

Exploring User Experience and Changes in Depression and Anxiety Symptoms with the Mobile Game App ‘Everyone’s Harmony’

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Abstract: *This study investigates the user experience and feasibility of the music therapy-based multi-modal mobile game app, Everyone's Harmony. The app consists of two main components: the Listening Therapy section, which serves as the starting page, and the Playing Therapy section, featuring a melody-based structured rhythm game with an improvisation mode. In Listening Therapy, users can select animal characters that produce unique sounds and act as interactive controls. In Playing Therapy, a squid character takes on a therapist-like role, offering encouragement and guidance throughout the gameplay. The app's reward system enables participants to earn "Courage Points" for improvisational performance, which can be used to unlock characters, and "Hearts" through Listening Therapy, necessary for accessing the rhythm game. This pilot, single-group exploratory study assessed the feasibility and initial indications of a multi-modal music-based mobile intervention for depression and anxiety. Participants who completed eight 30-minute sessions over eight weeks showed exploratory changes in mean self-reported depression-anxiety scores, measured using the Korean Depression-Anxiety Scale. Since no control condition was included, these findings should be viewed as preliminary and are intended to guide the design of future controlled trials.*

Keywords: Music Therapy; Digital Therapeutics; Depression and Anxiety; Gamification; Multi-modal Mobile App

1. Introduction

Music-based interventions have been widely recognized as an effective non-pharmacological intervention for depression and anxiety such as music therapy, supporting emotional regulation, stress reduction, and cognitive engagement [1, 2]. As a musician-researcher, the primary author initiated this study to explore distinctive musical phenomena, particularly the positive effects arising from improvisational performance and creative participatory music-making. With the advancement of digital therapeutics (DTx), integrating music therapy into app-based platforms has the potential to enhance accessibility, adherence, and engagement, particularly among young adults experiencing depressive and anxiety symptoms. In this study, the term game-based digital therapeutics refers to digital health interventions that incorporate game mechanics, such as progression systems, rewards, and interactive feedback, into structured therapeutic designs to support mental health and emotional regulation. However, translating individualized music experiences into a digital platform remains challenging. Existing mobile applications often focus on either passive listening or simple rhythm games, lacking adaptive mechanisms that account for user preferences, skill levels, and current emotional state [3].

To address this gap, this study introduces *Everyone's Harmony* [4], a multi-modal mobile application designed to support mood management through structured music interactions. The app comprises two primary

sections: Listening Therapy, which engages users with curated musical works, and Playing Therapy, enabling interactive rhythm and melody performance. *Playing Therapy* refers specifically to the mode in which users actively interact with the mobile device through touch-based musical performance, clearly distinguished from *Listening Therapy*, which involves receptive musical engagement. Both modules incorporate adaptive features, including difficulty progression, personalized recommendations, and a reward system, aiming to maintain engagement while supporting emotional regulation. The app was developed under the guidance of certified music therapists to ensure therapeutic validity, incorporating evidence-based principles derived from literature review and focus group interviews (FGIs) with young adults aged 20–39.

User-reported changes in depressive and anxiety symptoms were assessed using the Korean Depression–Anxiety Scale (K-DAS), a validated and reliable self-report measure [5]. This study explores user experience and K-DAS-based changes over eight weeks, providing preliminary evidence for the potential of multi-modal music-based mobile applications as digital tools for mood management and laying groundwork for future digital therapeutic applications. Recent research on game-based digital therapeutics has demonstrated meaningful improvements in emotional and cognitive functioning, highlighting the therapeutic potential of interactive game mechanics for mental health interventions [6]. Recent scoping reviews and design-focused studies further suggest that game-based digital therapeutics can effectively support mental health when grounded in structured therapeutic frameworks and adaptive, user-centered interaction design [7, 8].

2. Application Overview

2.1 Subsection Structure of *Everyone’s Harmony*

The app comprises two primary sections: Listening Therapy, which focuses on receptive musical engagement, and Playing Therapy, which enables interactive rhythm and melody performance through touch-based input. The overall system structure is illustrated in Figure 1 [4].

