DOI: 10.61782/fa.2025.0011

FORUM ACUSTICUM EURONOISE 2025

A DESIGN GUIDELINE FOR GAMIFIED INTERVENTION FOR MANAGING HYPERACUSIS: INSIGHTS FROM EXPERT INTERVIEW

Qianhui Liu[1*] **Tingting Wang**[1] **Hongli Yang**[2]
Elif Özcan[1]

[1] Critical Alarms Lab, Faculty of Industrial Design Engineering, Delft University of Technology
[2] School of Digital Media and Design Arts, Beijing University of Posts and Telecommunication

ABSTRACT

Sounds can evoke various emotional reactions based not only on their acoustic properties but also on their perceived meanings. Hyperacusis is a condition in which individuals experience heightened sensitivity to everyday sounds, often resulting in anxiety, fear, and avoidance behaviors. The concept of soundscape—an individual's subjective experience of the acoustic environment, combined with the appraisal theory provides insights for understanding the emotional roots of these behaviors. To support behavioral transformation, persuasive gamification offers a promising approach for designing effective and engaging interventions. By incorporating soundscapes into game world, such interventions can help individuals gradually acclimate to distressing sounds in a controlled and interactive way. This study aims to develop a design guideline for persuasive gamified interventions targeting hyperacusis listeners. We first integrated insights from literature and map hyperacusis behavior patterns based on appraisal processes. Semi-structured interviews with seven domain experts then inform six key design considerations: understanding hyperacusis listeners, entry points into the game world, the use of soundscapes as game elements, in-game coping strategies, the transfer effect to real-world behaviors, and ethical concerns.

Keywords: *hyperacusis listener, persuasive game, soundscape, appraisal theory*

**Corresponding author*: e.ozcan@tudelft.nl.

1. INTRODUCTION

For some listeners, everyday sounds like conversations or traffic are perceived as unbearably loud and overwhelming, despite the ubiquity of sounds and noise in our society. This heightened sensitivity, known as hyperacusis, often leads to irritation, tension, anxiety, or fear [1]. For such listeners noise is not only distressing but also a barrier for their social participation, mobility, and well-being. A significant portion of listeners experiencing hyperacusis are aware of their symptoms but remain clinically undiagnosed [2]. In contrast, existing studies have focused on clinical aspects to discover underlying mechanisms for diagnosis and treatment of hyperacusis and few studies explored how to support the self-reported hyperacusis listeners in daily life.

Symptoms of hyperacusis are more prevalent in the experience of certain soudnscapes. A soundscape refers to the acoustic environment as perceived by humans in context, evoking different responses based on its perceived meaning. For individuals with hyperacusis, these responses involve both subconscious physiological reactions and conscious behavioral adaptations. Persuasive gamification design has emerged as a potential therapeutic approach, using game world engagement to facilitate behavior transformation in real world. By gamifying the unconscious dynamic soundscape appraisal process, games could potentially create a controlled, interactive environment that helps individuals with hyperacusis adjust to distressing sounds. However, existing interventions have not explored this theoretical concept yet. Moreover, there is a lack of guidance on how to approach this intervention based on relevant theories.

This study aims to develop a design guideline of gamified interventions for behavior change in individuals with

hyperacusis experienced in certain sounsdcapes. Given the current lack of game-based approaches tailored for this condition, the guideline will establish a theoretical foundation by integrating insights from hyperacusis listeners, soundscape evaluation, appraisal theory, and serious gamification. It will also serve as a practical design guide, incorporating expert and target user perspectives based on interviews.

2. THEORETICAL INSIGHTS

In this section, we will synthesize literature from relevant disciplinary domains to build the theoretical background of how hyperacusis listeners experience sound events and cope with the acoustic environment. The insights will facilitate the expert interview and design process that will follow as our next step.

2.1 Hyperacusis: The Subjective Auditory disorder

Hyperacusis refers to a disorder of loudness perception in which sounds normally considered harmless can become intolerable. Experience of hyperacusis can be categorized into four: loudness, annoyance, pain, and fear [3] . Currently, there is no standard approach for the diagnosis of hyperacusis, with audiological measurements and self-report questionnaires being the most common methods [4]. However, many individuals with self-reported symptoms remain undiagnosed, and even fewer seeking medical help. The prevalence of hyperacusis varies between studies, is influenced by occupation and comorbid conditions (e.g., tinnitus and autism), and associated with older age, female sex, and higher levels of education [5].

