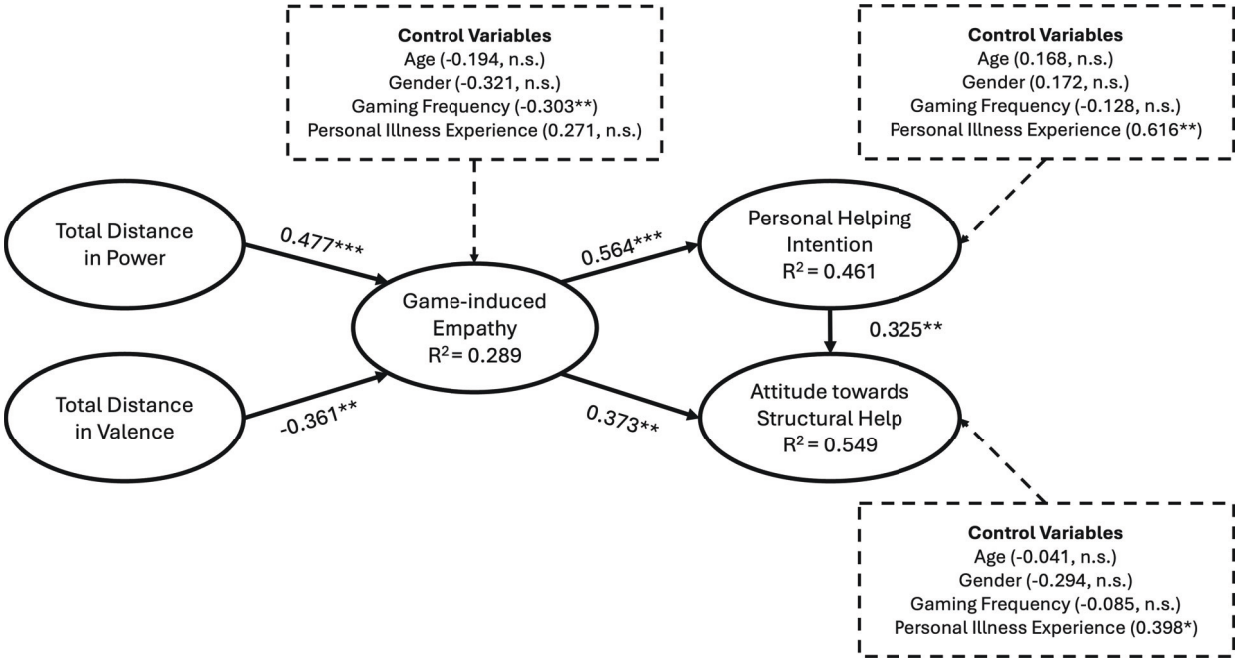


Fig. 10. PLS-SEM path model results with standardized beta coefficients, significance levels, and R^2 values for endogenous constructs.

activities: ”it was very difficult to study today and work felt like forever” (P46, day 4). Players recognized that activities had a clear cost associated, requiring an energy expenditure that may not be available. The need to prioritize some activities and forgo others often had consequences (”I couldn’t go to work. I disappointed my boss and got no money”, P29, day 4) and players manifested anxiety or worry about future energy capacity and illness progression: ”what is wrong with me?” (P59, day 17). It was clear to players that this lack of energy made achieving traditional milestones exceedingly difficult for Lena. The thesis became a symbol, with academic work representing failure to meet societal expectations. This all occurred in a context of overwhelming, competing demands that the players felt unable to manage, leading to a sense of ”losing control” (P61, day 13). As a response, players engaged in strategic pacing, or taking conscious decisions to allocate limited energy, which sometimes led to pride when successful (e.g., ”proud I didn’t waste energy arguing”, P25, day 13). On occasion, this strategic pacing led to small victories, or milestones such as steps towards completing the thesis itself: ”finally got that summary done! a stone falling off my heart ...” (P49, day 13).

