SelVReflect: A Guided VR Experience Fostering Reflection on Personal Challenges

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Figure 1: Schematic representation of a user creatively reproducing and reflecting on an emotionally loaded challenge using SelVReflect. The user is guided through voice-based prompts. The figure shows a small section of a 3D drawing done by P8.

ABSTRACT

Reflecting on personal challenges can be difficult. Without encouragement, the reflection process often remains superficial, thus inhibiting deeper understanding and learning from past experiences. To allow people to immerse themselves in and deeply reflect on past challenges, we developed SelVReflect, a VR experience which offers active voice-based guidance and a space to freely express oneself. SelVReflect was developed in an iterative design process (N=5) and evaluated in a user study with N=20 participants. We found that SelVReflect enabled participants to approach their challenge and its (emotional) components from different perspectives and to discover new relationships between these components. By making use of the spatial possibilities in VR, participants developed a better understanding of the situation and of themselves. We contribute empirical evidence of how a guided VR experience can support reflection. We discuss opportunities and design requirements for guided VR experiences that aim to foster deeper reflection.

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CCS CONCEPTS

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

KEYWORDS

Virtual Reality; Guidance; Reflection; Well-being; Self-care; Expression; Creativity; Emotion

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1 INTRODUCTION

Challenging situations in our lives, such as anxiety at work or a stressful family situation, can negatively affect our well-being [1]. Reflecting on these challenges can facilitate understanding, provide new meaning, and improve mental health and well-being [25, 54, 81]. However, finding the (head-) space, time, and resources to effectively reflect on personal challenges can be difficult. Although technologies for reflection exist [37, 49, 81], there is an ongoing need for tools that support users more productively in deconstructing and making sense of everyday problems [2, 43]. Existing technologies for reflection could be improved by focusing more on abstract expression [15] and experiential approaches [2]. There is also scope for a shift in how technology-supported reflective experiences are conceived within HCI, much of which currently utilises reflection as a means to an end, such as improved educational outcomes [13]. Instead, technologies could be designed to actively target reflection as a beneficial activity in its own right [81].

A technology that could cater to users' needs for reflective support is Virtual Reality (VR). Due to its unique affordance to (re)create highly controlled yet immersive environments [53], VR can provide meaningful interventions for well-being [17, 35, 38, 87]. For example, VR can be leveraged to alleviate stress through guided imagery (e.g., [80]), support emotion regulation [59], enhance creative expression in art therapy [24], and elicit positive change in mood, meaning, and interpersonal connectedness [19, 46]. However, few VR applications are specifically designed for everyday reflection [11, 43]. In this paper, we argue that in VR we can leverage unique interactive affordances that go beyond 2D drawing, enhancing the process of expressing and reflecting on personal challenges. VR offers the unique benefits of being able to use dynamic elements in a 3D virtual environment (VE), while the different dimensions can be used to represent temporal or thematic relationships, for example using spatial distancing to represent importance. These can be further explored by physically walking through one's creations and approaching them from different perspectives. Thus, VR offers an exceptional "breeding ground" for an engaging experience, which could lead to in-depth reflection. While Augmented Reality and Extended Reality may offer similar degrees of freedom for expressing oneself, they do not insulate the user from environmental distractions in the same way as VR.

An important consideration when designing VR tools for reflection is to effectively scaffold reflective processes [81] and prevent users from getting stuck in negative emotion cycles (i.e. rumination) [34]. In art therapy, professional therapists guide their clients throughout the reflection process while fostering an atmosphere of creativity, freedom, and playfulness [31, 73]. A challenge, therefore, is to provide comparable guidance for VR experiences that encourage reflection.

To address this, we set out to explore the potential design space surrounding guided reflection in VR. In particular, we investigate how a guided expressive VR experience can be designed and how it can encourage reflective processes. Specifically, our research is guided by the following two research questions (RQs):

- RQ_1: How can we design a VR experience that fosters reflection through guided creative expression?
- RQ_2: How does our design affect the overall experience and reflection?

SelVReflect is inspired by principles of Positive Psychology and art therapy, leveraging creative expression to make sense of successfully mastered personal challenges (e.g. [24, 56]). Such personal challenges might occur in many everyday life situations, such as in professional contexts or in personal relationships, and can be linked to anxiety, stress, or difficulties with planning, prioritising, or decision-making. All of these challenges could be expressed and reflected on in SelVReflect. We build upon prior research on VR applications which facilitate personal expression by allowing the user to create their own immersive emotional environment through drawing in 3D [88]. SelVReflect also builds upon approaches that scaffold and structure the process of reflection through guiding prompts that encourage users to explore and take on new perspectives [26, 48, 51, 69, 76]. In this work, we focused on voice-based prompts, as they were found to be better suited than visual text-based prompts at enhancing the effectiveness of emotional VR experiences [66] and less disruptive [63, 94], which is critical to consider in the context of immersive self-expression tasks.

First, we conducted an iterative user-centered design process (N=5) consisting of four stages. From this, we derived principles for the design of the voice-based guidance that provides inspiration, encouragement and reflective scaffolding in VR. In the first two stages, the user needs and challenges of performing creative self-expression in VR were identified. In the last two stages, approaches for providing guidance for reflection were explored, including timing, phrasing and the roles the guidance should take on, which were tested in the final part of the design process through enactment. The findings informed the design of SelVReflect, a guided VR experience for creative expression and self-reflection.

To evaluate SelVReflect, we conducted a user study (N=20) where participants visualised and reflected upon an emotionally loaded personal challenge they previously overcame. Overall, our findings suggest that SelVReflect can propagate the discovery of relationships between the components of past challenges. Understanding these relationships can then help identify constructive approaches to personal challenges in the future. This reflective process can evoke positive feelings (i.e. achievement) and support self-efficacy.

This paper contributes the following: (i) the design and implementation of SelVReflect - a guided VR experience for creative

expression and reflection, (ii) an exploratory evaluation of how SelVReflect can support creativity, reflection and self-awareness through a user study, and (iii) design requirements for building guided VR experiences that aim to foster reflection.

2 RELATED WORK

In this section, we review past research on systems designed to support reflection and define key terms within this area. We then describe previous work in conversational and voice-based interfaces designed to provide guidance and introduce relevant psychological concepts for self-expression, well-being, and positive psychology.

2.1 Conceptualising and Designing for Reflection

Reflection can be loosely defined as understanding, thinking about potential courses of action, and one's role within these [78]. Reflection is considered to be helpful [13, 58] as it can offer more self-insight [13], support life changes [82], and benefit health, well-being and personal growth [25, 54, 81]. Yet, reflection can be a challenging activity and often does not occur automatically, but needs to be encouraged [81]. Consequently, designing technology for reflection has become an ever-increasing interest of HCI researchers [37]. Previous work in HCI on reflection has been highly influenced by Schön's framing of reflection [13, 78, 81]. A systematic review conducted by Baumer [13] showed that in 70% of the HCI papers that explicitly define reflection, Schön's notion of reflection-in-action or reflection-on-action was utilised [15]. Reflection-in-action takes place during the action, which means we reflect on our actions while performing them [78]. In contrast, reflection-on-action occurs after an action has finished, in which we use our memories of an event to reconstruct an experience. This effort of stepping back into the experience, retrieving our memories, and organising these fragmented parts is conducted to understand what has happened and to draw out lessons for the future. While this framework offers a useful lens for reflection, it does not directly address how technology can support reflective processes, as remarked by Slovak et al. [81]. As shown by Bentvelzen et al. [16], various strategies have been used in HCI to foster reflection. Through a structured literature review and analysis of mobile applications for reflection, they propose a taxonomy consisting of four design resources: temporal perspective, conversation, comparison, and discovery. While the taxonomy offers a starting point for designing for reflection, it remains unclear which resources (and design patterns) can be used in which context. Therefore, in our work, we explore the use of two of these resources, i.e. *temporal perspective* and *conversation* (with technology), to facilitate reflection on personal challenges.

To assess how well a system fosters reflection, Bentvelzen et al. [16] propose a combined method. Results of a validated questionnaire, the Technology-Supported Reflection Inventory (TSRI) [14], should be combined with a qualitative inquiry, and it should be determined if the system leverages the aforementioned design resources for reflection [16].

