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An Experiential Study of Digital Interactive Feedback for Anxiety Attention Bias Modification

Di Fang, Jin Li, and Hanling Zhang

School of Design, Hunan University, Changsha, Hunan 410012, China

ABSTRACT

Attentional Bias Modification Training (ABMT) shows promise in digital therapy for anxiety. However, there's limited research on interactive feedback in ABMT for anxiety populations. This study examines ABMT's application in anxiety interventions, focusing on different interactive feedback effects on user experience, willingness to participate, and intervention outcomes. Using an emotional visual search task, the experiment comprised two parts: participants completed 100 trials with varied feedback, and their anxiety changes and eye-movement tendencies were recorded. In the second part, participants experienced each task 10 times, completed a user experience questionnaire, and underwent interviews. Results revealed ABMT's positive impact on anxiety. Combining avatar customization and points enhanced intervention effects, while points feedback alone was ineffective. Avatar customization or a combination of feedback methods led to a better participant experience. The study suggests points may increase stress, while customized images guide emotions positively, emphasizing interactive feedback's importance in digital interventions and offering insights for future development.

Keywords: Interactive feedback, User experience, Digital healthcare, Attentional bias modification, Anxiety

INTRODUCTION

Anxiety, a prevalent mental disorder (Charlson, 2019), can lead to severe mental and physical issues. Early prevention and intervention are crucial to prevent escalation. However, limited mental health resources result in underdiagnosis and undertreatment of anxiety (Mangolini, 2019). Effective methods are needed to enhance early identification and intervention rates to address society's mental health needs.

In the era of rapid technological advancement, Internet-based mobile psychological interventions have become an emerging psychotherapeutic approach. Digital therapy, as a therapy based on the Internet and smart devices, provides users with digitized therapeutic services with the help of smart media (Saramago, 2021). It bridges the gap of traditional psychotherapy, reduces the cost of interventions, improves accessibility, and enables users to receive psychotherapy in a more multifaceted way (McDonald, 2020).

Despite progress in digital therapy for anxiety, design flaws persist in user experience. Translating treatment theories into digital apps requires attention to interaction and user experience, impacting intervention effectiveness (Biagianti, 2023). Digital interventions struggle to ensure active user engagement and telemedicine utilization (Miu, 2021). User motivation and personalized treatment plans directly affect intervention experience and effectiveness, influencing future participation. To enhance psychotherapy appeal, thorough investigation into computerized psychological intervention user experience is essential in addressing psychological disorder traits.

In this study, we assessed different feedback types' impacts on intervention effects, task motivation, and user experience in an anxiety intervention task. We focused on points and avatar customization as feedback modalities, creating four versions of the Emotional Visual Search Task (EVST). We used both physiological and subjective data to measure intervention effects and task experience. Attentional Bias Modification Training (ABMT) had a positive effect on anxiety symptoms. We found that avatar customization maintained intervention significance, while points diminished it. Combining both feedback types positively influenced motivation, eye-movement attention, and intervention effects.

RELATED WORK

Anxiety and Attention Bias Modification Training

The information processing bias in anxiety is crucial to its development and maintenance (Bar-Haim, 2010). Anxious individuals typically exhibit attentional bias towards threatening faces and struggle with attention shifting (Hudays, 2022). This bias not only worsens anxiety but also leads to more severe cases (Nelson, 2015). Allowing attention to shift away from threatening stimuli effectively reduces anxiety responses and mitigates various anxiety disorders. (Bar-Haim, 2010). ABMT modifies abnormal attentional tendencies in anxiety patients (Bø, 2021), offering therapist-less interventions suitable for digital transformation. However, digital research on ABMT remains limited, requiring more focus on usability for further development. User experience is crucial in mental health interventions, significantly impacting treatment outcomes (Mohr, 2017).

User Experience and Self-Determination Theory

User experience refers to how users feel psychologically when using a product (Ma, 2012). Clever interactive design in digital psychotherapy will enhance user experience, leading to more effective interventions. Self-determination theory (SDT) highlights three psychological needs: autonomy, competence, and relatedness (Ryan and Deci, 2017). Autonomy is the main motivational principle (Bandura, 1977), and granting users more autonomy improves task performance and process experience (Peters, 2018). High willingness to participate encourages users to engage consciously in cognitive training, improving psychological intervention outcomes (Ryan and Deci, 2017). SDT

distinguishes between extrinsic and intrinsic motivation, emphasizing intrinsic motivation's importance and recognizing the potential for internalization of extrinsic motivation under appropriate conditions and environments.

Interactive Feedback Based on User Experience

Interaction feedback cues users about their actions' outcomes (De Sales, 2022), like answering a question correctly. Motivational feedback improves user experience and encourages active participation (Tang, 2021). However, inappropriate feedback decreases motivation sensitivity and impedes eliciting specific emotional experiences (Ming, 2021). Given that different user groups prefer various feedback methods, designing feedback based on user characteristics improves task outcomes. Thus, understanding system nature and user characteristics is crucial in crafting appropriate feedback for user-centered design.

