

Non-invasive technology for stress and anxiety: A qualitative case report and literature overview

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Abstract

Stress and anxiety are common features of modern life, leading many individuals to seek self-managed, non-invasive approaches to improve their emotional well-being. This white paper presents a qualitative, exploratory user evaluation of a non-invasive prototype device, *LYEONS HEART (HEART)*, designed to explore user perceptions of physiological modulation for stress management. One adult user trialled the device over a 21-day period in naturalistic settings. Feedback was gathered through self-reflective diaries and an interview, analysed using reflexive thematic analysis to identify patterns in user experience. Four key themes emerged: (1) device functionality and design; (2) ability to induce calm; (3) environmental and emotional contexts of use; and (4) emotional connection and trust in the device. The user described the device as physically soothing and supportive during stressful moments. This exploratory evaluation provides preliminary insights into user experience and design considerations for future development. It does not assess clinical outcomes, nor make any medical or therapeutic claims. Future studies with larger and more diverse user groups could explore how such devices fit within broader approaches to well-being and stress management.

Keywords

Stress, Anxiety, User experience, Non-invasive technology, Physiomodulation, Qualitative evaluation

Introduction

Stressful situations are commonly linked to heightened physiological arousal and negative emotional states. However, not all stressors are alike - different types of stress elicit distinct physiological and psychological responses. For instance, a cognitive stressor such as mental arithmetic induces different responses compared to a physical stressor like respiratory discomfort or a social stressor involving interpersonal evaluation. Social stressors, in particular, may involve the anticipation of negative judgment (e.g., public speaking) or social exclusion (e.g., rejection scenarios), each triggering unique patterns of autonomic and emotional activation [1,2].

In these contexts, the capacity to regulate physiological arousal and associated emotional responses becomes crucial not only for reducing anxiety but also for optimizing performance under pressure [3,4]. Due to the prevalence of stress and anxiety in everyday life, many people search for non-invasive and convenient methods to support their physiological and psychological wellbeing. The purpose of this case report is to describe an exploratory user evaluation of the LYEONS HEART prototype. The device was created to provide rhythmic tactile and auditory feedback that resembles a heartbeat. The objective was to collect qualitative feedback on comfort, usability, and perceived emotional support during everyday use. This was not a medical or therapeutic study.

Physiological modulation for stress and anxiety: literature overview

There are existing physiological modulation (physiomodulation) methods that are non-invasive and convenient to use that are available to support people with stress and anxiety. Physiomodulation can occur through a number of approaches including vagal nerve stimulation, breathing exercises and biofeedback of heart rate or neural oscillations (Table 1.).

Table 1. Approaches to physiomodulation aimed at reducing stress and anxiety.

Category	Mechanism	Advantages	Precautions needed	Reference
Mobile Mental Health Apps and AI-Powered Chatbots	Deliver guided meditation, CBT-based tools, mood tracking, or conversation	Convenient, low-cost, scalable	Variable quality, limited personalization, user dropout, often unregulated and lack clinical validation	Li et al., 2023 (DOI:10.1038/s41746-023-00979-5) Weisel et al., 2019 (DOI: 10.1016/j.jad.2019.03.069) Fitzpatrick et al., 2017 (DOI: 10.1016/j.jad.2017.02.043)

Virtual Reality (VR) Therapy	Immersive environments for relaxation or exposure therapy	High engagement, effective in controlled settings	Expensive, may cause cybersickness	Freeman et al., 2017 (DOI: 10.1192/bjp.bp.117.203660) Maples-Keller et al., 2017 (DOI: 10.1016/j.chb.2017.01.016)
Deep Breathing / Resonant Frequency Breathing Apps	Modulates vagal tone and HRV via slow breathing (typically ~6 bpm)	Free/inexpensive, instantly calming	Needs consistent practice	Zaccaro et al., 2018 (DOI: 10.3389/fpsyg.2018.00209)
Biofeedback Devices	Provide real-time feedback on physiological signals like breathing, heart rate, or neural oscillations	Promotes self-awareness and regulation	Learning curve, not always user-friendly	Schoenberg & David, 2014 (DOI: 10.3389/fpsyg.2014.00763)
Progressive Muscle Relaxation (PMR)	Reduces somatic tension through controlled tensing and releasing of muscles	Proven efficacy, easy to learn, no equipment	Requires practice, less effective in acute panic	Manzoni et al., 2008: <i>PMR reduces anxiety and stress</i> [5]
Wearables	Track physiological data (HRV, sleep, activity) to infer stress and prompt regulation	Passive monitoring, real-time feedback	Can cause stress if overused; accuracy varies	Smuck et al., 2021 (DOI: 10.1097/BRS.00000000000003880) Can et al., 2019 (DOI: 10.2196/11006)
Cranial Electrotherapy Stimulation (CES)	Delivers microcurrents to brain regions linked to mood & anxiety	Rapid onset, FDA-cleared for anxiety	Not suitable for everyone, unclear mechanisms	Shekelle et al., 2018 (DOI: 10.23970/AHRQEPCCER220)
Transcutaneous Vagus Nerve Stimulation (tVNS)	Stimulates the auricular branch of the vagus nerve non-invasively	Targets parasympathetic nervous system, reduces anxiety, low side effects	Still under research, variable efficacy, device access	Fischer et al., 2018 (DOI: 10.1016/j.neubiorev.2017.12.003) Yakunina et al., 2017 (DOI: 10.3389/fnins.2017.00644)

