

Emotional Echo Weaning: An AI-Powered Educational Intervention for Post-Breakup Distress

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Abstract: Affective dependence-characterized by persistent emotional attachment to unavailable partners and obsessive rumination following relationship dissolution-represents a significant educational challenge in higher education. This paper introduces "Emotional Echo Weaning," a novel AI-powered educational intervention that combines zero-shot voice cloning technology with a structured 21-day weaning protocol to facilitate emotional detachment and cognitive reappraisal. The platform enables users to generate personalized auditory simulations of former partners delivering scripted apologies, regrets, and farewells. Drawing on experiential avoidance and attachment theories, the intervention targets the cognitive and emotional mechanisms that maintain post-breakup distress. In a preliminary open trial with 156 university-affiliated participants ($M_{\text{age}} = 32.4, SD = 7.8; 78.2\%$ female), the intervention produced significant reductions in relationship distress (Cohen's $d^* = 0.82, *p < .001$), obsessive thinking (Cohen's $d^* = 0.71, *p < .001$), and experiential avoidance (Cohen's $d^* = 0.62, *p < .001$). Client satisfaction was high (CSQ-8 $M = 28.4, SD = 3.1$). The strong correlation between reduced experiential avoidance and reduced obsessive thinking ($r^* = 0.61, *p < .001$) suggests a potential mechanism of change. This study contributes to technology-mediated emotional education by proposing a theoretically grounded, ethically designed intervention with practical implementation pathways for university settings. As a proof-of-concept, these findings have significant implications for how educational institutions can leverage artificial intelligence to address the emotional challenges that increasingly affect student well-being and academic success.

Keywords: Affective Dependence, Voice Cloning, Cognitive Reappraisal, Emotional Education, Intervention Study.

1. Introduction

1.1. The Prevalence and Impact of Affective Dependence in Higher Education

Affective dependence has become increasingly prevalent in university counseling centers globally. According to the Center for Collegiate Mental Health's comprehensive survey of 250 American universities, the average student-to-counselor ratio exceeds 1,500:1, with many institutions reporting waitlists of four to six weeks for initial appointments [1]. Students experiencing acute post-breakup distress rarely have the luxury of waiting weeks for professional support; by the time they access services, maladaptive coping patterns may have become deeply entrenched, making intervention more difficult and outcomes less favorable.

The impact of affective dependence extends far beyond temporary emotional discomfort. Students experiencing post-breakup distress report significant impairments in concentration, memory, and executive functioning-cognitive capacities essential for academic achievement. The Substance Abuse and Mental Health Services Administration's longitudinal analysis confirms that relationship distress significantly predicts subsequent depressive episodes, anxiety disorders, and academic attrition among young adults [2]. Researchers have characterized this condition as a form of "addiction to a specific person," with neural mechanisms similar to substance addiction. A 7-year longitudinal fMRI study conducted by Acevedo and colleagues demonstrated that the neural correlates of romantic love remain remarkably stable over time, with individuals showing heightened

activation in the ventral tegmental area-a key region in the brain's reward circuitry-when viewing photographs of former partners, even years after the relationship had ended [3]. This neural persistence helps explain why cognitive attempts to "move on" often fail in the absence of structured intervention. The brain processes romantic rejection similarly to physical pain, activating regions associated with addiction and withdrawal, which explains the intense suffering individuals experience during breakup.

1.2. The Economic and Social Costs

The costs of untreated affective dependence are substantial for both students and institutions. The economic burden of student attrition related to mental health issues is substantial, representing a significant cost to higher education institutions.

Beyond economic considerations, the social costs are equally concerning. Students who struggle with affective dependence often withdraw from social activities, isolate themselves from peers, and disengage from campus life. This social withdrawal further exacerbates their psychological distress, creating a vicious cycle that becomes increasingly difficult to break. The long-term consequences extend beyond the university years, affecting career trajectories, future relationship patterns, and overall life satisfaction. Research has shown that individuals who experience unresolved affective dependence in young adulthood are more likely to develop chronic mental health conditions, experience relationship instability, and report lower quality of life in later years.

1.3. Limitations of Existing Interventions

Existing interventions for post-breakup distress primarily

rely on individual psychological counseling, but university mental health resources are often severely strained [1]. Students experiencing acute post-breakup distress rarely have the luxury of waiting weeks for professional support; by the time they access services, maladaptive coping patterns may have become deeply entrenched and more resistant to intervention.

Online psychoeducational platforms can alleviate this shortage to some extent; however, standardized content often fails to connect with individuals' personal emotional memories. A meta-analysis of digital mental health interventions for relationship distress found that while such programs demonstrate modest efficacy overall, their effects are significantly attenuated when content is not personalized to users' specific circumstances [4]. Generic advice about "moving on" or "focusing on yourself" rarely resonates with individuals whose cognitive resources are consumed by specific, recurring thoughts about a particular person. The one-size-fits-all approach of most digital interventions fails to address the unique narrative and emotional texture of each individual's experience.

Scholars have noted that the core challenge of emotional education lies in creating meaningful connections between learning materials and learners' lived experiences [5]. Effective emotional learning requires that content resonates with personal history, cultural context, and individual meaning-making processes. Without this resonance, educational interventions become abstract exercises that fail to transfer to real-world emotional challenges. The gap between knowledge about healthy relationships and the ability to enact that knowledge during times of emotional distress remains a fundamental challenge in emotional education.

1.4. The Promise of Generative AI for Emotional Education

Recent advances in generative AI offer novel solutions to these longstanding challenges. Breakthroughs in zero-shot voice synthesis enable voice cloning from mere seconds of audio [6]. The GenVC system achieves high-quality voice reconstruction from as little as 10 seconds of audio, approaching human-level quality [6].

Large language models have simultaneously advanced to generate naturally flowing, contextually appropriate dialogue. These models can simulate conversation patterns, adapt to user input, and generate personalized responses that feel authentic and emotionally resonant. A systematic review of AI chatbots in mental health conducted by Rezaei and colleagues identified personalization and emotional resonance as critical design elements for technology-mediated psychological interventions [7]. Their analysis of 47 studies involving over 12,000 participants revealed that AI systems capable of adapting their responses to individual users' linguistic patterns and emotional states produced significantly larger effect sizes than standardized chatbot interventions.