Recently, scholars in HCI have started engaging with the intricacies of reflection. For instance, a paper by Eikey et al. [34] highlights a potential risk for reflection-enhancing systems. Certain users of such systems have experienced negative emotional cycles. The authors use the term *rumination* to refer to these cycles and defines it as a counterpoint to self-reflection, in line with Trapnell and Campbell [85]. Eikey et al. [34] further discuss that rumination and reflection are related to a broader sense of the self, also known as self-awareness. While rumination can undermine technology for reflection, it remains an open question of how to balance promoting reflection on the one hand and preventing rumination on the other, which is what we aim to explore in this work.

Multiple systems that intend to facilitate reflection have been designed in HCI for various application contexts [3, 4, 12, 41]. For instance, the web-based application *MoodAdaptor* prompts participants to reflect on positive and negative memories depending on one's current mood [49]. Kocielnik et al. [47] designed *Robota*, a chatbot with voice interaction that aims to stimulate reflection and self-learning in the workplace by asking questions and chatting with the user of the system. A similar approach is used by Jung et al. [44], who designed a conversational agent that facilitate children's reflection as they design mechatronics systems. The agent asks open-ended questions that stimulate a dialogue between the child and the artefact while building the system. In regard to VR, most applications investigate reflection together with another concept, for example empathy skills (e.g. [83]), learning (e.g. [50]), or storytelling (e.g. [6]). Based on a scoping review of twelve VR applications specifically designed for reflection, Jian and Ahmadpour [43] built a conceptual model, named RIOR, that applies a theatrical lens to understand how reflection should be supported in VR. To facilitate reflection, users should mentally prepare before entering VR. Designers can manipulate users' viewpoints in VR, use observational and experiential learning, or include representations of personal items. While the RIOR model offers promising insights, it does not provide recommendations for designing guidance in VR. Furthermore, their model could be extended to examine the case that users design the virtual environment by themselves. Both of these research gaps are addressed in this paper.

2.2 Designing Voice-Based Guidance for Reflection

Conversational interfaces, such as chatbots or voice assistants, have been designed to guide users through complex tasks, as they were found to be effective in providing "scaffolds" to thought processes [36, 69, 70, 92]. Furthermore, such systems are shown to be effective for guiding and facilitating reflection with the aim of supporting well-being and mental health [5, 26, 48, 51, 52, 55, 67]. An important question when designing a guide to tie into and scaffold an ongoing task is, in which modality it should speak to the user. Compared to screen-based conversational interfaces, voice-based interfaces are generally considered less distracting [63, 94], making them the more appropriate choice for an application to support creativity and reflection. This is further supported by the study by Kocielnik et al. [48], comparing a speech-based and a text-based agent for the workplace to support employees' activity journaling and self-learning through reflection. Their findings suggest that the voice-based system is easier to use and feels more personal, interactive, and engaging.

When developing a voice-based interface for such purposes, various design decisions, including the agent's voice characteristics (e.g. gender) need to be considered. Research has shown that the identified gender of an agent has an impact on the user's experience [18, 21]. However, previous literature suggests that designing the right voice for an assistant in a given application depends on its context [28, 62, 64, 84]. While real human voices are traditionally utilised [64], other studies suggest that the choice between synthesised and real human voice is context-specific [28]. Previous work also recommends customisation of voice-based agents, as it enhances the user experience [95].

Given this divergent and evolving body of evidence, there is no clear answer on which voice characteristics - such as gender - are most suitable to support an ongoing reflection process. Furthermore, based on the ambiguous evidence on voice characteristics, it is very likely that there are differences in individual preferences. Therefore, we further explore this question through a user-centered design process (UCD) in the context of supporting reflection in VR.

2.3 Self-Expression to Support Well-being

Expressing and reflecting on oneself can help people understand challenging events better and give them a new meaning [25, 54, 81]. Similarly, visually expressing and reconstructing past experiences is also used in certain therapeutic approaches, such as art therapy [56]. A foundational theory in art therapy, called the Expressive Therapies Continuum [45], forms the relationships between drawing conceptual meaning using reflective activities and how feelings of positive affect occur through expressive activities. As an immersive medium for artistic expression, VR has also been recently explored as a tool to be administered to patients during advanced stages of art therapy [39, 40]. However, the authors also point out that it is important to have (verbal) guidance in the process of creation.

Creative expression in VR may be overwhelming since not everyone finds it easy to open up and express their emotions [72]. This needs to be considered when designing systems for such purposes. Here, the Dimensions of Emotional Openness model (DOE) by Reicherts et al. [72] can be a useful "predictor" for how difficult a person may find it to perform such a task: People engaging in creative self-expression and reflection (in VR) need to become aware of what emotions they experience and how to internally and externally represent, express, or communicate them. Therefore, it can be assumed that people with lower DOE scores i.e. who are "less" emotionally open will benefit the most from receiving guidance during the expressive process.

2.4 Positive Psychology Approaches to Support Self-Efficacy and Behavioural Change

Various psychological and psychotherapeutic approaches, such as goal-oriented psychotherapy [74] or Positive Psychology [79, 91], aim to help people understand how they can cope with challenges by focusing on which of their existing resources they could use to do so. The so-called Agentic Positive Psychology [9] specifically focuses on "mastery experiences", which refer to personal (past) successful behaviours to deal with and adapt to certain situations (e.g. [8]). Such mastery experiences have been proposed as one of the most effective ways to instill the belief in one's own ability to succeed (e.g. in performing certain desired behaviours), and they can lead to positive behaviour change [7]. This is referred to as *self-efficacy* [7]. Self-efficacy can be measured with questionnaires, such as the General Self-Efficacy Scale [77].

Reflecting on past experiences from a positive lens is referred to as *self-modeling* [32]. Self-modeling has been integrated in systems that aim to support positive behaviour change, such as StoryMap [75]. StoryMap is an app that promotes physical activity in families by letting them record, reflect on and share their activities with others. Thus, in addition to the possibility to reflect on and engage with one's own stories (self-modeling), the app also allows users to observe and reflect on other people's behaviour and performance, also known as *social modeling*. Both self-modeling and social modeling were found to help users build attitudes for developing healthy behaviour by positively influencing self-efficacy and outcome expectations.

Here, we aim to build upon and combine these existing therapeutic approaches and interventions, based on the creation of and reflection on representations of successfully mastered challenges. In contrast to Saksono et al. [75] our aim is to build an immersive experience in VR in which participants extensively engage with a past emotionally-loaded challenge through expressive, creative self-modeling. Through this, we hope the user can explore new perspectives on challenges in their life, gain a fresh understanding of them, and discover new ways of successfully dealing with them.

3 DESIGN

Our design is inspired by prior literature suggesting that moderately directed guidance helps with reflection [29, 30, 81]. However, we could not directly translate existing (human-human) practices of guiding someone through reflective and expressive activities from creative, educational, or therapeutic contexts (e.g. [33, 56, 71]) to the VR context. VR can immerse people in their creations in a different way, which makes it difficult to predict how existing approaches to providing guidance would translate and how they would "tie in" best into the user's creative process. Therefore, getting users to explore what might work best for themselves appeared to be the most promising approach. This will provide insights in regard to RQ_1.

Thus, we followed an iterative user-centered design process (UCD). The UCD was divided into four stages, which are shown in Figure 2. The aim was to explore through co-design (i) how the guide should be designed and what role it should take on, (ii) how and when it should appear (within VR), and (iii) the types of guidance and specific prompts it should provide. The same ($N = 5$) participants took part in every stage, which is similar to the average sample size of ($N = 6$) for participatory design at CHI [27]. We invited participants with prior knowledge of VR to reduce the novelty effect, but apart from that we strived for a diverse sample, female: 2, male: 3, age: 27.6 years (min-age: 21, max-age: 31). Two are students, two are PhD-students, one is research assistant. While all were familiar with general HCI research, none of them had previous experience with 3D drawing nor with comparable voice-based guidance systems.

Figure 2: The four stages of UCD to design guidance for SelVReflect with N=5 participants. 1: participants create and experience former challenges to understand own difficulties, 2: participants rewatch the recording of stage 1 to identify opportunities for guidance, 3: participants come together in a focus group to discuss their findings, 4: participants take over the role of guidance to test it.

