MoodShaper: A Virtual Reality Experience to Support Managing Negative Emotions

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Figure 1: MoodShaper encompasses three interventions for managing emotions, manipulating the visual representation of a previous drawing that visualises negative emotions. In *Launch Paper Planes*, users throw away paper planes; in *Frame a Picture Globe*, they take pictures of their drawing which then appears in a globe; in *Shine Your Light*, users pull their drawing depicting negative emotions towards them and start to sparkle.

ABSTRACT

Negative emotions such as sadness or anger are often seen as something to be avoided. However, recognising, processing and regulating challenging emotional experiences can facilitate personal growth and is essential for long-term well-being. To support people in regulating and reflecting on negative emotions, we designed MoodShaper — a VR experience where participants autonomously create a virtual environment combined with emotion regulation (ER) interventions. Our system included three different interventions designed based on interviews with psychotherapists. We evaluated MoodShaper in a mixed-method between-subject study with $n = 60$ participants. Participants experienced one of the three ER interventions, allowing them to manipulate visual representations of negative emotions through externalisation, seclusion, or appreciation. We found that MoodShaper significantly increased positive affect while decreasing difficulties in ER and negative affect. Our work demonstrates how VR can provide technology-mediated support to reflect on, engage with and manage negative emotions. We contribute insights for future VR systems which support ER for challenging situations.

DIS '24, July 1–5, 2024, IT University of Copenhagen, Denmark

ACM ISBN 979-8-4007-0583-0/24/07.
https://doi.org/10.1145/3643834.3661570

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; *Empirical studies in HCI*.

KEYWORDS

Emotion Regulation, Negative Emotions, Coping Mechanism, Cognitive Change, Self-Expression, Virtual Reality

ACM Reference Format:

Nadine Wagener, Arne Kiesewetter, Leon Reicherts, Paweł W. Woźniak, Johannes Schöning, Yvonne Rogers, and Jasmin Niess. 2024. MoodShaper: A Virtual Reality Experience to Support Managing Negative Emotions. In *Designing Interactive Systems Conference (DIS '24), July 1–5, 2024, IT University of Copenhagen, Denmark.* ACM, New York, NY, USA, 19 pages. https://doi.org/10.1145/3643834.3661570

1 INTRODUCTION

Negative emotions, such as anger, frustration, jealousy, and sadness, are often thought to be emotions that should be avoided. Research suggests that persistent engagement in repetitive negative thinking patterns, such as overthinking and rumination, can significantly impair mental health, contributing to increased levels of stress and anxiety [23, 31, 99]. Relaxation [98, 101, 117] and physical exercise [18] can potentially mitigate negative emotions and rumination, as can actively recognising, processing and regulating emotions [33, 36, 113]. However, often external support is needed to develop effective coping strategies to regulate and reflect on negative emotions. Many people turn towards digital solutions for autonomous mental health management in their everyday routine [19, 96, 105]. Here, 'everyday routine' refers to non-clinical settings, acknowledging that while clinical environments play a crucial role in mental health care, they represent a different context from the daily life settings where these digital tools are often used and that are the focus of our inquiry. Although digital technologies cannot substitute treatment by experts [19], they can offer new possibilities to help people practise coping strategies, such as consciously altering thoughts to change emotions [96, 105].

Among various tools for such contexts, Virtual Reality (VR) stands out as particularly promising. It allows for controlled yet immersive environments [53], blocking out distractions from the real world. It provides excellent potential for customising the 360° space to match personal preferences, allowing for creative expression through dynamic elements and metaphoric actions that are not possible in reality (e.g. [13, 32]). The approach of addressing negative emotions with VR treatment in Human-Computer Interaction (HCI) research has been studied in manifold cases, such as through adapting the VR setting (e.g. environment or lighting [54, 104]), or by confronting users with their fears in exposure therapy [59]. Others aim to uplift one's mood, teaching relaxation techniques [98, 101, 117], or providing mindfulness training [55, 63, 106]. Some therapeutic interventions also teach strategies to manage emotions directly [34, 61], e.g. teaching cognitive restructuring [49]. However, most of these interventions are meant for clinical use (e.g. [35, 49]), require substantial training and/or psychotherapeutic expertise (e.g. [59]), depend upon additional tangible objects (e.g. [106]), or focus on creating positive affect without supporting the user to cope with negative emotions (e.g. [117]).

Hence, there is a need for VR applications that support untrained users in regulating and reflecting on common negative emotions and providing self-care at home. Notably, two examples should be mentioned: Grieger et al. [32] studied coping with negative thoughts triggered by textual messages. Yet, their approach requires technical knowledge and focuses on specific negative thoughts instead of general everyday negative emotions. Wagener et al. [111] identified design requirements for VR interventions that support the processing of negative emotions. However, they explore the topic theoretically, based on interviews with therapists, and without implementation or user testing.

Thus, we introduce *MoodShaper*, a VR application designed to offer technologically-mediated support for managing everyday negative emotions. It allows users to autonomously create a virtual environment with the purpose of expressing emotions, then, employing one of three interventions aiming to manage and regulate emotions by providing means for users to manipulate visual representations of negative emotions in VR.

As suggested by HCI literature [93], MoodShaper is grounded in psychological theory, including aspects of positive psychology [47], metacognition therapy [16], ER strategies [34, 35, 58], and is based on principles of art therapy, leveraging creative expression to manage negative emotions (e.g. [14, 57]). Further, it is inspired by two theoretical frameworks. The first, proposed by Slovak et al., is used to situate our application [93], as MoodShaper is a VR application intended to provide unrestricted and unguided at-home self-care (e.g. no additional guidance provided by clinicians), targeting individuals who perceive themselves as mentally healthy and well-balanced who are interested in developing and practising ER skills. Further, we envision that, in the future, this system or a similar one, might be used by people who struggle with mental health challenges. The role of MoodShaper is to provide experiential practice, both when experiencing negative emotions in the moment ('on-the-spot' relief [93]) and when reflecting on a past emotionally charged situation ('offline' training based on own memory [93]). The second framework is by Wagener et al. [111]. They established design requirements and four design concepts together with psychotherapists to support independent self-care with VR, which is used to inform the design of MoodShaper. In brief, all three interventions for managing negative emotions promote the externalisation process [74]. Inspired by Wagener et al. [111], they (i) offer complete closure by allowing negative emotions to dissipate symbolically in a peaceful manner (*Launch Paper Planes*), (ii) compartmentalise emotions to reduce their salience, distancing from them in a detached mindful way [115] and spatially confining them to not feel overwhelmed (*Frame a Picture Globe*), and (iii) invite users to radically accept negative emotions [52] and reframe them [49] as useful, to develop resilience and self-growth (*Shine Your Light*). A schematic overview of the developed interventions is presented in Figure 1. MoodShaper is tailored to deductively learn emotion regulation (ER) strategies through the metaphoric use of its interventions alone. In other words, the vision of this work is to extend the design space of technology-mediated ER support in VR, expanding the "room for manoeuvre" when engaging with (challenging) emotions to diversify in-situ and offline options for untrained at-home usage.

To evaluate MoodShaper, we conducted a hybrid user study involving $n = 60$ participants in a remote and laboratory setting. The study aimed to provide initial insights, within one session, into the emotional impact, ER capabilities, overall engagement, and experiential outcomes associated with ER interventions in

VR. Our findings showed that all three interventions significantly increased positive affect, encouraged self-reflection and elevated a sense of control. We conclude with a set of implications to inform the future design of VR applications for independent everyday self-care through managing negative emotions to improve user well-being.

This paper contributes the following: (i) the design and implementation of *MoodShaper* – a VR experience for creatively expressing and visually coping with negative emotions, (ii) an exploratory evaluation of how MoodShaper can support managing emotions, and (iii) design implications for constructing VR experiences that aim to support practising ER strategies for negative emotions.

2 BACKGROUND & RELATED WORK

In this section, we define key terms within the area of psychology and ER, with a particular focus on strategies for managing emotions such as emotional expression and cognitive restructuring. We then review past work on VR applications aiming to provide support when managing emotions.

2.1 Managing Everyday Negative Emotions

Emotions are complex and elicit diverse definitions and a multitude of strategies for their management. Negative emotions are mostly defined as being unpleasant to experience, expressing negative affect towards an event or a person, and linking negative emotions with a negative outcome [51]. Many emotion theories, such as Russel's Circumplex Model of Affect [72], mirror this definition and categorise emotions based on their valence (positive-negative) and arousal or intensity (high-low). However, other research argues that the polarity of emotions is misleading due to the complexity of emotions [97], instead highlighting the positive aspect and utility of feeling so-called "negative emotions" such as sadness or anger [68]. As a source of information [86], negative emotions can help recognise threats and handle potential danger [24] and can be motivating for self-growth [40]. Still, dwelling too much on negative emotions can potentially lead to entering repetitive negative thought cycles, also called rumination [31]. Rumination disburses stress hormones and increases the stress response circuit [65], can result in harmful coping behaviours such as overeating or excessive alcohol consumption [26, 31], and can contribute to the onset of depression [41] while prolonging the time it takes to recover from negative experiences [99].

Consequently, managing negative emotions is essential for one's mental health and well-being. This is commonly referred to as Emotion Regulation (ER) [34, 58]. ER encompasses all (un-)conscious processes that affect one's emotional responses in order to achieve an appropriate mode of functioning and well-being [10, 35]. Thereby, ER is considered a process triggered by an emotional objective (such as aiming to feel better), with its achievement determining the effectiveness of ER. Considering the perspective of the meta-theory of self-determination (SDT), ER can be outlined into three types: integrative, controlled and amotivated ER [82]. Controlled and amotivated ER align with suppressive and dysregulated ER, which are respectively characterised by avoiding or suppressing emotions and impulsive or chaotic emotional responses. In contrast, integrative ER is a strategy that involves approaching emotions with curiosity and acceptance, which can lead to emotional awareness, meaningful exploration of emotions, enhanced functioning and overall well-being [7]. It is considered the healthiest and most adaptive, as it aligns with autonomous motivation. According to the integrative ER perspective from SDT, the success of ER interventions is assessed by the extent to which users internalise the presented strategies, aligning them with their own values and beliefs [82]. Therefore, openly exploring emotion regulation strategies that have the potential for acceptance and integration into personal value systems, even if they do not achieve immediate success as in classic emotion regulation, still yields benefits.

2.2 ER Methods: Emotional Expression and Cognitive Restructuring

Most ER strategies aim to regulate the intensity, duration, and/or quality of emotions, particularly negative ones, through methods such as selective attention to aspects (situational attention), changing perspectives (cognitive reappraisal), or controlling emotional reactions (response modulation) [113]. While numerous methods to practise ER exist, two methods are of particular importance for this paper, artistic emotional expression [34, 45] and cognitive restructuring [30, 49].

Emotional Expression is used in different therapeutic approaches, particularly art therapy [57]. Artistic activities such as drawing or role-play help externalise emotions [34, 39], facilitating sensemaking and fostering emotional control, self-regulation, and subjective well-being [45, 69]. Engaging in the process of expressive activities can increase positive affect [44]. Yet, creative expression using interactive technologies such as VR without additional therapeutic guidance may be overwhelming since not everyone finds it easy to open up and express their emotions [76]. Thus, there is a need to carefully design engaging experiences.

This paper also draws inspiration from cognitive change methods, specifically *cognitive restructuring* [30, 49]. Cognitive restructuring, also known as reappraisal or reframing, varies slightly across therapies. In this paper, we adhere to the definitions used in metacognitive therapy (MCT) [16, 116]. It involves re-evaluating one's thoughts, promoting flexible thinking and perspective changes. Cognitive restructuring can reduce rumination and negative emotions [116], and improve general mental health [30, 33, 49, 58]. While numerous methods for cognitive restructuring exist, here, we briefly define some pertinent ones: *Externalisation* teaches individuals to detach from problems, negative thoughts, and emotions [74]. For instance, within therapeutic practice, people can be taught to think that they are not defined by sadness but that sadness may occasionally manifest within them. *Metacognitive reframing* encompasses empathic perspective taking, taking an observing role, or using the socratic dialogue as methods [116]. *Detached mindfulness* describes choosing not to worry about an aversive thought, instead allowing the thought to occupy its own mental space [115]. Detached mindfulness, similar to radical acceptance, involves tolerating negative emotions without judgment and avoiding simplistic positive/negative divisions of emotions [17, 52].

However, visually expressing emotions and cognitive restructuring often rely on skill sets such as self-reflection, planning, and goal setting [12], which can be challenging to master without external

support. To mitigate, a tangible manifestation of negative thoughts and emotions can help the externalisation and metacognition process. For example, Brinol et al. [12] found that materialising and objectifying thoughts or emotions and discarding them in real life, for instance, by writing them on a piece of paper and throwing them away, supports the mental process of cognitive restructuring [13]. Additionally, the necessary distance for externalisation and taking on an observer's role was found to be exemplified using photography [62]. Further, research found that certain motoric gestures and body postures can facilitate cognitive restructuring as well [77]. We specifically target the practising of ER methods, particularly emotional expression and cognitive restructuring, applying them to VR and evaluating their impact on users.

2.3 VR for Managing Negative Emotions

In recent years, many also turn towards digital solutions for regulating emotions in their everyday routine [19, 96, 105]. However, many tools are not originally employed for ER [96] such as smartphones [83, 92], videogames [103], social media [9], and online shopping [15]. The potential of specialised technologies in supporting ER remains largely unexplored in HCI [95]. Further, Slovak et al. [93] criticise that most systems do not rely on theoretical grounding from psychology, and prioritise information conveyance over the actual development of ER skills, as this requires an emotionally charged but secure environment that many cannot provide.

To address this gap, we ground our interventions on psychological ER methods, and use VR to generate emotionally charged environments. In that regard, VR has emerged as a powerful tool for inducing and managing emotions, as it can evoke visceral responses akin to reality [39, 54] through a sense of "being there", called presence [70, 79, 104]. Immersive spaces in VR isolate users from real-world distractions and afford complete control [53], encouraging users to dedicate focused time to engage with their emotions, unlike augmented reality or conventional 2D conversation- or paper-based interventions. Despite being costlier, VR offers unique interactive features, enhancing emotional expression and cognitive restructuring. For example, dynamic elements in a 3D environment boost motivation, confidence, and creativity, even for those lacking artistic talent in real life [109, 110]. Additionally, VR enables spatial perspective-taking which can facilitate empathic understanding [25], a challenge in real life [48, 114].