Hyperacusis can severely impact daily life by causing fear, reducing quality of life, and triggering physiological reactions to sound. In particular, it is strongly associated with noise-related avoidance behaviors and anxiety [6]. Many individuals use earplugs, noise-canceling devices, or modify their surroundings to reduce sound exposure as a coping strategy. While these self-management strategies are common, clinical treatment still lacks a standardized protocol. Desensitization techniques, in which patients are gradually exposed to various sounds, are commonly used, often accompanied by counseling. Other treatments include Cognitive Behavioral Therapy (CBT), Tinnitus Retraining Therapy (TRT), assistive listening devices, medication and surgery. [7–9]

2.2 Soundscape approach: The experience of the acoustic environment

The acoustic environment in which hyperacusis listeners experience symptoms (i.e., soundscape) is crucial to study to be able to alleviate the symptoms. The soundscape approach to environmental sound perception acknowledges two main aspects: the physical environment that is objectively measurable and the psychological effects that are subjectively experienced [10]. As a result, the experience of soundscapes are characterised by how sound events in an environment are collectively appraised by the concerns of the listeners in that specific environment [11].

Although listeners are exposed to the same the physical properties of sound, the experience of sound and how listeners respond to it is highly subjective [12]. According to the soundscape approach, perceptual qualities of soundscapes derive from the two-dimensional experiences: *pleasantness* and *eventfulness*. Pleasantness reflects the emotional magnitude of sound perception, while eventfulness corresponds to its intensity [13]. These two dimensions underscore the composite experiences such as *vibrant* (pleasant and eventful), *calm* (pleasant and uneventful), *boring* (unpleasant and uneventful) and chaotic (*unpleasant* and eventful), These experiences experiences (AKA, soundscape descriptors) are positioned at a 45-degree angle to the original dimensions, form a four-factor model for soundscape evaluation [14].

Individuals with hyperacusis often interpret everyday soundscapes as unrealistically catastrophic [15] which explains why they tend to avoid environments perceived as stimulating and always seek out low-arousal, quiet settings—typically located within the calm quadrant of the soundscape model [4]. However, such avoidance behaviors may inadvertently reinforce auditory hypersensitivity, contributing to a vicious circle where anxiety and discomfort intensify with repeated exposure [3]. Thus, is the realm of the hyperacusis listeners, any soundscape that is slightly to moderately eventful (e.g., cafes or busses) will be experienced as chaotic.

2.3 Appraisal Theory: Root of the vicious circle

The avoidant behavioral pattern of hyperacusis listeners can be better understood through the theory of emotional appraisal, which emphasizes that the emotional responses of individuals are not determined solely by the stimulus themselves, but by how they cognitively interpret or ”construct” the situation in relation to their goals, beliefs and intentions [16]. According to Lazarus’s transactional

model of stress and coping, environmental stressors in an environment are appraised in two steps: first appraisal to interpret whether the stimulus is positive, dangerous or irrelevant; secondly, if dangerous, the availability of the resources are analysed to whether they are sufficient. If the resources are insufficient, two coping strategies are employed to overcome stress: *problem-focused* to change the situation itself or the *emotion-focused* to change the relation to the situation. Reappraisal can take place (i.e., pacing and learning) as the conditions the individuals are in may change which may also change. [17]

For individuals with hyperacusis, even mildly stimulating soundscapes, as primary environmental stimuli, may be interpreted as threatening due to pre-existing beliefs such as "most sounds are dangerous" or goals like "I need to isolate myself". Hyperacusis listeners may assess their environment as harmful depending on their condition which often concludes that they lack sufficient control. The results of their appraisal process manifest themselves in emotional responses (fear or anxiety), physiological arousal and action tendencies (escape from the environment). The action tendencies trigger coping strategies. *Problem-focused coping* involves changing the external soundscape or one's interactions with it, such as avoidance and hearing protection devices commonly used by hyperacusis individuals. While *emotion-focused coping* attempts to reshape emotional responses to auditory stimuli such as learning to assess them as positive or irrelevant eliminating the further need to cope with negativity.