Importantly, players could show both sides of energy management and in different order—the player who was desperate and ”losing control” expressed joy the next day: ”happy i made it to the bridal boutique.” Meanwhile, the player who felt ”a stone falling off my heart” reported desperation the next day: ”work today! i can’t. i just want everything to be done already.” Overall, this finding indicates that players navigated a complex space between frustration and anxiety derived from constraints and repercussions and pride, relief and hope derived from successful energy management.

Beyond energy management towards activities and milestones, players experienced a variety of *relational dynamics* brought about by chronic illness. The boyfriend’s supportive stance, for example, was precious but it also created guilt about not reciprocating: ”it makes me happy to have him but sad at the same time because he also deserves more of my attention” (P22, day 7). Other relationships were directly invalidating, when others did not understand or accommodate for the

illness, leading to strong averse feelings: ”I hate emily and ryan” (P29, day 10). In the end, the illness led players towards social isolation, or withdrawal from social activities due to energy limitations. Similarly, medical epistemic injustice was embodied by Lena’s relationship to doctors. Players noted how she was systemically dismissed by the medical system, leading to a sense that ”nobody believes me” (P61, day 17). While players sought validation and a medical proof to legitimize their situation, they faced structural obstacles to accessing care or support: ”I wish there was an option to quit my job. how long does it take to get on benefits? i’m probably gonna need them” (P55, day 15). Despite ups and downs (e.g., the player who declared hating Emily and Ryan was proud of having “helped emily” a few days later), it was clear that social relationships, both intimate and professional, became more difficult to navigate due to added dimensions such as trust and guilt.

Finally, experiences with energy management and the larger social landscape led to *identity fragmentation and reconstruction*. Here, players expressed grief for their former, healthy, productive self. This is captured by expressions such as ”my old life slipping away … Who will I be?” (P25, day 5). This process of reconfiguration involved self-advocacy as well, or the process of learning to prioritize health and set boundaries: the same player said on day 13, ”proud i didn’t waste energy arguing.” In some cases, displays of self-acceptance (”… i’m not sorry, i wont be sorry. i love myself, and that’s why i’m tucking [Lena] into bed …” P55, day 13) were combined with an explicit acceptance of loss and larger redefinition of life priorities: ”I’m not going to graduate” (day 12); ”i went to the dress shopping. wedding is new priority not university” (day 14). As will be discussed, this finding indicates that players recognized that managing their energy, tasks and relationships in the face of long COVID was not just a matter of pragmatic decision-making to maximize rewards and minimize negative consequences but an issue that had to be grappled with at the personal level, since these aspects impact how a person sees themselves as much as it determines how others see them.

6.2 Theme 2. Player relationship to chronic illness

This theme explores first-person reactions and opinions expressed by players outside of the strict frame of the game’s fiction.

In most cases, reactions were *receptive towards the game’s portrayal of the issue*. Some players reported increased awareness and learning about long COVID: ”I did not know about long COVID changing someone’s life forever, I thought it was a thing of some weeks …” (P29) and, more broadly, the game supported understanding of chronic illness in general: ”long COVID is a good example of invisible disabilities and it’s important that this gets discussed in a broader way” (P63). In general, the game was considered an attractive way to learn and create awareness. In addition, personal resonance and embodied connection were reported by those with chronic illnesses, who identified with Lena’s experience. ”as someone with lc-me/cfs, this game was very accurate a portraying our struggles” (P60). Others connected the difficulties facing Lena with their own experiences in other areas of life, e.g., other health issues or migration. Finally, beyond resonance with lived experiences, players expressed strong emotional reactions to Lena’s story, including crying (P46), ”crying multiple times” (P56), nondescript emotional involvement (P65), and ”a lot of this hit close to home” (P51). This led to one participant expressing concerns over boundaries, since the game experience triggered personal mental health issues that had to be managed by the player. This finding indicates that the game was capable of promoting cognitive engagement with chronic illness at the awareness and emotional levels, both for those with similar experiences and for those who had not lived similar situations.