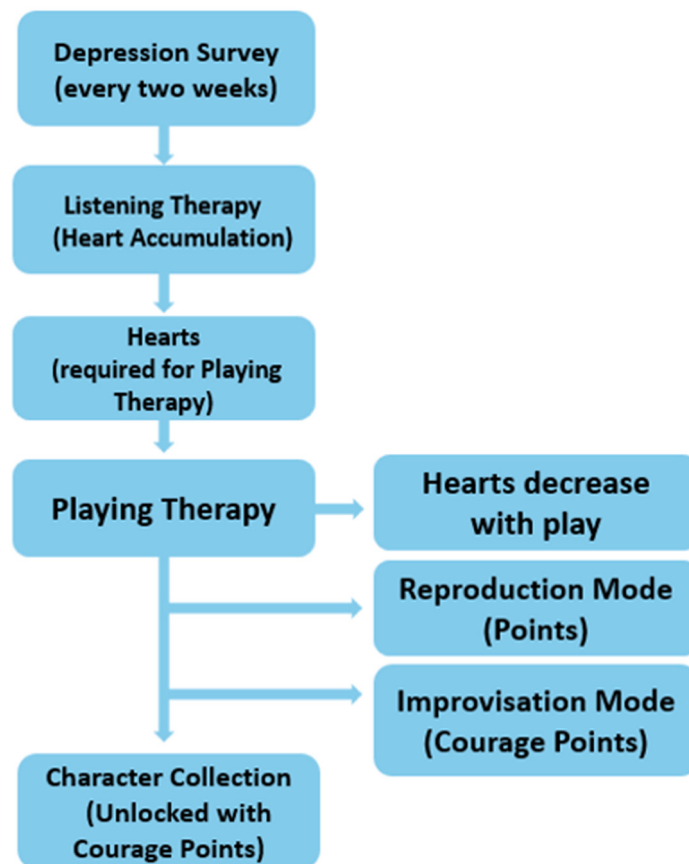


Figure 1. App Architecture Diagram

2.2 Listening Therapy: Receptive Musical Design

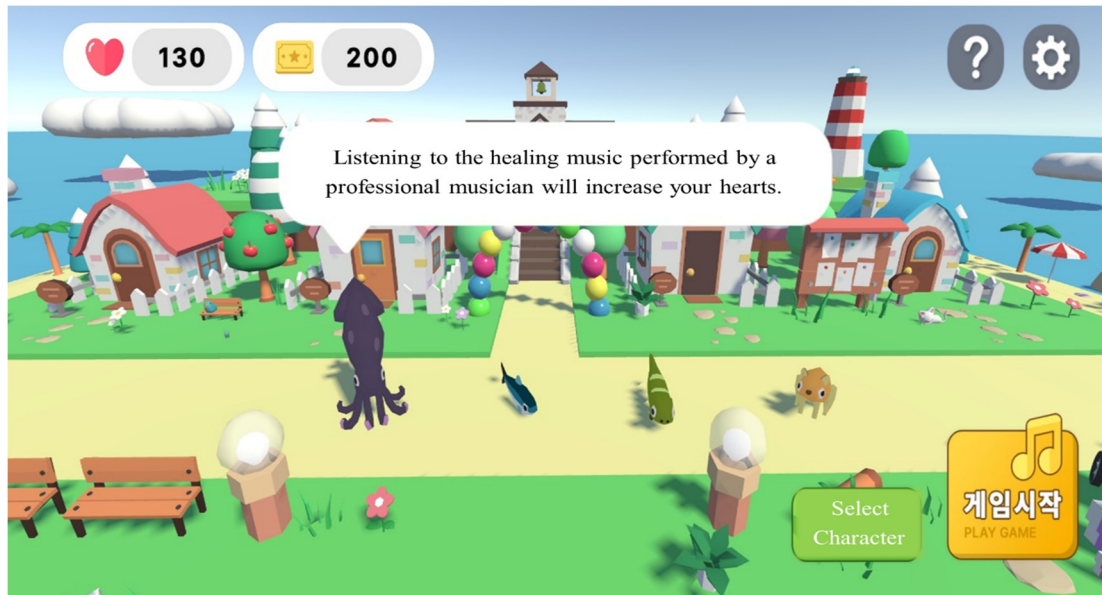


Figure 2. Listening Therapy stage. The initial waiting screen of *Everyone's Harmony* (Translated in English), where users engage in receptive listening to curated musical works and accumulate “Heart” resources required to access Playing Therapy. Environmental assets by ricimi [9], character assets by Omabuarts Studio [10].

As shown in Figure 2, the first screen users encounter is the Listening Therapy stage, where selected musical works are presented while users remain in a waiting environment. This stage features Bach–Gounod *Ave Maria*, Rachmaninoff’s *Vocalise* (clarinet version), and the Aria from Bach’s *Goldberg Variations*, selected based on expert interviews and focus-group input [4]. These slow, timbre-rich, and melodically organized works were chosen to promote physiological relaxation and emotional stabilization. From a therapeutic perspective, slow-tempo music (approximately 60–80 bpm) has been shown to synchronize with resting heart rate and promote parasympathetic activation, thereby inducing relaxation responses and reducing anxiety [11]. The timbral warmth and expressive contours of these pieces provide a “holding environment” that supports emotional containment and self-regulation [3], [12].

An in-game resource (“Heart”) functions as a key to access the main rhythm game: users can earn “Heart” continuously through listening sessions on the waiting page. This mechanic intentionally balances passive (listening) and active (playing) modes and reduces reward structures that could promote compulsive play. Evidence suggests that therapeutically designed rewards can reduce the risk of harmful overuse in game-based interventions [6]. Furthermore, their predictable melodic phrasing and balanced harmonic structure offer cognitive grounding and a sense of safety, which are essential for reducing hyper-arousal and facilitating mindfulness [13, 14].

2.3 Playing Therapy: Interactive and Expressive Design