It is important to break the vicious cycle for the individuals living with hyperacusis so that they can endure any acoustic environment. There are clinically-relevant psychological treatments such as Tinnitus Retraining Therapy (TRT) and Cognitive Behavioural Therapy (CBT). TRT works by gradually increasing exposure to sound to build tolerance to loudness, while CBT helps individuals break the negative cycle by identifying and modifying unhelpful thought patterns about sound [9, 15]. Both interventions aim to facilitate sustainable behavioural change and symptom relief by changing the individual's perception and appraisal of everyday soundscapes. Eventually, cognitive reappraisal involves learning new relationships between environmental stimuli and expected outcomes [18].

More recently, new approaches such as Cognitive Sound Exposure Therapy (CSET) emerged, which combines sound exposure with breathing and relaxation training [19]. Structured counseling protocols have also been developed to support transitional interventions [20]. Moreover, tinnitus therapy apps such as the ReSound Tinnitus Relief demonstrate the efficacy of related distress [21]. However, there is still a lack of self-directed, flexible, and accessible interventions specifically for people with hyperacusis. Most interventions are limited to clinical settings and lack self-directed, everyday tools for mild or undiagnosed cases of individual who may not wish to seek clinical treatment.

3. NEED FOR BEHAVIORAL TRANSFORMATION: INSIGHST FROM PERSUASIVE GAMING

Traditional cognitive therapies (e.g., in the context of post-traumatic stress syndrome) presented above can be intrusive, intense, and generally perceived as boring, which might result in poor adherence [22]. In contrast, serious gaming has shown potential to improve mental health and enhance the effectiveness of interventions [23]. Serious games have been increasingly applied in health-related contexts to educate, train, or raise awareness. [24] Persuasive games share many similarities with serious game and are specifically developed to influence players' real-world attitudes or behaviors [25]. While serious game design focuses on mechanics, persuasive game design often focuses on user experience [26]. In this study, the line between the two can be blurred; however, we adopt the term persuasive game to emphasise the focus on behaviour change for people with hyperacusis.

The Persuasive Game Design model (PGD) further emphasizes how transformations within the game world can map onto behavioral change in everyday life [26, 27] . The model outlines four key concepts: Real World (RW), Gamification, Game World (GW), and Transfer Effect. For hyperacusis, the RW objective is to alleviate anxiety and reduce avoidance behaviors towards soundscapes. Gamification refers to the integration of both game elements (e.g., points, rewards, badges, challenges) and RW serious elements (e.g., therapeutic information and soundscape appraisal) into a GW setting. The GW and RW are interdependent, experiences in one can shape perceptions in the other. The key point is that a safe soundscape experience can be simulated in GW, taking advantage of its protective and motivational qualities. Finally, the GW experience can transfer to RW and sustain an impact on the user's daily behavior, known as the transfer effect.

Gamified interventions may offer a unique coping approach for hyperacusis by integrating both problem-focused and emotion-focused strategies. Within the GW, users can engage with soundscapes in safe and interactive

ways (problem-focused), while also using game mechanisms to support stress reduction and emotional regulation (emotion-focused). Crucially, the GW can simulate safe soundscapes for the appraisal process. One study identified two key aspects of safety in GW: system safety, where mistakes have no RW consequences, and psychological safety, where players face unfamiliar situations and learn from their responses. [28] However, factors such as time pressure or behavior of other participants can influence this sense of safety, so a carefully calibrated level of imbalance and discomfort is needed to support the design of GW. [29] Bringing together all the insights from literature, it is possible to build a process model of RW soundscape appraisal for hyperacusis listeners as presented in Figure XX. This model is based on Lazarus's appraisal theory [16] and aims to help clarify the relationships between these key concepts. In the RW, soundscape is the acoustic environment that hyperacusis listeners face, and build the situational construal with their believes and intentions together which will trigger the appraisal and determine the individual coping strategies focused on the problem or the clinical coping method focused on altering emotional responses. Eitehr strategy will result in reappraisal alloowing for pacing and learning. In the figure, we conceptualize the GW and RW as parallel systems that share similar structural and cognitive mechanisms. While the GW offers a safer and more controllable environment for players, we predict that the appraisal processes triggered by environmental stimuli in RW will be influeced by the GW (i..e, transfer effect).