Conversely, other players seemed to express opinions that can be seen as *defensive minimization* — dismissing or downplaying the reality of the illness by attributing its difficulties to the protagonist’s poor choices or to external factors rather than to the condition itself. For instance, difficulties were

attributed to poor choices (”if you’re writing your bachelor’s thesis or if you have exams those are your priority, not some reading class, 120€ overpriced concerts, or gas station jobs”, P47). One other player was skeptical of the game’s portrayal of relationships, indicating that it need not be as shown: ”if you’re around genuine people, friends, and have a partner that truly loves you, it is not as portrayed in the game” (P47). In a similar vein, rather than focusing on the story they had experienced, other players criticized social and healthcare systems (”in Germany the social and insurance systems could help them, but the government just doesnt want to,” P67) and mentioned broader tax and policy issues, perhaps prompted by the post-game questionnaire (”i don’t want to pay higher taxes for long COVID patients when that is non-descriptive, along with the lack of tax on m/billionaires that could fund long COVID/me/cfs in an instant,” P43).

While generally it was not possible to establish a clear attitudinal progression for individual players given that only a minority wrote detailed enough diary entries and final feedback, P37 provided both to sufficient degree. In their diary entries, they criticize both Lena and others for their behavior (e.g., ”[Lena] has not enough stamina, should do more sports watch out on health,” day 5) while showing an understanding of and satisfaction with their own performance (”good managing of energy. i need to deal with my cards dealt,” day 8) and expressing more general views (”everything done again. everyone has burdens, you need to push through them,” day 17). In the final feedback, P37 indicates that people should ”push our selves more. i often feel exhausted too but complaining isn’t solving the problems. you need to prioritize health over everything, be clever with you financials and education and then try to overcome problems, find joy.” Therefore, while we have no clear evidence of any player’s empathy shifting as they played, P37 serves as an illustrative case of how some players maintained consistent attitudinal orientations throughout the game. Whether such patterns generalize to the broader sample cannot be determined from this single case.

6.3 Connecting qualitative and quantitative findings

Although the qualitative data comes from a self-selected subset of participants (28 of 68 wrote at least one diary entry) and cannot directly test the structural model, several points of contact with the quantitative findings are noteworthy. Players’ descriptions of ”losing control” and oscillating between capability and limitation (Theme 1) offer phenomenological grounding for the power variability $\rightarrow$ empathy pathway (H1: $\beta = 0.477$): the TDP construct captures quantitatively what players described qualitatively as a cyclical struggle with agency. The distinction between receptive and minimizing orientations (Theme 2) parallels the variance in empathy scores, though the cross-sectional nature of the qualitative data precludes establishing whether these orientations preceded or resulted from gameplay. Critically, players with low empathy scores were markedly underrepresented in the qualitative data, which limits the analysis’s ability to illuminate the unexpected negative valence–empathy relationship (H2). This absence is itself informative, suggesting that future studies should employ mandatory qualitative data collection to capture the full spectrum of player responses.

7 Discussion

In this study, we conducted an online experiment with 68 participants using a serious game intervention. The mixed-methods data analysis approach provides complementary insights. While quantitative analyses test the structural model relating emotional dynamics to empathy and prosocial attitudes, qualitative findings contextualize how players experienced the game and made sense of its content. Taken together, the two methodologies point towards theoretical and practical contributions, discussed at the end of this section.

7.1 Quantitative Results Discussion

Using Structural Equation Modeling, we examined how emotional variability in the control/power and valence dimensions of the Geneva Emotion Wheel [89, 91] predicted game-induced empathy and, in turn, prosocial outcomes. Emotional variability in the control/power dimension positively predicted game-induced empathy, whereas variability in valence was negatively associated with empathy. Game-induced empathy, in turn, positively predicted both personal helping intention and attitude toward structural help, and personal helping intention positively predicted attitude toward structural help. Together, these pathways accounted for 28.9% of the variance in empathy, 46.1% in personal helping intention, and 54.9% in attitude toward structural help.