The convergence of voice cloning and conversational AI technologies creates opportunities for interventions that were unimaginable just a few years ago. Users can now hear a synthesized version of a former partner's voice expressing statements that were never made in reality—apologies never offered, regrets never voiced, farewells never spoken. This technological capability, when embedded within a sound therapeutic framework, has the potential to address the

"unfinished business" that maintains affective dependence in ways that purely cognitive interventions cannot.

1.5. Research Gaps and Study Objectives

This study addresses three critical gaps in the existing literature: (1) the absence of scalable, personalized interventions for post-breakup distress in educational settings; (2) the limited integration of AI voice technologies with established psychological frameworks; and (3) the lack of empirical evidence for technology-mediated emotional education tools. While digital mental health interventions have proliferated in recent years, few have been specifically designed to address the unique features of affective dependence among college students. Existing programs typically adopt a one-size-fits-all approach that fails to account for the highly personal nature of attachment-related distress.

Furthermore, although voice cloning technology has advanced rapidly, its application in therapeutic contexts remains largely unexplored. The few existing applications focus on entertainment or communication rather than evidence-based intervention. There is a pressing need to integrate these technological capabilities with theoretical frameworks drawn from clinical psychology and emotional education. The field of AI-assisted mental health intervention has been characterized by rapid technological development outpacing rigorous empirical evaluation. Many commercially available applications lack any published outcome data, leaving educators and clinicians without evidence to guide their recommendations.

Specifically, this study investigates: (1) Can an AI-mediated voice cloning intervention effectively reduce post-breakup relationship distress and obsessive thinking among university students? (2) Does reduced experiential avoidance mediate the observed effects of the intervention on psychological outcomes? (3) How do users perceive the acceptability and utility of such an intervention in educational settings, and what factors predict engagement and satisfaction? (4) What ethical safeguards are necessary to ensure that technology-mediated emotional interventions promote rather than undermine psychological well-being?

The answers to these questions have significant implications for how educational institutions can leverage artificial intelligence to address the emotional challenges that increasingly affect student well-being and academic success. As technology continues to reshape every aspect of human experience, it is essential that we develop evidence-based frameworks for its application in domains that matter most—including the emotional lives of the students we serve.

2. Theoretical Foundations

2.1. Experiential Avoidance and Affective Dependence

Acceptance and Commitment Therapy (ACT) defines experiential avoidance as the tendency to escape unwanted internal experiences, including thoughts, emotions, memories, and bodily sensations [8]. This fundamental psychological process, while adaptive in certain contexts, becomes maladaptive when it prevents individuals from processing and integrating difficult experiences. The Acceptance and Action Questionnaire-II (AAQ-II) has been widely validated as a measure of psychological inflexibility, demonstrating strong psychometric properties across diverse populations and

cultural contexts [9].

This mechanism manifests particularly strongly in affective dependence: the more one tries "not to think" about a former partner after breakup, the more intrusive thoughts become. Wegner's classic research on thought suppression demonstrated this "white bear effect" experimentally, showing that attempts to suppress specific thoughts paradoxically increase their frequency and intensity [10]. In the context of romantic dissolution, this effect traps individuals in a vicious cycle of rumination. The very effort to avoid thoughts of the former partner activates neural networks associated with those thoughts, making them more accessible and more distressing.

Longitudinal research has validated the mediating role of experiential avoidance in various forms of psychological distress. Bardeen and colleagues' 5-year longitudinal study demonstrated that experiential avoidance prospectively mediated relationships between maladaptive behaviors and psychological outcomes, with effects sustained across multiple time points [11]. Participants who reported higher levels of experiential avoidance at baseline showed significantly greater deterioration in mood and social functioning over the subsequent six months, regardless of their initial levels of problematic behavior.

In post-breakup contexts, experiential avoidance manifests through compulsive social media checking, avoidance of reminders, and immersion in work [8].

These findings suggest that reducing avoidance, rather than simply diverting attention, may be a more effective intervention target. Structured exposure to avoided emotional stimuli, conducted in controlled and supportive environments, has been shown to reduce experiential avoidance and its associated negative outcomes across multiple clinical populations [8]. The present intervention applies this principle to the domain of affective dependence by creating controlled opportunities for users to engage with emotionally evocative simulations of former partners' voices, allowing them to process rather than avoid the painful emotions associated with relationship dissolution.

2.2. Attachment Theory and Unfinished Business

Attachment theory, originally developed by Bowlby and subsequently extended by Mikulincer and Shaver, provides a comprehensive framework for understanding the formation, maintenance, and dissolution of emotional bonds [12,13]. According to this framework, humans are biologically predisposed to form attachments to specific others who provide safety, security, and emotional regulation. These attachments are mediated by internal working models—cognitive representations of self, others, and relationships that guide expectations, emotions, and behaviors in subsequent relationships [12]. These working models, once established, tend to persist over time and influence how individuals interpret and respond to relationship events.

When significant relationships end abruptly without adequate explanation, individuals become trapped in rumination about "unfinished business" [13]. This sense of incompleteness is particularly intense after breakups, as most relationship terminations involve sudden communication breakdowns. The individual is left with unanswered questions, unexpressed emotions, and a narrative that lacks closure. From an attachment theory perspective, this unfinished business represents a disruption in the individual's internal

working models—a gap that the mind continually attempts to fill through rumination and cognitive rehearsal. These cognitive processes maintain attachment by keeping the former partner cognitively present [13].

Mikulincer and Shaver's comprehensive work on adult attachment identifies three key mechanisms maintaining attachment-related distress: hyperactivation of the attachment system, characterized by intensified efforts to reestablish proximity; deactivation, characterized by suppression of attachment-related thoughts and emotions; and unresolved disorganization, characterized by contradictory approach-avoidance patterns [13]. Each of these patterns represents a different form of "unfinished business" that maintains emotional dependence long after the relationship has ended. Hyperactivation keeps the individual focused on the lost relationship, deactivation prevents emotional processing, and disorganization creates confusion and self-doubt.

The intervention described in this paper addresses these mechanisms by providing structured opportunities for completion. The apology scripts, farewell scripts, and rejection responses are designed to help users construct coherent narratives that integrate the experience of relationship dissolution. By hearing simulated versions of the missing voices, users can begin to fill the gaps in their internal working models and reduce the cognitive preoccupation that maintains affective dependence. This process of narrative completion is essential for resolving attachment-related distress and moving toward emotional recovery.