3.1 Individual Design of the Virtual Environment

The VE will be created individually by each user. To provide users with the means to conduct a creative expression task in VR, we utilised a 3D drawing tool by Wagener et al. [88]. It offers a palette consisting of various (animated) brushes, animated and static 3D objects, pre-set environments and a colour panel, allowing the user to create their own environment while in VR. Wagener et al.[88] found that this approach of providing autonomy in the design process of a VE - called "Mood Worlds" - accommodates users in visualising affective states and in reflecting on previous experiences by drawing in VR (see Table 1 elements 1-3). It is thus aligned with our goals for SelVReflect. However, Wagener et al. did not specifically develop Mood Worlds to support reflection, but rather to express positive emotions, i.e. they did not provide any guidance as support for users to reflect (see Table 1 element 5).

Table 1: Elements of the Mood Worlds (MW) and SelVReflect (SR) experience.

	Elements of the Experience	MW	SR
1	Choosing a preferred 3D environment	✓	✓
2	Selecting tools/objects from the palette	✓	✓
3	Drawing in the 3D environment	✓	✓
4	Reflecting on one's 3D creation		✓
5	Being supported by guiding prompts		✓

3.2 Designing the VR Guidance

We followed a UCD process, which consisted of four iterative stages (see Figure 2). In *Stage 1: Creating a Personal Experience*, participants were asked to visualise a personal challenge using the 3D drawing tool "Mood Worlds" by Wagener et al. [88]. This experience was to familiarise them with creating emotional environments in VR and to help them with identifying possible hurdles that users might face. The drawing was followed by a short interview (approx. 5 min), in which the researcher inquired about thoughts and ideas behind the drawing to stimulate users' reflection regarding their creation.

The second stage, *Stage 2: Rewatching to Identify Personal Needs*, focuses on identifying opportunities for prompts through watching a screen recording from Stage 1. Whenever participants remembered themselves struggling to express their emotions, they described difficulties and reasons in a template that provided a structure they could follow when taking their notes. They then added ideas on how guidance could have helped at this point, such as an affirmation, inspiration for a new idea, or question for reflection. They also included suggestions for specific wording for those prompts.

Stage 3: Discussing & Agreeing on Design Solutions brought all N=5 participants together in a focus group to compare and discuss difficulties and opportunities for guidance. This UCD stage lasted one hour. The focus was placed on *when* and in *which form* (modality, phrasing, voice, etc.) the guidance should be delivered. Apart from the general desire to feel comfortable listening to the voice, there was no agreement on its specific characteristics among participants, such as its gender and degree of human-likeness. When the flow of the open discussion seemed to hesitate, a moderator provided new questions to the discussion, e.g. getting them to think about the role and goals they imagined the guide to play and possess, or how it would compare to having human-driven guidance.

Finally, *Stage 4: Enacting & Evaluating Feasibility* aimed to explore which of the previously identified aspects work well in practice, especially with focus on the guidance types and timing of the guidance. One researcher, who had not experienced the drawing tool before, took on the role of "drawer" and creatively reproduced a challenge in VR. The participants observed and played the role

Table 2: Example prompts from the three separate phases of the SelVReflect experience.

Phase	Example Prompt	Purpose
Warm-up	Now think about the main stages of the challenge from the start until the end, when you ultimately overcame it. How many different stages or steps were there?	Suggestions for concrete actions
Free flow	Have you considered how the separate stages might be connected to each other? How could you design these connections? Could they differ? Remember, there is no right or wrong here - as long as you express it in a way that feels right to you, that's all that matters!	Receive inspiration and encouragement for expression and reflection-in-action
Re-walk	Now, focus again on the actions and ideas that helped you overcome the challenge. How did you represent these and how do they tie into the whole process?	Receive thought-provoking questions for reflection-on-action

of the guidance by intervening with reflective questions (approx. 20min). Afterwards, the participants and the drawer discussed their insights (approx. 20min).

Each stage further informed and refined the design of the guidance and its prompts for the given usage scenario. Participants wished for a non-embodied guide. As a key reason, they mentioned that feeling watched by a human could negatively affect creativity and the experience, while a virtual guide would act as a facilitator in such a creative self-reflection process. Its role in providing self-support is different from a counsellor providing support, who in everyone's eyes, should be a human. The guide should talk in a reassuring, non-judgmental voice and be available whenever the drawer requests inspiration. As there was no agreement on the voice characteristics, we decided that users should be provided with different voice options.

Identified Phases of the Experience. The four-staged design process revealed that user needs differ and can be categorised into three phases. The guidance, therefore, needs to be designed accordingly. In the beginning, users may feel insecure about how to start with visualising challenges. Thus, guidance should facilitate decisions and help create an image of the challenge in their heads. This would pave the way for getting into a flow state and for empathising with one's emotions. One participant of the UCD (UCD P2) wanted to *"be prompted to then think more abstract and just draw something that works for me"*.

As soon as the drawer seems confident with the system, the guidance should not be as prominent anymore. *"Less is more"* (UCD P5) for this phase, in which a user should get into the flow. However, when progress stagnates, it should remind users to think in abstract ways, to take a new perspective into account or choose another tool. Participants recommended avoiding questions starting with "why", because as UCD P3 pointed out: *"It is an open creative space where people should not feel bad about their creation"*.

After the creation has been completed, the guide could ask if they were happy with their creation and nudge them to physically move around to look at their drawing from different perspectives. Reflective questions were suggested, such as "Think about the situation again. Does your drawing reflect it sufficiently well?".

4 FINAL PROTOTYPE

Based on the design process, we created the guidance for SelVReflect. A schematic representation is shown in Figure 1. As our findings and the previous literature do not provide a clear picture of the preferred gender and degree of human-likeness, participants are able to choose between female/male and human/synthetic voice. By allowing participants to choose their preferred voice, we intended to reduce the risk of feeling discomfort listening to the guidance, which could lead to undesirable effects (confounding factors) on the expressive/reflective task. In line with our findings, we defined three phases for the guided VR experience: (i) "Warm-up", (ii) "Free-flow", and (iii) "Re-walk", in which the guidance inhabits different roles and addresses specific needs. In Warm-up, users will actively request prompts to get started that point out some palette features. In Free-flow, the guide is activated either by the user pressing a specific button on the VR controller or through a longer period of inactivity, indicating that the user is unsure how to proceed. With the help of pilot testing (N=4), we defined that after 30 seconds of either looking at their creation without drawing or placing objects or scrolling through the menu without making a choice, a prompt would be triggered. Deeper reflection questions would only be asked in the Re-walk phase to avoid disrupting the flow.

The guidance addresses key needs identified in the UCD. For the first phase ("Warm-up"), this was to receive concrete actions to get started (i.e. overcoming the "blank page syndrome" and creating a basic structure. For the main phase ("Free flow") this was to receive (i) *inspiration* for new ideas about aspects to express and for using the tools, as well as (ii) *encouragement* to motivate users to continue drawing and to be expressive. For the last phase ("Re-walk") this was to receive thought-provoking prompts to enable in-depth reflection. Table 2 shows example prompts for each phase of the SelVReflect experience. The list of prompts can be found in the supplementary material. Each prompt contains an inspiration and an encouragement part, for example, *"[inspiration] Have you considered how the stages are connected with each other? How could you design these connections? [encouragement] Remember, there is no right or wrong here - as long as you express it in a way that feels right to you, that's all that matters."* Two researchers reviewed the list of all prompts, merged similar ones, and improved the phrasing to make them clear, non-imposing, playful, and easy to understand. The creation of the final set of prompts was informed by principles

used to foster self-reflection, self-expression, and creative flow from the following areas: (1) Counselling [71]: Examples are "What does (thinking of) this situation trigger in you?" and "How does it feel what you are creating here?" (2) Art therapy [56]: Here, questions are often combined with tasks such as creating an image that illustrates how a challenge can be divided into separate components (e.g. "What does this aspect of the image tell you about the challenge?"). (3) Education [33]: Emphasising the need to make learners feel secure, supported and encouraged to take risks (e.g. "What does this aspect of the image tell you about the challenge?"). (4) (Self-)Reflection Research [37]: Guidance should explicitly structure and offer encouraging prompts to review the produced material.

To put our design decision into context, Fleck and Fitzpatrick [37] describe a spectrum of five consecutive levels of reflective thought, ranging from "No Reflection" (R0) to "Critical Reflection" (R4). SelVReflect is designed to facilitate reflection for users to reach at least the "Dialogic Reflection" (R2). To evaluate the actual effects of SelVReflect, we conducted a user study.