These affordances are often leveraged to induce positive emotions for change [47], mindfulness [73, 106], relaxation [71, 78], and stress management [90], as well as negative emotions for exposure therapy [59], in art therapy [37, 38], and for managing negative emotions [54, 61]. However, if not carefully designed, VR has the potential to re-introduce trauma and induce rumination [107]. To render VR effective for ER, personalised content in VR is of uttermost importance [2]. Illustrative examples of personalised emotional content include visualising happiness through 3D drawing [109] and creating emotional islands to depict different valence in a multi-user VR setup [89]. Another notable example combines self-created virtual environments with voice-based guidance to help users reflect on a personal emotional challenge, for instance, related to one's work or relationship [110]. However, while these examples allow the autonomous design of the virtual space to visualise emotions similar to MoodShaper, they neither focus on negative emotions nor teach ER strategies.

To that end, the work of Grieger et al. [32] is noteworthy. They empower users to physically engage with personal negative text messages, allowing them to release frustration and transform their thoughts through punching and trashing those messages. Yet, Grieger et al. [32] have focused on investigating negative thoughts in response to certain text messages rather than exploring negative emotions as a broader spectrum, and technical knowledge of how to implement these messages in VR is essential. On another note, Wagener et al. [111] have explored VR interventions for ER in a holistic way, and have developed a set of design principles for VR interventions aimed at facilitating the coping of negative emotions in a self-care setting. However, they solely explored the topic conceptually, drawing insights from interviews with therapists, but without implementing their findings in VR. Therefore, in our work, we seek to address these research gaps. We introduce MoodShaper and conduct a user study in VR in which we evaluate carefully designed coping mechanisms for negative emotions in everyday life.

3 MOODSHAPER

MoodShaper is a VR application intended to provide unrestricted and unguided at-home self-care both when experiencing negative emotions in the moment (in-situ [93]) and when reflecting on a past emotionally charged situation (offline [93]). Thus, MoodShaper caters to unguided and untrained individuals interested in developing and practising effective ER strategies for future use and to those seeking immediate relief from negative emotions. The application is designed to be used by individuals who perceive themselves as mentally healthy and well-balanced, as well as those who might struggle with mental health challenges. Nevertheless, we restricted participation in our study to mentally stable users, due to our ethical responsibility to avoid potential risks for vulnerable users as we evaluated the prototype. Given this diverse and individualised usage, the design of MoodShaper has to be carefully crafted. Thus, it is inspired by existing literature and grounded in established psychological theories, as recommended by Slovak et al. [93]. The design rationale will be explained in detail in this section.

To support people in regulating and reflecting on negative emotions, prior HCI literature has shown that it is beneficial to use personalised environments [2, 70, 107]. For example, psychotherapists have recommended that VR applications aiming to support mental health and well-being should provide customisable options, including colours, shapes, and objects that have personal meaning for the user [107, 111]. As such, prior work (e.g. [46, 108–110]) has already used adapted versions of the 3D drawing application Open-Brush [1], providing a tool palette facilitating autonomous expressive drawing as used in art therapy (e.g. [57]), but adapted for use in VR. Thus, *MoodShaper provides personalised content of VR experiences for emotional expression.*

When envisioning VR applications that support ER strategies, therapists also emphasised the importance of movement, becoming active and feeling empowered, as physical exertion can support

[1]https://openbrush.app/. Tilt Brush, now called Open Brush, was made open source by Google in 2021 on GitHub.

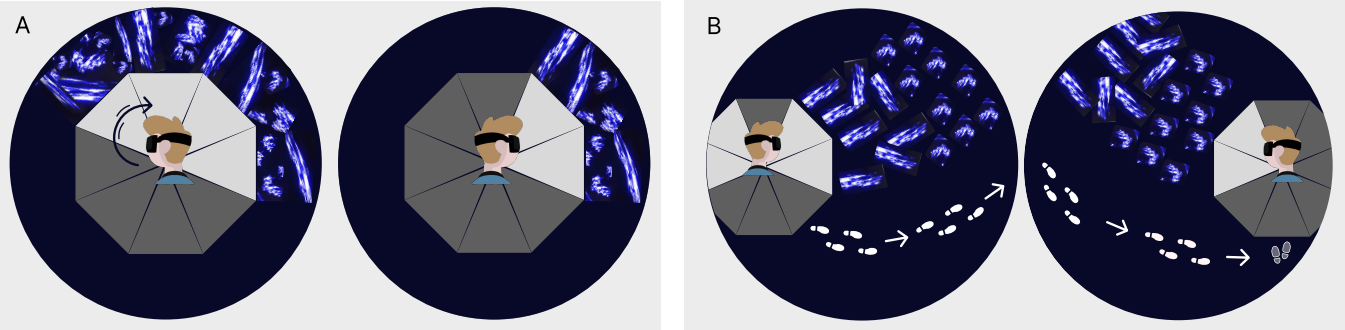


Figure 2: Schematic top-down view of the indicator on the floor. The light grey segments indicate the direction the user needs to turn to interact with the virtual world. The dark grey segments do not contain any brushes, either because nothing was drawn there or the user has already interacted with them. In option A, the user drew around themselves, resulting in a 360° turn. In option B, the user has drawn in front of themselves, leading to the user walking 360° around the drawing to interact with it from different perspectives.

cognitive engagement [111]. As such, therapists appreciated the idea of repetitive movement to engage users physically. Additionally, prolonging the interventions can also mirror the process of managing negative emotions in real-life therapy, which takes some time [111]. Further research found that certain motoric gestures and body postures, such as whole-body movement and standing tall, can activate a sense of power and can facilitate cognitive restructuring [77]. Hence, *the interventions in MoodShaper are repeated eight times and could foster a whole body movement.*

Additionally, related work has shown the benefits of the objectification of negative emotions for ER [12, 13]. They found that materialising and objectifying thoughts or emotions and discarding them in real life, for instance, by writing them on a piece of paper and throwing it away, supports the mental process of cognitive restructuring [13]. Adapting this concept to VR, Grieger et al. [32] have designed physical representations of negative text messages in VR that users were able to trash or punch for ER purposes, showing a positive shift in thoughts and emotions through the objectification. As such, *the interventions in MoodShaper allow for manipulating objectified representations of negative emotions.*

To foster reflection, we leverage the concept of physical and spatial perspective-taking. Previous work showed that physical and spatial perspective-taking (e.g. examining a drawing or an object from various angles), correlates with empathic perspective-taking and can change one's mental state [25]. Further, it can facilitate reflection and stimulate novel insights [110]. This approach has been elucidated by therapists [111] and confirmed in analogous studies using OpenBrush for contemplating personal challenges [110]. Thus, in each intervention, users have to manipulate visual representations of negative emotions from eight different perspectives, effectively either turning once around themselves (360°) or physically moving around their drawing to interact with it from eight different angles. Therefore, *MoodShaper is designed to facilitate physical and mental perspective-taking.*

Moreover, Wagener et al. [111] postulated that VR emotional regulation applications should always begin and conclude with positive elements, thereby rewarding users for their engagement in ER and instilling a sense of accomplishment (i.e. "Full Circle Concept"). Thus, *MoodShaper will end on a positive note.*

3.1 Final Prototype

Combining all the aforementioned design decisions, we designed MoodShaper. Users leverage a tool palette for 3D drawing, consisting of nine pre-set environments to choose from, which offers twelve (non-)animated brushes, and a colour panel that can be utilised to create what we call "worlds" in VR. This tool palette in MoodShaper is used to create two contrasting worlds: a positive world that represents happiness and enjoyment, and a negative world that embodies negative emotions.

In the intervention phase, users are required to perform interactions (such as launching paper planes, framing a picture globe, or assimilating the world and shining one's light. The design of these interventions is based on therapists' conceptualised ideas [111]; for more detailed information, see the following sections). All of these interventions result in the gradual dissipation of the representation of the negative world, which disappears gradually when users interact with their drawings. To explain the technical background, the space around the user is divided into eight segments (see schematical representation in Figure 2). During the creation of the negative world, the system records the segment in which the participant draws. It is important to note that, due to the limitations of OpenBrush, these stored segments are relative to the user's viewpoint at the time of creation. Therefore, if the user executes a 180° turn and then returns to the original viewpoint, the segment on the user's reverse side stores these brushes. This limits the interactions to a maximum of eight. Further, users have to rotate once around themselves (Figure 2 A) or physically move around the drawing to engage with it from different vantage points (Figure 2 B). To facilitate this process and ensure comprehensive coverage, we have integrated a visual floor indicator. Light grey sections on the indicator signify the required turning direction, which transitions to dark once the correct orientation is achieved and the interaction is performed (see schematical representation in Figure 2). On a side note, we carefully balanced repetitive movements alongside the gradual disappearance of drawings through preliminary testing.

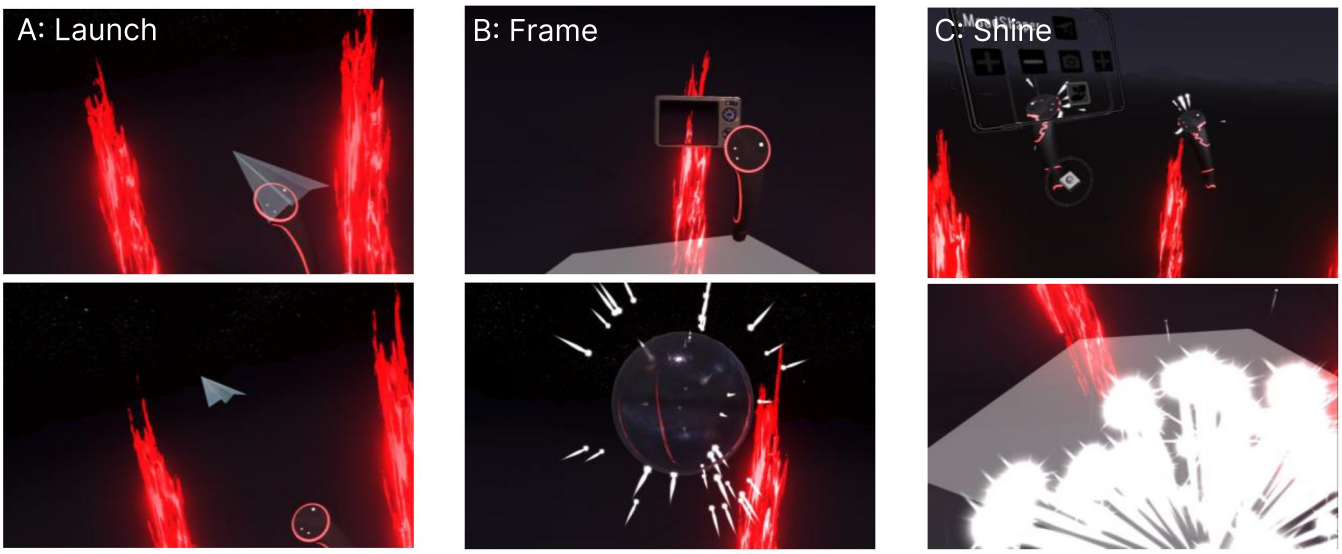


Figure 3: MoodShaper encompasses three interventions: (a) Launch Paper Planes, in which paper planes are attached to a controller that are launched in the sky, (b) Frame a Picture Globe, in which users take pictures of the negative emotional world with a camera attached to the controller and those pictures then appear in a picture globe, and (c) Shine Your Light, in which users extend their arms, and pull them towards the own body while using the trigger buttons. After succeeding, users emit a burst of sparkling light.

This is to ensure cognitive engagement and visual change without compromising the efficacy of ER methods, e.g. through tiring arms. Effectively, the intervention phase was intentionally shorter than VR world creation. Post-test interviews confirmed our design, providing adequate time for ER without becoming burdensome.

After using the intervention and all painted segments have disappeared, the initially self-created positive world reemerges ensuring that MoodShaper ends on a positive note. This step brings the experience full circle (compare [111]) and serves as a reward and relief for participants, who were thus not previously informed about the re-emerging of the positive world.

3.1.1 Launch Paper Planes. All interventions are inspired by conceptual suggestions by therapists who shared their ideas of VR interventions for managing negative emotions [111]. They are thus building on their extensive experience and commonly employed ER techniques in psychotherapy. The three interventions are depicted in Figure 3.

The first intervention - called *Launch Paper Planes,* abbreviated to *Launch* - is based on an ER technique in which clients label balloons or paper planes with negative thoughts or emotions and release them into the sky [111]. Through this, they externalise negative thoughts and mentally and physically distance themselves from them, performing a symbolical closing gesture [111]. *Launch* follows ideas also used in externalisation narrative therapy, metaphorically helping clients to separate themselves from problems, negative thoughts and negative emotions they are facing [74]. In line with prior work ([13, 32]), *Launch* uses objects (paper planes) as visual proxies to represent negative emotions. However, we decided to visualise a less "forceful" or aggressive object manipulation such as punching or burning them as was tested in prior work (e.g. [13, 32]). Releasing negative thought patterns in a peaceful manner was emphasised by therapists [111], and can also be found in VR meditation and relaxation games that target feeling peaceful and free (e.g. ReMind VR [2]). This is further in line with prior HCI research emphasising the need to design interventions for ER in a careful way to avoid re-introducing trauma and mitigating the risk of rumination (e.g. [107]). Hence, this intervention uses paper planes that were launched into the sky to externalise and find complete closure through peacefully releasing negative emotions.

3.1.2 Frame a Picture Globe. Similar to *Launch, the second intervention - Frame a Picture Globe, abbreviated to Frame - follows ER methods of externalisation [74], separating oneself from the emotions, but emphasises the metacognitive therapy techniques of detached mindfulness [115]* In contrast to leaving negative emotions behind completely, *Frame* revolves around packaging and storing negative emotions in a specific secluded spot. Based on Wagener et al.'s framework [111], the assignment of a specific space for negative emotions allows users to create an appropriate distance, while supporting reflection by enabling them to re-visit those spaces again. This intervention aims to strengthen the idea in users that distancing from one's emotions and spatial perspective-taking can reframe one's thought pattern and facilitate empathic concern [25]. Further, we draw inspiration from photo art therapy and phototherapy [114], in which photography is used in art therapy as the camera creates beneficial distance between photographer and subject [48]. Effectively, through this distance and through the mechanical nature of taking pictures, photographers can regain a sense of control and possession over feelings, ordering internal chaos and reducing the

[2]https://store.steampowered.com/app/862220/ReMind_VR_Daily_Meditation/

power of traumatising memories [48]. In their role as photographers, participants can also gain confidence as they are often more familiar with photography than painting which reduces the emotional and personal involvement when creating the photograph, again creating necessary distance [20]. Thus, in this intervention, a camera is attached to the main controller, and users take pictures of their VR drawings from different angles.