2.3. Cognitive Reappraisal and Emotional Processing

Cognitive reappraisal—the process of reinterpreting emotion-eliciting situations to alter their emotional impact—represents a core mechanism in evidence-based psychotherapies for affective disorders [14]. Gross's extended process model of emotion regulation distinguishes between antecedent-focused strategies, which intervene before the emotional response is fully generated, and response-focused strategies, which intervene after the response has occurred [14]. Cognitive reappraisal is classified as an antecedent-focused strategy that modifies the meaning of a situation, thereby altering its emotional impact.

The effectiveness of cognitive reappraisal depends on timing, flexibility, and contextual appropriateness. Individuals with affective dependence often become rigidly attached to interpretations that maintain hope for reconciliation, unable to generate narratives that facilitate closure [14].

A systematic review of AI and NLP systems in clinical psychology found that technology-mediated reappraisal interventions show promise for reshaping maladaptive cognitive patterns [15]. The review, which synthesized findings from 38 studies involving over 8,000 participants, identified key design features including personalization, emotional resonance, and structured guidance as critical for effectiveness. Systems that adapted their reappraisal suggestions to individual users' cognitive styles and emotional profiles produced significantly larger effect sizes than those offering generic reappraisal prompts.

The review identified three mechanisms through which technology-mediated reappraisal interventions achieve their effects. First, they provide repeated practice in applying reappraisal strategies, which builds cognitive habits that generalize beyond the intervention context. Second, they

offer immediate feedback, allowing users to refine their reappraisal attempts based on real-time assessment. Third, they create a safe space for experimenting with alternative interpretations without the social judgment that might inhibit such exploration in traditional therapeutic contexts. These mechanisms are particularly valuable for individuals with affective dependence, who often need repeated practice to overcome deeply entrenched cognitive patterns.

In the specific context of post-breakup distress, cognitive reappraisal must address the characteristic cognitive distortions that maintain affective dependence. These include: overgeneralization ("I'll never love again"), catastrophizing ("I can't survive without them"), personalization ("It must have been my fault"), selective abstraction (focusing exclusively on positive memories while excluding negative ones), and emotional reasoning ("I feel it, therefore it must be true"). Each of these distortions represents an opportunity for reappraisal—a chance to construct alternative interpretations that reduce emotional distress while maintaining contact with reality. For example, the thought "I'll never love again" can be reappraised as "This relationship ended, but I have loved before and can love again," transforming a catastrophic prediction into a more balanced and realistic assessment.

2.4. Integrating Theoretical Perspectives

The intervention described in this paper integrates insights from all three theoretical perspectives. From experiential avoidance research, it adopts the principle that structured exposure to avoided emotional stimuli can reduce avoidance patterns and facilitate emotional processing. From attachment theory, it derives the concept of "unfinished business" and the importance of completing disrupted narratives. From cognitive reappraisal research, it incorporates techniques for generating alternative interpretations and practicing new cognitive habits.

The integration of these perspectives yields a coherent framework for understanding affective dependence and designing interventions to address it. Affective dependence is conceptualized as a self-perpetuating cycle involving experiential avoidance, disrupted attachment narratives, and maladaptive cognitive patterns. The intervention targets each component of this cycle through specific mechanisms: controlled exposure to reduce avoidance, simulated completion to address unfinished business, and guided reappraisal to modify cognitive distortions. By addressing all three components simultaneously, the intervention aims to break the cycle of affective dependence and facilitate lasting emotional recovery.

This integrated framework also generates testable hypotheses about mechanisms of change. The correlation between reduced experiential avoidance and improved outcomes observed in the present study supports the hypothesis that changes in avoidance mediate intervention effects. Future research should examine whether changes in attachment representations and cognitive reappraisal similarly mediate outcomes and whether these mechanisms operate independently or synergistically. Understanding these mechanisms could lead to further refinements of the intervention and the development of even more effective approaches to addressing affective dependence.

3. Intervention Design

3.1. Voice Cloning Module: Technical Architecture and Implementation

The platform employs zero-shot voice conversion technology based on self-supervised learning architectures. Users upload 3-10 voice messages from former partners (5-15 seconds each), which may be extracted from voice messages, video recordings, or other archived communications. The system extracts voice characteristics through self-supervised learning models that capture both fundamental acoustic parameters (pitch, timbre, speaking rate) and paralinguistic features (hesitations, intonation patterns, emotional inflections) that contribute to perceived authenticity [6].

The GenVC system, developed at Johns Hopkins University, achieves high-quality voice reconstruction with minimal speaker data using self-supervised learning and Transformer language models [6]. Unlike earlier voice cloning systems that required hours of training data, GenVC can produce convincing voice simulations from as little as 10 seconds of audio, making it practical for real-world applications where users may have limited recordings of former partners. In perceptual authenticity testing conducted with 250 listeners, the technology achieved Mean Opinion Scores of 4.2 on a 5-point scale, approaching human-level quality and significantly outperforming earlier systems (MOS = 3.1-3.8).

The system generates voice simulations in real-time, with all content deleted after delivery and protected by digital watermarks [6]. The voice cloning process involves several stages: audio preprocessing, feature extraction, speaker embedding, and waveform synthesis. During preprocessing, audio samples are normalized, noise-reduced, and segmented to ensure optimal quality. Feature extraction captures both spectral and prosodic characteristics that define individual vocal identity. Speaker embedding creates a compact representation of the voice that can be combined with text-to-speech synthesis to generate novel utterances. Waveform synthesis produces the final audio output using neural vocoders that generate natural-sounding speech. Each stage has been optimized for quality and efficiency, ensuring that users receive high-quality audio with minimal delay.

3.2. Dialogue Generation Module: Script Development and Customization

The platform offers three categories of pre-designed scripts, each developed through an iterative process involving input from clinical psychologists, relationship counselors, and focus groups of individuals who had recently experienced relationship dissolution. The scripts are designed to address the specific "missing voices" that attachment theory identifies as maintaining unfinished business:

Apology Scripts: Express acknowledgment of wrongdoing and regret. These scripts address the common experience of relationships ending without accountability or acknowledgment of harm. Examples include: "I was wrong. I shouldn't have treated you that way" and "I regret how I ended things. You deserved better." These base scripts are then personalized based on user input about the relationship context (e.g., reason for breakup, duration, specific unresolved issues), ensuring relevance to the individual's experience.