An additional physiomodulation mechanism that has been explored is physiological synchrony (PS). PS is when the physiology (eg. breathing rate, heart rate) of an individual synchronises with another person or stimulus. The value of physiological synchrony has also been investigated between therapists and their patients, as increased skin conductance synchrony has been shown during cognitive behavioural therapy (CBT) [5]. Improved self-reported ratings during psychotherapy sessions also correlated with cardiac physiological synchrony [6].

Exploratory Case Description`

User profile

One adult female volunteer, aged forty-four, took part in this user evaluation. The user completed a brief self-assessment using the Generalised Anxiety Disorder Questionnaire (GAD-7) at the beginning of the evaluation to provide contextual information about perceived stress and anxiety levels. The questionnaire was self-administered, and the results

were used only to inform understanding of the user's experience. No medical diagnosis, clinical interpretation, or treatment-related conclusions were made.

No other medical information or records were collected. The participant provided written consent to share anonymised feedback for publication. This was an exploratory, voluntary activity designed to understand individual experiences of using the device in everyday life.

This user testing case report explores the lived experience of a user engaging with a neuromodulation prototype, for 21 days, with the aim of collecting qualitative data of understanding how the neuromodulation device is integrated into daily life and emotional regulation practices.

Device Description and Use

LYEONS HEART is a non-invasive handheld prototype designed to explore the effects of physiological modulation through cardiac synchrony. The device emits a rhythmic tactile and auditory signal that mimics a human heartbeat, intended to facilitate a form of cardiac physiological synchrony between the user and the device. This concept draws on evidence suggesting that rhythmic cues such as heartbeat or breathing patterns may promote parasympathetic activation and support emotional regulation.

The prototype provides both tactile vibration and audible heartbeat feedback, allowing the user to engage with the rhythm through multiple sensory channels. This multisensory design aims to encourage entrainment, which is the alignment between the user's physiological rhythm and the external rhythm generated by the device.

The user was invited to use the device freely over a period of twenty-one days in everyday environments. No instructions on therapeutic or prescriptive use were provided, and the study did not include any medical or diagnostic components.

Throughout the testing period, the participant was asked to document her experiences, thoughts and reflections in a user diary, capturing both situational responses and general impressions of the device. To complement the qualitative diary data, a semi-structured interview was conducted at the end of the testing period to expand upon her reflections. The discussion focused on usability, comfort and perceived emotional responses rather than any clinical or psychological outcomes.



Figure 1. A photograph of the LYEONS HEART non-invasive device. The HEART provides audio and tactile heartbeat stimulus and underwent 21 days of User testing.

Data analysis information

Reflexive Thematic Analysis (RTA) was employed to identify patterns in the diary and interview data. Data sources included reflective feedback via diary notes taken at different points in time throughout the testing, and a conversation at the end of the testing period. The combination of both real-time and reflective data provided a more comprehensive understanding of the participant's engagement with the device across different contexts. An inductive approach was used, allowing themes to emerge directly from the data rather than being guided by a pre-existing coding framework. The analysis process involved familiarisation with the dataset, initial coding, and the identification of recurring patterns of meaning. RTA was selected for its flexibility and its capacity to capture the complexity, emotional depth, and subjective nature of personal experiences, making it particularly well-suited to exploring how the device was perceived and utilised in everyday settings. From this analysis four major themes emerged: 1) Device functionality and design; 2) Perceived induction of calm; 3) Environmental and emotional context of use, and; 4) Trust and emotional bond with device.