The Playing Therapy consists of five performance rooms, differing in difficulty, mood, and genre. Participants can select the room and difficulty level that best matches their current state and preferences, supporting autonomy and competence [1], [15]. Using data from questionnaires on mood, skill, genre preference, and tempo, the system automatically suggests an optimal level of play tailored to each participant [4].

The five performance rooms are named and programmed to evoke distinct atmospheres: *Mellow Bach* (몽글몽글 바흐), *Swaying Cat Dance* (흔들흔들 고양이춤), *Boom-chick, boom-chick* — *Radetzky* (쿵짝쿵짝 라데츠키), *Fresh Spring Breeze* (상쾌상쾌 봄내음), and *Turkie Turkie March* (터키터키 행진곡). Table 1 summarizes the five Playing Therapy rooms used in the app, including the original pieces, BPM (Beat per minute), key musical characteristics, and the therapeutic mechanism.

Table 1. Playing Therapy rooms, BPM, musical style, and therapeutic mechanism

Room	Original Piece	BPM	Musical Style	Therapeutic Mechanism
Mellow Bach	J.S. Bach, The Well-Tempered Clavier, Book I, Prelude No.1	Easy=64, Medium=64, Hard=70	Slow, melody-focused; organ sound	supports melodic awareness
Swaying Cat Dance	Traditional/Anonymous	Easy=132, Medium=132, Hard=138	Two-note touches; fast monophonic melodies (Hard)	Enhances dexterity and rhythmic anticipation
Boom-chick, boom-chick — Radetzky	Johann Strauss I, Radetzky March	Easy=126, Medium=136, Hard=146	March rhythm; prominent percussion	Promotes rhythmic precision and attention
Fresh Spring Breeze	Original	Easy=180, Medium=200, Hard=230	Primary melody; resonant percussion	Encourages hand coordination and melodic awareness
Turkie Turkie March	W.A. Mozart, Piano Sonata No.11, 3rd movement	Easy=170, Medium=190, Hard=224	Patterned percussion; sequence-like rhythms	sequence memory through patterned percussion

The musical styles are presented in concise terms to highlight the key features relevant for engagement, such as melody focus, rhythmic patterns, or percussion emphasis. Detailed therapeutic mechanisms, such as supporting melodic awareness, dexterity, or rhythmic accuracy, are described in the following narrative paragraphs.