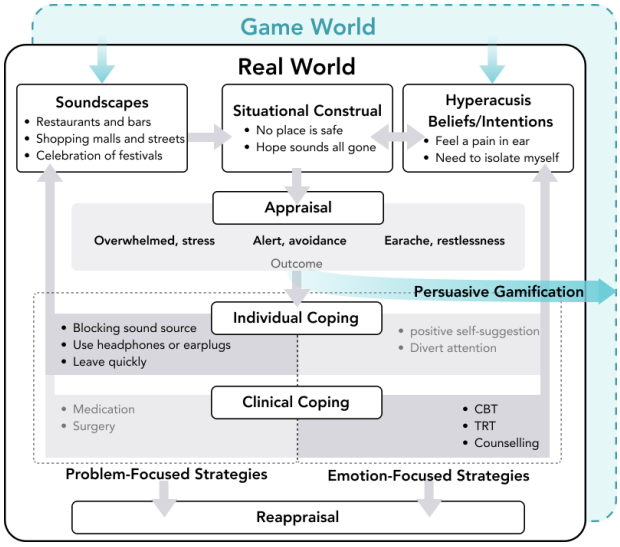

Figure 1. Soundscape appraisal by hyperacusis listeners explained (after Lazarus [16])

4. DEVELOP THE DESIGN GUIDELINE BASED ON EXPERT INTERVIEWS

4.1 Method

To gather input for the design guideline, we conducted semi-structured interviews with seven experts from five disciplines: soundscape (n=1), psychology (n=2), persuasive game design (n=2), otolaryngology (n=1) and hyperacusis listeners (n=2, one of whom also specializes in game design). Due to geographical constraints, a combination of face-to-face interviews and online Teams meeting was used to conduct interviews, each lasting app. 35 minutes.

4.2 Participants

In this study, seven experts were recruited meeting the commonly accepted threshold for thematic saturation in qualitative research [30]. At least one expert from each relevant discipline was included. For hyperacusis subjects, participants self-reported the duration of the symptoms and completed the *Questionnaire on Hypersensitivity to Sound* (GÜF) [31] to assess the severity of the symptoms. Both selected hyperacusis listeners were classified as having severely impaired function (scores of 20 and 18). One had experienced symptoms for more than 15 years and had a medical diagnosis, the other had a background in game design. For other experts, the selection criteria was at least 5 years of professional experience. Experts were recruited through the academic network of TU Delft and peer recommendations. The composition of the expert group is summarized in the table below.

4.3 Materials and Procedure

All interviews followed a one-to-one format with signed informed consent and audio recording. Participants were first introduced to the four key concepts via printed A4 visual summaries (in person) or interactive slides in Figma (online), with the same visuals and text setting. This is for understanding disciplines they might not be familiar with and facilitating conversation. Tailored questions aligned with each participant's background were posed to formulate the design guideline, followed by general questions such as potential reference cases, practical applicability, ethical considerations, key opportunities, and challenges.

No.	Disciplines	Experience (Year)	Title	Online Interview
E1	Otolaryngologist	20	Doctor	✓
E2	• Positive psychology • Behaviour change	6	College teacher	✓
E3	• Mood and behavior • Emotion Design	5	PhD candidate	
E4	• Persuasive game • Psychology & Health	5.5	PhD candidate	
E5	Soundscape	6	Assistant professor	✓
E6	• Hyperacusis • Game designer	Sensitivity: 5 Game: 8	Senior game designer	
E7	Severe Hyperacusis	15	Patient	

Figure 2. Composition of the expert group

4.4 Data Analysis

All audio recordings are transcribed, and grammatically corrected where necessary to prepare for analysis. Conversations in Chinese were translated into English for data analysis. A deductive approach was used to categorize and interpret the interview data, guided by the previously established appraisal framework for hyperacusis. Therefore, we applied the same appraisal model originally developed to describe how hyperacusis listeners appraisal RW soundscapes to the GW setting as well. Insights from expert interviews were then systematically mapped onto this model, and the parts of the model that are specifically addressed are highlighted in order to summarise the design guideline.