Further, this intervention aims to emphasise to users that emotions sometimes can be better dealt with when manifesting them in a tangible form [13, 62]. Effectively, each picture taken with the camera gradually removes part of the drawing representing negative emotions, and the disappearing parts reappear as a picture within a globe that is in front of the user. As with all interventions of MoodShaper, after the repetition of the intervention for eight times, the positive world previously created by the user reappears. While in *Launch* and *Shine* nothing of the negative world perseveres, here we follow principles of metacognitive therapy, specifically detached mindfulness [115], emphasising that negative emotions should not and cannot overwhelm us but are allowed in their own (somewhat restricted) space. To mirror this idea, the *Picture Globe* encapsulating the negative world is still visible in the positive world: users can pick up the *Picture Globe*, place it somewhere or look again inside it to deal with the negative emotions again and reflect on them as desired by therapists [111]. Hence, this intervention uses a camera to create emotional distance between the user and their negative emotions to regain power and confidence, and negative emotions recorded in pictures are stored in a manifested 3D object to represent the notion of detached mindfulness.

3.1.3 Shine Your Light. The third intervention - *Shine Your Light,* abbreviated to *Shine* - draws on principles of radical acceptance [52], acknowledging and tolerating all negative emotions without judgement and accepting the reality as a grey area instead of black and white thinking [52]. Instead of denying the existence of negative emotions or trying to avoid feeling them, people should welcome the complexity of all emotions [97] due to their helpful nature [68, 86], which can form fertile ground for self-reflective development and self-growth [40, 111]. Therapists emphasised welcoming all emotions, including the negative, due to their important role in forming fertile ground for self-reflective development and self-growth [111]. In that regard, users shift their view of negative emotions as something undesirable to something focused on facilitating positive transformation, resilience and self-growth, drawing on principles of reframing [16] through re-interpreting the emotions. To visually represent these concepts, users pull the negative emotions towards them, assimilating them into themselves. After each performed gesture, the user emits a burst of white and sparkling light, which gradually increases in intensity over time, as a sign of positive transformation and increased resilience and self-growth.

4 EVALUATION

MoodShaper has been evaluated through an exploratory hybrid VR study with $n = 60$ participants. Following suggestions by Ratcliffe et al. [75] and as MoodShaper targets VR users seeking everyday in-situ and offline ER support, we conducted the study remotely in participants' homes, allowing them to be comfortably alone with their feelings. The study set-up varied for remote participants (see section 8). However, to ensure a diverse participant sample, including those with little or no VR experience, we also offered the option to participate in a laboratory setting. Laboratory studies were conducted in a room-sized $4m$ by $7.5m$ ($30m^2$), using the Meta Quest 2 with AirLink wireless connection to allow free movement. Similar to other related works (e.g. [32, 73, 89, 110]), we adopted an exploratory approach because comparing to conventional baselines introduces several confounding factors. For instance, comparing our work with mobile phone applications for ER (e.g. [83, 92]) would limit the autonomy and movement possible in 3D spaces. VR approaches by Semsioglu et al.[89] lack ER support and focus on multiplayer settings, while Grieger et al.[32] offer ER strategies that are limited to regulating negative thoughts in a forceful way, not everyday emotions. Further, many VR ER systems require significant technical knowledge and preparation time [102], making them incomparable to our objectives. The study received prior ethics approval from the University of St. Gallen (HSG-EC-20220503). The overall aim was to evaluate how MoodShaper can support ER, affect, user experience and user engagement, with a specific focus on exploring the different interventions. This section first presents how we collected and analysed the data. We then introduce our participant sample and procedure.

4.1 Data Collection

Quantitative data was collected from four different validated questionnaires. Further, we gathered qualitative feedback from participants to understand their experience with MoodShaper.

4.1.1 Measures. **PANAS** We used the PANAS questionnaire [112] to measure the affective states of users before and after creating the negative world and experiencing the ER intervention. Participants indicated on a 5-point Likert scale to what extent they felt ten positive and ten negative emotions at that moment. By using this measure, we can assess if MoodShaper creates positive affect, and reduces negative affect.

S-DERS We used the S-DERS questionnaire [50], containing 21 statements, to measure participants' ER capabilities before and after the intervention. It focuses on short-term factors such as interpersonal experiences and situational influences, assessing nonacceptance, modulation, awareness, and clarity on a 5-point Likert scale. Scores range from 21 to 105; higher scores indicate more difficulties with ER, and lower scores post-intervention suggest improved coping strategies facilitated by MoodShaper.

UEQ-S We used the UEQ-S questionnaire [84] to measure the user experience of the interventions. Participants rate eight pairs of attributes on a 7-point Likert scale, assessing pragmatic (usability and utility) and hedonic (joy and stimulation) qualities. The questionnaire helps determine if the interventions are user-friendly and enjoyable, as low scores could undermine the effectiveness of the ER interventions. Scores range from -3 to +3, with higher values indicating a superior experience.

UES-SF We utilised the UES-SF questionnaire [67] to assess user engagement with the interventions. Participants rated 12 items on a 5-point Likert scale, assessing averaged scores for aesthetic appeal, focused attention, perceived usability, reward factor and the overall

score. Higher values indicate greater perceived engagement and active involvement, potentially fostering reflection [5, 28].

4.1.2 Interview Protocol. We conducted semi-structured interviews averaging 18 : 56 minutes (min: 8 : 30, max: 34 : 57). Participants discussed their reflective capacities, emotions, and thoughts during the study, focusing on their interpretation of the intervention and their experience with MoodShaper. Additionally, they viewed demonstrational videos of the other interventions to gather initial reactions. The full interview protocol is available in the supplementary material.

4.1.3 Data Analysis. For our quantitative analysis parametric tests were used, since only validated scales were employed (PANAS and S-DERS) which have previously also been tested parametrically [3, 21, 29, 64]. This fact, combined with cell sizes larger than five, allows for reliable parametric analysis, as recommended by Norman [66]. *Pre* and *Post* measurements were analysed using paired t-tests. A one-way ANCOVA was conducted with *Post* measurements for all subscales as a dependent variable and factor *Intervention* with *Pre* measurements of the respective subscale as covariate [22]. This was with the aim to compare the effect of *Pre* on *Post* measurements for the different Interventions *(Launch, Frame, Shine,)*. Thus, we study the difference between the interventions in terms of the relationship between the *Pre* and *Post* scores. A Two-way ANOVA with *Intervention* and *Stage (Pre/Post)* as factors were not adequate for the present study design, as it would lead to pairwise comparisons that are not meaningful given the between-subjects design (such as *Pre Launch Post Shine*). Dugard and Todman suggest that such analyses should be avoided [22]. We chose the ANCOVA approach as it was deemed the most suitable for pre/post designs by Dugard and Todman [22]. Dugard and Todman [22] showed how this approach offers increased validity over a repeated-measures ANOVA solution. This approach, however, results in the pre and post-scores being subject to two tests. Thus, a Bonferroni correction of $\alpha = .025$ was used. All p-values reported in this paper are Bonferroni-adjusted. All details of the analysis can be accessed in the supplementary material.

For qualitative analysis, all audio recordings were transcribed verbatim and imported into Atlas.ti software. Initially, two authors coded eight interviews using open coding and established a coding tree through iterative discussion. The remaining transcripts were then individually coded by one author using the established tree. A final discussion session between two authors identified themes through thematic analysis [11]. Additionally, one author re-experienced each participant's recording to deepen understanding and help with theme construction.

4.2 Participants

We recruited participants through our extended social network and snowball sampling, resulting in a diverse group of fifteen nationalities. A total of $n = 60$ participants evaluated MoodShaper quantitatively, and $n = 62$ participants provided qualitative feedback (14 females, 46 males, 2 non-binary; $M = 28$ years, $min : 20$ years, $max : 44$ years; see section 8 for details). To elaborate: initially, $n = 68$ participants were recruited, but six were excluded due to technical difficulties early in the study, and two experienced technical challenges towards the end of the VR experience, preventing them from completing post-test questionnaires, but they could still offer valuable qualitative insights. Participation was voluntary and unpaid, and participants self-assessed mental stability. While our intended user group includes those struggling with mental health, we restricted participation in testing this prototype as a precaution due to our ethical responsibility. About half of the participants were regular VR users (34), while the rest used it infrequently (28). See section 8 for details.

4.3 Procedure

Google Forms guided participants through the study in our hybrid setting, with one researcher available for technical support if needed. For in-laboratory participation, a researcher prepared the technical, without further involvement ensuring consistency. After providing informed consent, participants watched a tutorial on VR controls for painting and world creation and were briefed on the working of the indicator guiding through the interventions (see Figure 4 for an overview of the procedure).

Participants entered VR to create a world representing happiness, serving both as an exploration phase to get used to the controls and a way to end positively after the intervention, as suggested by prior research [111]. This step also serves as an additional safety measure considering MoodShaper's status as a prototype; in real-world scenarios, MoodShaper would adapt to personal needs, allowing participants to immerse themselves in previously created positive worlds (e.g. if participants strive to only experience the ER interventions when feeling down) or create new ones to match their current emotional state (e.g. if participants want to use this step to mentally prepare for the ER task to come). Creating a positive world took, on average, 13 : 05 minutes.

Participants then returned to reality, where a negative affective state was induced using the autobiographical emotional memory task (AEMT)[42], a widely used validated method in HCI [109, 110]. This mood-congruent procedure prompts participants to recall and write about recent situations, thereby increasing the likelihood of re-experiencing strong emotions [4, 60]. Participants followed the AEMT guidelines by describing a situation where they felt strong negative emotions. Then, participants answered the PANAS [112] and S-DERS [50] questionnaires.

They then returned to VR to create a world reflecting the emotions expressed in the AEMT. Subsequently; creating the negative world took 10 : 12 minutes on average. They performed their randomly assigned intervention (Launch Paper Planes, Frame a Picture Globe, or Shine Your Light). Participants spend about 4 : 08 minutes on average with the interventions. Upon completion, they were automatically returned to their previously created positive world and could end the study whenever they chose, staying there for 1 : 34 minutes on average. Back in reality, participants answered PANAS, S-DERS, UEQ-S, and UES-SF. Participants completed the AEMT and questionnaires in reality so that interventions and study setup remain separate to simulate the experience of using MoodShaper as a consumer product. Remote participants saved and transferred their recordings and VR creations to the experimenter. Following completion, the experimenter conducted semi-structured interviews,

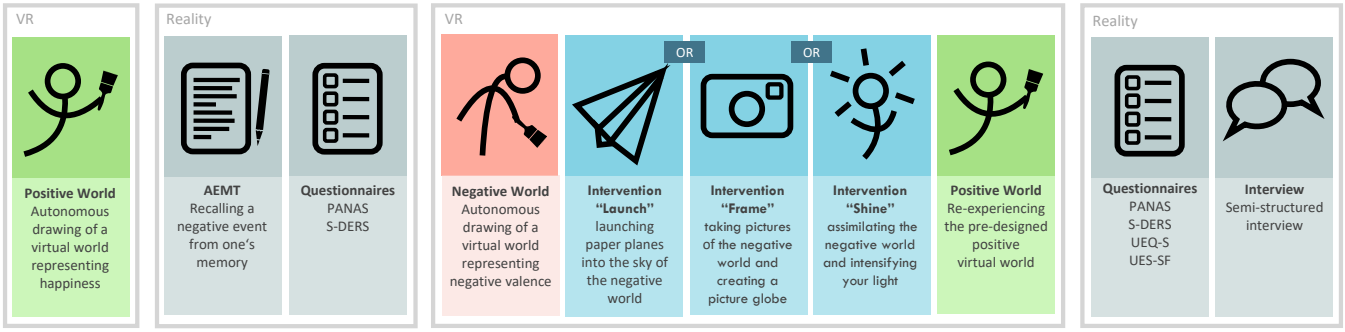


Figure 4: Schematic representation of the MoodShaper procedure. Participants autonomously create a virtual world representing positive emotions. Then, they are induced with negative emotions and answer some questionnaires in reality. Then, they design a virtual world representing negative emotions, followed by experiencing one of three interventions (based on their condition) that allow them to manipulate their negative world. Afterwards, their self-created positive world reappears to go full circle. Post-intervention questionnaires and a semi-structured interview form the end.

averaging 18 : 22 minutes. In total, the study took an average of 1 : 25 : 36 hours (1 : 12 : 49 for laboratory study, 1 : 38 : 51 for remote study).

On a side note, determined through design choices and preliminary testing, we balanced repetitive movements and physical engagement, both known to enhance cognitive engagement [111], alongside the gradual disappearance of drawings, to ensure visual change without compromising efficacy. Effectively, the intervention phase was intentionally shorter than VR world creation. Post-test interviews confirmed that this balance provided adequate time for ER without being burdensome.

5 FINDINGS

This section presents quantitative results from the questionnaires as well as qualitative insights from the interviews.

5.1 Quantitative Findings

On a general note, due to the hybrid study design, t-tests were conducted to test for significant differences between study stages (*Pre* and *Post*). The results showed that there are no significant differences between the remote and lab participants for S-DERS ($p = .990$), PANAS Positive Affect ($p = .132$) and PANAS Negative Affect ($p = .362$). The participants were thus not grouped for further analyses.

Paired t-tests were conducted on *Pre* and *Post* measurements for the three interventions of all the subscales of PANAS and S-DERS. The differences were significant for all subscales except the *S-DERS* subscales *Awareness* ($p = .881$) and *Clarity* ($p = .123$) (see table Table 1 and box plots in Figure 5). ANCOVAs were conducted to compare the relationships between *Pre* and *Post* measurements for the different Interventions. This was performed by measuring the effect of the intervention type on each of the subscale *Post scores, controlling for the Pre score.* The ANCOVA was only significant for *Clarity* ($F_{2,57} = 3.278$, $p = .045$ $\eta^2 = 0.103$). Post-hoc testing with Tukey HSD showed that there was a difference between conditions *Shine* and *Launch*, at $p = .01$ as can be observed in Figure 6 (see supplementary materials for all ANCOVAs). Consequently, we gathered no evidence of differences between the three Interventions with the exception of *Clarity* where *Shine* outperformed *Launch*.