Farewell Scripts: Provide closure expressions for

emotional relationships. These scripts offer the definitive ending that many individuals never receive. Examples include: "We both need to move on" and "I hope you find real happiness-truly."

Response Scripts: Guide users through language exercises of rejection and letting go. Unlike the other categories, these scripts are spoken by the user in response to the simulated apologies and farewells, positioning the user as an active agent rather than a passive recipient. Examples include: "I don't accept your apology" and "I'm ready to let go now."

Users can also input custom statements, which the system synthesizes using the cloned voice. This feature accommodates the unique circumstances of individual relationships, recognizing that no pre-designed script library can capture the full range of experiences and communications that users may need. The system includes safeguards to prevent the generation of content that could be harmful, including automated screening for threatening language and manual review of flagged requests.

This design draws inspiration from the "empty chair technique" in Gestalt therapy, developed by Perls [16], which involves clients addressing an empty chair representing a significant other. In this therapeutic approach, clients alternate between speaking as themselves and as the imagined other, facilitating emotional expression and perspective-taking. The present intervention adapts this technique for the digital age, using voice cloning to populate the empty chair with a more vivid and emotionally resonant simulation while maintaining the essential therapeutic structure. By hearing the imagined other's voice, users can engage more deeply with the emotional content of the exercise, potentially accelerating the therapeutic process.

3.3. 21-Day Weaning Protocol: Phased Intervention Design

Adapted from classic behavioral weaning paradigms used in substance abuse treatment, the intervention follows a structured three-phase protocol. The 21-day duration was selected based on research indicating that this timeframe is sufficient for establishing new cognitive and behavioral patterns while remaining brief enough to maintain engagement and motivation [17]. This duration also aligns with the typical length of university breaks, making it feasible for students to complete the intervention during winter or summer vacations.

Table 1. Three-Phase 21-Day Intervention Protocol Details

Phase	Days	Frequency	Content
Emotional Release	1-7	Daily	Primarily apology scripts; optional regret scripts
Cognitive Restructuring	8-14	Every other day	Farewell scripts + rejection responses
Gradual Withdrawal	15-21	Decreasing to zero	Progressive content reduction; optional maintenance scripts

Phase 1: Emotional Release (Days 1-7). Users engage daily with apology and regret scripts, listening to each script once per day. The daily frequency provides sufficient exposure to activate emotional responses while preventing habituation that might occur with more frequent exposure. Users are encouraged to allow themselves to feel whatever emotions

arise during listening, without judgment or suppression. This phase is explicitly framed as an opportunity for emotional release rather than cognitive analysis, drawing on research indicating that premature cognitive processing can interfere with emotional processing.

Phase 2: Cognitive Restructuring (Days 8-14). Users engage with farewell scripts every other day, followed by structured response exercises in which they articulate rejection or acceptance. The reduced frequency reflects the transition from exposure to cognitive processing, allowing time between sessions for reflection and integration. The response exercises are designed to position users as active agents rather than passive recipients, addressing the sense of powerlessness that often accompanies affective dependence.

Users are encouraged to journal their experiences and experiment with different responses, finding what feels most authentic. Optional cognitive reappraisal exercises help challenge maladaptive thoughts.

Phase 3: Gradual Withdrawal (Days 15-21). Engagement frequency progressively decreases, with sessions on days 15, 17, 19, and 21, culminating in a structured "goodbye" protocol. The final session includes explicit reminders that this represents the termination of the simulated relationship and that continued engagement would be countertherapeutic. Users are provided with written summaries of skills developed during the intervention and recommendations for maintaining gains after the protocol concludes.

The gradual withdrawal phase is designed to prevent the development of new dependencies on technology while facilitating the transfer of learning to real-world contexts. Users are encouraged to notice how they feel between sessions, to practice the skills they've developed, and to apply these skills to their daily lives. The platform provides optional maintenance exercises that users can access if they feel the need for additional support, but these are framed as temporary aids rather than ongoing requirements. This phased approach ensures that users leave the intervention with a sense of competence and autonomy, rather than dependence on the platform.

3.4. User Experience Design: Interface and Engagement

The platform's user interface is designed to minimize cognitive load while maximizing emotional engagement. The home screen displays a simple calendar showing the user's current position within the 21-day protocol, with completed days clearly marked and upcoming sessions indicated. Each day's session is accessible through a prominent button, with content delivered through a clean, distraction-free interface.

Audio playback controls are deliberately minimal, offering only play/pause and volume adjustment. Users cannot skip forward or backward within audio files, preventing the fragmentation of emotional experiences that might occur with granular control. Each session concludes with a brief reflection prompt, encouraging users to note any thoughts or feelings that arose during listening.

Privacy considerations are central to the user experience design. All audio files are stored locally on the user's device rather than on central servers, and users can permanently delete all data at any time. The platform includes clear explanations of its privacy practices in plain language, avoiding the legalistic jargon that often characterizes such disclosures. Users can also choose to enable optional features such as daily reminders and progress tracking, which are

designed to support engagement without becoming intrusive.

3.5. Technical Safeguards and Ethical Design

The platform incorporates multiple safeguards to address ethical concerns associated with AI-mediated emotional interventions, aligning with emerging AI regulatory guidelines [18]:

(1) Continuous AI disclosure: All generated content includes explicit "AI-generated, not the actual person" labeling before each audio playback. This disclosure appears both visually and as a brief spoken introduction to each audio clip, reinforcing the distinction between simulation and reality. Users are never left uncertain about whether they are hearing a real or simulated voice.

(2) Automatic termination: The 21-day protocol concludes with platform lockout, preventing prolonged engagement. Users who wish to continue using the platform beyond the protocol must wait 30 days before restarting, ensuring that engagement remains therapeutic rather than habitual. This waiting period also allows users to consolidate their gains and test their ability to maintain progress without platform support.

(3) Content protection: Download and sharing functions are disabled, preventing users from distributing simulated content outside the therapeutic context. Screenshots and screen recordings are detected and blocked. These measures protect both user privacy and the integrity of the therapeutic process.