Results

Multiple themes were identified through the analysis of user feedback gathered from diary

notes and a follow-up conversation (Table 2.). Reflexive thematic analysis was used to explore recurring patterns and meanings within the user’s reflections, offering a qualitative understanding of her experience with the device. Each theme is described and illustrated with participant quotes to provide insight into the experiences, perspectives, or phenomena highlighted by the user.

Table 2. RTA Coding Table. This table provides a sample of coded data from a reflective thematic analysis (RTA) of diary entries and a face-to-face interview by the participant. Excerpts were categorised by data type and inductively coded into themes that emerged in relation to the use of the device.

Theme	Data Excerpt	Data Type
Device function & design	<i>"Wearable design: Eg watch?, Wearable headset over ears, Rhythm: can user choose different Rhythm or is the 2x beat sound set for a reason"</i>	Diary Entry
	<i>"HEART inside my bra as I am currently writing, doesn't always feel comfortable"</i>	Diary Entry
Induction of a state of calm	<i>"I wish I could have an earphone HEART so I can hear the beat as well as experiencing thumping against my ears"</i>	Diary Entry
	<i>"I held onto HEART. Feel it's beat against my palm"</i>	Diary Entry
	<i>"Holding onto HEART, I breath, I tell myself 'I am safe'. I put the device against my ear... To block out sound"</i>	Diary Entry
	<i>"Held onto HEART in my pocket, rotating between palm and thumb, feeling the beat"</i>	Diary Entry
	<i>"It's okay. I am good enough. I am worth it. I have more than enough of everything"</i>	Diary Entry
	<i>"Holding on to HEART as I continue to write and breath"</i>	Diary Entry

	<i>"I held my HEART against my left ear. Could this stop my busy mind? Listening to the HEART beat is actually quite something. It tells much better than just holding! I love the gentle thumping against my ear. Eyes closed & Breath. Still very busy mind but feel a lot better"</i>	Diary Entry
	<i>"Held it on my right palm. Put against right ear at one point because I felt overwhelmed. I wanted to block out all the noise"</i>	Diary Entry
	<i>"I did this lift 5-6 times. Sometimes there were other people and I felt 'packed'... Just listen to HEART, just feel the beat"</i>	Diary Entry
	<i>"Hold onto HEART - Will tuck into my elbow when on call at 3pm. I am holding onto it now to calm myself down..."</i>	Diary Entry
	<i>"Think positive. Focus on what you have achieved! The future is unknown enjoy it and have a go! You've made it to Brugge! 20 years!"</i>	Diary Entry
	<i>"Listen to HEART block out all the noise"</i>	
	<i>"Sometimes I'll just hold it like this.. I can feel it more"</i>	Interview
Environmental & Emotional context when device is used	<i>"; of store announcement, baby cry, people chatting!"</i>	Diary Entry
	<i>"Mood ¾ - because I found out [redacted] wasn't invited to a birthday party. It's not party that I am upset about. It's the fact that I feel excluded because I thought the mums and I were friends? Obviously not"</i>	Diary Entry
	<i>"Girls are whining, moaning and we are stuck! Got HEART out"</i>	Diary Entry
	<i>"I had a cocktail as opposed to a mocktail. Felt sick, went to bed..."</i>	Diary Entry
	<i>"This long, clear, narrow, zig-zagged long plastic walk-way is very very claustrophobic!"</i>	Diary Entry
	<i>"About to go to a meeting. Feeling slightly on edge, anxious because its HARD work"</i>	Diary Entry
	<i>"I just want to block out noise.. It's kind of shielding and protecting me away from a lot of noise"</i>	Interview

	<i>“I was scared because I think if they see this, they’ll be thinking, what is that?”</i>	Interview
Trust & Emotional bond with device	<i>“Yes I wanted to work but am scared. So I took HEART with me”</i>	Diary Entry
	<i>“The thought of having HEART gives me reassurance and comfort.... I trust her team. I trust HEART”</i>	Diary Entry
	<i>“Found a table held on to HEART put it against my ear”</i>	Diary Entry
	<i>“I walked back inside the buffet and held onto HEART. Feeling a lot calmer and happier”</i>	Diary Entry
	<i>“Throughout the evening I kept HEART with me... When it got too noisy I listened to the beat”</i>	Diary Entry
	<i>“There was something comforting about having it there, even if I wasn’t actively using it”</i>	Interview
	<i>“After a few minutes, I could actually feel myself relaxing, like my breathing slowed”</i>	Interview

Device functionality & Design

The theme “Device functionality & Design” captures the users’ experience and perception regarding how the device operates and its physical and interface design.