5 EVALUATION

We conducted an exploratory user study with $N = 20$ participants. The overall aim was to evaluate how SelVReflect (for details about its design see sec. 4) affects users (RQ_2), with a particular focus on the dependent variables POSITIVE AND NEGATIVE EMOTIONS ($RQ_{2.1}$), SELF-EFFICACY ($RQ_{2.2}$) and REFLECTION ($RQ_{2.3}$). We further investigated how differences in emotional openness within our participant sample affect the above dependent variables.

The study received prior ethics approval from University College London.

5.1 Data Collection

For each participant we measured the time spent for the drawing phase and the reflection phase separately. Quantitative data was collected from three validated questionnaires. Further, we collected qualitative data through interviews.

5.1.1 Measures. We used the DOE-20 questionnaire [72] to assess participants' affect processing. The questionnaire encompasses five components, including cognitive-conceptual representation of emotions (REPCOG) and communication and expression of emotions (COMEMO). Both traits are relevant for the task of expressing and representing emotions, which participants will carry out in SelVReflect. Capturing REPCOG and COMEMO in our participant sample will allow us to explore how different levels of these traits affect performance and experience with SelVReflect.

We used the PANAS questionnaire [89] to measure participants' affective states before and after using SelVReflect. Participants indicated on a 5-point-Likert scale to what extent they felt a specific emotion (ten positive, ten negative) at that moment. Scores can range from 10 to 50. By using this measure, we can assess if SelVReflect creates positive affect, as can be assumed based on prior research [56, 88]. Increased positive emotions are further relevant as they can co-occur with a sense of achievement and mastery [8]. Moreover, with the PANAS we can measure if SelVReflect increases negative affect. Experiencing negative emotions could be a sign of rumination, one of the risks identified by mental health experts regarding at-home self-care [34]. SelVReflect should prevent rumination and support reflection.

The GSE by Schwarzer and Jerusalem [77] was used to capture the perceived self-efficacy before and after the VR experience (one general factor, good psychometric properties). Participants indicated on a 4-point-Likert scale to what extent they agree with ten items. Scores can range from 10 to 40. Although GSE is designed to capture traits rather than states it has been successfully used for pre-post evaluation of short-term interventions (e.g. [10, 90]). Reflecting on mastery experiences, as is done in SelVReflect, can increase self-efficacy.

After using SelVReflect, we utilised the Technology-Supported Reflection Inventory (TSRI) [14]. This scale specifically addresses how well a system supports reflection. Items 1-3 were reused with the same wording, 4-5 were slightly adjusted to fit the present tool and reflection task (see fig. 4 for more information) and items 6-9 were excluded, since they were not applicable (as they were related to long-term usage of a system and exchange with other people, which was not part of the present reflective activity).

5.1.2 Interview Protocol. We conducted semi-structured interviews that lasted on average 15 min (min : 08:04 min, max : 24:40 min). Within the interview, we asked participants to elaborate on differences between drawing in VR compared to drawing in 2D, how the prompts made them feel, if and how the prompts changed how they visualised and thought about the challenge, and what they took away from using SelVReflect. The full interview protocol can be found in the supplementary material.

5.1.3 Data Analysis. A one-way repeated measures ANOVA was performed to examine the effect of TIME (i.e. PRE and POST) and DOE GROUP on EMOTIONS (PANAS) and on SELF-EFFICACY (GSE). We further checked for interaction effects of TIME and DOE GROUP.

All audio recordings were transcribed verbatim and imported into MAXQDA software. Two authors both coded four interviews using open coding. Next, a coding tree was established through iterative discussion with all authors. The remaining transcripts were coded individually by one author using the coding tree. A discussion session between the two main co-authors was conducted to identify themes using thematic analysis [22]. Those were discussed and agreed upon in a final discussion round between the two main authors and additional two co-authors, who were experienced in psychology and reflection research.

5.2 Participants

We used our extended social network and snowball sampling to recruit participants. In total, $N = 20$ (7 females, 12 males, 1 non-binary); see also Table 3 for more details) participants took part in the study ($M = 29$ years, min : 23, max : 53). They received remuneration of an equivalent of 12€ in the respective currency. Participants were recruited from four research labs within different domains and from industry. Participants self-indicated that they felt mentally stable and healthy at the moment of participation. Most participants had limited experience with VR (14 have used it a couple of times or less and 3 people on a regular basis). In DOE-20, our participant sample had scores similar to the reference values for DOE, indicating "normal" affect processing: for REPCOG ($M = 2.26$,

Table 3: Overview of the participants.

	Age	Gender	Profession	VR Knowledge	Chosen Voice	Duration	Challenge Context
P1	31	male	Student	minimal	Synth. Male	23 min	studies
P2	23	male	Student	minimal	Human Male	19 min	studies
P3	30	male	Project manager	minimal	Human Female	17 min	work
P4	25	male	Student	minimal	Human Female	21 min	studies
P5	28	female	Scient. assist.	minimal	Synth. Male	34 min	relationship
P6	31	male	Scient. assist.	extensive	Synth. Female	21 min	studies
P7	31	female	Scient. assist.	occasional	Human Male	18 min	work
P8	32	female	PhD student	minimal	Human Female	22 min	relationship
P9	32	male	PhD student	extensive	Human Male	10 min	work
P10	25	female	PhD student	occasional	Human Male	22 min	studies
P11	27	female	PhD student	minimal	Human Female	34 min	studies
P12	27	male	PhD student	minimal	Synth. Male	18 min	work
P13	26	male	PhD student	minimal	Synth. Female	28 min	work
P14	28	non-binary	PhD student	occasional	Human Female	36 min	studies
P15	27	male	IT specialist	minimal	Human Female	35 min	friends & family
P16	24	male	PhD student	minimal	Synth. Male	28 min	friends & family
P17	29	male	PhD student	occasional	Synth. Female	33 min	university
P18	26	female	PhD student	minimal	Synth. Female	14 min	friends & family
P19	53	male	Scient. assist.	minimal	Human Female	31 min	work
P20	27	female	PhD student	minimal	Human Female	20 min	studies

$SD = 1.11$) and COMEMO ($M = 1.89$, $SD = 1.10$) versus the reference values [23, 72] of REPCOG ($M = 2.42$, $SD = 0.77$) and COMEMO ($M = 2.01$, $SD = 0.82$). Participants' combined REPCOG-COMEMO score was used to form two groups, one with an elevated (upper half) and one with a lower (lower half) capability of representing and expressing emotions, which we will refer to as HI-EMO and LO-EMO. The two groups will be used to investigate how emotional openness affects the dependent variables (PANAS, GSE, and reflection).

5.3 Study Set-up

The studies were conducted in a 35m² lab and lasted 1h 26min on average (*min* : 55 min, *max* : 1h 50 min). The application was developed in Unity and run on an Oculus Quest 2 using AirLink. The VE was created by the participants themselves, using the toolkit tested for emotional expression from Mood Worlds [88] (see sec. subsection 3.1 for detailed description and Table 1, element 1-3). An additional component was added for the voice-based guidance, delivering the separate prompts when requested by the user (through the VR controller), or based on the user's behaviours (i.e. 30-second inactivity thresholds). A detailed description of the design and implementation of the prototype can be found in sec. 4.

5.4 Procedure

Similar to Prpa et al. [68], we chose an exploratory study design. After giving consent and sharing demographic data, participants completed the DOE-20, PANAS and GSE. Participants then started a tutorial phase, in which they familiarised themselves with the tool's functionality. Afterwards, they were asked to choose their favourite voice (human/synthetic and female/male) for the guidance. While the experimenter set up SelVReflect with the chosen voice guidance, participants were asked to recall and write about an emotionally loaded challenge they had successfully overcome. This approach is based on the Autobiographical Emotional Memory Task (AEMT) [42]. Then, they created a representation of the challenge, its stages and the emotions attached to each stage using SelVReflect. During that, they either requested guidance or it would be proactively provided in case of inactivity. Towards the end, the guidance would ask reflection prompts, inviting participants to "experience" their creation again and approach it from different perspectives. They could choose to think aloud at that moment. When finished, participants filled out PANAS and GSE again. Additionally, they answered the reflection scale TSRI and questions specifically designed to assess their experience with SelVReflect as well as the guidance they received while using it. The study ended with a semi-structured interview.