In the *Mellow Bach* room, users perform melody-focused passages with organ timbre. Missed notes trigger animal sounds, supporting melodic awareness. In the *Swaying Cat Dance* room, alternating two-note touches like chords and fast monophonic melodies develop dexterity and rhythmic anticipation. *Boom-chick, boom-chick — Radetzky* emphasizes precise march rhythms for rhythmic attention, *Fresh Spring Breeze* promotes hand coordination with resonant percussion, and *Turkie Turkie March* enhances rhythmic accuracy and sequence memory through patterned percussion [4]. Each room offers three progressive difficulty levels like Figure 3 (Easy, Medium, Hard), allowing users to select the level that best matches their current skill and emotional state.

Song Name	Difficulty Level		
	Easy	Medium	Hard
Mellow Bach	5	20	40
Swaying Cat Dance	10	25	50
Boom-chick, boom-chick — Radetzky	15	30	65
Fresh Spring Breeze	20	35	90
Turkie Turkie March	25	30	100

Figure 3. Difficulty level of all rooms

In each performance room, participants primarily engage in Structured Rhythm/Melody Play, in which they must accurately execute selected rhythms and melodies to progress through the game, as shown in Figure 4 [4]. To reduce performance anxiety, the timing window for achieving a “perfect” response is intentionally wider than that of conventional rhythm games, and missed inputs are not presented as punitive visual feedback. This design choice lowers the perceived cost of failure and encourages sustained engagement without inducing excessive performance pressure.



Figure 4. Structured Rhythm/Melody Play. Users perform rhythm and melody patterns along a linear track with a widened accuracy window designed to reduce performance anxiety and minimize punitive feedback. Environmental assets by ricimi [9]. Character assets by Omabuarts Studio [10].

2.4 Improvisation and Emotional Regulation Mechanism

An Integrated Improvisation mode, as in Figure 5, follows in most rooms, providing an opportunity for expressive musical interaction and awarding Courage Points. This combination promotes musical competence while supporting emotional and creative expression. The app prioritizes evidence-based personalization by allowing participants to select preferred music genres and difficulty levels. This approach was intended to support user motivation and emotional regulation, which are central goals in contemporary music therapy practice [1], [3], [16, 17].

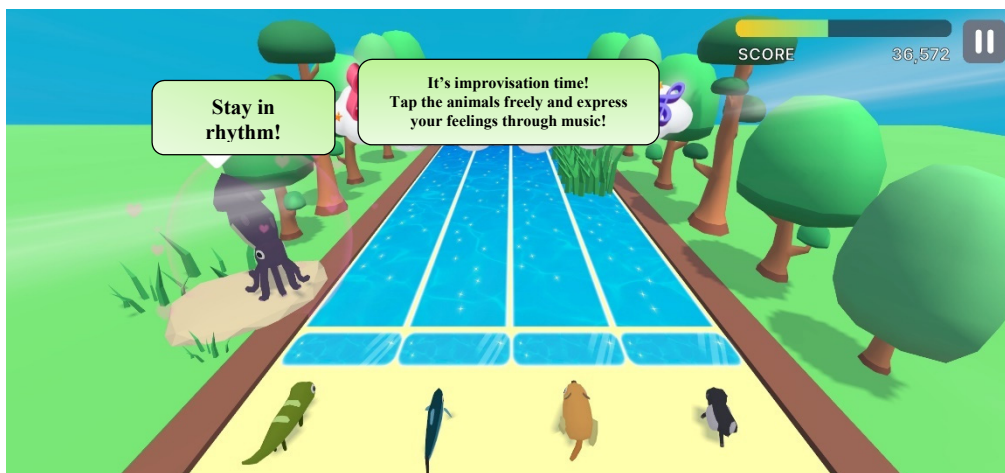


Figure 5. Integrated Improvisation mode in *Everyone's Harmony* (translated in English). After completing structured rhythm/melody play, users interact freely with the musical environment, generating sounds that dynamically respond to background music and embedded cues. Environmental assets by ricimi [9]. Character assets by Omabuarts Studio [10].