UEQ-S scores for all the Interventions suggest that there were no notable user experience issues. *Launch* was rated with $UEQ\text{-}S_{Launch} = 1.069$, *Shine* with $UEQ\text{-}S_{Shine} = 0.963$, and *Frame* $UEQ\text{-}S_{Frame} = 0.706$. While the former is above average, the latter two are slightly below average. All these scores are within a 'typical' range [85]. For both UEQ-S and UES a One-way ANOVA was conducted to investigate if there should be any differences in scores between the conditions. However, no differences in scores could be found depending on the condition, for UES ($F_{2,57} = 0.0406$, $p = .960$) and for UEQ-S ($F_{2,57} = 0.718$, $p = .492$).

5.2 Qualitative Findings

Based on our qualitative inquiry, five themes were construed from the data: *Complexity of Emotional Experiences*, *Regaining Control*, *Understanding the Process*, *Transcending to Reality* and *Potential & Risks*. Our findings are described below and illustrated with excerpts from the interviews. Example screenshots from participants' sketches can be found in Figure 7.

5.2.1 Complexity of Emotional Experiences. The first theme focuses on the complex interplay between depicting negative emotions and their experiential emotional effects. Initially, participants faced greater challenges when attempting to visualise negative emotions compared to positive emotions, resulting in more abstract and complex representations. Hence, their negative worlds often reveal a mix of negative emotions, mainly encompassing anger, sadness, frustration, distress, and stress. In this context, participants reported that especially MoodShaper's simplified tool palette facilitated effective representation and reflection, despite or because of being in stark contrast to the complexity of emotions they aimed to convey. One participant explained:

> But this space reduces you to a kind of childlike capability in a way that feels like a safe way to engage with your emotional state. (...) The simplicity of the lines and the drawings lined up very nicely with how

Table 1: Mean values and standard deviations for PANAS and S-DERS subscales across the three conditions along with t-test statistics. The four S-DERS subscales measure different problems with ER. Thus, a lower score is 'better' for all S-DERS subscales. For PANAS Positive Affect a higher score is 'better' while for PANAS Negative Affect a lower score is more desirable. Statistically significant results are marked with asterisks *.

	PANAS				S-DERS									
	Neg. Affect		Pos. Affect		Nonacceptance		Modulate		Awareness		Clarity		Total	
Stage	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
M	23.17	14.38	22.73	26.05	11.60	8.45	13.67	10.78	12.27	12.33	3.42	3.10	40.95	34.67
SD	8.943	4.267	7.390	7.139	4.917	2.740	5.313	3.309	3.204	3.977	1.769	1.734	11.017	7.469
t-test	$t = -3.284$		$t = 7.816$		$t = 5.796$		$t = 5.548$		$t = -0.151$		$t = 1.565$		$t = 4.8515$	
$df = 59$	$p = .002*$		$p < .001*$		$p < .001*$		$p < .001*$		$p = .881$		$p = .123$		$p < .001*$	

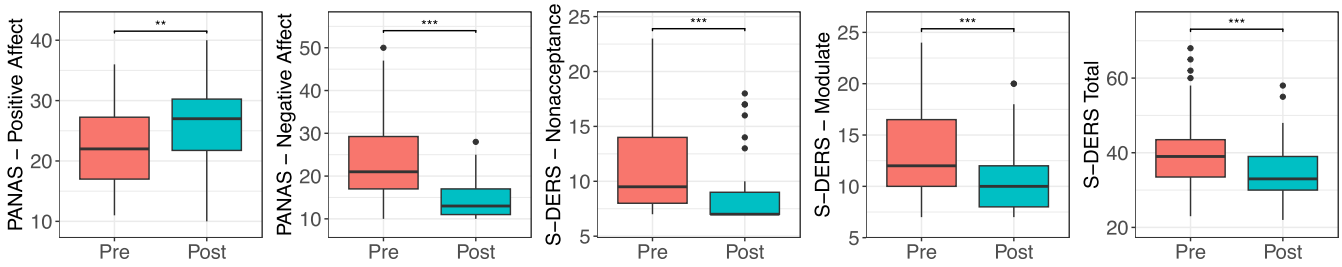


Figure 5: Box plots showing the differences in *Pre* and *Post* measurements for the subscales with significant t-tests. A lower score is 'better' for all subscales apart from PANAS Positive Affect for which higher scores are 'better'.

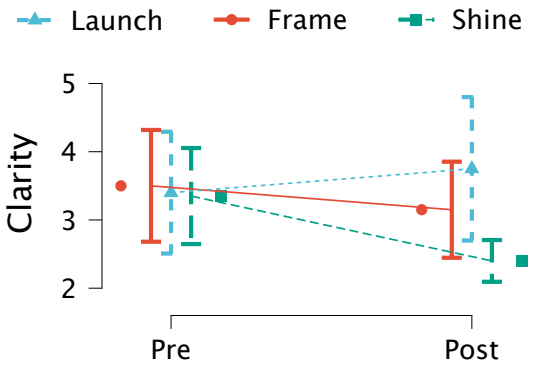


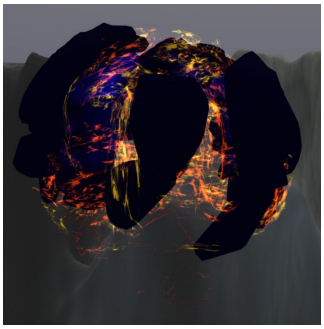
Figure 6: Line plot showing the differences in *Pre* and *Post* measurements including standard error bars for the *Clarity* subscale across the three Interventions. The subscale measures limited clarity about one's current emotions and thus lower scores are 'better'. The *Clarity subscale was the only subscale for which the ANCOVA was significant. Shine scored significantly lower than Launch.*

> emotions are incredibly complex and to try and get very specific with them is usually either going to cost you a lot in therapy or not going to address the problem as a whole. That childlike clumsiness, I think, is the word that I would use. You have these very blunt tools that let you just mess around with colour and that there's no opportunity really to get very specific is really powerful. (P61)

The process of visualising and being immersed in complex negative emotions induced strong emotional responses among participants. Despite their abstract nature, negative emotions became corporeal and tangible through visual representation, exerting power over the participants. Participants frequently visualised feelings of helplessness and loss of control by enclosing themselves within their drawings, often crafting cages or caves around themselves or positioning themselves above an abyss to evoke sensations of danger and fear, as P61 described: *"I was thinking about a stressful situation and I, in fact, had made that situation even more stressful by creating this duct tape cocoon around myself"* (P61). This self-induced encapsulation triggered physical reactions in some participants, leading to reported unease, tingling sensations, and heightened heart rates.

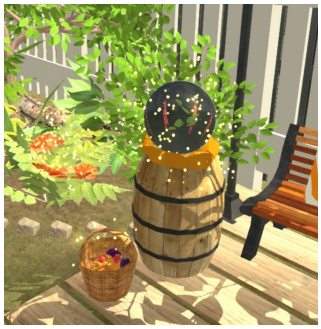
5.2.2 Regaining Control. Our second theme revolves around the significance of regaining a sense of control through the MoodShaper interventions in order to feel empowered to break free from the negative emotional state. Thus, the majority of participants emphasised physical engagement which helped them to also get mental control over their emotions. Despite the consensus on this theme, opinions on which intervention was the most effective varied. For instance, some participants perceived throwing *Launch* as a highly active and empowering action (e.g. 48), while others found it *"too soft"* (P11, P19, P30) to address their negative emotions in a meaningful way. On the other hand, the *Frame* intervention made participants feel in control by containing negative emotions in a secluded space,

(a) Positive World:
P1 individualised the pre-defined virtual environment to create a cosy atmosphere where they feel happy. They added a vase with flowers, a picture on the TV, a cake on the table, a fire in the fireplace, and decorations on the shelf.



(b) Negative World:
P65 used a dark black brush and the animated fire brush to draw a cage around themselves to symbolise the loss of power and hopelessness (for visualising purposes, an outside view is presented here).

(c) Negative World:
P30 drew their anger and frustration about an authoritative person denying them sushi. They chose a dirty industrial landscape as backdrop.



(d) Re-Experiencing Positive World:
P31 found a place for the picture globe next to the bench and drew around it using colourful sparkles. This setup should symbolise the benefit of reflecting on negative emotions when being in a relaxed and positive state of mind.

Figure 7: Sample screenshots from participant sketches.

"visually shrinking their negative emotions into a smaller world" (P34) as participant P34 put it, which allowed participants to perceive themselves as more physically and psychologically powerful, as *"oneself feels way bigger"* (P34). However, the act of taking pictures in this intervention was considered less physically active. In contrast, the *Shine* intervention provided a strong sense of control for participants, as it felt like a proactive approach to confronting and managing negative emotions, as it felt like *"actively tackling negative emotions and doing something with them"* (P55). The theme of re-gaining control is nicely illustrated by the following quote:

> *There's obviously a very deep link behind interaction with physical things (...), like movements and the way that you kind of feel about them. (...) So doing something active, doing like movement in that way is helpful for dealing with emotions like that.* (P8)

5.2.3 Understanding the Process. The third theme encompasses comprehensive insights into the impact of MoodShaper's composition on ER. Participants reported that initially, they encountered some confusion regarding the indicators and controls of each intervention, as well as the unexpected disappearance of their drawings. However, as they engaged more with the interventions, they realised that the dissolution of their drawings served to emphasise the ER aspect of the interventions, marking it as a release from negative emotions. In that regard, participants stressed the importance of the temporal aspect for successfully regulating emotions. Time was considered a crucial element of the transition phase, supporting them to shift from a state of being overwhelmed by negative emotions to a more reflective and composed mindset. One participant describes the transition phase as follows:

> *Throwing these things several times was already better than only throwing once. Because it kind of graduates the emotion level piece by piece. If I just throw one thing now, then it could be that it's still stuck in my mind, and so it [the negative emotion] can gradually be reduced piece by piece, like, from the intensity maybe of my feelings.* (P11)

Further, participants liked that MoodShaper facilitated the possibility of taking a step back and nudged them to change one's perspective. Participants reported that rotating 360° to see the drawing from different angles and the interventions themselves helped to focus on smaller aspects of the drawing. Thereby, *Launch* encouraged participants to hit certain parts of the drawing, and *Shine* made them shift to focus on the intervention itself, as *"the glow was already something positive"* (P48), and how *"it somehow dissolves a bit the dark, somewhat dangerous environment"* (P48). *Frame* was considered to trigger the highest level of detachment from negative emotions, attributed to the presence of a camera. Participants described that they *"kind of stepped away from the canvas" (P28)*, taking on the role of an observer. Furthermore, it was surprising that participants transcended the interventions' intended designs, particularly when using *Frame*. Participants often mimicked interaction concepts central to *Launch*, i.e. closure by burying or concealing the globe in the positive world, *"to forget that they exist" (P21)*, and to *Shine*, embracing negative emotions by transforming the globe into something positive, drawing sparkles around it (i.e. see Figure 7 d).

Lastly, participants appreciated the clear conclusion of the intervention phase, marked by the reappearance of the positive world. The positive world was considered a reward, which made *"positive memories flood in"* (P7), felt like a *"safe space"* (P57), a *"home"* (P25) and *"like you were seeing an old friend"* (P42). It marked an endpoint and provided closure and satisfaction within the emotional regulation process, as one participant noted:

> *For me in my head, I have dealt with the negative world now, it's now closed, and now I'm back, where I feel comfortable, in the safe space. Yes, that was a good conclusion, after you have to deal with the negative world, to come back to the positive one, it felt good.* (P57)

5.2.4 Transcending to Reality. Our fourth theme, *Transcending to Reality*, deals with learnings from MoodShaper that are applicable to real life. Participants emphasised that their experience with MoodShaper felt like an activation of resources that would make them more resilient when managing emotions in real life. As one participant explained:

> *Going through the intervention of assimilating made me able to think about negative emotions in a different way. And accepting that part of me as something I can hopefully learn and grow from.* (P42)

For example, they commented on being better equipped to accept negative emotions, i.e. not being embarrassed about feeling fear (P8), that it is normal that negative emotions are also part of a positive state of mind (P28), and as a reminder that one is not "*invalidating [negative] feelings when you don't let them consume you (...), it's not like you have to let them ruin your whole day*" (P31). Effectively, some participants also proposed to create a real artefact as a reminder, *"so that I could engage with it outside of VR"* (P29).

Some participants were also inspired to reflect on their personalities. For instance, P19 pondered about what it reveals about their character that they enjoyed the most active and "aggressive" (P19) intervention the most. As such, participants described MoodShaper as creating self-insights and self-growth:

> *I need a little bit more 'boom'. A little bit more of destruction, when I am angry. What does that say about me, now, as a person?* (P19)

5.2.5 Ambivalent Experiences. The fifth theme focuses on opportunities and risks when using MoodShaper. Participants considered MoodShaper to be an *"exciting, playful"* (P3) and *"meaningful"* (P13) VR application. They stated that VR allows for lightness when approaching a "heavy" topic such as ER which is difficult to achieve in reality, and many mentioned that they were surprised by how well the interventions of MoodShaper actually work. One participant emphasised that MoodShaper *"helped heal an emotional wound I had for a year"* (P7). Participants viewed MoodShaper as an appealing self-care tool, valuing its enjoyment and high privacy factors. They also envisioned its potential in therapeutic settings. One participant reflected:

> *I think it might be a cool tool for a therapeutic application, where you have more room to express yourself, and you also feel completely private in this environment. I think this is also what I would use it for, to be reflective. That's what it's meant to do, to be reflective of your own emotions.* (P28)

However, participants reported that the effectiveness of the interventions to support reflection varied across situations and designated emotions. For instance, P19 emphasised that *Launch* would work for sadness, while not for anger or frustration as it is *"too soft"*, while P8 found *Frame* to work best for sadness as well as for certain situations that one cannot face at that moment. Additionally, interpretations of the interventions varied a lot across participants. For instance, some participants viewed *Launch* as a way to externalise and release negative emotions, as intended, while others interpreted it as an active act of destruction aimed at eradicating the negative world. Despite the different interpretations, both were regarded as successful ER strategies. Similarly, *Shine* generated ambiguous reactions. One prevalent interpretation involved absorbing, internalising and accepting negative emotions, as designed, but some interpreted the burst of light as a sign of destroying negative emotions.