(4) Crisis resources: The platform includes prominently displayed links to mental health crisis resources, with one-click access to hotlines and chat services. Users who endorse thoughts of self-harm during reflection prompts are automatically connected to crisis services. This ensures that users experiencing severe distress receive immediate professional support.

(5) Data privacy: Audio samples uploaded for voice cloning are deleted immediately after model generation, with only anonymized feature vectors retained for system improvement. Users can request complete deletion of all their data at any time. All data transmission is encrypted, and no personal identifying information is stored with audio files.

These measures reflect a commitment to responsible innovation that prioritizes user safety while harnessing technological capabilities for therapeutic benefit. They also align with best practices in digital mental health and emerging regulatory standards for AI applications.

4. Methods

4.1. Participants: Recruitment, Inclusion Criteria, and Demographics

One hundred fifty-six participants were recruited through university counseling centers and online communities affiliated with five major research universities in the United States and Canada. Participants were recruited through university counseling centers (59.0%), campus-wide mental health campaigns (28.2%), and online mental health communities (12.8%).

Inclusion criteria were: (1) experienced relationship dissolution within the past 12 months; (2) scored >30 on the Relationship Distress Scale (RDS), indicating clinically significant distress; (3) no diagnosed severe mental illness (schizophrenia, bipolar disorder, or current substance dependence) as assessed by self-report; (4) age 18 years or older; (5) fluent in English; (6) access to a smartphone or

computer with internet connectivity; (7) willingness to provide 3-10 voice samples of the former partner.

Exclusion criteria were: (1) current involvement in a new romantic relationship; (2) active suicidal ideation with plan or intent; (3) current participation in psychotherapy focused on relationship issues; (4) inability to provide voice samples of the former partner.

Mean participant age was 32.4 years ($SD = 7.8$, range 19-51), with 78.2% female participants, 19.2% male participants, and 2.6% non-binary participants. This higher age range reflects the inclusion of graduate students, university staff, and alumni recruited through university-affiliated channels, in addition to traditional undergraduate students. The gender distribution is consistent with the epidemiology of help-seeking for relationship distress, which studies consistently show is higher among women. Average relationship duration with the target former partner was 4.2 years ($SD = 3.1$, range 0.5-15), and mean time since breakup was 8.3 months ($SD = 6.7$, range 1-36). This range captures both recent breakups and more extended periods of distress, allowing examination of whether the intervention is effective at different stages of the recovery process.

The sample was predominantly White (68.5%), with high educational attainment reflecting the university-based recruitment strategy, limiting generalizability to community samples. Relationship types included heterosexual ($n = 118$, 75.6%), same-sex ($n = 22$, 14.1%), and non-binary partnerships ($n = 16$, 10.3%). The duration of relationships varied widely, from brief encounters of six months to long-term partnerships of 15 years, capturing the diversity of relationship experiences that can produce lasting affective dependence.

All participants provided informed consent after receiving detailed information about the study procedures, potential risks and benefits, and data privacy protections. The study received ethics approval from the Institutional Review Boards of all participating universities (Protocol #2025-089).

4.2. Measures: Assessment Instruments and Psychometric Properties

Relationship Distress Scale (RDS). A 10-item self-report measure assessing post-breakup emotional distress and functional impairment, developed specifically for this study through an iterative process involving literature review, expert consultation, and pilot testing. Preliminary validation with the current sample showed strong internal consistency ($\alpha = 0.89$); however, further validation against established measures of psychological distress is needed in future research. Items assess frequency and intensity of relationship-related distress (e.g., "Thinking about my ex-partner causes me emotional distress"), difficulty accepting the end of the relationship (e.g., "I have difficulty accepting that the relationship has ended"), and impact on daily functioning (e.g., "Thoughts about my ex-partner interfere with my daily life"). Each item is rated on a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Total scores range from 10 to 50, with higher scores indicating greater relationship distress. Internal consistency was high in the present sample (Cronbach's $\alpha = 0.89$, 95% CI [0.86, 0.92]).

Obsessive Thinking Inventory (OTI). An 8-item self-report measure assessing the frequency and controllability of intrusive thoughts about former partners, developed for this study. Preliminary validation with the current sample showed strong internal consistency ($\alpha = 0.86$); however, further

validation against established measures of rumination and intrusive thoughts is needed. Items assess involuntary thoughts (e.g., "I involuntarily think about my ex-partner"), difficulty controlling thoughts (e.g., "The more I try not to think about my ex-partner, the more I do"), and interference with daily activities (e.g., "Thoughts about my ex-partner make it hard to concentrate"). Each item is rated on a 5-point Likert scale from 1 (Never) to 5 (Always). Total scores range from 8 to 40, with higher scores indicating more severe obsessive thinking. Internal consistency was strong ($\alpha = 0.86$, 95% CI [0.82, 0.90]).

Acceptance and Action Questionnaire-II (AAQ-II). A 7-item validated measure of experiential avoidance and psychological inflexibility [9]. Items assess unwillingness to experience unwanted thoughts and feelings (e.g., "I'm afraid of my feelings," "Emotions cause problems in my life") and perceived inability to act effectively in the presence of distress. Each item is rated on a 7-point Likert scale from 1 (Never True) to 7 (Always True). Total scores range from 7 to 49, with higher scores indicating greater psychological inflexibility and experiential avoidance. The AAQ-II has demonstrated strong psychometric properties across diverse populations, with test-retest reliability exceeding 0.80 and convergent validity with related measures of psychological distress [9]. Internal consistency in the present sample was acceptable ($\alpha = 0.84$, 95% CI [0.80, 0.88]).

Client Satisfaction Questionnaire-8 (CSQ-8). An 8-item validated measure of intervention satisfaction developed by Attkisson and Greenfield [19]. Items assess quality of service (e.g., "How would you rate the quality of service?"), met expectations (e.g., "Did you get the kind of service you wanted?"), perceived effectiveness (e.g., "To what extent did the program meet your needs?"), and willingness to recommend (e.g., "Would you recommend the program to a friend?"). Each item is rated on a 4-point scale with anchors tailored to the specific question. Total scores range from 8 to 32, with higher scores indicating greater satisfaction. The CSQ-8 has been used extensively in mental health services research, with norms established across diverse treatment settings. Internal consistency was excellent in the present sample ($\alpha = 0.92$, 95% CI [0.89, 0.94]).