The positive effect of emotional variability in control suggests that perceived controllability is central to empathy development in this context. By adopting the protagonist's perspective and experiencing shifts in emotional control—from a healthy, self-determined state to the constrained and uncertain condition of long COVID—participants likely recognized the loss of situational control associated with the illness. This perspective shift may have reduced dispositional blame and mitigated the fundamental attribution error [48], fostering the understanding that the patient's suffering stems from external rather than internal causes [71], thereby supporting empathy.

Contrary to our hypothesis, greater emotional variability in valence was negatively associated with game-induced empathy, suggesting that emotional stability—rather than pronounced fluctuation between positive and negative affect—is more conducive to empathy here. Two interpretive constraints should be noted at the outset. First, variability in valence (TDV) and in control/power (TDP) were moderately correlated ($r = 0.554$), so each structural coefficient reflects the predictor's unique effect after controlling for the other; the negative valence path therefore indexes affective movement not shared with control/power. Second, personal distress—the construct on which we will rely below—was inferred rather than measured; the accounts we offer are thus interpretive rather than directly testable with these data.

A first, game-induced account builds on the contrast between positive and negative affect. The game initially portrays the protagonist as a healthy, socially integrated student, inducing positive affect when participants adopt her perspective. Whereas positive affect reliably predicts prosocial behavior, including charitable giving and helping [57] and is thought to broaden social orientation and facilitate empathic concern, intense negative affect can instead elicit personal distress: a self-focused, aversive reaction aimed at alleviating one's own discomfort rather than the other's [25, 36]. Under this account, the volatile traversal of aversive valence states captured by TDV constitutes a form of sustained affective exposure that overrides other-oriented concern.

A second, complementary account treats TDV as a marker of stable individual differences in emotion regulation rather than a purely situational response. Meta-analytic evidence links greater short-term affect variability and instability to lower psychological well-being, with the effect strongest for negative affect [52]. In Eisenberg's framework, whether vicarious affect becomes other-oriented sympathy or self-focused personal distress depends critically on regulatory capacity: intense, poorly regulated affect tips responding toward personal distress, whereas regulation channels it into sympathy [34, 36]. Although these frameworks were developed around dispositional emotional intensity rather than within-session variability, we propose that the two are related: volatile traversal of aversive valence states, when poorly regulated, plausibly produces the same shift toward personal distress [25, 84]. This pathway is consistent with clinical evidence that, under sustained emotional demand, the self-oriented affective facet of empathy predicts exhaustion and disengagement, whereas perspective taking remains protective [42, 97]; although these findings stem from prolonged caregiving rather than a single game session, they offer a plausible analog for why volatile within-session valence might suppress rather than build empathy. Trait-level

Neuroticism, which predicts personal distress [74, 98], is one specific instantiation of this account, though baseline mood, prior experience, and dispositional emotional reactivity could play analogous roles. A third, related possibility is that frequent affective transitions habituate or fatigue players over the course of play, shifting attention toward managing one's own reactions [42].

Our data cannot adjudicate among these accounts: they share the prediction that high TDV is associated with reduced empathy, and the design provides no instrument (e.g., a personal-distress or emotion-regulation measure) capable of separating them. We therefore present them as a roadmap for future work rather than as competing explanations, while noting that the individual-differences account is the most directly supported by existing evidence.

Game-induced empathy positively predicted both personal helping intentions and attitudes toward structural support, consistent with the empathy–altruism framework [5, 7]. Personal helping intentions, in turn, predicted attitudes toward structural support, consistent with norm activation theory's prediction that internalized moral obligations generalize into support for structural change [93, 100].