6 FINDINGS

Based on the evaluation, we gathered quantitative results from the questionnaires, as well as qualitative insights from the interviews. Our findings will be presented in this section.

6.1 Quantitative Findings

Based on visual inspection of our data and the Shapiro–Wilk statistic we could not assume normally distributed data. Therefore, we applied the Aligned Rank Transformation (ART) [93]. Due to a misunderstanding in the task instructions, one participant was excluded in the analysis. When examining participants' choices of the available voices using descriptive statistics, we found that the *human female* voice was chosen 8 times, while the other voices - *human male, synthetic female, synthetic male* - were all chosen 4

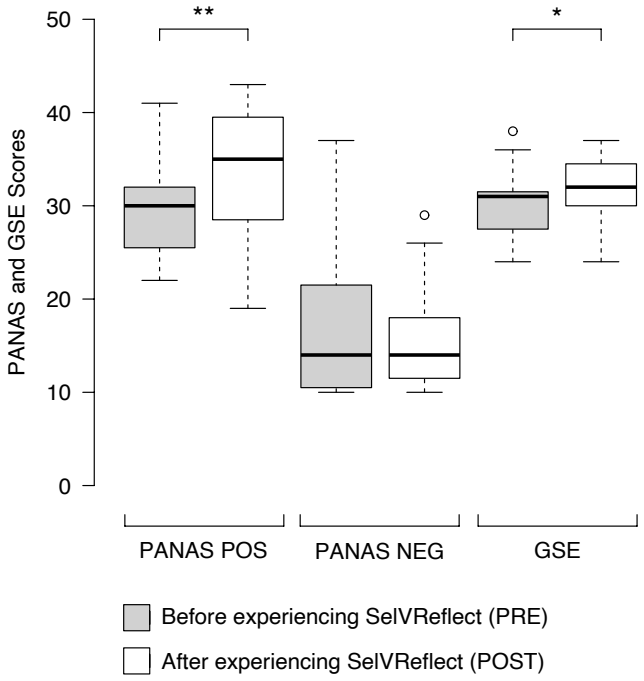

Figure 3: Mean scores for pre and post measurements of PANAS (positive and negative) and GSE scales. Significant results are indicated with * for p<0.05 and ** for p<0.01.

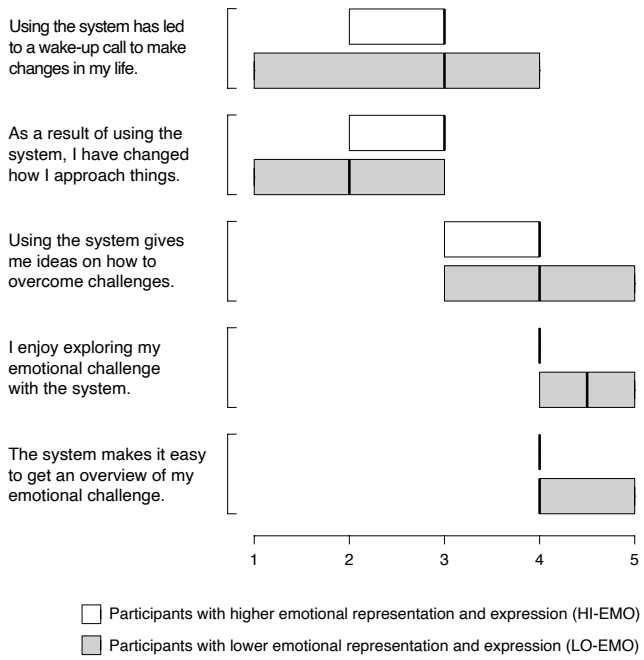

Figure 4: Median ratings and interquartile range for the first five items of the TSRI scale. They are split up for HI-EMO and LO-EMO groups.

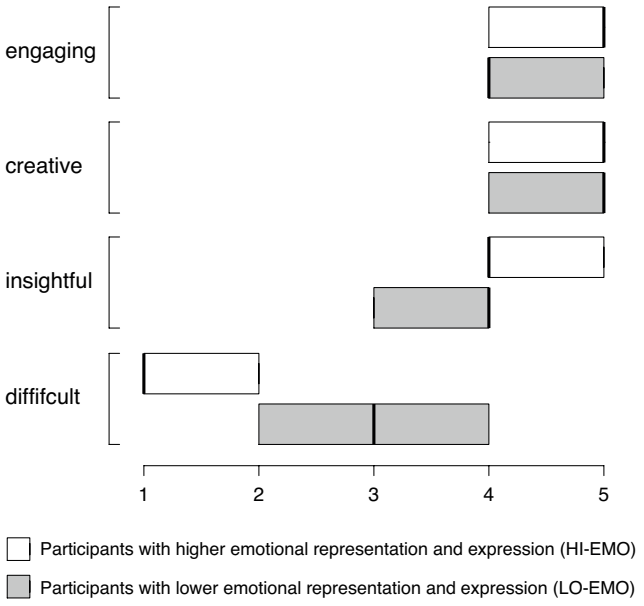

Figure 5: Median ratings and interquartile range for the ratings for the experience of using SelVReflect, split up for HI-EMO and LO-EMO groups.

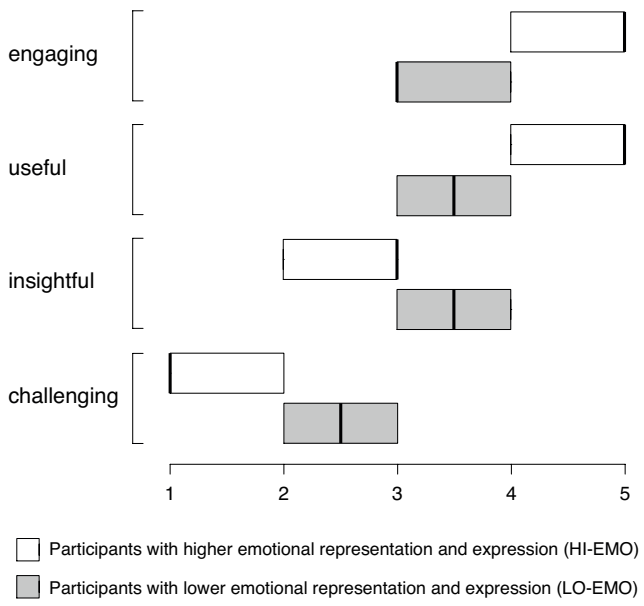

Figure 6: Median ratings and interquartile range for the ratings for the guidance received, split up for HI-EMO and LO-EMO groups.

Table 4: ANOVA statistics for PANAS and GSE scores for factors TIME, DOE_GROUP, TIME DOE_GOUP. Statistically significant results are marked with asterisks (* < .05, ** < .001).

Factor	PANAS Pos.	PANAS Neg.	GSE
TIME	$F = 10.720$	$F = 0.446$	$F = 6.189$
	$p = 0.004^{**}$	$p = 0.513$	$p = 0.024^{*}$
	$\eta^2 = 0.387$	$\eta^2 = 0.026$	$\eta^2 = 0.267$
DOE_GROUP	$F = 0.998$	$F = 4.781$	$F = 2.041$
	$p = 0.332$	$p = 0.043^{*}$	$p = 0.171$
	$\eta^2 = 0.055$	$\eta^2 = 0.220$	$\eta^2 = 0.107$
TIME:DOE_GROUP	$F = 0.335$	$F = 1.998$	$F = 1.224$
	$p = 0.570$	$p = 0.176$	$p = 0.284$
	$\eta^2 = 0.019$	$\eta^2 = 0.105$	$\eta^2 = 0.067$

times. Participants received a prompt approximately every $M = 92s$ ($SD = 33s$).

6.1.1 Emotions (PANAS). The one-way repeated measures ANOVA showed a significant effect of Time on Positive Emotions $F(1, 17) = 10.720, p = .004$ (see Table 4 and Figure 3). We found no significant interaction effects of Time and DOE Group $F(1, 17) = 0.335, p = .570$. We did the same analysis for Negative Emotions (PANAS). The test showed neither a significant effect of Time on the Negative Emotions $F(1, 17) = 0.446, p = .513$ nor an interaction effect of Time and DOE Group $F(1, 17) = 1.998, p = .176$.