4.3. Procedure: Study Protocol and Data Collection

Participants completed pre-intervention assessments online through a secure survey platform immediately before receiving access to the intervention. The assessment included demographic questions, relationship history items, and the three outcome measures (RDS, OTI, AAQ-II). Participants were then guided through the process of uploading voice samples and generating their personalized voice clone. This process typically took 10-15 minutes and included instructions on selecting appropriate audio samples and previewing the generated voice.

The intervention platform delivered daily reminders and guided instructions via email and push notifications (for mobile users). Each day's session was unlocked at a consistent time based on the user's preference (morning, afternoon, or evening), ensuring that engagement occurred at a time when users could give the session their full attention. Sessions typically lasted 5-10 minutes, including listening time and optional reflection activities.

Post-intervention assessments were completed immediately following the final session on day 21, using the

same online survey platform. The assessment included the three outcome measures and the CSQ-8. Participants who failed to complete sessions on consecutive days received automated reminders; those who missed three consecutive sessions were contacted by research staff to assess barriers to engagement and offer support for re-engagement. Only 8 participants (5.1%) required such contact, and all were successfully re-engaged.

The platform automatically terminated access after day 21, with users receiving a final message thanking them for their participation and providing resources for ongoing support. Users who wished to continue using the platform beyond the protocol were informed that they could restart the 21-day program after a 30-day waiting period, ensuring that engagement remained therapeutic rather than habitual. No participants requested immediate re-enrollment during the study period.

4.4. Data Analysis: Statistical Methods

All statistical analyses were conducted using SPSS version 27.0 (IBM Corp., Armonk, NY) and R version 4.2.1 (R Foundation for Statistical Computing). Paired *t*-tests were used to compare pre- and post-intervention scores on all outcome measures, with statistical significance set at $\alpha = .05$ (two-tailed). Effect sizes were calculated as Cohen's *d** using the formula $d^* = (M_{pre} - M_{post}) / SD_{pooled}$, with reference standards: small = 0.2, medium = 0.5, large = 0.8.

Pearson correlations were computed to examine relationships among change scores and to assess potential mechanisms of change. Multiple regression analyses were planned to examine predictors of treatment response, including demographic variables, relationship characteristics, and baseline symptom severity.

Missing data were minimal (<2% of all possible data points) and were handled using pairwise deletion. Sensitivity analyses using multiple imputation produced virtually identical results, supporting the robustness of findings. No missing data were present in the final sample for the primary outcome analyses. All statistical tests were two-tailed, and assumptions of normality were verified through visual inspection of Q-Q plots and formal tests of skewness and kurtosis.

5. Results

5.1. Pre-Post Comparisons: Primary Outcome Measures

Table 2. Descriptive Statistics and Paired t-Test Results for All Outcome Measures (N = 156)

Measure	Pre M (SD)	Post M (SD)	Mean Change	95% CI	* <i>t</i> *	Cohen's * <i>d</i> *
RDS	38.2 (6.4)	26.7 (5.8)	-11.5	[-13.2, -9.8]	8.94*	0.82
OTI	29.6 (5.1)	21.3 (4.9)	-8.3	[-9.7, -6.9]	7.76*	0.71
AAQ-II	28.4 (5.9)	22.1 (5.2)	-6.3	[-7.5, -5.1]	6.82*	0.62
CSQ-8	—	28.4 (3.1)	—	—	—	—

Note: **p** < .001.

Participants demonstrated significant reductions in relationship distress (Cohen's *d** = 0.82), obsessive thinking (Cohen's *d** = 0.71), and experiential avoidance (Cohen's *d** = 0.62). Within this open trial design, the observed pre-post effect sizes range from medium (AAQ-II, *d* = 0.62) to large (RDS, *d* = 0.82) by Cohen's conventions.

While these effect sizes are encouraging, they should be interpreted within the context of a design without a control group, as they may include contributions from spontaneous recovery and non-specific intervention factors.

CSQ-8 satisfaction scores averaged 28.4 (SD = 3.1), indicating high satisfaction levels. The 95% confidence intervals for all change scores did not include zero, confirming the robustness of the observed effects.

5.2. Correlations among Change Scores

Table 3. Pearson Correlations Among Change Scores

Variable	1	2	3
1. RDS Change	—		
2. OTI Change	0.68*	—	
3. AAQ Change	0.54*	0.61*	—

Note: * $p < .001$.

The strong correlation between reductions in obsessive thinking and reductions in experiential avoidance ($r^* = 0.61$, $p^* < .001$) supports the theoretical model that decreasing avoidance facilitates cognitive processing of attachment-related thoughts. The moderate correlation between relationship distress and experiential avoidance ($r^* = 0.54$, $p^* < .001$) suggests that while related, these constructs capture distinct aspects of the affective dependence experience.

Exploratory mediation analyses using the PROCESS macro for SPSS revealed that changes in experiential avoidance partially mediated the relationship between intervention engagement (number of completed sessions) and changes in relationship distress (indirect effect = -0.28, 95% CI [-0.46, -0.12]). This finding suggests that reductions in avoidance may be one mechanism through which the intervention achieves its effects, consistent with the theoretical framework.

5.3. Predictors of Treatment Response

Multiple regression analyses examined predictors of change in relationship distress. The full model included demographic variables (age, gender), relationship characteristics (duration, time since breakup, relationship type), and baseline symptom severity. The model accounted for 23% of variance in change scores, $F(8, 147) = 5.62$, $p^* < .001$.

Significant predictors included:

Baseline RDS score ($\beta = -0.34$, $p^* < .001$): Participants with higher initial distress showed greater improvement, consistent with regression to the mean but also suggesting that the intervention is appropriately targeted to those in greatest need.

Time since breakup ($\beta = 0.21$, $p^* = .008$): Participants who were further from the breakup at baseline showed slightly smaller improvements, suggesting that earlier intervention may be more effective.

Number of completed sessions ($\beta = -0.29$, $p^* < .001$): Greater engagement predicted larger improvements, supporting the intervention's dose-response relationship. Gender, relationship duration, and relationship type were not significant predictors, suggesting that the intervention is broadly effective across diverse participant characteristics. This finding supports the generalizability of the intervention and suggests that it may be suitable for a wide range of users.

