Social Augmentation for Group Therapy: A Co-located Mixed Reality Experience for Eating Disorder Prevention

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Abstract

Social XR systems can augment human connection by making socio-emotional processes visible, shareable, and actionable. We present *The Tree of Self*, a co-located, multi-user Mixed Reality (MR) experience that augments group Dialectical Behaviour Therapy (DBT) sessions for adolescent eating disorder (ED) prevention by externalizing emotion regulation (ER) dynamics into shared, interactive metaphors. The experience overlays a communal "tree" that reflects collectively identified triggers and maladaptive strategies, and individual "stars" charged through skill verbalization and validated by the facilitator, treating MR artifacts as boundary objects that scaffold shared attention, peer-supported reflection, and discussion while preserving therapist oversight. Framed within Social XR's agenda of shaping future human connection through social augmentation, we discuss implications for responsible, inclusive design in sensitive group settings and outline next steps toward longitudinal deployment and personalization.

Keywords

eating disorder, Dialectical Behavior Therapy, emotion regulation, social XR, mixed reality, co-located multi-user interaction, mental health

1. Introduction

Preventing eating disorders (EDs) among young people is a pressing global health priority. EDs are characterized by maladaptive eating behaviors and harmful weight-control practices, and they represent a significant public health concern, particularly for adolescents and young adults, due to their profound medical, psychological, and social consequences [1]. These disorders impose substantial burdens on individuals, families, and healthcare systems, contributing to high healthcare costs and ranking among the leading causes of mental disability worldwide [2]. Despite their severity, more than 80% of individuals affected by EDs do not receive treatment [3, 4], underscoring critical gaps in early detection and prevention efforts. Consequently, the development and large-scale deployment of effective preventive interventions has become a key public health and research objective. Such efforts are especially crucial during adolescence and young adulthood—developmental periods marked by heightened vulnerability and the typical onset of many EDs [5]. To develop effective prevention strategies for this vulnerable demographic, it is essential to first understand the underlying psychological mechanisms that drive these disorders, particularly the role of emotion regulation.

2. Background and Motivation

Multiple theoretical frameworks explain the development and persistence of eating disorders (EDs) by highlighting the central role of affective processes and the interaction between cognitive and emotional mechanisms [6]. Empirical evidence further indicates that emotional states, and particularly the emotion regulation (ER) cycle, are key contributors to both the onset and maintenance of EDs [7]. ER refers to the set of automatic and deliberate strategies used to identify, understand, and modulate emotional

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experiences [8]. Individuals with emotion dysregulation show difficulties in flexibly directing attention and regulating behaviour in response to emotional states [8], and this dysregulation has been identified as a transdiagnostic vulnerability factor closely linked to ED psychopathology. Compared to healthy controls, individuals with EDs rely more on maladaptive strategies such as rumination, avoidance, and emotional suppression, and less on adaptive strategies such as reappraisal, problem solving, and emotional acceptance [9, 10], and present greater overall difficulties in regulating emotions [11, 12]. ER has also been identified as a critical mechanism in the development and persistence of disordered eating behaviours [13], with rumination, repetitive negative thinking, and non-acceptance of emotions associated with more severe ED symptomatology in both clinical and non-clinical populations [14].

Given the central role of emotional processes in ED vulnerability, there is growing consensus that preventive interventions should explicitly target underlying emotional dynamics, including ER processes. In this context, third-wave therapies, which extend cognitive-behavioural traditions by incorporating acceptance, mindfulness, dialectical principles, therapeutic relationship, and values-based work, have gained increasing attention [15]. The strategies used in these approaches are largely oriented towards strengthening ER capacities and promoting psychological flexibility and acceptance, including mindfulness practices, distress tolerance skills, defusion techniques, and decentring exercises [16]. Preventive research supports their potential, with a recent meta-analysis showing significant pre–post and follow-up reductions in ED symptoms compared to control conditions, although not significantly different from other active treatments such as cognitive behavioural therapy [17]. Among third-wave approaches, Dialectical Behaviour Therapy (DBT) has shown the largest effects in reducing ED symptomatology, a pattern consistent with findings in clinical ED populations [18]. DBT is grounded in a comprehensive, empirically validated model of affect regulation and specifically targets emotional mechanisms known to precipitate and maintain disordered eating and body image disturbances [18].