The User consistently emphasised the importance of the device’s discreetness, attributing it to HEART’s compact size and unobtrusive design. A core component of its effectiveness in managing anxiety was its ability to stimulate both auditory and tactile sensations. Notably, the auditory feedback was identified as a particularly powerful feature for inducing calm. As expressed: “Listening to the heartbeat is actually quite something. It feels much better than just holding!” The significance of this feature was further underscored by their suggestion to develop an “earphone HEART so I can hear the beat as well as experiencing thumping against my ears.” In addition to the auditory component, tactile feedback emerged as another key design strength. The User valued the ability to actively modulate the intensity of the sensation: “I’ve got full control really quick, because then you can release a little bit and then you can feel a bit more and then you’ve got this kind of control over how much you want.” This flexibility not only enhanced physical comfort but also reinforced a sense of personal agency, enabling them to tailor the device’s use to their emotional state in the moment. Finally, HEART’s discreet design: small, portable, and easily concealed — was highlighted as a major factor in the positive user experience. The ability to carry and use the device without drawing attention allowed the user to receive emotional support without fear of social

stigma or external judgment. However, when used for auditory stimulation, this discreetness was diminished, at times drawing attention and unintentionally exacerbating feelings of stress.

Induction of a state of calm

The device demonstrated an ability to induce a physiological state of calm in the User. The User consistently reported that within minutes of use, they could “feel themselves relaxing,” suggesting an effective engagement of somatic calming mechanisms. While the participant continued to experience cognitive symptoms of stress, describing “a very busy mind but feel a lot better”, this indicates that the device may predominantly support physical relaxation and emotional regulation.

Repeated use of the device appeared to enhance its efficacy, with the User describing it as both a sensory buffer and a tool for emotional stabilisation. The participant frequently integrated the device into a broader wellness strategy, combining its tactile and auditory feedback with affirmations such as “It’s okay. I am good enough. I am worth it.” This multimodal approach appeared to strengthen its therapeutic impact in stress reduction throughout the work day and travel.

Furthermore, the device was used in anticipatory contexts, such as before meetings, where the participant employed it to manage anxiety while affirming their achievements (“You’ve made it to Brugge! 20 years! The next 30 mins or even an hour is NOTHING”). Over time, the participant began incorporating the device into their daily routine, using it as a cue to begin winding down at night. This shift suggests a broadening of the device’s perceived utility, extending from acute anxiety management to general relaxation support.

Environmental & Emotional context in which the device was used

The User engaged with the device across a range of anxiety-provoking environments. Situations characterised by excessive sensory input, particularly auditory overstimulation, were commonly cited as triggers for distress. Specific environmental stimuli included “store announcements, babies crying, people chatting,” all of which contributed to rapid sensory overload in stressful situations and prompted use of the device as a regulatory tool.

In addition to sensory triggers, the participant reported using the device in contexts associated with perceived danger or uncertainty. Examples included navigating in the dark or being far from home, as well as situations involving social evaluation, such as attending meetings. In these settings, the device was carried proactively and functioned as a psychological safety aid, alleviating anticipatory anxiety by providing a sense of preparedness.

The device was also employed in response to internally generated distress. Thought-induced anxiety, particularly stemming from perceived social exclusion, was another context for use. The participant reflected, “It’s the fact that I feel excluded because I thought the mums and I

were friends,” illustrating how cognitive and emotional factors, independent of the immediate physical environment, prompted engagement with the device.

Trust and Emotional Bond with the Device

The participant developed a notable sense of emotional connection and psychological reliance on the device, often describing it as a source of comfort and safety. The device was not only used reactively during heightened anxiety but was also carried proactively as a preventative measure. Diary entries revealed that its mere presence offered reassurance: “Yes, I wanted to work but I am scared. So I took HEART with me.” Even when not actively in use, the participant remarked that “there was something comforting about having it there,” portraying the device’s perceived reliability and role as a source of stability.

The participant frequently referenced using the device intuitively, switching it on in response to increasing anxiety: “Throughout the evening I kept HEART with me. When it got too much I’ll switch it on.” This pattern of use suggests a personalised and dynamic relationship with the device, integrating it into their broader self-regulation strategy.

During interviews, the User noted that having both the device and medication available (travel sickness pills), reduced anticipatory anxiety: “I’ve got medicine, I’ve got this... So from a mental perspective, if I know that I’ve got everything covered, what else do I need to worry?” This parallel positioning of the device alongside trusted pharmaceuticals reflects a high level of emotional trust and psychological investment.