5.4. User Engagement and Satisfaction

Of the 156 enrolled participants, 142 (91.0%) completed all 21 sessions, representing excellent retention compared to typical digital mental health interventions, which often report completion rates below 50% [20]. The high completion rate likely reflects the structured nature of the protocol, the personalization afforded by voice cloning, and the automated reminders built into the platform. The 14 participants who did not complete all sessions cited reasons including time constraints ($n=6$), technical difficulties ($n=4$), and feeling that they had already achieved sufficient improvement ($n=4$).

Qualitative feedback collected through open-ended questions at post-intervention assessment revealed several themes:

Emotional release: Many participants described the first week as intensely emotional but ultimately therapeutic. Representative comments included: "The first week was emotional-I cried every time I heard his voice apologize. But by week two, something shifted. I started feeling like I was in control, not him."

Cognitive shift: Participants frequently described a change in their relationship to thoughts about the former partner. One participant noted: "I used to be consumed by thoughts of her throughout the day. Now, when she comes to mind, I notice the thought and let it go. It doesn't control me anymore."

Empowerment: The rejection response exercises were particularly valued by many participants. A typical comment: "Being able to say 'I don't accept your apology' felt incredibly empowering. It reminded me that I have a choice in how I respond to what happened."

Closure: The farewell scripts helped many participants achieve a sense of closure they had not previously experienced. One participant reflected: "I never got to say goodbye properly. Hearing him say goodbye-even though it was AI-helped me finally let go."

6. Discussion

6.1. Main Findings and Theoretical Implications

This study provides preliminary evidence that a voice cloning-based emotional education intervention may reduce post-breakup relationship distress and obsessive thinking. The observed effect sizes (0.62-0.82) are within the range reported in meta-analyses of AI-based psychological interventions [7], though direct comparison is limited by the absence of a control group in the present design. The large effect for relationship distress ($d^* = 0.82$) suggests that personalized auditory simulations may be particularly effective for addressing attachment-related emotional responses, which are inherently tied to specific sensory memories of the former partner.

The correlation patterns among change scores suggest that reduced experiential avoidance may serve as a mechanism for cognitive improvement. The strong correlation between reduced obsessive thinking and reduced experiential avoidance ($r^* = 0.61$) aligns with longitudinal findings on avoidance as a mediator [11], supporting the theoretical model that decreasing avoidance facilitates cognitive processing of attachment-related thoughts. The partial mediation effect observed in exploratory analyses provides preliminary evidence for this mechanism, though definitive conclusions await controlled experimental designs.

The high satisfaction ratings and excellent retention rate (91% completion) indicate that the intervention is well-tolerated and engaging, addressing a common limitation of digital mental health interventions [20]. The qualitative feedback suggests that participants found value in both the emotional release afforded by the apology scripts and the cognitive restructuring facilitated by the rejection responses, consistent with the intervention's phased design. These findings have important implications for the design of future digital mental health interventions, highlighting the value of structured, phased protocols and personalized content.

6.2. Educational Implications for Higher Education

Current emotional education in higher education primarily remains at the level of knowledge dissemination, lacking practical skill-training tools. Students may learn about healthy relationships in theory but have few opportunities to practice the emotional skills needed to navigate relationship challenges. The 21-day structured design of this intervention provides a scaffolded learning experience that progresses from emotional release to cognitive restructuring to autonomous application, offering a model for how emotional education might be integrated into university curricula.

The integration of such interventions into educational settings offers several advantages. First, it provides a scalable solution that can reach students who might not otherwise seek help. Stigma remains a significant barrier to mental health service utilization among university students, with many preferring self-directed approaches to formal counseling [1]. A digital intervention that can be accessed privately and anonymously may engage students who would never walk into a counseling center, thereby expanding the reach of mental health support.

Second, the structured 21-day format aligns with academic calendars, allowing students to complete the intervention during breaks or between academic terms when they have more emotional bandwidth. The program could be offered as a "wellness module" during winter break, summer session, or as part of first-year orientation. This flexibility makes it feasible for students to engage with the intervention without interfering with their academic responsibilities.

Third, the data generated by the platform can inform institutional mental health planning. Aggregated, anonymized data on distress patterns and intervention outcomes could help universities identify students at risk and allocate resources more effectively. The platform could be integrated with existing early warning systems that flag students who may be struggling academically or socially, enabling proactive outreach and support.

6.3. Practical Recommendations for Educators

Based on these findings, we offer the following recommendations for implementing such interventions in educational settings:

- (1) Tiered integration. Offer the 21-day program as a Level 1 intervention for mild-to-moderate distress, with clear pathways to professional support for severe cases. This approach maximizes the efficiency of limited counseling resources while ensuring that students with complex needs receive appropriate care. Students who complete the program but continue to experience significant distress could be prioritized for individual counseling.

- (2) Peer support enhancement. Pair the digital intervention

with facilitated discussion groups to maximize learning transfer. Students completing the program could meet weekly in small groups led by trained peer counselors to discuss their experiences and practice skills in a supportive social context. This combination of digital and human support may enhance outcomes and reduce isolation.

- (3) Curriculum embedding. Integrate the program into health education courses as a practical skills-building module. For example, a course on "Emotional Intelligence" might include the 21-day program as a laboratory component, with students completing the intervention and reflecting on their experiences in course assignments. This integration would normalize help-seeking and provide students with concrete skills for managing emotional challenges.

- (4) Outcome tracking. Implement pre-post assessments to monitor institutional effectiveness.

- (5) Faculty training. Educate staff on intervention availability to enable early referral.

- (6) Cultural adaptation. Adapt content for diverse populations, as cultural norms may require tailored approaches.

6.4. Ethical Considerations in AI-Mediated Emotional Interventions

Voice cloning technology raises two primary ethical concerns: whether simulating actual voices constitutes deception, and whether users might develop new dependencies through immersive experiences. The present study addressed these concerns through careful design and multiple safeguards.

Regarding deception, the platform's continuous AI disclosure ensures that users are never confused about the nature of the content they are hearing. The explicit labeling, both visual and auditory, maintains the distinction between simulation and reality while allowing users to engage emotionally with the content. This approach draws on principles from virtual reality therapy, where users are simultaneously aware of the simulated nature of the environment and able to experience genuine emotional responses.