5. RESULTS

All experts agreed that the theoretical insights could serve as a good starting point. However, they highlighted key areas for further clarification and development, particularly the design of game elements and how to achieve the intended transfer effects. The experts brought different perspectives, with the audiologist emphasizing personal experience, the doctor focusing on treatment methods, the soundscape expert raising concerns about personalized soundscape, the game designers discussing possible game elements and interactions, and the psychologist emphasizing the need for evaluation tools. Five experts identified user research as the next essential step and four experts mentioned ethical considerations.

6. DISCUSSIONS

Theoretical insights and expert interviews provided us with sufficient insights to further explore the GW for supporting self-reported hyperacusis listeners. Below we present these in Figure 3 in a comprehensive way following the appraisal theory and persuasive gaming principles as a guide to design an intervention that fits the hyperacusis listener (i.e., user).

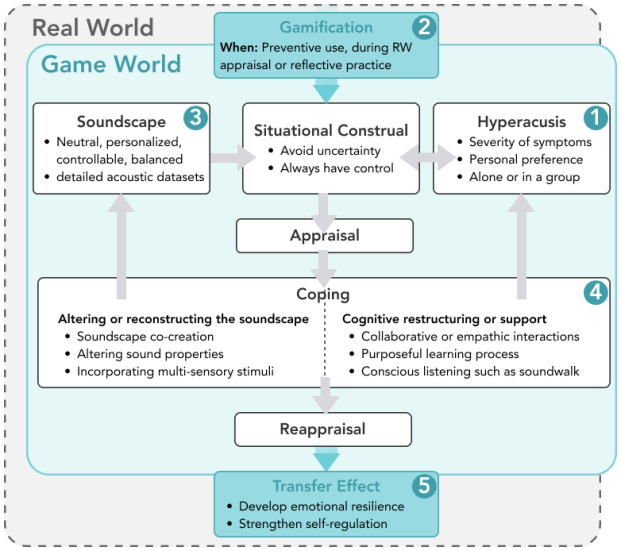

Figure 3. Game World appraisal process and design considerations explained (after Lazarus [16])

6.1 Hyperacusis listeners

When identifying hyperacusis listeners for intervention, there are two main focuses: *i.* providing **autonomy** based on individual differences, such as severity of symptoms and varying personal preferences (E2, E3); *ii.* establishing a **common ground** for all possible hyperacusis users. Larger-scale user research and profiling are crucial to address these aspects.

Coping preferences vary among individuals, some prefer handling anxiety alone (E5), while others experience increased anxiety when isolated (E1). Experts suggest that interventions can be tailored based on **severity and individual preference**: severe cases may require one-to-one interventions for privacy and to avoid social settings (E1, E3), while less severe cases may benefit from one-to-many interactions and social support (E1, E3, E6). Other factors, such as gender (E2) and age (E2, E3), as

well as game preferences, should be considered in the decision-making process.

Hyperacusis individuals often avoid uncertainty to reduce anxiety (E1, E5, E3, E7) and may be sensitive to non-sound stimuli like odor and light as well(E5). They shared a preference for turning off video game sounds and avoiding noisy physical games, emphasizing the need for well-designed sound elements in interventions (E1, E5).

6.2 Time of entry to the Game World

Experts have suggested three potentially suitable times to enter the GW: *i.* Preventive use before encountering certain soundscapes(E3, E7); *ii.* Real-time guidance during RW soundscape appraisal for relief(E5); *iii.* Reflective practice at irregular intervals in daily life (E1, E5). Since hyperacusis is a long-term symptom, the GW experience should encourage repetitive, flexible use, users should be allowed to return to it when needed (E3, E4).It should also support self-paced training, allowing gradual adaptation to sound stimuli (E1, E3, E5).