6.1.2 Self-Efficacy (GSE). We conducted another one-way repeated measures ANOVA with Time on *GSE* $F(1, 17) = 6.189, p = .024$ showing a significant effect (see Table 4 and Figure 3). Again, we found no significant interaction effects of Time and DOE Group $F(1, 17) = 1.224, p = .284$.

6.1.3 Reflection (TSRI). When considering how participants rated the reflection they engaged in while using SelVReflect, neutral ratings were given to the first two items related to (1) making changes in one's life ($Md = 3, SD = 1.305$) or to (2) the ways in which one approaches things ($Md = 2, SD = 1.170$), as can also be seen in Figure 4. High ratings were given for item (3) the extent to which the system gives ideas to overcome challenges ($Md = 4, SD = 0.994$), (4) the enjoyment of exploring the challenge ($Md = 4, SD = 0.911$), and (5) the ease of getting an overview of the challenge ($Md = 4, SD = 0.946$). Figure 4 divides those results further into participants with higher and lower capability of representing and expressing emotions.

6.1.4 Exploratory Analysis of Experience Ratings. When asked about the experience with SelVReflect, participants gave it positive ratings along various dimensions (on a Likert scale from 1 to 5), including how engaging ($Md = 4.5$), creative ($Md = 5$), and insightful ($Md = 4$) they found the experience. When considering these ratings from the HI-EMO and LO-EMO groups separately, they are generally very similar, as can be seen in Figure 6. However, LO-EMO ratings for difficulty were lower ($Md = 3$) than for HI-EMO ($Md = 1$).

When participants rated the received guidance, it was also highly rated for how engaging ($Md = 4$) and useful ($Md = 4.5$) it was. The guidance was given a rating of $Md = 3$ for how insightful it was. Again, the ratings from the HI-EMO and LO-EMO are very similar (see Figure 5). However, there was a more noticeable difference in the ratings for how challenged they felt by the guide in their process of expression and reflection, with LO-EMO participants $Md = 2.5$ versus HI-EMO $Md = 1$.

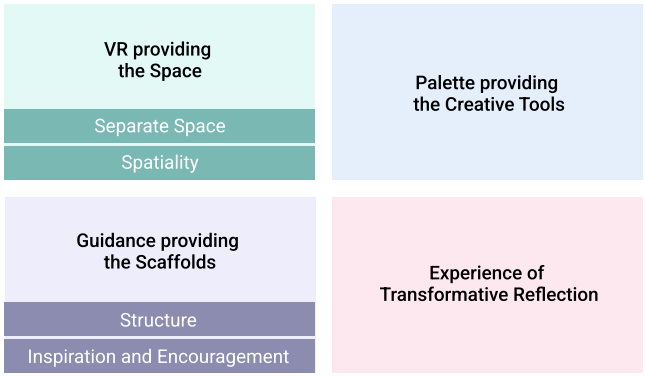

Figure 7: Thematic map of four themes and codes identified in the semi-structured interviews.

6.2 Qualitative Findings

Based on our qualitative inquiry, four themes were derived from the data: *VR Providing the Space*, *Palette Providing the Creative Tools*, *Guidance Providing the Scaffolds*, and *Experience of Transformative Reflection* (see Figure 7). Our findings are described below and illustrated with excerpts from the interviews.

Most of the chosen challenges were related to participants' studies in University (9) or work settings (6), while the remaining (5) were related to friends and family or romantic partners (see also Table 3). Five out of the latter were about deciding on how to allocate time between different friend groups, family, or work. Six challenges were related to interpersonal difficulties as part of studies (e.g. group projects, theses) or professional settings. Four challenges dealt with approaching a major decision (e.g. switching jobs or moving homes) and three were related to adjusting to a new situation or setting (e.g. a new home or job).

6.2.1 VR Providing the Space. The first theme focuses on the specific benefits of VR for facilitating creativity and reflection. It encompasses the codes *Separate Space* and *Spatiality*.

Participants reported that being in VR enabled them to enter a different "mindset". Most participants chose a mostly black (standard or space) environment as a backdrop for their creation, because it provided a "stark contrast" to the university lab space where the study was conducted. A key reason was that VR offers a *separate space* without external disturbing factors, which allowed them to dive deeper into their thoughts. VR can facilitate the experience of flow, to *"almost get lost in whatever you drew, whatever the image you created"* (P5). One participant elaborated on the benefits of VR:

> You're like cut off from everything. You're like in this empty void. It helps a lot of people to be with their thoughts and explore them more because they're cut off and for themselves. (P9)

Figure 8: Two exemplary SelVReflect drawings (above: P4 below: P11). The first row depicts a concrete representation of a challenge. Trees and dice stand for different friend groups (stage 1), sharing an evening together (stage 2), becoming friends (stage 3). The second row depicts an abstract representation. Uncertainty and anger represented with blue smoke, plasma and fire (stage 1), transitioning from mud through smoke by going up a ladder (stage 2), joy of overcoming the challenge in bright colours (stage 3).

VR also allowed participants to utilise the virtual 3D space to express components of their challenge beyond what would be possible in physical reality. For example, they used the third dimension as representation for time or they link the relationships between components of their challenge, as 3D drawing *"makes it easier to show correlations between several things"* (P7).

Further, they utilised the *spatiality* of VR to immerse themselves in, as well as physically, mentally, and emotionally distance themselves from different elements (of their challenge). On the one hand, they enjoyed being surrounded by their creation, exploring their emotional challenge environment through a first-person perspective. This allowed participants to enclose themselves within their drawings, break through their drawings, and become more physically involved in the depiction of their challenge.

> "You can actually 'paint yourself in', completely all around you, if you like, and take up different positions." (P13)

Although 2D figures cannot convey the feeling of being cornered by ones' own drawing, or physically moving through a wall when overcoming a challenge, we have provided previews in Figure 8. On the other hand, participants also enjoyed being able to taking a literal 'step back' from their drawings. This change of perspective led to another experience of the emotions and enabled them to see the whole picture, which sometimes made the problem seem smaller than before.

> I just recognise kind of the third person perspective on your decisions, so putting yourself not in your shoes, but just having a bird's eyes view. There might be something that is interesting and is now more tangible with having done it yourself [in 3D]. (P16)

However, for some the blank space surrounding them created a feeling of being lost, and not knowing where to start. On a similar note, some participants found it challenging to "think in 3D" when drawing and to utilise the complete space available for their creation.

6.2.2 Palette Providing the Creative Tools. As a second theme, we found that the variety of tools provided the means for creative self-expression and reflection. Most participants emphasised that using the palette increased their motivation, and made them think in a more abstract way, so that "visual elements [are used] as a sort of analogy or metaphor" (P19). Objects were mainly used as placeholders for people (see Figure 8) or abstract constructs, such as loss of agency (e.g. dice), personal growth (e.g. tree) or emotions (e.g. fire for anger). Animated brushes were often used to represent emotions and relationships between components. For one example of abstract representation, see Figure 8. One participant clarified:

> I feel like the choice of tools was surprisingly wide enough to try out different things and also to, yeah, express more complex emotions. (P5)

However, this availability of choice was also a limitation for some participants. Roughly half of the participants reported difficulties in choosing a tool, especially at the beginning. As well as some (technical) problems with actually drawing or resizing objects, four participants reported difficulties in identifying emotions, and eight participants were unsure how to visualise them with the provided tools.

6.2.3 Guidance Providing the Scaffolds. The third theme encompasses the reactions to and effects of the voice-based guidance participants were offered throughout the study. We present the codes *Structure* and *Inspiration and Encouragement.*

The guide provided *structure* by encouraging participants to decompose their challenge into smaller stages, which in turn structured their thinking of the challenge's process. Overall, participants' reported feeling reassured by this guidance. Participants emphasised the importance of feeling inspired and encouraged by the spoken prompts. This was due to both their content, which led them to approach components differently, and their tone: *"it's not just about what they say, but how they say it. It helps you relax and ease into it"* (P9). This led them to think in greater detail about the challenge they were depicting. Furthermore, their self-confidence was strengthened by both the tone of the voice and the affirmations it offered. P8 further summarised:

> I really loved the guide. [...] In taking the time to dissect the situation where I was in, I think that really helps also because it made me feel more confident about what I did. It [the guidance] supported me in looking back on it [the situation] and seeing it from multiple perspectives, probably more than what I thought about so far. (P8)

Nevertheless, more than half of the participants expressed a desire for more context-aware guidance. This includes more individual timing and content-specific questioning towards aspects of their creation, e.g. intervening at a specific moment when an important choice was made. They also desired more specific help and inspiration with how they could visually represent specific elements of their emotional experience (e.g., in the form of symbols, visual metaphors etc.).