Points, commonly utilized as extrinsic rewards, cater to users' extrinsic motivation (Yang, 2021). They prove motivating for tasks lacking inherent appeal (Legault, 2016) and can incentivize both extrinsic and intrinsic motivation under appropriate circumstances. For instance, points may symbolize a user's competence and be easily recognized by others (Yang, 2021). A well-crafted points system can address users' emotional needs, thereby enhancing task engagement.

In systems and tasks, avatar customization offered flexibility in presenting a user's identity, allowing adjustments based on personality needs (Kang, 2020). It enhanced autonomy satisfaction and strengthened identity, fostering intrinsic motivation (Birk, 2019; Kang, 2020). Avatars served as process aids in cognitive training, boosting effectiveness, reducing anxiety (Birk, 2019), and improving health education through increased intrinsic motivation and task engagement (Kang, 2020). Despite its benefits, current cognitive tasks primarily used avatars during setup or as selected affective pictures. No studies explored using images as part of interactive feedback.

Therefore, in this ABMT task, we investigated feedback design using two key elements: points and avatar customization, targeting intrinsic and extrinsic motivation promotion, respectively. Our goal was to explore how different feedbacks impact intervention effectiveness, task motivation, and user experience in an anxiety intervention task.

RESEARCH METHODOLOGY

Experimental Task

Free-viewing Task: Participants freely viewed three sets of emotional images, each with 16 face images, including 8 non-threatening and 8 threatening images. The images were randomized distributed on the screen. Each set appeared for 15 seconds, with a 1.5-second red "+" gaze point between switches to cue participants to refocus their attention

ABMT: During the intervention session, participants underwent training using the EVST, a method of ABMT known for effectively correcting cognitive biases (Li, 2023). In the EVST, participants actively searched for positive

stimuli among 4 pictures, 3 of which were threatening and 1 non-threatening. They used a mouse to select the non-threatening picture within 10 seconds. If no response occurred within 10 seconds, "timeout" appeared, and the next set of pictures displayed. A 1.5-second red "+" and 1.5-second white screen between picture sets directed participants' attention.

Avatar Customization: To enable avatar customization, we utilize the iOS system's simulated expression function. Users can select various hairstyles, hair colors, eye colors, mouth shapes, and more to customize avatar. After creating the characters, users can also choose from a variety of facial expressions and actions, such as smiling, frowning, and winking. During character creation, users can observe the dynamic effects of their characters in real-time. In this experiment, participants in the image group and the integrated group customized their images at the start. They were instructed to create images based on their preferences and select expressions and actions reflecting positive emotions.

Stimulus

In all tasks, stimuli comprised facial images displaying various emotions, including non-threatening (neutral or happy) and threatening (angry or sad) expressions. Images were sourced from the Geneva Affective Picture Database (Dan-Glauser, 2011) and the Open Affective Standardized Image Set (Kurdi, 2017), known for effectively stimulating emotions. From these databases, 112 images were chosen and uniformly resized to 473x378px and 72dpi to match the task program. The selection included characters of different genders and age groups to prevent specific demographics from influencing the task.

Measures

State Trait Anxiety Inventory (STAI): We used the STAI to measure subject anxiety. Participants completed the scale both before and after the task. The STAI includes 20 trait anxiety (T-AI) assessment items and 20 state anxiety (S-AI) assessment items, covering a range of descriptions like "I feel calm." Responses were rated on a 4-point scale from "not at all" to "very noticeable" (Spielberger, 1971).

Motivation Scale: We employed the scale adapted from Tang et al. to evaluate participants' task motivation (Tang, 2021). The modified scale consisted of nine questions assessing extrinsic motivation, intrinsic motivation, and willingness to participate, utilizing a five-point Likert scale for all questions.

User Experience Questionnaire (UEQ): We utilized the UEQ to evaluate the user experience of the ABMT. The UEQ is a standardized tool for assessing software user experiences. It measures six experiential factors: attractiveness, clarity, efficiency, reliability, stimulation, and novelty to synthesize overall user experience quality (Laugwitz, 2008). Participants rated their feelings on a 7-point Likert scale, ranging from "unpleasant" to "pleasant," in relation to the problem.

Eye Movement: We focused on subjects' attentional behavior as an objective measure. Anxious populations tend to pay pronounced attention to

threatening stimuli, with their eye-movement behavior differing significantly from healthy groups (Bar-Haim, 2010). Moreover, individuals paying more attention to positive stimuli contribute to maintaining a favorable mental state (Blanco, 2019). As attentional behavior is a key target of anxiety interventions, we assessed whether subjects' eye-movement behavior was modified during a free-viewing emotional picture task. We adapted the procedure used by Zhang et al. (Zhang, 2022), where participants freely viewed emotional images. Gaze duration and gaze counts for emotional stimuli were recorded using a Tobii Pro Glasses 3 eye-tracker, and eye-movement data were analyzed in detail using Tobii Pro Lab.

User Interview: We conducted user interviews to understand subjects' experiences in different tasks. Our questions included, but were not limited to, "Which feedback do you prefer?" and "Why do you feel good/not good about this feedback?" We collected subjective statements from participants and asked follow-up questions to gain deeper insights into their feelings and perspectives.