6.3 Soundscapes as game elements

When designing the soundscapes in GW as game elements, we must prioritize four key principles: *i.* Select **Neutral**, normal sound as the baseline auditory stimuli to avoid generalized distress (E1, E7); *ii.* **Personalized** adaptation based on individual trigger profiles and preference datasets (E1, E3, E5, E6); *iii.* **Controllable** parameters enabling real-time user adjustments to sound properties (E1, E3, E4, E6); and *iv.* **Balanced** integration of positive/negative elements with gradual exposure methods to build tolerance (E1, E2, E3, E7).

As hyperacusis triggers vary widely (e.g., thunder, neighborhood chat, or repetitive noises) and are highly subjective and personalized, requiring comprehensive and detailed acoustic datasets (E1, E3, E5, E6). In addition, whether the game elements contain indoor or outdoor soundscapes needs to be considered, as there are different standards for them (E5). In general, soundscapes should be relaxed, soothing, and predictable to avoid triggering discomfort caused by uncertainty (E5, E3, E1, E7).

6.4 Coping strategies in the Game World

Problem-focused coping in GW could be breaking the listeners' old appraisal of sound by altering or reconstructing the soundscape. This can be achieved through soundscape co-design, adjusting sound properties, or creatively reshaping auditory contexts with support from others (E6, E5, E1). Experts have also suggested some methods to gamify soundscape without changing the sound triggers in it, including rhythmic re-composition, augment metaphors, and introducing positive associations with sounds (E1, E6). *Emotion-focused coping* can be supported by fostering social connections and cognitive restructuring without changing the soundscapes. Collaborative or empathic interactions that promote emotional safety (E1, E3, E6) can be helpful, though some users may prefer solitary coping. Cognitive restructuring can be achieved by placing the sound in different contexts to shift perception (E1, E5). Structured exposure and desensitization training (E2, E7) can help users gradually adapt to the trigger sounds, while pairing sounds with multi-sensory inputs, such as fusion visuals or scents, may also be helpful(E1). The ultimate goal of both coping strategies is to develop emotional resilience, reappraisal the soundscape, and strengthen self-regulation (E3, E7).

6.5 Transfer effect to the Real World

In order to assess the transfer effects of interventions, it is important to define clear and testable objectives from the outset. Effective interventions should show improvements in self-regulation and emotional resilience. It is desirable to combine subjective and objective indicators and to design controlled experiments to make the results more credible (E1, E3). On the *subjective* side, self-reports of symptom relief or disappearance (E7, E2, E3) are an important measure. A well-designed self-assessment tool is also part of the overall experience and can encourage more meaningful responses (E3). The process of completing the questionnaire itself can enhance reflection and emotional processing. Follow-up sessions can help to assess long-term retention and behavioural change (E3, E7). On the *objective* side, measurements can include physiological indicators such as heart rate variability (if possible) (E2, E3, E6, E7). Digital footprint analysis, can provide insights into ongoing changes in emotional expression, or behaviour, outside of the game (E7).

6.6 Ethical considerations

First, the purpose of the intervention should be clarified to all participants: it aims to supporting users manage mild to moderate symptoms of hyperacusis in a non-clinical everyday context, not to treat severe conditions (E1, E2, E3, E5). Furthermore, the goal of the intervention should not

be to forcibly 'fix' negative feelings that the user has already accepted, but rather to support the user in coping without the pressure of 'not being good enough' or 'needing to improve' (E7).Moreover, the game design needs to prioritise participant well-being before/during/after gaming by ensuring appropriate personal control and autonomy, including the option to terminate the game if they feel uncomfortable (E4, E5). Soundscape in the intervention requires special attention, as users may develop new sensitivities to previously neutral or pleasant sounds (E1, E6, E7). Universally distressing sounds should be avoided (E5, E7) to not further harm the listener.