6.2.4 Experience of Transformative Reflection. Participants reported that they reflected *"along the way" (P15)* by decomposing the challenge, abstractly visualising their emotions, and adding details. This was especially prominent during the Free-Flow phase. In the Re-walk phase, while (re-)experiencing their creation, some participants reported that they felt stimulated by the prompts prompting deeper reflection, while others were less affected. However, all (N=20) agreed that they were successfully reflecting at some point during the SelVReflect experience.

Taking up the opportunities for reflection, participants approached their challenge and its (emotional) components from different perspectives. This led to a change in their conceptualisations of the following:

(1) The challenge itself. They gained new (or deeper) knowledge about the reasons behind the challenge, the emotions involved, and their role within the process (e.g. *"It's an even deeper engagement with the situation [in contrast to writing it down]" (P19); "I thought more about what kicked it off" (P9); "It's a sense of accomplishment, a sense of resolution, also a sense of closure." (P5)*).
(2) Themselves as a person. This encompasses self-awareness about one's character, one's beliefs, and one's role within the social ecosystem. They also felt proud of themselves (e.g. *"That was actually a realisation that I never had before: That talking to people and the opening up and not always trying to solve things by myself, which is what I do now, [is healthy]" (P8)*).
(3) The bigger picture. Participants appreciated their relationships to their friends more than before, discovering alternative approaches or solutions to their challenges, such as thinking in stages, which made them feel better equipped to act more effectively in equivalent scenarios in the future (e.g.*"It [SelVReflect] is a possibility to reflect on certain problems, especially also from an emotional point of view, and to find other approaches and therefore to be able to adapt one's behaviour better"* (P13)).

We want to emphasise that the experience of SelVReflect did not evoke the same level of reflection in all participants. However, even when no perspective change was reported, participants felt reassured by and comfortable with the system.

7 DISCUSSION

In this work, we set out to explore the potential of a VR experience that fosters reflection through guided creative expression **(RQ1)**. To answer this question, we developed SelVReflect through an iterative design process. It facilitates the expression of and reflection upon personal challenges within a VR environment. Provided with an eclectic palette of tools, the users created their own virtual environment, assisted by a voice-based guide that encouraged and supported their abstract expression and motivated them to reflect. We further examined the effects of SelVReflect on the overall experience of reflection **(RQ2)**. We conducted a user study (N=20) in which we tested our approach within the context of reflection on personal challenges. We found that SelVReflect was perceived as an engaging, creative and thought-provoking experience, which had a significant effect on positive affect and self-efficacy of participants. Our findings further indicate that the experience was more difficult for participants with lower affect processing scores compared to those with higher scores - however, despite differences in difficulty, both reached similar outcomes.

In this section, we discuss our main findings and show how SelVReflect relates to and extends existing research. We then outline design recommendations for supporting expressive and reflective tasks in VR. Finally, we discuss limitations and ways forward.

7.1 Reflecting on SelVReflect

SelVReflect has been specifically designed to cater for deep reflection (see section 4), thus addressing a need discussed by Baumer et al. [13] and extending approaches explored by Wagener et al. [88]. To evaluate whether we achieved these goals, we measured reflection through a combined method, as proposed by Bentvelzen et al. [16]. First, we used the TSRI [14], which indicates that a high level of reflection was evoked. Second, our system actively leverages two design resources. It utilises *Temporal Perspective* by triggering past memories of an emotionally loaded challenge, and the guidance to help users dive into' them more deeply. The guidance also encouraged users to engage with internal and/or think-aloud "conversations" with themselves. As a third assessment [16], we conducted a qualitative inquiry. All ($N = 20$) participants mentioned aspects that fit to existing conceptualisations of reflection in literature. Some reported discovering new constructive approaches for challenges [37], gaining (self-)awareness [57] (such as general self-knowledge of how to deal with problems, their relationship

with friends), developing new understandings and appreciation [20] (such as about reasons for the challenge and appreciation of relationships to friends), and feeling empowered or better equipped for the future [61]. We also found no evidence of rumination. On the contrary, qualitative findings indicate an active prevention of rumination as SelVReflect motivates the user to reflect "through" *continued* expression and guidance [85]. Hence, we can confirm that our approach for a guided VR experience actively supports reflection, answering RQ2.

However, the levels of reflection [37] that users reached through SelVReflect differed - some participants' reached level 1 (Reflective Description), while others progressed to level 2 (Dialogic Reflection). While some felt confirmed in their previous perspective on the challenge, others discovered new ways of how they could approach them more effectively in the future. This suggests that transformative reflection took place. Discovering new ways of dealing more effectively with challenging situations is closely related to self-efficacy. Self-efficacy was significantly increased through using SelVReflect. Participants who did not reach higher levels indicated that (i) it might be because they had already reflected extensively on the given challenge, (ii) the chosen challenge would not allow for more discovery, or (iii) because they do not reflect a lot in general. Applying the RIOR model by Jiang and Ahmadpour [43] (for more information see subsection 2.1) could possibly support users in achieving level 2. Adding further functionalities to SelVReflect, such as importing personal photos could help deepen the reflection further. However, this should be carefully considered as it could lead to very different types of expression than the abstract ones SelVReflect is currently designed for.

7.2 Design Recommendations

Based on our findings, we discuss design recommendations for designing VR-based interventions that aim to foster reflection in creative open-ended tasks. We will discuss three specific design recommendations relevant for the HCI community.

In our research, we encountered that users were often confronted with the fear of facing a blank page or canvas [73]. Upon seeing the empty space around them, experiencing the sometimes overwhelming degrees of freedom, and not knowing how to visualise a challenge, some participants were uncertain how to proceed (e.g., [39, 40]). This can inhibit users from entering a state of flow [31]. Guidance can and should create a reassuring atmosphere, a 'framework of freedom' as Rubin [73] calls it. In our case, guidance can mitigate the negative feelings of feeling lost. Thus, especially in the beginning, guidance could be provided rather frequently. Besides talking in a calm and reassuring voice, that is preferably chosen by the users themselves beforehand to reach the best effect, the guidance should provide encouraging prompts similar to approaches from art therapy [31]. To overcome the first stage of blockage or insecurity, we found that more specific *prompts*, such as *"Choose a suitable colour and type of brush that match your feeling and then colour the space around you where you are currently standing"* were most promising. They break down the task into smaller ones to help the user take a step forward. In the "Free-flow" phase, the frequency of the prompts should decline and the context should shift towards theme-based prompts. As an example from our work, each of our prompts was formed by an *inspiration* part, prompting users to think about other topics (e.g. how people were involved, how to connect the phases) and an *encouragement* part. The latter has the aim to give users self-confidence and addresses the need for encouragement for meaningful reflection as proposed by Fleck and Fitzpatrick [37] and Slovák et al. [81]. In line with research showing that human guidance can facilitate flow [31], we propose that voice-based guidance can cater for the same in an exploratory open-ended VR experience. Towards the end of the experience, we found that users have more head-space to process deeper reflection questions than when they were still in the process of creating. The guidance can be used here to provide such questions, e.g. *"Now, focus again on the actions and ideas that helped you overcome the challenge. How did you represent these and how do they tie into the whole process?"*.

Overall, we found that reflection can be successfully supported in-action and on-action with a single intervention [78]. However, we have also shown that guidance for reflection has to constantly adapt to the evolving user needs throughout the whole process. This mirrors findings from personal informatics, in which reflection is also described as a dynamic process over time [15]. Based on these aspects, we recommend that guided VR experiences for reflection should:

Recommendation 1—Provide guidance adjusted to users' changing needs over time, starting with "hands-on" suggestions for specific actions and ending with more high-level reflection probes.