While several DBT strategies make it particularly suitable for preventing emotion dysregulation and maladaptive ER patterns in young people at risk of EDs, significant challenges remain. When delivered in preventive contexts, some studies have reported difficulties among students in understanding and working with the abstract cognitive-emotional concepts involved in DBT interventions [19]. In addition, attrition remains a significant challenge, with dropout rates typically ranging between 17% and 33% [20], which threatens the validity and real-world impact of these programmes. These limitations highlight the need for novel approaches that enhance engagement, facilitate experiential understanding, and improve retention in DBT-based preventive interventions for EDs.

To address these challenges, we propose leveraging Mixed Reality (MR) technology to make abstract emotional concepts more tangible. The following sections will detail our proposed co-located group-based MR intervention, designed specifically to overcome these barriers by providing a shared, interactive environment for emotional learning. However, the integration of immersive technology into mental health prevention cannot be approached as a mere technical translation of existing manuals. To successfully bridge the gap between abstract therapeutic principles and the concrete needs of vulnerable adolescents, it is essential to ground the technological development in the lived realities of the target users. Consequently, our proposed solution began not with software implementation, but with a rigorous participatory framework designed to ensure clinical meaningfulness and emotional safety.

3. Co-Design Process and Stakeholder Engagement

The design of the proposed MR intervention was grounded in a participatory, user-centred co-design approach that actively involved key stakeholders throughout the early stages of development. This approach was chosen to ensure that the resulting system was clinically meaningful, emotionally safe, and aligned with the lived experiences, needs, and expectations of those directly affected by EDs and their prevention.

Four focus groups were conducted with distinct stakeholder groups. The first focus group involved young adults with current or past experiences of EDs, who provided first-hand insights into emotionally triggering situations, maladaptive coping strategies, and perceived barriers to engaging with preventive

and therapeutic interventions. This group contributed rich experiential accounts of daily contexts associated with emotional dysregulation, body image concerns, and disordered eating patterns, which were essential for identifying realistic scenarios and meaningful targets for intervention.

The second focus group was conducted with family members and caregivers of individuals with eating disorders. Their participation enabled the exploration of relational dynamics, environmental stressors, and early warning signs of emotional and behavioural dysregulation that may not be fully visible to patients themselves. Caregivers also provided valuable perspectives on feasibility, acceptability, and potential challenges related to the implementation of technology-based preventive interventions in everyday contexts.

The third focus group brought together clinicians and experts in the treatment of eating disorders, including professionals with extensive experience in DBT and emotion regulation-focused interventions. This group contributed clinical expertise on core therapeutic mechanisms, critical risk factors, and evidence-based strategies, as well as guidance on ethical considerations, therapeutic boundaries, and safety requirements when translating psychological interventions into immersive technological formats.

A fourth focus group, involving four school and university psychologists, focused specifically on preventive interventions for EDs and emotion dysregulation within educational settings. Participants discussed current needs and gaps in schools and universities, and explored how PrevED could be implemented in these contexts. They also reflected on the potential advantages and disadvantages of adopting PrevED, along with key challenges, opportunities, and practical considerations for successful implementation in those settings.

Following the completion of the focus groups, the multidisciplinary research team, composed of psychologists, HCI researchers, and extended reality designers and developers, conducted a series of collaborative analysis and design sessions. Qualitative data from the focus groups were reviewed, discussed, and thematically analysed to identify recurring patterns, unmet needs, design opportunities, and potential risks. These insights were then translated into concrete design requirements and interaction concepts for the MR intervention.

4. Co-Located Group-Based Mixed Reality Intervention

The proposed intervention is implemented as a co-located, group-based mixed reality experience designed to support and augment DBT sessions. Both the therapist and participants wear head-mounted displays (HMDs) and share a synchronised mixed reality environment in which virtual elements are anchored to the same physical space. This enables all users to see and interact with the same augmented objects in real time, from their own physical perspectives, while remaining aware of each other's presence. By combining shared spatial context, embodied interaction, and real-world grounding, the system creates a collective experiential space in which emotional processes, cognitive patterns, and therapeutic exercises can be externalised and explored collaboratively during the intervention.

4.1. Shared Garden Metaphor: Externalising Triggers and Emotions

Prior to each MR session, the therapist draws on individual clinical knowledge acquired through previous one-to-one therapeutic work with each participant. This includes a structured list of emotionally triggering situations, related with body, weight or food concerns, that have been identified during the previous weeks, which is compiled in a CSV format and loaded into the MR system before the group experience.

At the beginning of the MR experience, participants and the therapist are immersed in a shared virtual garden environment. At the centre of this environment stands a large tree, which is introduced by the therapist as a symbolic representation of the user emotional state. This metaphor is used to anchor the experience emotionally and conceptually, helping participants situate the subsequent exercises in relation to their own identity and internal states.