7. CONCLUSIONS

In this paper, we gathered theoretical insights and conducted interviews with seven experts and developed a design guideline for gamified interventions to manage hyperacusis. Based on the process view of Lazarus' appraisal theory, both the theoretical framework and expert insights were mapped to corresponding stages of the appraisal process. The resulting guideline outlines six key design considerations: understanding hyperacusis listeners, entry points into the game world, soundscapes as game elements, coping strategies within gameplay, transfer effects to real world, and ethical concerns. Future work will focus on applying this guideline in practical game design scenarios to evaluate its effectiveness and refine its application with hyperacusis listeners.

8. ACKNOWLEDGMENTS

We thank all the experts who participated in the study. This study is based on Qianhui Liu's graduation project in the Design for Interaction MSc program.

9. REFERENCES

[1] R. S. Tyler, M. Pienkowski, E. R. Roncancio, H. J. Jun, T. Brozoski, N. Dauman, C. B. Coelho, G. Andersson, A. J. Keiner, A. T. Cacace, *et al.*, "A review of hyperacusis and future directions: part i. definitions and manifestations," *American journal of audiology*, vol. 23, no. 4, pp. 402–419, 2014.

[2] A. L. Smit, I. Stegeman, R. H. Eikelboom, D. M. Baguley, R. J. Bennett, S. Tegg-Quinn, R. S. Bucks, R. J. Stokroos, M. Hunter, and M. D. Atlas, "Prevalence of hyperacusis and its relation to health: The busselton healthy ageing study," *The Laryngoscope*, vol. 131, no. 12, pp. E2887–E2896, 2021.

[3] D. M. Baguley, "Hyperacusis," *Journal of the Royal Society of Medicine*, vol. 96, no. 12, pp. 582–585, 2003.

[4] Y. Huang, T. Xiang, F. Jiang, J. Ren, T. Xu, and D. Lai, "Combined evaluation of audiology examination and self-reported symptoms in patients with hyperacusis," *Scientific Reports*, vol. 13, no. 1, p. 1522, 2023.

[5] J. Paulin, L. Andersson, and S. Nordin, "Characteristics of hyperacusis in the general population," *Noise and Health*, vol. 18, no. 83, pp. 178–184, 2016.

[6] K. Fackrell, M. Sereda, S. Smith, J. Sheldrake, and D. J. Hoare, "What should be considered when assessing hyperacusis? a qualitative analysis of problems reported by hyperacusis patients," *Brain Sciences*, vol. 12, no. 12, p. 1615, 2022.

[7] P. J. Jastreboff and M. M. Jastreboff, "Treatments for decreased sound tolerance (hyperacusis and misophonia)," in *Seminars in hearing*, vol. 35, pp. 105–120, Thieme Medical Publishers, 2014.

[8] K. Fackrell, I. Potgieter, G. S. Shekhawat, D. M. Baguley, M. Sereda, and D. J. Hoare, "Clinical interventions for hyperacusis in adults: a scoping review to assess the current position and determine priorities for research," *BioMed research international*, vol. 2017, no. 1, p. 2723715, 2017.

[9] J. A. Henry, S. M. Theodoroff, C. Edmonds, I. Martinez, P. J. Myers, T. L. Zaugg, and M.-C. Goodworth, "Sound tolerance conditions (hyperacusis, misophonia, noise sensitivity, and phonophobia): Definitions and clinical management," *American Journal of Audiology*, vol. 31, no. 3, pp. 513–527, 2022.

[10] B. M. Brooks, B. Schulte-Fortkamp, K. S. Voigt, and A. U. Case, "Exploring our sonic environment through soundscape research & theory," *Acoustics today*, vol. 10, no. 1, pp. 30–40, 2014.

[11] P. Dunbavin, "Iso/ts 12913-2: 2018—soundscape—part 2: Data collection and reporting requirements—what's it all about," *Acoust. Bull*, vol. 43, pp. 55–57, 2018.

[12] E. Özcan, C. L. Broekmeulen, Z. A. Luck, M. van Velzen, P. J. Stappers, and J. R. Edworthy, "Acoustic biotopes, listeners and sound-induced action: a case

study of operating rooms," *International Journal of Environmental Research and Public Health*, vol. 19, no. 24, p. 16674, 2022.

[13] M. Erfanian, A. J. Mitchell, J. Kang, and F. Aletta, "The psychophysiological implications of soundscape: A systematic review of empirical literature and a research agenda," *International journal of environmental research and public health*, vol. 16, no. 19, p. 3533, 2019.