Improvisation phases are incorporated because musical improvisation in clinical settings has been associated with enhanced emotional regulation and reductions in depressive symptoms [18]. In nearly all rooms, participants engage with a dynamic musical environment in which their actions interact with the background

music (BGM) and embedded cues, shaping evolving harmonic and rhythmic trajectories. This mechanism resembles the processes reported in prior therapeutic music and music-improvisation studies, where interactive musical engagement has been shown to influence emotional states and support affective regulation [18, 19].

During the improvisation phase, participants' notes sometimes harmonize with the BGM, while at other times they generate tension through dissonant or rhythmically divergent patterns. Through this interaction, participants may experience shifts between emotional states, including synchrony, tension, and release, which have been discussed in music-based affective neuroscience research [20].

Other studies support that such interactive musical behaviors evoke measurable neural responses associated with emotional perception, reward prediction, and regulation processes, indicating that musical interaction can modulate both physiological and psychological states [2], [20-22]. In music therapy, experiences of consonance and dissonance can facilitate emotional regulation and enhance expressive flexibility [19]. By enabling free yet structured musical responses, the improvisation phase mirrors therapist–client interaction in traditional improvisational music therapy, providing space for emotional expression, tension–release cycles, and musical dialogue [3], [19]. Although some freedom is constrained by the game structure, this phase constitutes the therapeutic core of the system.

2.5 Characters

The app offers six pastel-hued animal characters (squid, monkey, cat, etc.) drawn in a low-poly style, each producing characteristic and unique sounds [10]. If the player plays a note missing the target, a sound of a corresponding animal is heard. This link lends some grounding to the interaction, which helps to build user agency, in the sense of establishing a multimodal audio identity for the character. Characters execute slow and random idle actions, and when touched, they respond in their own characteristic manner with animated and sound feedback. This design derives from three related theoretical rationales: (1) survey/FGI responses from the sample (ages 20–39) providing increased perceived warmth and familiarity with pastel color palettes [23]; (2) literature demonstrating that non-human companions (animals/animal images) elicit calming and loneliness reduction effects among those with mental stress [24, 25]; and (3) clinician recommendations that encourage an approachable, non-threatening visual for mood treatment. The squid character (the prototype companion) generates patterned, encouraging phrases (short scripted lines) that serve as social/relatedness cues and support engagement; these prompts find their way into the game narrative to increase coherence and meaning [26, 27].

3. Materials and Methods

3.1 Participants

A total of 24 participants were recruited through local centers and the community. Among them, 13 participants completed all required sessions and post-assessments and were included in the final analysis. Participants consisted of 8 females (61.5%) and 5 males (38.5%), aged 20 to 39 years ($M = 28.1$, $SD = 6.4$). Baseline depression scores on the Korean Depression Scale developed by Choi et al. [5] ranged from 10 to 43 ($M = 21.8$, $SD = 8.7$).

All participants owned or had access to an Android smartphone or tablet, and none reported severe psychiatric or neurological disorders. Inclusion criteria required participants to have a depression score of ≥ 9 on the K-DAS [5], be physically capable of performing the music game with both hands and have not taken psychiatric medication within the past eight weeks. Anxiety scores were collected for comparative purposes but were not used as inclusion criteria.