Our findings also revealed some insights into how drawings were made (see Figure 8), about thought processes and the effects of in- and on-action reflection. We found that SelVReflect successfully guided the visualisation process by inspiring and encouraging users. SelVReflect was specifically designed, using VR as medium, a tool palette as means, and voice-based guidance, to cater for autonomous expression. In particular the encouragement part of the guidance has the aim to give users self-confidence and addresses the need for encouragement for meaningful reflection [37, 81]. However, SelVReflect is also designed to provide restrictive scaffolding, to reign in the free flow of expression so that users can actively reflect [81].

As can be seen in the participants' drawings (see Figure 8), participants visualised the challenges in concrete and more abstract ways. As an artifact mirroring participants' thoughts, one can deduce that different mental representations prevail. Participants further reported developing a more structured thought-process, discovered new relationships between components of the challenge, formed new conceptualisations of themselves, and gained appreciation of how these insights may help them in the future. As an understanding lens, we take the Construal Level Theory (CLT) [86] into account. CLT has inspired work on personal growth, well-being and reflection in HCI (e.g. [15, 65]). It describes that when thinking about a situation on a low construal level, thus in a concrete way, users place the focus on the 'how' of the activity. In turn, higher construal and more abstract mental representation show a focus on the 'why' and indicates a greater psychological distance towards the challenge. Related to SelVReflect, we found that a guided VR experience for reflection should support both forms of construing information: On an interpersonal level, some participants need

to be prompted to think more abstract or more concrete to gain deep insights. On an interpersonal level, some participants need to be prompted to think more abstract or more concrete to gain deep insights. On an intra-personal level, and taking the fear of facing a blank page or canvas [73] into account, systems should motivate operating on a low construal level, especially at the beginning of the process, then the system can change the focus and promote conceptualising situations in a higher level of construal. Although SelVReflect seems to succeed in this task for most users, e.g. by using objects to represent complex constructs such as loss of agency, there is still more research and development needed to fine-tune the experience. As an example, adding context-aware prompts and individually-adapted guidance beyond what SelVReflect can currently provide, seem to be promising next steps. Generally, we propose that guided VR experiences for reflection should:

Recommendation 2—Provide encouragement to think and express oneself in an abstract way while providing context-aware scaffolding to facilitate reflection.

We designed SelVReflect to provide users with a fertile (virtual) ground for transformative reflection, leveraging space, means and guidance to support this. As established in previous research, effective reflection benefits from structured support and encouragement [37, 81]. However, as Agapie et al. [2] emphasise, deep reflection also requires effort, which can decrease the enjoyment of the task itself and lead to a loss of motivation to persevere. In addition, excessive scaffolding can also decrease the level of creativity in reflection and reduce the potential for lasting transformation. The risks of hindering reflection can be mitigated when autonomy and joy are a central focus of the design.

Hence, to inform designs striving to guarantee transformative reflection, systems should place careful attention not to detract from their sense of autonomy and self-actualisation. To be more precise, systems should strike the right balance between motivating users to reflect and allowing "breathing room" for joy and playful expression. Our findings emphasise the importance of free choice and the benefits of step-specific guidance that withholds from authoritative statements to guarantee creativity, flow and playful expression. Thus, we recommend that guided VR experiences for reflection should:

Recommendation 3—Provide *reflective "stimulation"* instead of *instructions* to facilitate reflection.

7.3 Limitations and Future Work

In this section, we discuss the limitations of SelVReflect. Although we carefully designed SelVReflect, paying special attention to the timing of prompts, the guidance still interrupted some participants in undesirable ways. In particular, subsequent prompts were triggered prematurely for those who took more time in selecting colour hues. Although some commented on this during the interviews, it was usually not disruptive to the general flow, although not helpful for reflection in those cases. As Reicherts et al. [70] discuss, the key reason for prompts not being perceived as disruptive can be due to the nature of an open-ended and/or creative task.

Furthermore, we could not compare experiencing SelVReflect to a control group using another pre-existing application, as it offers a completely new technology-supported experience. For instance, it goes beyond translating art therapy into VR, extending previous research in this regard (e.g. [39, 40]), combining drawing with other components such as sound, three-dimensional environments, light, animation and (user) movement [88], and providing voice-based guidance specifically designed for expressive reflection in VR, forming a new experience altogether. Consequently, it is challenging to identify a valid baseline to compare the prototype with. Given the novelty of this experience, it is thus more meaningful to first explore how and what it enables users to create and discover, as we endeavoured to understand in this work. Nevertheless, based on the exploratory evidence generated in this study concerning the interplay between the key constructs (e.g. relationship between guided, expressive reflection and self-efficacy), future studies on similar tools could further formalise them as hypotheses as part of an experimental design. In our study, we also empowered users to choose a comfortable-sounding voice, as research suggests that preference for gender or human-likeness varies on an inter- and intrapersonal level, and is context-specific [28, 62, 64, 84]. Yet, the identified gender of an agent can influence the user experience [18, 21]. Although in our study it was more valuable to make users comfortable with the guidance (and reduce potential confounding factors, e.g. due to discomfort), we gave users the option to choose their preferred voice (and it was thus included as a "feature" of SelVReflect). However, future work could extend our research and investigate the effects of gender, tonality and human-likeness on expression and reflection in a controlled experiment with separate conditions.

Additionally, we did not check for the reflective capacity of the participants beforehand, as suggested by Bentvelzen et al. [14]. Instead, we focused on how the expression of emotions would affect reflection. As the ability to express one's emotions is tightly linked with participants' affect processing, we chose to assess their representation and expression of emotions, as measured by the DOE-20 [72]. Still, we advise future studies to include a measurement of reflective capacity, e.g. through SRIS [14], as this could reveal interesting insights into how people who reflect less may benefit more from SelVReflect. We also want to point out that we tested SelVReflect mostly with people with tertiary education. While reflective capacity develops with age and also within an educationally stimulating environment [60], it also varies among individuals and it cannot be deduced that reflection capacities are lower in lower educational levels. Nevertheless, we cannot assume that our findings apply to everyone across social groups and socioeconomic status without further research.

Further, three participants emphasised the risks of SelVReflect when used in a more therapeutic setting, e.g. as a tool to deal with ongoing and unfinished challenges. However, one participant also emphasised the opportunities of exploring such unfinished challenges despite certain constraints of the current system: (*"A lot of challenges that came to mind are still in this destructive phase. That's why I think it would have been exciting to do that. But I would probably have missed things, like the world bursting into flames." (P7)*). This shows how SelVReflect can trigger the desire in some users to deeply and extensively express themselves and their emotions, and how it can be approached as part of an intervention with multiple, continued applications. It appears plausible that the creative reconstruction of past events can positively impact and facilitate transformation at a later stage. However, while this highlights our

approach's potential to be useful in other fields, such as emotion regulation and problem-solving, this was not the focus of our research. We want to emphasise that the effects of using systems similar to ours for self-care approaches - in particular for unfinished challenges - remain unclear and need to be carefully researched, to investigate the psychological effects and potential risks when being able to set the VE "bursting into flames". Although mental health experts see the benefits of at-home self-care, they also emphasise the risks of getting stuck in negative emotion cycles [34]. They are concerned that negative feelings might increase when exposed to and immersed in strong negative emotions without professional guidance [87], which suggests that more research is needed on how VR applications should be specifically designed to support people to cope with negative emotions. However, it is necessary for us to point out that, while findings of SelVReflect indicate an active prevention of rumination, these results can only be supported for our specific setting. Thus, future studies should revisit this topic and test SelVReflect with professionals.

8 CONCLUSION

To provide a novel way to reflect, we created SelVReflect - a guided expressive VR experience to foster reflection. Through a user-centered design process (N=5) and a mixed-methods study (N=20), we showed how this experience could lead to new insights into past challenges and oneself through drawing in the three-dimensional space. SelVReflect enabled participants to draw connections between the different components of past challenging experiences, (re-)approach them from new perspectives, and in some cases even helped them identify (new) constructive ways of approaching similar challenges in the future. Furthermore, the quantitative analyses revealed that expressive reflection in VR is not only considered highly engaging and insightful but it also enhances positive affect and self-efficacy. In sum, there seems to be promise in building VR experiences for reflection in which users can freely express themselves while also having the chance to receive inspiring and encouraging guidance. However, to strike the right balance between autonomy and scaffolding guidance requires careful crafting of the timing, content, and phrasing. We hope our work and design recommendations inspire designers and researchers to further explore this promising research field.

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