Finally, the participant explicitly stated, “I trust LYEONS,” indicating that the perceived effectiveness of the device may be partially influenced by confidence in the brand itself. This introduces a compelling avenue for further investigation: whether such outcomes would continue in a blind setting, where branding and expectations are removed. Understanding the role of brand trust and potential placebo effects may help delineate the mechanisms underlying the observed psychological impact.

Limitations

This protocol presents findings from a single-user experience, which limits the ability to generalise the observations. Although the qualitative depth provides valuable insight for hypothesis generation, further work involving a wider and more diverse group of users would be necessary to explore the consistency of these experiences.

The absence of long-term follow-up also limits understanding of continued engagement or sustained effects over time. All data were self-reported through diary entries and interviews, which may be influenced by recall or response bias. These factors should be considered in the design of future user evaluations.

While the findings suggest that non-invasive physiomodulation devices may have perceived value as supportive tools for managing stress in daily life, they do not indicate clinical or therapeutic outcomes.

Future exploratory work will include a larger number of users, longer testing periods and structured usability and engagement measures. Any subsequent studies will continue to focus on understanding user experience and product interaction rather than health or clinical impact.

Discussion

This case report provides an early qualitative account of user's experience in managing stress and related symptoms based on observations and their feedback on themes we identified, including 1) Device functionality & design; 2) Induction of a state of calm; 3) context in which used, and; 4) Trust & Emotional bond with device. The user described a subjective sense of calm, emotional regulation and relief when engaging with the device during stressful situations. These reflections suggest that rhythm-based tactile and auditory stimulation may be perceived as supportive for relaxation and emotional comfort.

Adaptations to the design and functionality were suggested by the user (Table 2.) which included the ability to select the heartbeat rhythm rather than the two presettings of the device. Several comments suggested a wearable device would be more convenient, with the current method they used 'doesn't always feel comfortable' and the suggestion of headphones as an alternative to allow audible heartbeat in both ears. The headphones may be particularly convenient for the user who mentioned on several occasions using the device to '...block out all the noise' and using the device 'When it got too noisy...'.

The non-invasive and user-directed nature of physiomodulation based on cardiac physiological synchrony positions LYEONS HEART as an accessible and flexible approach for individuals seeking to manage daily stressors in a self-guided way. The ability to integrate use of the device into ordinary routines may encourage continued engagement and support personal agency in emotional self-regulation.

By offering an approach that can complement existing wellbeing strategies, such technology has the potential to serve as a non-clinical adjunct to other methods of support. In doing so, it may help to reduce reliance on resource-intensive interventions and contribute to easing

pressure on existing care systems. Although this report represents the experience of only one user and cannot be generalised, the insights provide valuable guidance for design development and future investigation.

Further exploratory work with larger and more diverse user groups could evaluate usability, comfort and engagement over extended periods. Quantitative methods could be used to assess patterns of use and perceived benefits, focusing on user experience rather than health outcomes. As stress continues to affect quality of life in modern society, tools that empower individuals to manage their own wellbeing while supporting a sustainable approach to care hold meaningful value for individuals and the wider community.

Abbreviations

RTA: Reflexive Thematic Analysis

Declarations

Author contributions

JA: Visualisation, Writing—original draft, Writing—review & editing.

LSE: Conceptualisation, Methodology

MR: Writing—review & editing, Supervision.

VC: Writing —review & editing

SMJ, A: Conceptualisation, Methodology, Supervision, Writing – original draft, review & editing, Project administration.

Conflicts of interest

All authors are employees, inventors or collaborators of LYEONS, the company that developed the prototype device described herein. This affiliation represents a potential conflict of interest. We declare that we have taken care to present findings objectively and transparently.

Ethics approval and consent to participate.

This work involved a voluntary, low-risk user evaluation of a non-medical prototype device. No physiological, diagnostic or therapeutic procedures were conducted, and no identifiable health data were collected. According to guidance from the Health Research Authority's Defining Research Table and the "Is my study research?" decision tool, this evaluation does not meet criteria requiring NHS REC review. hra-decisiontools.org.uk¹ The ESRC's Framework for Research Ethics also offers guidance on ethical conduct of low-risk qualitative research. UK Research and Innovation² University Haxhi Zeka² The evaluation was

conducted in line with principles of informed consent, confidentiality and voluntary participation.

Consent to participate

Informed consent to take part in this evaluation was obtained from the participant.

Consent to publication

Informed consent for publication was obtained from the participant.

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Disclaimer

This exploratory study does not evaluate or imply therapeutic effects, diagnostic capabilities, or clinical performance of any product. The prototype device used in testing is not a medical device and is not intended for medical use..

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