3.2 Procedure

Participants were asked to complete at least eight gameplay sessions within an eight-week period, engaging in the game for a minimum of 30 minutes per day. All sessions were conducted at home using an Android phone or tablet. Pre- and post-assessments were administered using the K-DAS. To ensure proper use of the application, participants were provided with standardized written and verbal instructions before starting the intervention. The study protocol was reviewed and approved by the Institutional Review Board (IRB approval number: KNU-2024-HR-23-33) to ensure ethical compliance.

3.3 Data Collection

During gameplay, the application generates interaction-related logs such as note accuracy, timing deviation, improvisation patterns, and reward progression. These logs are typical of rhythm-based mobile games and are used to describe user engagement and performance characteristics.

Mood-related information was obtained separately through pre- and post-study questionnaires administered outside the app as part of the research protocol. Participants provided demographic information (age, gender) and responded to items regarding musical habits, prior gaming experience, and familiarity with rhythm games. They also completed the Korean Depression–Anxiety Scale (K-DAS) before and after the 8-session intervention. Post-study surveys included questions about usability, perceived appropriateness of the game’s structure (e.g., performance rooms, improvisation segments, difficulty system), and open-ended feedback on improvement needs.

4. Results

4.1 Participant Completion

A total of 24 participants were recruited, of whom 13 completed all required sessions and post-assessments, resulting in a completion rate of 54%. Completion required participation in at least eight gameplay sessions within eight weeks. Dropouts were due to scheduling conflicts or withdrawal of consent.

4.2 Depression and Anxiety Levels

Descriptive analysis of pre- and post-intervention K-DAS scores showed a decrease in mean scores:

- Depression: Mean score decreased from 21.46 (pre) to 14.69 (post), a 31.5% reduction.
- Anxiety: Mean score decreased from 21.54 (pre) to 13.92 (post), a 35.4% reduction.

As shown in Figure 6, these results suggest that gameplay with *Everyone’s Harmony* was associated with reductions in both depressive and anxious symptoms. Furthermore, paired-sample t-tests were conducted to determine whether the observed reductions were statistically significant. The decrease in depressive symptoms from pre- to post-intervention was found to be significant ($p = 0.02574$), and anxiety symptoms demonstrated a similarly significant reduction ($p = 0.04132$). Both values fall below the conventional significance threshold of .05, indicating that the improvements are unlikely to be attributable to chance. These results provide statistical support that engagement with *Everyone’s Harmony* contributed to meaningful reductions in depressive and anxious symptom severity among participants.

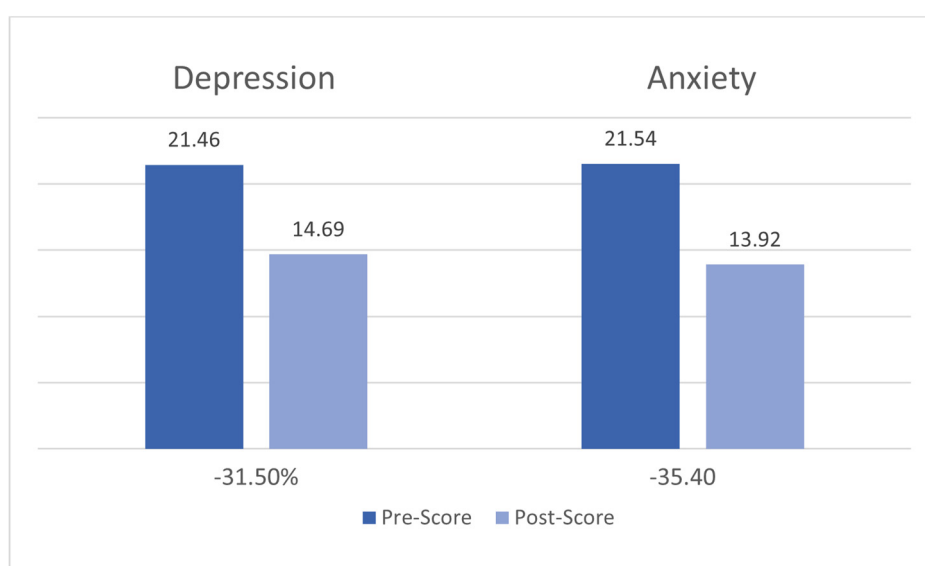


Figure 6. Comparison of Depression and Anxiety level

4.3 App Evaluation

- Expert Satisfaction: Mean score of 8.6/10
- User Satisfaction: Mean score of 9.4/10

Both expert and user satisfaction scores were high, suggesting strong usability, engagement, and preliminary therapeutic potential. High satisfaction scores indicate strong usability, engagement, and potential therapeutic value of the app.