Analysis of the control variables indicates that personal experience with long COVID predicted both personal helping intentions and attitudes toward structural help: individuals with such experience were more likely to report prosocial intentions and attitudes after the intervention, plausibly because prior knowledge facilitated understanding of the protagonist's struggles and reinforced beliefs about personal and systemic support. Notably, personal illness experience did not predict game-induced empathy, suggesting that the game's empathy mechanism operates independently of prior exposure to the condition. Gaming frequency was negatively associated with game-induced empathy; we speculate, without independent evidence, that more experienced gamers may approach the game as a system to optimize rather than a perspective to inhabit, or that gaming expertise shifts attention toward rule-based processing at the expense of narrative engagement. In contrast, age and gender had no significant effect, suggesting that the intervention may be effective across diverse demographics. Combined with the manipulation check, which confirmed significant pre–post changes in personal helping intentions and attitudes toward structural support (Wilcoxon Signed-Rank tests), these findings highlight the potential of serious games to raise awareness about long COVID and foster prosocial attitudes and intentions in a broad audience.

7.2 Enriching Interpretation through Qualitative Analysis

The exploratory thematic analysis contextualized the quantitative model by revealing how players experienced chronic illness in the game (Theme 1) and how they related it to real-life contexts outside of the game's frame (Theme 2).

Regarding Theme 1, players' descriptions of energy management, relational dynamics, and identity reconstruction reflected core aspects of chronic illness self-management. Research shows that adaptation to chronic illness involves cycling through positive and negative moments rather than steady linear progress [65, 66], and players exhibited this pattern — alternating between frustration at constraints and pride in successful pacing. Notably, the qualitative data revealed an interesting asymmetry in relational dynamics: while in real life social isolation is often imposed by others who perceive the ill person as too demanding [21], in the game isolation was largely player-initiated, as participants chose to withdraw to conserve energy. This suggests that the game's energy mechanics successfully conveyed the internal logic of pacing decisions.

Players' encounters with medical epistemic injustice — repeated dismissal by doctors, lack of validation — also parallel documented consequences of diagnostic uncertainty in real chronic illness contexts, where guilt and desperation are compounded by the absence of concrete proof [21, 94]. These findings underscore the importance of public education and psychosocial support for affected individuals [2, 56, 108].

Regarding Theme 2, player responses fell into two patterns: those who deeply engaged showed increased awareness and personal resonance, while those with defensive responses minimized illness or critiqued societal structures. This aligns with the quantitative finding that emotional engagement relates to empathy development, and suggests that pre-existing beliefs can block transformation even within a well-designed experiential intervention.

An important limitation regarding the integration of qualitative and quantitative findings emerged: in relation to the quantitative finding that variability in emotional valence is negatively associated with empathy, we examined the qualitative data to see whether any information could contribute to understanding this phenomenon. Yet, players with low empathy scores tended to not participate meaningfully when it came to providing written diary entries or final feedback, both of which were optional. Therefore, if future researchers are interested in understanding the details of a particular construct, especially when it comes to understanding why someone may not engage as expected, we encourage future studies to collect such data as explicitly and obligatorily as possible, using both quantitative and qualitative measures. The existence of more player comments could have illuminated this finding also from a qualitative perspective.

More broadly, games do not operate in a vacuum when serious topics are concerned [38], and media portrayals of chronic illness play a role in constructing norms and values around these conditions [21, 70, 76].

7.3 Theoretical Contribution and Practical Implications

Our findings contribute to the understanding of games as empathy interventions by identifying emotional variability — grounded in the GEW's dimensional structure — as a mechanism for empathy development, and by demonstrating that the control and valence dimensions operate differently. The study also contributes to the literature linking empathy and prosocial behavior. However, this is a first approximation of these phenomena in this field, therefore future research should further explore these constructs and relationships.