Moreover, participants reported being deeply immersed in MoodShaper, losing track of time and surroundings, particularly in negative worlds. This deep immersion led to a heightened awareness and emotional connection to positive elements afterwards, realising more details and they *"felt much more connected"* (P37) to the positive drawing than before. However, others reflected on the risks of being that deeply immersed, and of *"lingering emotions"* (P28) after the intervention phase. These risks are exacerbated by the experience of software bugs and glitches. One participant, who is a VR developer and very experienced with the concept of presence, shared their insights about the speed and intensity with which negative emotions were intensified when the intervention (i.e. *Launch*) surprisingly did not work:

> *When I was unable to escape this negative space that you've created because of the software bug, the gravity and speed with which frustration occurred were intense. I find that very interesting that something like being stripped of your agency at the very moment that you need it most is something that VR could afford you. (...) It is a feeling of helplessness that is really extraordinary. And because I've worked in VR, I've felt it before in a much less intense way. But here, you forget that you are in a virtual space. And so when your ability to engage with that space suddenly disappears, you're utterly helpless for a moment until you remember to take the headset off.* (P61)

6 DISCUSSION

In this work, we endeavoured to understand how VR can provide technologically-mediated support for managing everyday negative emotions. Users employed a diverse set of tools to create visual representations of both positive and negative emotions in VR. They then engaged in one of three carefully designed interventions aimed at regulating these negative emotions through manipulation of the drawing representing negative emotions. Our quantitative findings show that all the three interventions were similarly successful in supporting ER. As the vision of this work is to extend the design space of ER support in VR, we do not aim to replace established practices and interventions. Instead, the goal of this work is to extend the "room for manoeuvre" when engaging with (challenging) emotions. Emotional experiences and how people deal with them are complex [76]. Thus, we need to expand the tool palette which people can use for ER support. Hence, we hope that our work — may it be by the design and the usage of our prototype MoodShaper or through our design recommendations applicable to other VR systems for ER support through VR — inspires future systems that can be used by people in their everyday life as part of their mental well-being routine. In the long run, we envision that our insights might also lead to systems that can be useful in clinical contexts to support participants in their mental health journey with the help and guidance of mental health experts.

In this section, we present our key findings, discuss MoodShaper's relevance to and expansion of existing research and situate them within the broader context of HCI research. Further, we outline implications for the HCI community and beyond when designing VR experiences for learning and practising ER strategies. We also reflect on limitations and opportunities for future research.

6.1 Ludic Engagement for Serious Contexts

This section is partly based on and inspired by the themes *Complexity of Emotions*, *Regaining Control* and *Ambivalent Experiences*. We will discuss how playful design, coupled with clear objectives, can boost user confidence and control when experiencing negative emotions. This can also promote mindfulness, potentially contributing to healing and self-growth, in line with previous work [43, 63, 88, 91]. Our quantitative results indicate that MoodShaper offers an engaging experience (UES-S) that enhances positive affect (PANAS-PA). This is in line with our qualitative findings, where participants expressed childlike joy while using the tool palette in VR, describing a sense of lightness not achievable in reality. While the tool palette can be used to create artistic paintings [3], our sample described having limited artistic expertise, describing a "childlike clumsiness" (P61) when visualising complex emotions. Still, most lost track of time, disregarding external factors (e.g. the experimenter's presence in the laboratory), and experienced strong emotions within their virtual negative worlds—indicative of presence [79]. Thus, MoodShaper aligns with research suggesting that VR can evoke visceral emotional responses akin to reality (e.g. [39, 54, 80]) through immersive environments [53]. Notably, many VR applications for mental health emphasise photorealistic landscapes (for an overview, we refer to Wagener et al. [107]). However, our qualitative findings are indicative that simple yet playful VR drawing tools could effectively foster presence - when combined with clear intent communication and a high degree of personalisation features.

Further, these findings also underscore that a ludic approach appears promising when addressing serious, complex and emotionally challenging topics such as negative emotions. MoodShaper's strength lies in its combination of playfulness and clear intent, making it particularly effective for addressing serious and emotionally challenging topics like negative emotions. Importantly, MoodShaper was not designed as a serious game [1, 14] with the purpose of teaching serious content in a gamified manner (compare 3). Instead, the design rationale was to support the engagement with and the processing of challenging emotions in a reflective manner. Thus, we recommend:

Recommendation 1—Integrate ludic elements with a strong and meaningful purpose when addressing serious and emotionally challenging topics.

6.2 Reflection in VR and Beyond

In this section, we will discuss insights of the themes *Understanding the Process* and *Transcending to Reality*, highlighting which elements of MoodShaper's process were perceived as especially helpful for ER and how a clear process can support reflective insights that go beyond VR and facilitate internalising of ER strategies that can be applicable to future real-life situations. Our findings indicate that MoodShaper evokes reflection. First, participants reflected on the meaning behind and effects of the interventions while performing them. Second, they also explored their depicted emotionally charged situations, insights about their character, and behavioural strategies for ER in relation to these situations and beyond. They also reflected on their fundamental views about negative emotions and how to manage them in real-life contexts. These findings are in line with the definition of reflection by Schön et al. [87], defining it as understanding, thinking about potential courses of action, and one's role within these [87]. On a more granular level, and used by about 70% of HCI papers that explicitly define reflection [6], we encountered reflection-in-action, occurring during the action (i.e. while engaging with the interventions in MoodShaper), and reflection-on-action, using memories to reconstruct an experience, re-organising them to give meaning and draw lessons for the future (i.e. during drawing phases and in the interview) [87]. Participants attributed the reason for reflection to remembering the specific emotional situation, and to the design choices of the interventions: establishing emotional distance (e.g. using a camera to distance oneself from the emotions [48]), altering spatial perspectives to also change mental and empathic perspectives [25] (e.g. having to interact with the representations of negative emotions from eight different perspectives), and mirroring the effort involved in ER processes through the temporal aspect [111]. Thus, as reflection can be a challenging activity and often needs to be encouraged [94], our design approach (see section 3), seems effective in providing this encouragement. Importantly, our qualitative data suggested that MoodShaper actively discouraged rumination by encouraging reflection and providing a clear, positive endpoint to the ER process [31, 99].

Recommendation 2—Integrate a transition phase and a clear ending to facilitate and conclude the reflection process effectively.

6.3 Transformative Experience

Drawing upon findings presented in *Transcending to Reality*, we will outline how MoodShaper had created lasting impact on participants, highlighting how VR designers could strengthen and prolong the impact of VR-based interventions to generate lasting change. While not applicable to all participants, our study highlights the capacity of MoodShaper to evoke various levels of reflection [28]. Fleck and Fitzpatrick [28] outline a spectrum encompassing five consecutive reflection levels, ranging from level 0 (Description) to level 4 (Critical Reflection) [28]. Qualitative data suggests that some participants reached level 1 (Reflective Description), reinforcing their existing perspectives on negative emotions and their regulation strategies. Others discovered new approaches to managing emotions, such as not being embarrassed by them (e.g. P8, P25) and not being consumed by them (e.g. P25), which could be interpreted as progressing to level 2 (Dialogic Reflection). Moreover, some participants reported fundamental shifts in their formerly negative outlook on "negative emotions", such as accepting them as something to grow from (e.g. P42). This could signal successful

[3] for some examples we refer to TiltBrush Artists in Residence, https://www.tiltbrush.com/air/

cognitive restructuring [49], indicative of level 3 (Transformative Reflection).

To remind themselves of their reflective insights and the feeling of having grown, some participants expressed a desire to carry a physical object back into the real world. This desire for tangibility reminiscent of the virtual experience in MoodShaper likely stems from the physical qualities assigned to negative emotions, such as tangibility and corporeality. Ascribing a physical or almost haptic quality to experiencing emotions in VR is in line with previous work [109]. It may also be influenced by the transition of the picture globe from the negative world to the virtual positive one in the application. This finding extends previous research where participants wanted to create a virtual catalogue of their VR experiences [109]. As such, we recommend:

Recommendation 3—Reinforce users' reflective insights by transforming reminders and emotional experiences made in VR into tangible objects that can be transferred to reality.

6.4 Opportunities and Risks

In this section, we draw upon findings of the themes *Understanding the Process* and *Ambivalent Experiences*, emphasising the (potentially negative) effects when feeling intense emotions. We will discuss specific safety mechanisms, design choices and necessary future research that could mitigate risks and strengthen opportunities for VR applications aiming to provide ER support. During the study, participants raised critical concerns and emphasised the need to discuss the opportunities and risks of using MoodShaper to an equal degree. Our findings in that regard will be critically reflected on in the following. One noteworthy finding in MoodShaper was the swift and deep sense of presence reported by many participants. As an example, an experienced VR developer shared that when they encountered a software bug, it made them momentarily panic and forget they could remove the VR glasses. This highlights both the potential and risks of potent VR applications addressing negative emotions, reinforcing expectations by therapists [107]. It also emphasises the importance of involving all stakeholders - VR developers, interaction designers, therapists and end-users - throughout the whole study process to uncover and mitigate these risks, as well as the need for longitudinal studies with therapist guidance to assess long-term effects.

Despite MoodShaper being based on therapists' expertise [111], therapeutic practices (i.e. art therapy [57]), and psychological constructs (i.e. cognitive restructuring [49]), some participants still interpreted the metaphors in the interventions differently. Particularly, *Shine*, originally designed to allow for embracing negative emotions, was sometimes misconstrued as an attack, alas only from participants who had solely watched the demonstrational video. This example illustrates the challenge HCI researchers face when balancing the creation of self-care therapeutic interventions for home use, as desired by participants while minimising the risk of inadvertently causing distress or harm to users.

6.4.1 Managing Risks. To address these challenges, we stress the importance of incorporating safety measures in all VR applications aiming to provide support when managing challenging emotions. Based on prior research (i.e. [111]) and our own findings, applications should provide clear visual endings that feel like closure to prevent rumination. Additionally, warning and risk notifications should be added at the beginning of the intervention to raise awareness, as also previously suggested by therapists [107]. Recognising that studies are required to properly inform participants of the potential risks of participating in a study and to obtain informed consent, this is an implication especially relevant for practice [102]. Furthermore, when made available on platforms like Steam, applications such as MoodShaper can easily be misclassified as wellness applications. Here, policymakers should intervene to establish regulations that mitigate the risk of users encountering (un-)intended harmful design when downloading such applications. This is in line with previous work that discusses the tensions and potential risks (both from a user as well as from a legal perspective) of classifying health and well-being apps as either medical or health apps [56]. Moreover, applications such as MoodShaper should be adapted to the specific needs of different ages and user groups, being particularly considerate when designing for vulnerable user groups. To elaborate, prior works have identified specific needs of children [100], teenagers [8, 27, 46] and older adults [61] when dealing with emotions. Here, a combination of participatory design approaches [46, 100] and longitudinal studies is recommended to build an understanding of age-group-specific needs and requirements. Without further research, for now, MoodShaper should be restricted to adults only to mitigate risks such as re-introducing traumata. Future work should also investigate the needs of more diverse users, such as users who are not affine to technology, neurodivergent users, as well as those with various mental health issues. For instance, people with ADHD or people experiencing depression will probably need different support. However, to date, little research has been conducted in regard to using VR in both fields [2]. In the long run, we envision that MoodShaper and the insights gathered in this study might lead to systems that can be useful in clinical contexts to support participants in their mental health journey. This process entails further risks, as it includes vulnerable user groups. Consequently, such a system would need to undergo prior meticulous testing through longitudinal studies in order to get clinical approval. Further, it would have to be appropriately integrated in and adapted to different therapeutic approaches. Along similar lines, safety measures, such as additional support and guidance outside of the therapy sessions might need to be provided by mental health experts. Based on prior research [93, 107], we hypothesise that in clinical settings a higher level of scaffolding might be beneficial. However, this might limit users' autonomy. We envision step-by-step guidance paired with psycho-educational elements informing about the underlying psychological principles of each intervention, either by visual means or through voice-based guidance as formerly explored in regard to reflecting on personal challenges [110]. Lastly, we call upon HCI researchers to recognise their responsibility in reporting negative incidents, albeit rare, in their publications. By upholding these ethical standards, they can serve as valuable drivers for improving the design of VR applications aimed at preventing negative emotions from escalating uncontrollably. Thus, we recommend:

Recommendation 4—Incorporate evident risk notices and integrate fail-safe mechanisms and appropriate support mechanisms to avert harmful design.

6.5 Limitations & Future Work

In this section, we discuss the limitations of MoodShaper. We adopted an exploratory design in line with similar research ([32, 73, 89, 109, 110]), and fitting to our research objective to design experiential ER strategies in VR that support untrained individuals in regulating and reflecting on common everyday negative emotions, offering in-situ and offline support. We refrained from comparing our work with past research systems using autonomous self-design of virtual environments as these works do not offer ER interventions (e.g. [89, 109, 110]), or lack the means for autonomous visual expression (compare [61]) or require technical skills not feasible for our target group (e.g. [32]). We acknowledge that including a control condition would help validate the effectiveness of ER interventions. The present study design only permits comparisons of the three interventions with each other. A no-intervention condition in VR would help determine if the observed differences stemmed from the interventions (Launch, Frame, or Shine) or the system (creating and engaging with virtual spaces). A waitlist approach would illustrate changes over time, while comparisons with analogue ER interventions, such as physically launching paper planes, would provide deeper insights into the advantages of VR as an immersive medium. Given the novelty of the experience of MoodShaper, our primary aim was to understand its impact on users' ER processes to effectively inform future work. Our contributions include the system's design, a quantitative assessment of how MoodShaper can support ER through different interventions, and a qualitative analysis of how this is achieved, based on the exploratory evidence generated in this study concerning the interplay between key constructs (i.e. the relationship between autonomous expression and efficiency of three ER interventions). However, a randomised controlled trial would be needed to evaluate the effectiveness of MoodShaper compared to other established ER methods.

We opted for a hybrid study approach to target VR users interested in engaging with negative emotions in their daily lives while being mindful of data-gathering risks. For a comprehensive overview of the benefits and limitations of this approach, please refer to Ratcliffe et al. [75]. In this study, we observed no significant differences between remote participants and those in the laboratory, but we acknowledge that we could not fully control all variables that may have influenced our data.

Furthermore, we did not account for individual differences in participants' inherent capability for ER, which could have influenced the findings of our between-subjects design. Including a dispositional measure that assesses trait-level ER, such as the Emotion Regulation Inventory (ERI) [81], could enhance our understanding of MoodShaper's impact on various ER traits.