Using a dedicated therapist interface, the facilitator then spawns the list of triggering situations around the central tree. Each triggering situation appears as a floating thought cloud, visually representing

Figure 1: Shared mixed reality environment showing the central tree and thought clouds representing triggering situations.

Figure 2: Selection of emotions associated with a triggering situation using coloured spheres in the shared mixed reality environment.

Figure 3: Attachment of selected emotions to a triggering situation through direct manipulation of coloured spheres in mixed reality.

Figure 4: Catastrophising.

Figure 5: Experiential avoidance.

Figure 6: Expressive suppression.

Figure 7: Self-criticism.

Figure 8: Rumination.

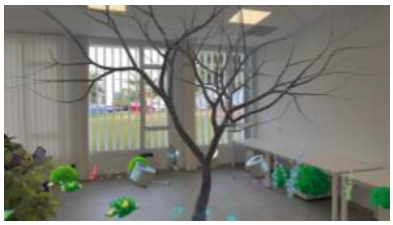

Figure 9: Overcontrol.

Figure 10: Explosive behaviour.

intrusive or recurrent thoughts associated with emotional distress (Figure 1). These clouds are spatially arranged around the tree, creating a shared visual landscape of the group's emotional triggers. Through group discussion, participants collectively decide which triggering situation they wish to explore during the session.

Once a specific cloud is selected by touching it, six coloured spheres appear around it, each representing one of the basic emotions: anger, joy, sadness, surprise, fear, and disgust (Figure 2). Participants are invited to reflect on their own emotional responses to the selected triggering situation and to indicate

which emotions are involved by dragging the corresponding spheres towards the cloud. As emotions are attached, the cloud dynamically changes colour to reflect the selected emotional states (Figure 3).

4.2. From Triggers to Coping: Visualising Maladaptive Strategies

Once the triggering situation and associated emotions have been identified, the group moves on to explore the maladaptive strategies that participants typically use to cope with those emotional states. This phase focuses on making habitual, often automatic regulation patterns visible and discussable by externalising them into the shared mixed reality environment.

The system supports up to seven common maladaptive emotion regulation strategies, each represented through a distinct adverse phenomenon that primarily affects the central tree and the surrounding environment. These visual metaphors, inspired by the feedback collected during the focus groups, were designed to be immediately interpretable, emotionally resonant, and consistent with the underlying psychological processes.

- **Catastrophising** is represented as heavy rain, symbolising the amplification and overwhelming nature of negative predictions (Figure 4).
- **Experiential avoidance** appears as dense fog that obscures vision, representing emotional disengagement and withdrawal (Figure 5).
- **Expressive suppression** is visualised as falling snow that covers the environment and mutes expression (Figure 6).
- **Self-criticism** is depicted as a wildfire damaging the tree, reflecting its destructive and self-attacking quality (Figure 7).
- **Rumination** takes the form of a tornado circling the tree, conveying repetitive and uncontrollable thought loops (Figure 8).
- **Overcontrol** is represented by the tree being overwatered until it becomes saturated and begins to rot, illustrating rigidity and excessive constraint (Figure 9).
- **Explosive behaviour** is visualised as a thunderstorm with sudden lightning and loud effects, reflecting emotional outbursts and loss of control (Figure 10).

Using the therapist control interface, the facilitator activates the visualisation corresponding to the maladaptive strategy being discussed. As each phenomenon is triggered, it dynamically alters the shared environment in real time, allowing all participants to simultaneously observe its impact on the tree and the surrounding space. This collective visualisation supports group discussion, perspective sharing, and reflective dialogue, helping participants recognise their own patterns in an external, non-judgemental way. By transforming abstract coping strategies into tangible, environmental changes, the system facilitates emotional insight and prepares the ground for subsequent work on adaptive regulation strategies.

4.3. Restoration Phase: Dialectical Therapy and Emotional Regulation

The final phase of the experience focuses on supporting the transition from maladaptive regulation patterns to adaptive, healthy coping strategies, in line with core principles of DBT. Specifically, this phase operationalises the dialectical movement between acceptance (acknowledging and validating internal experience) and change (committing to effective action), by guiding participants to explicitly identify what they typically do when emotionally triggered and to rehearse alternative responses drawn from the DBT skills taught in the programme (i.e., mindfulness, emotion regulation, and distress tolerance exercises).