Drawing on our quantitative findings and qualitative themes, we offer the following design implications: First, *design for cyclical agency fluctuation through core mechanics.* Our finding that total power distance positively predicted empathy ($\beta = 0.477$) indicates that the cumulative experience of gaining and losing control—not a one-time loss of agency—is associated with empathy development. In our game, the energy system, post-exertional malaise mechanic, and varying daily demands created a pattern of good days and bad days that mirrors the lived experience of chronic illness. Qualitative data showed that players experienced both the frustration of constraints ("it was very difficult to study today and work felt like forever", P46) and the pride of successful management ("proud I didn't waste energy arguing", P25). Designers should therefore embed cyclical agency patterns in core game systems rather than relying on scripted narrative events alone. Second, *concentrate emotional variability in the control dimension, not the valence dimension.* While power variability predicted higher empathy, valence variability was negatively associated with empathy ($\beta = -0.361$), suggesting that emotional whiplash between positive and negative affective states undermines empathic engagement. In practical terms, when designing "good days" for the character, emphasize functional empowerment (restored capabilities, more available choices, successful task completion) rather than emotional euphoria. Qualitative data supports this distinction: players' most meaningful positive moments were about what they could *do* ("finally got that summary done! a stone falling off my heart", P49) rather than how happy they felt. Third, *frame for perspective-taking, not strategic optimization.* The negative association between gaming frequency and game-induced empathy ($\beta = -0.303$) suggests that players who approach games as systems to optimize may develop less empathy than those who inhabit the character's perspective. Qualitative data showed that some players criticized the character's choices rather than engaging with her constraints

(e.g., P47 attributing difficulties to poor prioritization, P37 suggesting the character should ”do more sports”). Fourth, *balance challenge with moments of agency recovery*. The qualitative data reveals that players experienced both despair and pride at different times, and that this oscillation was meaningful rather than detrimental. However, excessive or unrelenting loss of control risks triggering personal distress rather than empathic concern. Designers should calibrate the magnitude of agency fluctuations to maintain engagement without overwhelming players, providing occasional recovery moments that feel earned rather than arbitrary. Beyond these specific patterns, our findings demonstrate that serious games can increase societal awareness of long COVID and foster supportive attitudes toward structural assistance for affected individuals, and suggest that serious games can serve as powerful tools for facilitating nuanced engagement with sufferers from various chronic health conditions. For equality and inclusion initiatives, these findings underscore the potential of well-designed prosocial serious games to reduce stigma, promote mutual understanding, and strengthen social cohesion.

7.4 Limitations and Future Research

As with any study, several limitations should be acknowledged. First, the generalizability and external validity of the findings may be limited by the relatively small and homogeneous sample. Although the minimum sample size required for the SEM analyses was achieved and gender distribution was balanced, participants were predominantly young students with prior gaming experience. Given the voluntary nature of participation and the tendency of students to score higher on openness to experience, it remains unclear whether the findings would generalize to older or more diverse populations. Future research should therefore include broader and more representative samples. In addition, half of the participants reported prior exposure to long COVID, either through personal experience or through knowing someone affected. While such exposure may be relatively common given the substantial prevalence of long COVID following the acute COVID infection [22, 32, 90], future research may specifically recruit individuals who may be less familiar with the condition and potentially more susceptible to stigmatizing attitudes.

Second, the study employed a short-term design and measured intentions rather than actual behavior. Prosocial intentions were assessed immediately after gameplay, leaving open whether these effects persist over time or translate into sustained behavioral change. Future studies should incorporate longitudinal follow-ups and behavioral measures to examine whether game-induced empathy and improved prosocial intentions actually leads to long-term real-world support for individuals with long COVID.

Third, the game incorporates specific design features, such as cartoon-style visual aesthetic and particular gameplay mechanics. While the combined design effectively elicited emotional responses, fostered empathy, and increased prosocial intentions, the individual contribution of each element remains unclear. Future research should isolate and systematically examine these components to determine their distinct effects.