This paper aligns with traditional notions of ER, where the success of interventions is measured by achieving emotional objectives [82]. Our findings highlight MoodShaper's potential to support users in their ER goals. However, our findings also align with the SDT perspective on ER, where success is viewed as not just superficial compliance with techniques but deeper acceptance and integration of them into one's value system. Qualitative results across all themes indicate that some participants began exploring their emotions with an open and non-judgemental mind, which may be a first step toward understanding strategies and assessing their potential for deeper integration, indicative of integrative ER. Future work could specifically evaluate MoodShaper's potential to facilitate integrative ER.

MoodShaper is intended for individuals interested in developing and practising effective ER strategies and who seek relief from negative emotions, regardless of their mental health. In this study, we restricted participation to self-indicated mentally healthy and well-balanced people out of ethical concerns when testing the prototype. Due to the broad profile of our target group, we opted for self-assessment instead of validated mental health assessments such as GAD-7 or PHQ-8, in line with other research in this area (e.g. [109, 110]). Furthermore, the procedure of MoodShaper was adapted for study purposes as well. Our design, especially the autonomous creation of the positive world and re-experiencing it in the end, was based on recommendations of therapists to always end such interventions on a positive note [111]. However, in real-life use cases, some participants may prefer to focus solely on the intervention, while others may enjoy the mental preparation and comfort of creating and being in a positive environment. We envision MoodShaper to cater for these individual preferences. However, changes in the study design and how they might affect the overall experience of users should be tested in advance by future research. Based on the exploratory evidence generated in this study, future work could further explore MoodShaper or similar ER approaches using VR with participants struggling with mental health issues. However, we emphasise the risks associated with engaging this vulnerable user group and strongly recommend careful consideration of the study design and the incorporation of therapeutic safety measures.

7 CONCLUSION

To provide a novel way for managing negative emotions in VR, we created MoodShaper – a VR application allowing users to visualise emotions by autonomously creating a virtual environment and providing three interventions (*Launch, Frame, Shine*) for how to manipulate these visual representations with the aim to explore ER strategies. Quantitative and qualitative findings of a hybrid study with 60 participants highlight the potential of MoodShaper to support ER. Users felt empowered through the interventions and reflected on personal insights beyond the application itself. With our work, we emphasise the importance of playful design to explore complex negative emotions and discuss opportunities and risks when engaging with negative emotions using VR. In sum, there seems to be promise in building VR experiences for managing emotions in which users can freely express themselves while also receiving interventions that provide necessary distance, perspective-taking and reflection opportunities scaffolding the ER process. We hope our work and design recommendations inspire designers and researchers to further explore this promising research field.

ACKNOWLEDGMENTS

This research is funded by the German Research Foundation (DFG) under Germany's Excellence Strategy (EXC 2077, University of Bremen) and by a Lichtenberg Professorship funded by the Volkswagen Foundation.

REFERENCES

[1] Julian Alvarez, Damien Djaouti, and Olivier Rampnoux. 2012. *Introduction au Serious Game - Serious Game an Introduction (French and English).*

[2] Nilufar Baghaei, Lehan Stemmet, Andrej Hlasnik, Konstantin Emanov, Sylvia Hach, John A. Naslund, Mark Billinghurst, Imran Khaliq, and Hai-Ning Liang. 2020. Time to Get Personal: Individualised Virtual Reality for Mental Health. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) *(CHI EA '20)*. Association for Computing Machinery, New York, NY, USA, 1–9. https://doi.org/10.1145/3334480.3382932

[3] Veerpal Bambrah, Amanda Wyman, and John D. Eastwood. 2022. A longitudinal approach to understanding boredom during pandemics: The predictive roles of trauma and emotion dysregulation. 13 (2022), 1050073. https://doi.org/10.3389/fpsyg.2022.1050073

[4] Rosa M. Baños, Víctor Liaño, Cristina Botella, Mariano Alcañiz, Belén Guerrero, and Beatriz Rey. 2006. Changing Induced Moods Via Virtual Reality. In *Persuasive Technology*, Wijnand A. IJsselsteijn, Yvonne A. W. de Kort, Cees Midden, Berry Eggen, and Elise van den Hoven (Eds.). Springer Berlin Heidelberg, Berlin, Heidelberg, 7–15.

[5] Eric P.S. Baumer, Vera Khovanskaya, Mark Matthews, Lindsay Reynolds, Victoria Schwanda Sosik, and Geri Gay. 2014. Reviewing Reflection: On the Use of Reflection in Interactive System Design. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (Vancouver, BC, Canada) *(DIS '14)*. Association for Computing Machinery, New York, NY, USA, 93–102. https://doi.org/10.1145/2598510.2598598

[6] Eric P.S. Baumer, Vera Khovanskaya, Mark Matthews, Lindsay Reynolds, Victoria Schwanda Sosik, and Geri Gay. 2014. Reviewing Reflection: On the Use of Reflection in Interactive System Design. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (Vancouver, BC, Canada) *(DIS '14)*. Association for Computing Machinery, New York, NY, USA, 93–102. https://doi.org/10.1145/2598510.2598598

[7] Moti Benita. 2020. Freedom to feel: A self-determination theory account of emotion regulation. *Social and Personality Psychology Compass* 14 (09 2020). https://doi.org/10.1111/spc3.12563

[8] Arpita Bhattacharya. 2019. Designing to Support Teen Mental Health Using Asynchronous Online Groups. In *Proceedings of the 18th ACM International Conference on Interaction Design and Children*. 723–727.

[9] Fran Blumberg, Jaime Rice, and Anne Dickmeis. 2016. *Social Media as a Venue for Emotion Regulation Among Adolescents*. 105–116. https://doi.org/10.1016/B978-0-12-801857-6.00006-3

[10] Tibor Bosse, Charlotte Gerritsen, Jeroen de Man, and Jan Treur. 2013. Learning Emotion Regulation Strategies: A Cognitive Agent Model. In *2013 IEEE/WIC/ACM International Joint Conferences on Web Intelligence (WI) and Intelligent Agent Technologies (IAT)*, Vol. 2. 245–252. https://doi.org/10.1109/WI-IAT.2013.116

[11] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2 (2006), 77–101. https://doi.org/10.1191/1478088706qp063oa

[12] Pablo Briñol, Margarita Gascó, Richard E. Petty, and Javier Horcajo. 2013. Treating Thoughts as Material Objects Can Increase or Decrease Their Impact on Evaluation. *Psychological Science* 24, 1 (2013), 41–47. https://doi.org/10.1177/0956797612449176 arXiv:https://doi.org/10.1177/0956797612449176 PMID: 23184587.

[13] Pablo Briñol, Richard Petty, and Jennifer Belding. 2017. Objectification of people and thoughts: An attitude change perspective. *British Journal of Social Psychology* 56 (02 2017). https://doi.org/10.1111/bjso.12183

[14] Christian Brown and Rick Garner. 2017. *Serious Gaming, Virtual, and Immersive Environments in Art Therapy*. 192–205.

[15] My Bui and Elyria Kemp. 2013. E-tail emotion regulation: Examining online hedonic product purchases. *International Journal of Retail & Distribution Management* 41 (03 2013). https://doi.org/10.1108/09590551311304338

[16] Lora Capobianco and Henrik Nordahl. 2023. A Brief History of Metacognitive Therapy: From Cognitive Science to Clinical Practice. *Cognitive and Behavioral Practice* 30, 1 (2023), 45–54. https://doi.org/10.1016/j.cbpra.2021.11.002

[17] Alexander L. Chapman. 2011. *The Dialectical Behavior Therapy Skills Workbook for Anxiety: Breaking Free from Worry, Panic, PTSD, and Other Anxiety Symptoms*. New Harbinger Publications.

[18] Emma Childs and Harriet de Wit. 2014. Regular exercise is associated with emotional resilience to acute stress in healthy adults. *Frontiers in physiology* 5 (2014), 161. https://doi.org/10.3389/fphys.2014.00161

[19] Rebecca A. Clay. 2021. Mental health apps are gaining traction. *Monitor on Psychology* 52, 1 (2021). Retrieved January 27, 2021 from http://www.apa.org/monitor/2021/01/trends-mental-health-apps

[20] Claire Craig. 2009. *Exploring the Self Through Photography: Activities for Use in Group Work*. Jessica Kingsley Publishers. 204 pages. https://doi.org/10.1017/S0144686X10000632

[21] R.Thomas Dudley. 2000. The relationship between negative affect and paranormal belief. *Personality and Individual Differences* 28, 2 (2000), 315–321. https://doi.org/10.1016/S0191-8869(99)00100-2

[22] Pat Dugard and John Todman. 1995. Analysis of Pre-test-Post-test Control Group Designs in Educational Research. *Educational Psychology* 15, 2 (1995), 181–198. https://doi.org/10.1080/0144341950150207

[23] Elizabeth V. Eikey, Clara M. Caldeira, Mayara C. Figueiredo, Yunan Chen, Jessica L. Borelli, Melissa Mazmanian, and Kai Zheng. 2021. Beyond self-reflection: introducing the concept of rumination in personal informatics. *Pers Ubiquit Comput* 25 (2021), 601–616. https://doi.org/10.1007/s00779-021-01573-w

[24] Marwa El Zein, Valentin Wyart, and Julie Grèzes. 2015. Anxiety dissociates the adaptive functions of sensory and motor response enhancements to social threats. *eLife* 4 (dec 2015), e10274. https://doi.org/10.7554/eLife.10274

[25] Thorsten Erle and Sascha Topolinski. 2015. Spatial and Empathic Perspective-Taking Correlate on a Dispositional Level. *Social Cognition* 33 (06 2015), 187–210. https://doi.org/10.1521/soco.2015.33.3.187

[26] Susan A. Everson, Debbie E. Goldberg, George A. Kaplan, Juhani Julkunen, and Jukka T. Salonen. 1998. Anger expression and incident hypertension. *Psychosomatic medicine* 60, 6 (1998), 730–735. https://doi.org/10.1097/00006842-199811000-00014

[27] Daniel Fitton, Janet C C Read, and Matthew Horton. 2013. The challenge of working with teens as participants in interaction design. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems*. 205–210.

[28] Rowanne Fleck and Geraldine Fitzpatrick. 2010. Reflecting on Reflection: Framing a Design Landscape. In *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction* (Brisbane, Australia) *(OZCHI '10)*. Association for Computing Machinery, New York, NY, USA, 216–223. https://doi.org/10.1145/1952222.1952269

[29] Laura Galbusera, Michael T. M. Finn, Wolfgang Tschacher, and Miriam Kyselo. 2019. Interpersonal synchrony feels good but impedes self-regulation of affect. 9, 1 (2019), 14691. https://doi.org/10.1038/s41598-019-50960-0 Number: 1 Publisher: Nature Publishing Group.

[30] Nadia Garnefski, Tessa Van Den Kommer, Vivian Kraaij, Jan Teerds, Jeroen Legerstee, and Evert Onstein. 2002. The relationship between cognitive emotion regulation strategies and emotional problems: comparison between a clinical and a non-clinical sample. *European Journal of Personality* 16, 5 (2002), 403–420. https://doi.org/10.1002/per.458 arXiv:https://doi.org/10.1002/per.458

[31] William Gerin, Matthew Zawadzki, Jos Brosschot, Julian Thayer, Nicholas Christenfeld, Tavis Campbell, and Joshua Smyth. 2012. Rumination as a Mediator of Chronic Stress Effects on Hypertension: A Causal Model. *International journal of hypertension* 2012 (02 2012), 453465. https://doi.org/10.1155/2012/453465

[32] Florian Grieger, Holger Klapperich, and Marc Hassenzahl. 2021. Trash It, Punch It, Burn It – Using Virtual Reality to Support Coping with Negative Thoughts. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI EA '21)*. Association for Computing Machinery, New York, NY, USA, Article 459, 6 pages. https://doi.org/10.1145/3411763.3451738

[33] J.J. Gross and Ross Thompson. 2007. Handbook of emotion regulation. *Emotion regulation: Conceptual foundations* (01 2007), 3–26.

[34] James J. Gross. 1998. The Emerging Field of Emotion Regulation: An Integrative Review. *Review of General Psychology* 2, 3 (1998), 271–299. https://doi.org/10.1037/1089-2680.2.3.271 arXiv:https://doi.org/10.1037/1089-2680.2.3.271

[35] James J. Gross. 2015. Emotion Regulation: Current Status and Future Prospects. *Psychological Inquiry* 26, 1 (2015), 1–26. https://doi.org/10.1080/1047840X.2014.940781 arXiv:https://doi.org/10.1080/1047840X.2014.940781

[36] James J. Gross. 2015. The Extended Process Model of Emotion Regulation: Elaborations, Applications, and Future Directions. *Psychological Inquiry* 26, 1 (2015), 130–137. https://doi.org/10.1080/1047840X.2015.989751 arXiv:https://doi.org/10.1080/1047840X.2015.989751

[37] Irit Hacmun, Dafna Regev, and Roy Salomon. 2018. The Principles of Art Therapy in Virtual Reality. *Frontiers in Psychology* 9 (10 2018). https://doi.org/10.3389/fpsyg.2018.02082

[38] Irit Hacmun, Dafna Regev, and Roy Salomon. 2021. Artistic creation in virtual reality for art therapy: A qualitative study with expert art therapists. *The Arts in Psychotherapy* 72 (2021), 101745.

[39] Wendy Hadley, Christopher Houck, Larry Brown, Josh Spitalnick, Mirtha Ferrer, and David Barker. 2019. Moving Beyond Role-Play: Evaluating the Use of Virtual Reality to Teach Emotion Regulation for the Prevention of Adolescent Risk Behavior Within a Randomized Pilot Trial. *Journal of pediatric psychology* 44 (2019), 425–435. https://doi.org/10.1093/jpepsy/jsy092

[40] Eddie Harmon-Jones, Tom Price, P.A. Gable, and C.K. Peterson. 2014. Approach motivation and its relationship to positive and negative emotions. *Handbook of positive emotions* (01 2014), 103–118.

[41] Carroll E. Izard. 2009. Emotion theory and research: highlights, unanswered questions, and emerging issues. *Annual review of psychology* 60 (2009), 1–25.