Using the therapist control panel, the facilitator spawns a luminous star in front of each participant (Figure 11). Participants are then invited to describe, aloud, how they would shift from the maladaptive strategy previously discussed and visually represented to a more adaptive and healthy regulation strategy, using the specific DBT exercise practiced in that session. For instance, in a mindfulness session,

participants charge the star by applying Observe–Describe–Participate skills with a non-judgmental stance; in an emotion regulation session, they charge it by outlining the steps of the skill they will use, such as emotion labeling and Check the Facts, or carrying out the opposite Action; and in a distress tolerance session, they charge it by describing the crisis-survival strategy they would implement. As participants speak, the star responds in real time, flickering and gradually increasing in brightness, visually representing the process of "charging" it with emotional and cognitive energy. This neutral, light-based feedback is intended to reinforce verbalisation, self-reflection, and intentionality in the formulation of adaptive responses.

Once a participant has performed the verbalisation exercise, the therapist can validate the response using the control interface. If the articulated strategy is considered appropriate and healthy, the star changes colour from a neutral yellow tone to a vivid pink, providing immediate visual confirmation of validation. If the response is incomplete, unclear, or maladaptive, the therapist can choose to deactivate the star, prompting further reflection and guidance. This mechanism allows the therapist to maintain clinical oversight while preserving the experiential and interactive nature of the task.

When all participants have successfully charged and validated their stars, they are invited to physically grasp them and bring them towards the central tree. As the stars approach, their energy is transferred to the tree and the surrounding environment, gradually neutralising the previously activated adverse phenomena. Once all stars reach the tree, the environment transitions to a restored state, and the tree visibly heals and blooms with pink flowers (Figure 12). This transformation symbolically represents emotional repair, resolution of the triggering situation, and the successful application of adaptive regulation strategies, marking the end of the mixed reality experience.

Figure 11: Participant charging and placing a validated star to heal the tree during the adaptive regulation phase.

Figure 12: Resolved state of the environment, with the tree healed and blooming after successful application of adaptive strategies.

5. Future Work

In order to assess real-world value, future work will prioritize longitudinal evaluation in preventive DBT settings to examine whether MR-supported engagement translates into sustained skill acquisition and transfer outside the session. This includes studying retention and attendance over time, perceived comprehensibility of DBT concepts, and whether participants report increased confidence applying skills in daily life—particularly in emotionally triggering contexts relevant to ED vulnerability.

Second, we plan to expand personalization in ways that remain clinically safe and therapist-governed. While the current metaphors were designed to be immediately interpretable, stakeholders may differ in what feels resonant or non-triggering; thus, we will explore configurable metaphor "families" (e.g., alternative visualizations for the same maladaptive pattern), adjustable intensity levels, and options that better reflect individual lived experience—recognizing that one user's "storm" might be another's "drought." Importantly, such personalization should preserve shared legibility for group discussion while enabling individual relevance.

Third, we will explore how the system can be adapted for implementation in school/university

prevention contexts (e.g., shorter modules, space constraints, differing group sizes), without undermining therapeutic fidelity.

Finally, we aim to refine the system's instrumentation and reflection support, exploring privacy-preserving ways to capture session-level interaction traces (e.g., selected triggers, chosen emotions, sequence of metaphors) that therapists could use for post-session reflection and personalization in subsequent sessions—without shifting the focus away from human-led therapy.

Together, these steps advance the overarching goal of transforming MR from a spectacle into a quiet, dependable tool for resilience: supporting young people in recognizing emotions, naming patterns, and rehearsing healthier regulation in ways that generalize beyond the MR room.

6. Conclusion

This work explored the potential of Mixed Reality not merely as a medium for visualization, but as a shared space for emotional externalization. By transforming abstract DBT concepts—such as rumination or acceptance—into tangible, environmental phenomena, we aim to lower the cognitive barrier for adolescents engaging in preventive interventions.

However, we reflect that the value of this system lies not in the graphical fidelity of the holograms, but in its capacity to serve as a "boundary object" between the therapist and the group. Unlike typical VR experiences that isolate users in separate virtual worlds, our MR co-located approach prioritizes the shared reality, ensuring that technology amplifies, rather than replaces, the therapeutic alliance. The artifacts—the tree, the storms, the stars—are merely scaffolds for the difficult conversations that must happen in the real world.

Our broader contribution is an HCI perspective on Social XR as social augmentation for sensitive mental health contexts: rather than replacing in-person interaction, co-located MR can function as a collective experiential medium that supports shared attention, reflection, and coordinated meaning-making. We hope this work encourages further research on how immersive technologies can be designed not for spectacle, but for therapeutic clarity—helping young people articulate difficult internal experiences and rehearse healthier responses together, guided by a facilitator, in ways that can extend beyond the MR session.

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Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT-5.2 in order to: grammar and spelling check. The authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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