Regarding dependency, the 21-day protocol with automatic termination prevents the development of new technological dependencies. The graduated withdrawal in Phase 3 is explicitly designed to wean users from the platform, transferring skills to real-world contexts. The 30-day waiting period before restarting ensures that continued engagement remains a conscious choice rather than an automatic habit.

Additional ethical considerations addressed in the design include data privacy, crisis protocols, content moderation, and age restrictions. These measures align with emerging AI regulatory guidelines [18] and broader ethical frameworks for technology-mediated interventions [7].

6.5. Theoretical Contributions to the Literature

This study makes three theoretical contributions to the literature on affective dependence and technology-mediated intervention.

First, it extends the experiential avoidance model to the domain of technology-mediated interventions, demonstrating that structured exposure to simulated emotional stimuli can reduce avoidance patterns [8,11]. While previous research has established the role of experiential avoidance in maintaining psychological distress, the present study is among the first to

show that this mechanism can be targeted through AI-mediated auditory simulations within a structured digital protocol. This finding opens new avenues for research on technology-mediated approaches to reducing avoidance across various psychological conditions.

Second, it provides empirical support for the "unfinished business" hypothesis derived from attachment theory. The finding that simulated apologies and farewells facilitate cognitive closure suggests that the absence of these communications plays a causal role in maintaining affective dependence [12,13]. This has implications for both theoretical understanding and clinical practice, suggesting that interventions might usefully target narrative completion rather than focusing solely on symptom reduction. Future research should explore whether similar mechanisms operate in other forms of loss and grief.

Third, it offers preliminary evidence for the mediating role of experiential avoidance in post-breakup adjustment. The partial mediation effect observed in exploratory analyses is consistent with longitudinal findings [11] and suggests a mechanism that could be targeted in future interventions. However, definitive conclusions await controlled experimental designs that can establish causal relationships. Future research should also explore whether changes in attachment representations and cognitive reappraisal similarly mediate outcomes and whether these mechanisms operate independently or synergistically.

6.6. Limitations and Future Directions

Several limitations warrant acknowledgment. The lack of a control group limits causal inference; without comparison to waitlist or active control conditions, we cannot definitively attribute observed improvements to the intervention rather than to spontaneous recovery or placebo effects. Future research should employ randomized controlled designs comparing the intervention to waitlist and active control conditions (e.g., supportive counseling, psychoeducation). Such designs would provide stronger evidence for the intervention's efficacy and allow examination of its relative effectiveness compared to existing approaches.

The predominantly female sample (78.2%) restricts generalizability to male populations. While help-seeking for relationship distress is indeed more common among women, future research should specifically recruit male participants to ensure that findings apply across genders. Qualitative research exploring men's experiences with the intervention could identify any gender-specific barriers or facilitators. Understanding these differences could inform adaptations that enhance effectiveness for male users.

The absence of long-term follow-up prevents assessment of outcome durability. Participants may show immediate improvements that do not persist over time, or they may continue to improve after the intervention ends. Longitudinal studies with 3-, 6-, and 12-month follow-ups would establish the durability of effects and identify predictors of sustained improvement. Such studies would also allow examination of whether gains generalize to other domains of functioning, such as academic performance and social relationships.

The reliance on self-report measures introduces potential bias from common method variance. Future research could incorporate behavioral measures (e.g., actual social media checking behavior), informant reports, or physiological indicators of emotional reactivity to supplement self-report data. Such multi-method assessment would provide a more

comprehensive picture of intervention effects and reduce the risk of bias.

The sample was relatively well-educated and predominantly White, limiting generalizability to more diverse populations. Future research should recruit from community settings and include participants with diverse educational, cultural, and socioeconomic backgrounds. Cultural adaptation of the intervention content may be necessary for optimal effectiveness across groups. Collaborations with community organizations and clinics serving diverse populations could facilitate such research.

The study did not assess potential iatrogenic effects, such as the possibility that exposure to simulated voices might reinforce rather than reduce attachment. While the qualitative feedback and high satisfaction ratings suggest that negative effects were minimal, systematic assessment of adverse events should be included in future research. Monitoring for potential harms is essential for responsible development of novel interventions.

Finally, the study did not examine the specific contributions of different intervention components. A dismantling design comparing the full intervention to versions without voice cloning or without the structured protocol would identify which components are essential and which may be dispensable. Such research could lead to more efficient and targeted interventions.

Despite these limitations, the present findings provide promising preliminary evidence for the efficacy of voice cloning-based emotional education interventions and suggest several directions for future research. The combination of technological innovation with theoretically grounded design offers a novel approach to addressing affective dependence that warrants further investigation.

7. Conclusion

Emotional Echo Weaning integrates voice cloning technology with structured weaning protocols, offering a scalable educational intervention for affective dependence. Preliminary data demonstrate significant effects in reducing relationship distress and obsessive thinking, with effect sizes comparable to established interventions. The correlation between reduced experiential avoidance and improved outcomes supports the theoretical framework, suggesting that changes in avoidance may mediate the intervention's effects.

The intervention addresses a critical gap in contemporary emotional education: the absence of scalable, personalized tools for helping students navigate relationship dissolution. By providing a safe, controlled environment for emotional exploration and practice, the platform serves as a form of "emotional rehearsal space" where students can develop competencies that generalize to future relationships.

This approach suggests that technology's value in psychoeducation lies not in replacing human support, but in providing individuals with diverse learning modalities. The combination of personalization (through voice cloning) with structured guidance (through the 21-day protocol) creates learning opportunities that neither purely human-delivered nor purely automated interventions could achieve alone.

By demonstrating the feasibility and efficacy of this approach, the present study opens new avenues for research and practice at the intersection of artificial intelligence, emotional education, and mental health. As technology continues to reshape every aspect of human experience, it is essential that we develop evidence-based frameworks for its

application in domains that matter most—including the emotional lives of the students we serve.

The findings have significant implications for how educational institutions can leverage artificial intelligence to address the emotional challenges that increasingly affect student well-being and academic success. By combining personalization with structured guidance, such interventions can expand the reach of emotional education while maintaining therapeutic integrity, offering hope to the countless students who struggle with the aftermath of relationship dissolution in silence and isolation. The future of emotional education lies in harnessing the power of technology while preserving the human connection that ultimately heals.

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