[42] Christophe Jallais and Anne-Laure Gilet. 2010. Inducing changes in arousal and valence: Comparison of two mood induction procedures. *Behavior research methods* 42, 1 (2010), 318–325. https://doi.org/10.3758/BRM.42.1.318

[43] Amishi P Jha, Jason Krompinger, and Michael J Baime. 2007. Mindfulness training modifies subsystems of attention. *Cognitive, Affective, & Behavioral*

Neuroscience 7, 2 (2007), 109–119. https://doi.org/10.3758/CABN.7.2.109
[44] Sandra L. Kagin and Vija B. Lusebrink. 1978. The expressive therapies continuum.
[45] Eileen Kennedy-Moore and Jeanne Watson. 2001. How and When Does Emotional Expression Help? *Review of General Psychology* 5 (09 2001), 187–212. https://doi.org/10.1037/1089-2680.5.3.187
[46] Alexandra Kitson, Alissa N. Antle, and Petr Slovak. 2023. Co-Designing a Virtual Reality Intervention for Supporting Cognitive Reappraisal Skills Development with Youth. In *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference* (Chicago, IL, USA) *(IDC '23)*. Association for Computing Machinery, New York, NY, USA, 14–26. https://doi.org/10.1145/3585088.3589381
[47] Alexandra Kitson, Mirjana Prpa, and Bernhard E. Riecke. 2018. Immersive Interactive Technologies for Positive Change: A Scoping Review and Design Considerations. *Frontiers in Psychology* 9 (2018), 1354. https://doi.org/10.3389/fpsyg.2018.01354
[48] Alexander Kopytin. 2004. Photography and art therapy: An easy partnership. *International Journal of Art Therapy* 9 (04 2004), 49–58. https://doi.org/10.1080/02647140408405677
[49] Andreas Larsson, Nic Hooper, Lisa Osborne, Paul Bennett, and Louise Mchugh. 2016. Using Brief Cognitive Restructuring and Cognitive Defusion Techniques to Cope With Negative Thoughts. *Behavior modification* 40 (05 2016), 452–82. https://doi.org/10.1177/0145445515621488
[50] Jason M Lavender, Matthew T Tull, David DiLillo, Terri Messman-Moore, and Kim L Gratz. 2017. Development and validation of a state-based measure of emotion dysregulation: The State Difficulties in Emotion Regulation Scale (S-DERS). *Assessment* 24, 2 (2017), 197–209.
[51] Dirk Lindebaum and Peter Jordan. 2012. Positive emotions, negative emotions, or utility of discrete emotions? *Journal of Organizational Behavior* 33 (10 2012). https://doi.org/10.1002/job.1819
[52] Marsha M. Linehan. 2014. *DBT Skills Training Manual.* Guilford Press. 504 pages.
[53] Jack M. Loomis, Jim Blascovich, and Andrew C. Beall. 1999. Immersive virtual environment technology as a basic research tool in psychology. *Behavior Research Methods, Instruments, & Computers* 31 (1999), 557–564. https://api.semanticscholar.org/CorpusID:13343372
[54] Valentina Lorenzetti, Bruno Melo, Rodrigo Basílio, Chao Suo, Murat Yücel, Carlos J. Tierra-Criollo, and Jorge Moll. 2018. Emotion Regulation Using Virtual Environments and Real-Time fMRI Neurofeedback. *Frontiers in Neurology* 9 (2018), 390. https://doi.org/10.3389/fneur.2018.00390
[55] Kai Lukoff, Ulrik Lyngs, Stefania Gueorguieva, Erika S. Dillman, Alexis Hiniker, and Sean A. Munson. 2020. From Ancient Contemplative Practice to the App Store: Designing a Digital Container for Mindfulness. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference* (Eindhoven, Netherlands) *(DIS '20)*. Association for Computing Machinery, New York, NY, USA, 1551–1564. https://doi.org/10.1145/3357236.3395444
[56] Laura Maaß, Merle Freye, Chen-Chia Pan, Hans-Henrik Dassow, Jasmin Niess, and Tina Jahnel. 2022. The definitions of health apps and medical apps from the perspective of public health and law: Qualitative analysis of an interdisciplinary literature overview. *JMIR mHealth and uHealth* 10, 10 (2022), e37980.
[57] Cathy A. Malchiodi. 2012. *Handbook of Art Therapy, 2nd ed.* The Guilford Press, New York, NY, US. Pages: xv, 496.
[58] Kateri Mcrae and James Gross. 2020. Emotion regulation. *Emotion (Washington, D.C.)* 20 (02 2020), 1–9. https://doi.org/10.1037/emo0000703
[59] Katharina Meyerbröker and Paul Emmelkamp. 2011. *Virtual Reality Exposure Therapy for Anxiety Disorders: The State of the Art.* Vol. 337. 47–62. https://doi.org/10.1007/978-3-642-17824-5_4
[60] Caitlin Mills and Sidney D'Mello. 2014. On the Validity of the Autobiographical Emotional Memory Task for Emotion Induction. *PloS one* 9 (04 2014), e95837. https://doi.org/10.1371/journal.pone.0095837
[61] Jessica Isbely Montana, Marta Matamala-Gomez, Marta Maisto, Petar Aleksandrov Mavrodiev, Cesare Massimo Cavalera, Barbara Diana, Fabrizia Mantovani, and Olivia Realdon. 2020. The Benefits of Emotion Regulation Interventions in Virtual Reality for the Improvement of Wellbeing in Adults and Older Adults: A Systematic Review. *Journal of Clinical Medicine* 9, 2 (2020). https://doi.org/10.3390/jcm9020500
[62] Catherine Hyland Moon. 2010. *Materials & Media in Art Therapy: Critical Understandings of Diverse Artistic Vocabularies.* Routledge. https://doi.org/10.4324/9780203858073
[63] Marivi Navarro Haro, Hunter Hoffman, Azucena Garcia-Palacios, Mariana Sampaio, Wadee Alhalabi, Karyn Hall, and Marsha Linehan. 2016. The Use of Virtual Reality to Facilitate Mindfulness Skills Training in Dialectical Behavioral Therapy for Borderline Personality Disorder: A Case Study. *Frontiers in Psychology* 7 (2016). https://doi.org/10.3389/fpsyg.2016.01573
[64] Hien Nguyen and Judith Masthoff. 2009. Designing Empathic Computers: The Effect of Multimodal Empathic Feedback Using Animated Agent. In *Proceedings of the 4th International Conference on Persuasive Technology* (Claremont, California, USA) *(Persuasive '09)*. Association for Computing Machinery, New York, NY, USA, Article 7, 9 pages. https://doi.org/10.1145/1541948.1541958
[65] Susan Nolen-Hoeksema. 1991. Responses to depression and their effects on the duration of depressive episodes. *Journal of abnormal psychology* 100 4 (1991), 569–82.
[66] Geoff Norman. 2010. Likert scales, levels of measurement and the "laws" of statistics. *Advances in health sciences education* 15 (2010), 625–632.
[67] Heather O'Brien, Paul Cairns, and Mark Hall. 2018. A Practical Approach to Measuring User Engagement with the Refined User Engagement Scale (UES) and New UES Short Form. *International Journal of Human-Computer Studies* 112 (04 2018). https://doi.org/10.1016/j.ijhcs.2018.01.004
[68] W. Parrott. 2002. The functional utility of negative emotions. *The Wisdom in Feeling: Psychological Processes in Emotional Intelligence* (01 2002), 341–359.
[69] James W. Pennebaker, Emmanuelle Zech, and Bernard Rimé. 2001. Disclosing and sharing emotion: Psychological, social and health consequences. https://api.semanticscholar.org/CorpusID:143267648
[70] Andres Pinilla, Jaime Garcia, William Raffe, Jan-Niklas Voigt-Antons, Robert Spang, and Sebastian Möller. 2021. Affective Visualization in Virtual Reality: An Integrative Review. *Front. Virtual Real.* 2, 630731 (2021). https://doi.org/10.3389/frvir.2021.630731
[71] Silvia Francesca Maria Pizzoli, Ketti Mazzocco, Stefano Triberti, Dario Monzani, Mariano Luis Alcañiz Raya, and Gabriella Pravettoni. 2019. User-Centered Virtual Reality for Promoting Relaxation: An Innovative Approach. *Frontiers in Psychology* 10 (2019). https://doi.org/10.3389/fpsyg.2019.00479
[72] Jonathan Posner, James A. Russell, and Bradley S. Peterson. 2005. The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and Psychopathology* 17, 3 (2005), 715–734. https://doi.org/10.1017/S0954579405050340
[73] Mirjana Prpa, Kıvanç Tatar, Jules Françoise, Bernhard Riecke, Thecla Schiphorst, and Philippe Pasquier. 2018. Attending to Breath: Exploring How the Cues in a Virtual Environment Guide the Attention to Breath and Shape the Quality of Experience to Support Mindfulness. In *Proceedings of the 2018 Designing Interactive Systems Conference* (Hong Kong, China) *(DIS '18)*. Association for Computing Machinery, New York, NY, USA, 71–84. https://doi.org/10.1145/3196709.3196765
[74] Heather Ramey, Donato Tarulli, Jan Frijters, and Lianne Fisher. 2009. A Sequential Analysis of Externalizing in Narrative Therapy with Children. *Contemporary Family Therapy* 31 (12 2009), 262–279. https://doi.org/10.1007/s10591-009-9095-5
[75] Jack Ratcliffe, Francesco Soave, Nick Bryan-Kinns, Laurissa Tokarchuk, and Ildar Farkhatdinov. 2021. *Extended Reality (XR) Remote Research: A Survey of Drawbacks and Opportunities.* Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3411764.3445170
[76] Michael Reicherts. 2022. Dimensions of Openness to Emotions (DOE). A Model of Affect Processing. Manual with Instruments, Recent Studies and Reference Values (Technical Report 168-C, 2022). https://doi.org/10.13140/RG.2.2.28225.02401
[77] Martin Reimann, Wilko Feye, Alan Malter, Joshua Ackerman, Raquel Castaño, Nitika Garg, Robert Kreuzbauer, Aparna Labroo, Angela Lee, Maureen Morrin, Gergana Nenkov, Jesper Nielsen, María Perez, Gratiana Pol, Carolyn Yoon, Chen-Bo Zhong, and José Rosa. 2012. Embodiment in Judgment and Choice. *ORG: Rationality, Cognition, & Decision Making (Topic)* 5 (02 2012). https://doi.org/10.1037/a0026855
[78] Simon Riches, Lisa Azevedo, Leanne Bird, Sara Pisani, and Lucia Valmaggia. 2021. Virtual reality relaxation for the general population: a systematic review. *Social psychiatry and psychiatric epidemiology* 56 (2021), 1707–1727.
[79] Giuseppe Riva, Fabrizia Mantovani, Claret Capideville, Alessandra Preziosa, Francesca Morganti, Daniela Villani, Andrea Gaggioli, Cristina Botella, and Mariano Alcañiz Raya. 2007. Affective Interactions Using Virtual Reality: The Link between Presence and Emotions. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 10 (2007), 45–56. https://doi.org/10.1089/cpb.2006.9993
[80] Radiah Rivu, Ruoyu Jiang, Ville Mäkelä, Mariam Hassib, and Florian Alt. 2021. Emotion Elicitation Techniques in Virtual Reality. In *Human-Computer Interaction – INTERACT 2021*, Ardito C. et al. (Ed.). Springer International Publishing, Cham, 93–114. https://doi.org/10.1007/978-3-030-85623-6_8
[81] Guy Roth, Avi Assor, Christopher Niemiec, Richard Ryan, and Edward Deci. 2009. The Emotional and Academic Consequences of Parental Conditional Regard: Comparing Conditional Positive Regard, Conditional Negative Regard, and Autonomy Support as Parenting Practices. *Developmental psychology* 45 (07 2009), 1119–42. https://doi.org/10.1037/a0015272
[82] Guy Roth, Maarten Vansteenkiste, and Richard M. Ryan. 2019. Integrative emotion regulation: Process and development from a self-determination theory perspective. *Development and Psychopathology* 31, 3 (2019), 945–956. https://doi.org/10.1017/S0954579419000403
[83] Dmitri Rozgonjuk and Jon Elhai. 2021. Emotion regulation in relation to smartphone use: Process smartphone use mediates the association between expressive suppression and problematic smartphone use. *Current psychology (New Brunswick, N.J.)* (07 2021), 1–10. https://doi.org/10.1007/s12144-019-00271-4

[84] Martin Schrepp, Andreas Hinderks, and Jörg Thomaschewski. 2017. Design and Evaluation of a Short Version of the User Experience Questionnaire (UEQ-S). *International Journal of Interactive Multimedia and Artificial Intelligence* 4 (01 2017), 103. https://doi.org/10.9781/ijimai.2017.09.001

[85] Martin Schrepp, Jörg Thomaschewski, and Andreas Hinderks. 2017. Construction of a Benchmark for the User Experience Questionnaire (UEQ). 4 (2017), 40–44. Issue Regular Issue. https://www.ijimai.org/journal/bibcite/reference/2604

[86] Norbert Schwarz and Gerald L. Clore. 1996. Feelings and phenomenal experiences. https://api.semanticscholar.org/CorpusID:14849230

[87] Donald A. Schön. 1992. *The Reflective Practicioner: How Professionals Think in Action.* Routledge, Abingdon, Oxfordshire. 384 pages. https://doi.org/10.4324/9781315237473

[88] Elizabeth Seabrook, Ryan Kelly, Fiona Foley, Stephen Theiler, Neil Thomas, Greg Wadley, and Maja Nedeljkovic. 2020. Understanding How Virtual Reality Can Support Mindfulness Practice: Mixed Methods Study. *J Med Internet Res* 22, 3 (18 Mar 2020), e16106. https://doi.org/10.2196/16106

[89] Sinem Semsioglu, Pelin Karaturhan, Saliha Akbas, and Asim Evren Yantac. 2021. Isles of Emotion: Emotionally Expressive Social Virtual Spaces for Reflection and Communication. In *Proceedings of the 13th Conference on Creativity and Cognition* (Virtual Event, Italy) *(C&C '21)*. Association for Computing Machinery, New York, NY, USA, Article 24, 10 pages. https://doi.org/10.1145/3450741.3466805

[90] Lubna Bte Iskhandar Shah, Samantha Torres, Premarani Kannusamy, Cecilia Mui Lee Chng, Hong-Gu He, and Piyanee Klainin-Yobas. 2015. Efficacy of the virtual reality-based stress management program on stress-related variables in people with mood disorders: the feasibility study. *Archives of psychiatric nursing* 29, 1 (2015), 6–13.