5. Discussion

5.1 Interpretation of Results

In the current study, engagement with *Everyone's Harmony*, a rhythm-based music game incorporating structured melody and rhythm play, improvisation, and interactive multimodal feedback, was associated with reductions in self-reported depressive and anxiety symptoms among young adults, as measured by the K-DAS [5]. Participants showed a mean reduction of 31.5% in depression scores and 35.4% in anxiety scores following the 8-session intervention. High expert and user satisfaction scores further suggest that the system was perceived as usable, engaging, and therapeutically promising.

The observed effects are likely attributable to the combination of structured and improvisational musical activities within a gamified environment. In each performance room, participants engaged in Structured Rhythm/Melody Play, executing specific rhythmic and melodic passages while interacting with background music (BGM) that was carefully selected and composed based on FGI results, prior literature, and clinician guidance [1], [3], [17, 18]. This design, which included graded difficulty levels, allowed participants to experience mastery, build musical competence, and maintain motivation while minimizing performance anxiety through non-punitive feedback windows [4], [15, 17].

Following structured play, participants entered the Integrated Improvisation mode, where free yet guided musical expression was supported by character feedback and BGM interaction. Improvisation phases allowed for emotional exploration, including experiences of tension, resolution, and synchrony, mirroring therapeutic mechanisms reported in music therapy and improvisational studies [3], [18, 19]. EEG and neuroimaging evidence support that such interactive musical behaviors engage reward, emotional regulation, and auditory-motor neural circuits, suggesting plausible neurophysiological mechanisms underlying the reduction in depressive and anxious symptoms [2], [20-22].

The inclusion of low-poly, pastel-hued animal characters (e.g., Squid Teacher) that provided multimodal audio-visual feedback reinforced user agency, social presence, and engagement [8], [23-27]. The combination of melodic and rhythmic play, improvisation, attentive listening to high-quality BGM, and responsive character interaction constitutes a multi-modal therapeutic environment that likely synergistically supported emotion regulation, cognitive engagement, and intrinsic motivation, producing effects beyond those observed in conventional single-function music therapy interventions [1], [3], [17, 18], [23].

Overall, the findings suggest that rhythm-based music games incorporating structured play, improvisation, graded difficulty, responsive feedback, and curated musical content may have potential as an adjunctive approach for supporting emotional well-being in young adults. Future work should investigate controlled designs, including diverse age groups, and explore remote monitoring or guided sessions to enhance adherence and generalizability.

5.2 Limitations

Participants were young adults with mild to moderate depression and anxiety, playing independently at home. The completion rate was 54%, which may limit generalizability. The lack of a control group prevents causal interpretation of the findings. Participants were primarily young adults, limiting the generalizability to other age groups. In addition, outcomes were assessed solely using the Korean Depression–Anxiety Scale (K-DAS), a validated self-report instrument commonly used in Korean populations. However, given the pilot and exploratory nature of the present study, reliance on a single self-report measure limits the ability to assess objective or clinically meaningful change and may be subject to response bias. Accordingly, the findings should be interpreted with caution. Future studies will incorporate clinician-rated assessments, behavioral indicators, or physiological measures to strengthen outcome validity.

5.3 Future Work

5.3.1 Stratified Therapeutic Pathways Based on Musical Engagement Profiles

Future research should implement stratified therapeutic pathways that distinguish active musical performance/improvisation from passive listening-based modules rather than relying on a single uniform intervention flow. Baseline evaluations, including mood severity, musical preference, prior performance experience, auditory sensitivity, and gameplay-related anxiety, may help identify appropriate therapeutic starting points for individual users.