Fourth, the generalizability of the findings to chronic illnesses more broadly is limited, as the study focused exclusively on long COVID. The results may extend to ME/CFS due to shared features such as chronic fatigue and symptom unpredictability, for which the game mechanics were specifically designed. However, other chronic conditions (e.g., diabetes or asthma), despite also involving invisibility, may require different design approaches to be represented effectively. Future research should examine condition-specific design mechanisms and work toward developing a taxonomy for prosocial serious games aimed at fostering empathy across different types of chronic illness.

Fifth, the study employed a single-group pre–post design without a control condition involving established empathy induction methods (e.g., guided imagery, patient-perspective videos, or role-play). However, this design was appropriate, as the aim was not to compare the effectiveness of different empathy induction methods, but to examine the relationships between emotional dynamics, empathy, and prosocial outcomes such as attitudes and behavioral intentions. Given the promising pre-post differences in prosocial outcomes, future research should directly compare game-based methods with traditional empathy induction techniques using controlled experimental designs.

Sixth, the measurement validity of TDP and TDV warrants consideration. As single-indicator formative constructs derived from cumulative absolute differences in GEW coordinates, TDP and TDV cannot be assessed for internal consistency through standard reliability metrics. While nomological validity is supported by the structural model (TDP significantly predicts game-induced empathy, which in turn predicts prosocial outcomes) and discriminant validity between TDP and TDV was established (r = 0.554), several limitations remain. Each daily emotion measurement relies on a single GEW selection, providing a coarse snapshot that may not capture the full emotional complexity of each game day. Additionally, as novel operationalizations without prior validation, the generalizability of these metrics to other game contexts is untested. The metrics also cannot distinguish between different patterns of emotional change (e.g., gradual decline vs. sharp oscillation) that may have different implications for empathy development. Future research should validate TDP and TDV against alternative operationalizations and multi-method emotional assessment.

Seventh, the negative association between valence variability and empathy warrants careful interpretation, as it may reflect processes beyond the game-induced mechanism discussed above. In particular, the study did not measure the trait variables—such as Big Five personality, dispositional empathy, and emotion-regulation capacity—that most plausibly underlie the personal-distress account we propose; the one plausible moderator we did measure, personal experience with long COVID, did not significantly predict game-induced empathy ($\beta = 0.271$, $p > 0.05$), leaving unmeasured traits as the more likely source of the association. Moreover, because power and valence variability were not independently manipulated — both emerge from the same coupled game mechanics, while narrative events (e.g., supportive or dismissive characters) might additionally shape valence — the differential outcome may reflect how players re-appraise the same experience along these dimensions rather than a difference in design intent. Future work should therefore include such trait measures and manipulate valence and control variability independently to disentangle game-induced from trait-driven effects.

8 Conclusion

This study conducted an online experiment with 68 participants using a serious game intervention which allowed participants to adopt the perspective of a long COVID patient. Data were analyzed using a mixed-methods approach. A structural equation model showed that emotional variability in the power dimension positively predicted empathy for the game's protagonist, whereas variability in valence showed a negative association. Empathy, in turn, predicted personal helping intention and attitude toward structural help, while personal helping intention positively predicted attitude toward structural support. Gaming frequency was negatively associated with empathy, suggesting that more experienced gamers may develop less empathy. Pre–post comparisons showed measurable increases in prosocial intentions, and neither age nor gender significantly predicted the outcomes, suggesting the intervention's association with prosocial intentions was not demarcated by these demographics. An exploratory qualitative analysis complements these findings, revealing that players navigated complex emotional terrain between frustration and adaptation and that responses ranged from deep engagement to defensive minimization. While the single-group design limits causal claims,

the findings identify emotional variability in the control dimension as a promising mechanism for empathy induction through serious games. Future research should build on these results through randomized comparisons with established empathy induction methods, longitudinal assessment of attitude persistence, and validation across diverse populations and chronic conditions. Overall, these findings provide theoretical and practical insights, including specific design implications, for creating perspective-taking games that effectively leverage emotional dynamics to foster empathy and prosocial intentions.

Acknowledgments

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Received 18 February 2026; revised 03 June 2026; accepted 03 July 2026