[91] Shauna L Shapiro, Doug Oman, Carl E Thoresen, Thomas G Plante, and Tim Flinders. 2008. Cultivating mindfulness: effects on well-being. *Journal of clinical psychology* 64, 7 (2008), 840–862. https://doi.org/10.1002/jclp.20491

[92] Yaoxi Shi, Peter Koval, Vassilis Kostakos, Jorge Goncalves, and Greg Wadley. 2023. "Instant Happiness": Smartphones as tools for everyday emotion regulation. *International Journal of Human-Computer Studies* 170 (2023), 102958. https://doi.org/10.1016/j.ijhcs.2022.102958

[93] Petr Slovak, Alissa Antle, Nikki Theofanopoulou, Claudia Daudén Roquet, James Gross, and Katherine Isbister. 2023. Designing for Emotion Regulation Interventions: An Agenda for HCI Theory and Research. *ACM Trans. Comput.-Hum. Interact.* 30, 1, Article 13 (mar 2023), 51 pages. https://doi.org/10.1145/3569898

[94] Petr Slovák, Christopher Frauenberger, and Geraldine Fitzpatrick. 2017. Reflective Practicum: A Framework of Sensitising Concepts to Design for Transformative Reflection. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. Association for Computing Machinery, New York, NY, USA, 2696–2707. https://doi.org/10.1145/3025453.3025516

[95] Petr Slovák, Ran Gilad-Bachrach, and Geraldine Fitzpatrick. 2015. Designing Social and Emotional Skills Training: The Challenges and Opportunities for Technology Support. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (Seoul, Republic of Korea) *(CHI '15)*. Association for Computing Machinery, New York, NY, USA, 2797–2800. https://doi.org/10.1145/2702123.2702385

[96] Wally Smith, Greg Wadley, Sarah Webber, Benjamin Tag, Vassilis Kostakos, Peter Koval, and James J. Gross. 2022. Digital Emotion Regulation in Everyday Life. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (<conf-loc>, <city>New Orleans</city>, <state>LA</state>, <country>USA</country>, </conf-loc>) *(CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 444, 15 pages. https://doi.org/10.1145/3491102.3517573

[97] Robert Solomon and Lori Stone. 2002. On "Positive" and "Negative" Emotions. *Journal for the Theory of Social Behaviour* 32 (11 2002), 417 – 435. https://doi.org/10.1111/1468-5914.00196

[98] Florian Soyka, Markus Leyrer, Joe Smallwood, Chris Ferguson, Bernhard E. Riecke, and Betty J. Mohler. 2016. Enhancing Stress Management Techniques Using Virtual Reality. In *Proceedings of the ACM Symposium on Applied Perception* (Anaheim, California) *(SAP '16)*. Association for Computing Machinery, New York, NY, USA, 85–88. https://doi.org/10.1145/2931002.2931017

[99] Yvette Szabo, Ashlee Warnecke, Tamara Newton, and Jeffrey Valentine. 2017. Rumination and posttraumatic stress symptoms in trauma-exposed adults: a systematic review and meta-analysis. *Anxiety, Stress, & Coping* 30 (04 2017), 1–19. https://doi.org/10.1080/10615806.2017.1313835

[100] Nikki Theofanopoulou and Petr Slovak. 2022. Exploring Technology-Mediated Parental Socialisation of Emotion: Leveraging an Embodied, In-Situ Intervention for Child Emotion Regulation. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) *(CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 217, 16 pages. https://doi.org/10.1145/3491102.3502130

[101] Jennifer G. Tichon and Timothy Mavin. 2019. Using the Experience of Evoked Emotion in Virtual Reality to Manage Workplace Stress: Affective Control Theory (ACT). https://doi.org/10.4018/978-1-5225-8356-1.ch011

[102] Niels van Berkel and Kasper Hornbæk. 2023. Implications of Human-Computer Interaction Research. *Interactions* 30, 4 (jun 2023), 50–55. https://doi.org/10.1145/3600103

[103] Daniela Villani, Claudia Carissoli, Stefano Triberti, Antonella Marchetti, Gabriella Gilli, and Giuseppe Riva. 2018. Videogames for Emotion Regulation: A Systematic Review. *Games for Health Journal* 7 (02 2018). https://doi.org/10.1089/g4h.2017.0108

[104] Jan-Niklas Voigt-Antons, Robert Spang, Tanja Kojić, Luis Meier, Maurizio Vergari, and Sebastian Möller. 2021. Don't Worry be Happy - Using virtual environments to induce emotional states measured by subjective scales and heart rate parameters.. In *2021 IEEE Virtual Reality and 3D User Interfaces (VR)*. 679–686. https://doi.org/10.1109/VR50410.2021.00094

[105] Greg Wadley, Wally Smith, Peter Koval, and James J. Gross. 2020. Digital Emotion Regulation. *Current Directions in Psychological Science* 29, 4 (2020), 412–418. https://doi.org/10.1177/0963721420920592 arXiv:https://doi.org/10.1177/0963721420920592

[106] Nadine Wagener, Alex Ackermann, Gian-Luca Savino, Bastian Dänekas, Jasmin Niess, and Johannes Schöning. 2022. Influence of Passive Haptic and Auditory Feedback on Presence and Mindfulness in Virtual Reality Environments. In *Proceedings of the 2022 International Conference on Multimodal Interaction* (Bengaluru, India) *(ICMI '22)*. Association for Computing Machinery, New York, NY, USA, 558–569. https://doi.org/10.1145/3536221.3556622

[107] Nadine Wagener, Tu Dinh Duong, Johannes Schöning, Yvonne Rogers, and Jasmin Niess. 2021. The Role of Mobile and Virtual Reality Applications to Support Well-being: An Expert View and Systematic App Review. *Interact 2021: Proceedings of the International Conference on Human-Computer Interaction* 12935. https://doi.org/10.1007/978-3-030-85610-6_16

[108] Nadine Wagener and Jasmin Niess. 2021. Reflecting on Emotions within VR Mood Worlds. *UbiComp - ISWC '21*. https://doi.org/10.1145/3460418.3479342

[109] Nadine Wagener, Jasmin Niess, Yvonne Rogers, and Johannes Schöning. 2022. Mood Worlds: A Virtual Environment for Autonomous Emotional Expression. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, Vol. 22. Association for Computing Machinery, 16. https://doi.org/10.1145/3491102.3501861

[110] Nadine Wagener, Leon Reicherts, Nima Zargham, Natalia Bartłomiejczyk, Ava Elizabeth Scott, Katherine Wang, Marit Bentvelzen, Evropi Stefanidi, Thomas Mildner, Yvonne Rogers, et al. 2023. SelVReflect: A Guided VR Experience Fostering Reflection on Personal Challenges. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. 1–17.

[111] Nadine Wagener, Johannes Schoning, Yvonne Rogers, and Jasmin Niess. 2023. Letting It Go: Four Design Concepts to Support Emotion Regulation in Virtual Reality. In *2023 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*. 763–764. https://doi.org/10.1109/VRW58643.2023.00224

[112] David Watson, Lee Anna Clark, and Auke Tellegen. 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology* 54, 6 (1988), 1063–1070. https://doi.org/10.1037//0022-3514.54.6.1063

[113] Thomas Webb, Eleanor Miles, and Paschal Sheeran. 2012. Dealing With Feeling: A Meta-Analysis of the Effectiveness of Strategies Derived From the Process Model of Emotion Regulation. *Psychological bulletin* 138 (05 2012), 775–808. https://doi.org/10.1037/a0027600

[114] Judy Weiser. 2015. PhotoTherapy Techniques in Counselling and Therapy – Using Ordinary Snapshots and Photo-Interactions to Help Clients Heal Their Lives. *Canadian Art Therapy Association Journal* 17 (05 2015), 23–53. https://doi.org/10.1080/08322473.2004.11432263

[115] Adrian Wells. 2005. Detached Mindfulness In Cognitive Therapy: A Metacognitive Analysis And Ten Techniques. *Journal of Rational-Emotive & Cognitive-Behavior Therapy* 23 (12 2005), 337–355. https://doi.org/10.1007/s10942-005-0018-6

[116] Adrian Wells. 2011. *Metacognitive Therapy for Anxiety and Depression.* Guilford Press.

[117] Kieran Woodward, Eiman Kanjo, David Brown, Thomas McGinnity, Becky Inkster, Athanasios Tsanas, and Donald Macintyre. 2020. Beyond Mobile Apps: a Survey of Technologies for Mental Well-being. *IEEE Transactions on Affective Computing* (2020), 21. https://doi.org/10.1109/TAFFC.2020.3015018

8 APPENDICES

Table 2: Participant sample: ID's have been reassigned for anonymity. Participants marked with asterisks (*) experienced technical difficulties and were only part of qualitative feedback. The (+) in VR Activities indicates additional activities.

P	Intervention	Setting	VR-Device	Age	Gender	Nationality	VR-Usage	VR-Activities
1	Launch	Remote	HTC Vive Pro 2	44	Male	German	Daily	Games, Social
2	Launch	Remote	Valve Index	38	Male	Canadian	Weekly	Games, Social
3	Launch	Remote	Valve Index	31	Male	Danish	Weekly	Games, Social, Fun
4	Launch	Remote	Valve Index	25	Male	German	Monthly	Games, Sport
5	Launch	Lab	Meta Quest 2	27	Male	German	Sporadical	Studies, Games
6	Launch	Remote	HTC Vive Pro	23	Male	USA	Weekly	Studies, Social, Sport, Health+
7	Launch	Remote	Valve Index	31	Male	USA	Weekly	Games, Social, Fun
8	Launch	Remote	Oculus Rift CV1	23	Male	German	Monthly	Games, Sport, Research
9	Launch	Remote	Meta Quest 2	31	Male	Malaysian	Yearly	Studies, Games
10	Launch	Remote	Meta Quest 2	28	Male	German	Monthly	Studies, Games - Museum
11	Launch	Lab	Meta Quest 2	26	Female	German	Never	None
12	Launch	Lab	Meta Quest 2	30	Male	German	Weekly	Studies, Games, Research
13	Launch	Remote	Meta Quest 2	23	Male	Dutch	Weekly	Games, Social, Sport, Fun
14	Launch	Remote	Valve Index	32	Male	Canadian	Weekly	Games, Social, Sport, Fun
15	Launch	Lab	Meta Quest 2	31	Male	German	Yearly	Studies, Games, Development
16	Launch	Lab	Meta Quest 2	27	Male	German	Yearly	Studies, Games, Sport
17	Launch	Lab	Meta Quest 2	35	Female	Iranian	Sporadical	None
18	Launch	Lab	Meta Quest 2	31	Male	German	Sporadical	Games
19	Launch	Lab	Meta Quest 2	29	Female	German	Sporadical	Games
20	Launch	Lab	Meta Quest 2	26	Male	German	Sporadical	Studies, Games
21	Frame	Remote	Meta Quest 2	20	Male	Polish	Weekly	Games, Social
22	Frame	Remote	Meta Quest 2	37	Male	USA	Yearly	Games, Social, Fun
23	Frame	Remote	Oculus Quest pro	27	Male	British	Weekly	Games, Social, Sport
24	Frame	Lab	Meta Quest 2	26	Male	German	Sporadical	Games, Fun
25	Frame	Lab	Meta Quest 2	25	Female	Chinese	Monthly	Studies, Sport
26	Frame	Lab	Meta Quest 2	28	Female	German	Sporadical	Social
27	Frame	Lab	Meta Quest 2	27	Female	German	Monthly	Studies, Work
28	Frame	Lab	Meta Quest 2	28	Male	German	Sporadical	Studies, Social
29	Frame	Lab	Meta Quest 2	31	Male	German	Sporadical	Marketing
30	Frame	Lab	Meta Quest 2	32	Male	German	Yearly	Studies, Sport, Development
31	Frame	Lab	Meta Quest 2	28	Female	Greek	Yearly	Studies
32	Frame	Lab	Meta Quest 2	25	Male	German	Monthly	Games
33	Frame	Lab	Meta Quest 2	30	Male	German	Yearly	Studies, Development
34	Frame	Lab	Meta Quest 2	25	Male	German	Yearly	Studies, Games, Work
35	Frame	Remote	HTC Vive Pro Eye	28	Male	German	Daily	Work
36	Frame	Remote	Valve Index	27	Male	USA	Weekly	Games, Social, Fun
37	Frame	Remote	Meta Quest 2	30	Male	German	Yearly	Studies, Games, Fun
38	Frame	Lab	Meta Quest 2	29	Female	German	Yearly	Studies, Fun
39	Frame	Lab	Meta Quest 2	30	Male	German	Yearly	Studies, Games
40	Frame	Lab	Meta Quest 2	25	Female	German	Sporadical	Studies, Games
41	Shine	Remote	Valve Index	26	Male	French	Daily	Studies, Games, Social, Sport+
42	Shine	Remote	Valve Index	37	Male	British	Weekly	Games, Social, Sport, Fun
43	Shine	Remote	Oculus Quest 1	23	Male	Dutch	Monthly	Games, Social, Fun
44	Shine	Remote	Valve Index	21	Male	Swedish	Daily	Games, Social, Sport
45	Shine	Remote	Valve Index	28	Male	Dutch	Weekly	Games, Social, Sport, Fun
46	Shine	Lab	Meta Quest 2	27	Male	German	Monthly	Studies
47	Shine	Lab	Meta Quest 2	32	Male	Iranian	Sporadical	Studies
48	Shine	Remote	Meta Quest 2	32	Female	German	Yearly	Studies, Fun
49	Shine	Remote	Valve Index	27	Non-binary	Austrian	Daily	Games, Social, Development
50	Shine	Lab	Meta Quest 2	31	Female	German	Monthly	Studies, Development
51	Shine	Remote	Valve Index	27	Non-binary	Canadian	Weekly	Games, Social
52	Shine	Remote	Valve Index	27	Male	Puerto Rican*	Daily	Games, Social, Sport, Fun
53	Shine	Remote	Valve Index	26	Male	German	Daily	Games, Social, Sport, Fun
54	Shine	Remote	Valve Index	24	Male	Polish	Daily	Games, Social, Sport
55	Shine	Remote	Meta Quest 2	29	Male	Austrian	Weekly	Studies, Games, Social, Fun
56	Shine	Remote	Valve Index	20	Male	German	Monthly	Games, Social, Sport
57	Shine	Lab	Meta Quest 2	26	Male	German	Yearly	Studies, Sport, Development+
58	Shine	Lab	Meta Quest 2	30	Male	German	Sporadical	Health
59	Shine	Remote	Oculus Quest 1	24	Female	German	Monthly	Studies, Games, Fun
60	Shine	Lab	Meta Quest 2	31	Female	German	Never	None
61*	-	Remote	Meta Quest 2	39	Male	American	Daily	Studies, Games, Development
62*	-	Remote	Meta Quest 2	28	Female	German	Sporadical	Studies, Fun