This approach is supported by neuroscientific evidence showing that active music-making engages sensorimotor, premotor, and frontoparietal predictive coding networks, whereas passive listening primarily recruits auditory–limbic circuits associated with emotional regulation. Importantly, individuals with prior performance experience show motor-network activation even during mere listening, whereas novice listeners do not, indicating partially dissociable neural substrates between playing and listening [28, 29].

Given that the current system integrates listening therapy, structured melody/rhythm performance, and improvisation, future versions should personalize module allocation so that users who benefit more from motor-driven engagement (e.g., structured playing, improvisation) begin with performance-oriented content, while users who respond better to sensory-driven affect regulation begin with higher-level listening modules. Such stratification may enhance early therapeutic responsiveness, reduce dropout, and improve precision in digital music-therapy deployment.

5.3.2 Improvisation Analysis and Practice Room Enhancement

Future work should expand the improvisation subsystem beyond simple free-play into graded, therapeutically structured improvisation layers. Rhythm-only, melody-only, and combined melodic–rhythmic modes can be introduced to systematically manipulate cognitive load, sensorimotor coupling, and emotional expressiveness.

To support the development of musical agency and reduce performance anxiety, a dedicated Practice Room should enable users to rehearse skills in a low-pressure setting, with AI-assisted guidance on timing accuracy, interval stability, phrase contour, and expressive gestures. Additionally, real-time analysis of improvisational input using symbolic music features may provide information related to emotional valence, arousal, and self-regulation. This analytical layer would enable adaptive therapeutic progression, ensuring that improvisation functions not merely as entertainment but as a continuously monitored affective-motor therapeutic process.

5.3.3 Biomarker Integration

Integration of physiological and behavioral digital biomarkers during music-therapy gameplay can greatly enhance the precision and adaptability of digital interventions. Wearable sensors and in-game data collection can monitor heart rate variability, galvanic skin response, and performance patterns, providing real-time insight into users' emotional and cognitive states [30]. In future studies, such biomarkers may offer a basis for adjusting intervention flow, including supporting engagement, rest, and the longitudinal documentation of musical performance or improvisation patterns.

Building on this, algorithms can be developed to identify users who may benefit most from digital music therapy interventions, effectively functioning as DTx screening tools and supporting integration with clinical workflows. By combining real-time biomarker feedback with predictive user stratification, the system can optimize therapeutic outcomes, maintain motivation, and minimize early dropout, aligning with principles of precision digital therapeutics.

6. Conclusion

Everyone's Harmony demonstrates the feasibility and preliminary therapeutic potential of a multi-modal, gamified music therapy intervention for young adults with mild to moderate depression and anxiety symptoms. The current implementation integrates structured rhythm/melody performance, guided improvisation, and interactive listening, combined with a gamified reward system and responsive character interaction, to provide an engaging and therapeutically informed user experience.

The system architecture incorporates structured rhythm and melody play, brief integrated improvisation sessions, listening-based therapy rooms, reward-based character collection, and companion-style feedback. Its design was informed by prior music therapy research [1], [3] and was intended to support emotional regulation, engagement, and reduced performance anxiety.

In this pilot study, engagement with *Everyone's Harmony* was associated with reductions in self-reported depression and anxiety scores among young adult participants. Although causal effects cannot be inferred, these findings are consistent with the therapeutic assumptions underlying the system design. The observed changes in depression and anxiety levels suggest that this integrated, multi-modal design warrants further investigation as a feasible approach for delivering music-based digital interventions [1], [3], [6, 7], [31].

Future works should explore biomarker integration, stratified therapeutic pathways, and advanced adaptive feedback systems, as well as algorithms to identify users who may benefit most from digital music therapy, effectively functioning as DTx screening tools. These enhancements could advance precision digital therapeutics in music-based interventions.

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