[14] Ö. Axelsson, M. E. Nilsson, and B. Berglund, "A principal components model of soundscape perception," *The Journal of the Acoustical Society of America*, vol. 128, no. 5, pp. 2836–2846, 2010.

[15] H. Aazh, M. Landgrebe, A. A. Danesh, and B. C. Moore, "Cognitive behavioral therapy for alleviating the distress caused by tinnitus, hyperacusis and misophonia: current perspectives," *Psychology research and behavior management*, pp. 991–1002, 2019.

[16] R. S. Lazarus, *Emotion and adaptation*. Oxford University Press, 1991.

[17] R. S. Lazarus and S. Folkman, "Transactional theory and research on emotions and coping," *European Journal of personality*, vol. 1, no. 3, pp. 141–169, 1987.

[18] Y.-X. Wang and B. Yin, "A new understanding of the cognitive reappraisal technique: an extension based on the schema theory," *Frontiers in Behavioral Neuroscience*, vol. 17, p. 1174585, 2023.

[19] S. Thieren, P. van Dommelen, and M. R. Benard, "New hyperacusis therapy combines psychoeducation, sound exposure, and counseling," *American Journal of Audiology*, vol. 33, no. 3, pp. 613–623, 2024.

[20] D. Cherri, C. Formby, C. A. Secor, and D. A. Eddins, "Counseling protocol for a transitional intervention for debilitating hyperacusis," *Journal of Speech, Language, and Hearing Research*, vol. 67, no. 6, pp. 1886–1902, 2024.

[21] P. Kuppens, F. Tuerlinckx, J. A. Russell, and L. F. Barrett, "The relation between valence and arousal in subjective experience.," *Psychological bulletin*, vol. 139, no. 4, p. 917, 2013.

[22] A. Mert, R. Buirma, J. van Luijk, G. Melkonian, J. Pels, and E. Vermetten, "Development of a theory-based applied game for the treatment of post-traumatic stress disorder: proof of feasibility," in *Games for Health: Proceedings of the 3rd european conference on gaming and playful interaction in health care*, pp. 247–253, Springer, 2013.

[23] C. Cheng and O. V. Ebrahimi, "Gamification: A novel approach to mental health promotion," *Current Psychiatry Reports*, vol. 25, no. 11, pp. 577–586, 2023.

[24] D. R. Michael and S. L. Chen, *Serious games: Games that educate, train, and inform*. Muska & Lipman/Premier-Trade, 2005.

[25] I. Bogost, *Persuasive games*, vol. 5. Cambridge, MA: MIT Press, 2007.

[26] K. Van der Kooij, E. Hoogendoorn, R. Spijkerman, and V. Visch, "Validation of games for behavioral change: Connecting the playful and serious.," *International Journal of Serious Games*, vol. 2, no. 3, 2015.

[27] V. Visch, N. Vegt, H. Anderiesen, and K. Van der Kooij, "Persuasive game design: A model and its definitions," in *CHI¿ 13 Designing gamification: Creating gameful and playful experiences, Paris, France*, pp. 1–5, 2013.

[28] E. Hijmans, V. Peters, M. van de Westelaken, J. Heldens, and A. v. Gils, "Encounters of a safe environment in simulation games," 2009.

[29] V. Peters, M. van de Westelaken, and J. Bruining, "Simulation games as a safe environment: What can game designers and facilitators do to guard the psychological security of participants?," *Studies in Simulation and Gaming*, vol. 22, no. SPECIAL, pp. 59–64, 2012.

[30] G. Guest, A. Bunce, and L. Johnson, "How many interviews are enough? an experiment with data saturation and variability," *Field methods*, vol. 18, no. 1, pp. 59–82, 2006.

[31] M. Nelting, N. Rienhoff, G. Hesse, and U. Lamparter, "The assessment of subjective distress related to hyperacusis with a self-rating questionnaire on hypersensitivity to sound," *Laryngo-rhino-otologie*, vol. 81, no. 5, pp. 327–334, 2002.