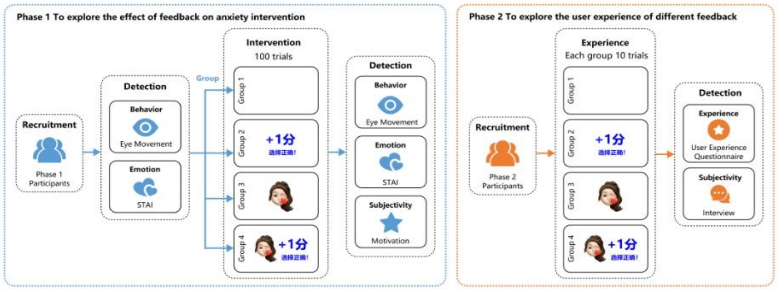

Figure 1: Framework of this study.

Participants

To better explore feedback's impact, we recruited participants in two stages.

Phase 1: To explore the impact of feedback on anxiety intervention effectiveness, we recruited 43 participants (25 males, 22 females) from Hunan University using an online questionnaire. Participants had a mean age of 23.40 years (SD = 2.14), ranging from 21 to 30 years. Anxiety conditions are prevalent among individuals aged 21 to 30 (Zhang, 2020), who are also more accustomed to electronics and likely to adapt to digital interventions.

Phase 2: To delve deeper into users' feedback experiences, participants were recruited again via a questionnaire. None of the re-recruited participants had previously taken part in the anxiety intervention task used in the experiment. A total of 33 subjects were recruited, including 21 males and 12 females, with a mean age of 23.67 years (SD = 2.259) and an age range of 21 to 30 years.

Both stages of the study received approval from the Ethics Committee of the School of Design at Hunan University. All participants provided informed consent at the beginning of the experiments.

Procedure

The entire experimental procedure and framework are illustrated in Figure 1.

In Phase 1, participants were briefed on the study's duration (60 min) and compensation (60 RMB) and informed about the inclusion of images depicting threatening emotions. They completed a demographic survey and the STAI. Participants with high anxiety scores were selected and randomly assigned to one of four groups: no-feedback (Group 1), points (Group 2), avatar customization (Group 3), and points & avatar customization (Group 4). Each participant underwent a free-viewing task with Tobii Pro Glasses 3 and completed a 100-trial image selection task, receiving feedback based on their group assignment. After ABMT, they repeated the free-viewing task and completed the STAI and motivation scales.

In Phase 2, participants completed a questionnaire, provided demographic information, and customized avatars after learning about the experiment's duration (30 min) and compensation (30 RMB). Unlike Phase 1, participants individually experienced each of the four tasks. They completed 4 tutorial exercises before starting the task and were randomly assigned to one task group. After 10 image selections, participants filled out the UEQ and were interviewed upon completion.

Analysis

Throughout the study, we maintained a significance level of $p < 0.05$. Data analysis was conducted using SPSS version 26. We assessed normality using the Shapiro-Wilk Test, confirming that samples were normally distributed. Paired-samples t-tests were conducted within each group to examine the intervention effect of ABMT on anxiety. One-way ANOVA analyses were performed to explore differences in anxiety changes between groups. We also investigated the impact of different feedback and motivation scale components on task motivation using one-way ANOVA analyses. Spearman correlation coefficients were calculated to assess the relationship between willingness to participate and intervention effects. In the third analysis, eye movement data were processed using Tobii Pro Lab. Gaze duration in threatening versus non-threatening areas of interest was analyzed with paired-sample t-tests to evaluate changes before and after ABMT. Additionally, Spearman's correlation coefficient was utilized to examine the correlation between eye-movement behavior and anxiety scores, validating the eye movement data.

In phase 2, normal distribution was again confirmed using the Shapiro-Wilk Test. A one-way ANOVA analysis with task group as the factor and each UEQ question as the dependent variable was conducted. Post hoc multiple tests using the LSD method were performed to assess significant differences between task groups and integrate results with interview content.

RESULTS

The results of the statistical tests are shown in Figure 2 and Table 1.

STAI: We found significant differences in S-AI scores before and after training in Groups 1, 3, and 4 ($p < 0.05$), while no significant differences were observed in Group 2 ($p = 0.077$). Interestingly, only Groups 3 and 4, which included avatars, showed a significant effect on T-AI ($p3 < 0.05$, $p4 < 0.01$). Group 4 had a significantly better S-AI intervention than Group 1 ($p < 0.05$), whereas the group that only included points (Group 2) and the group that only included avatars (Group 3) failed to present a significant difference from the control group.

Motivation: The groups did not significantly differ in terms of extrinsic motivation and willingness to participate. However, extrinsic motivation was notably higher in Group 4 compared to Group 2 ($p < 0.05$). Correlation analysis showed no significant correlation between task participation motivation and intervention effectiveness.

Eye Movement: Before and after ABMT, Group 1 and Group 2's positive picture attention tendencies remained unchanged ($p1=0.997$, $p2=0.284$). However, Groups 3 and 4, which included avatars, experienced significant alterations in attentional behavior ($p < 0.05$). Particularly, Group 4 showed superior corrective effects compared to the control group ($p < 0.05$). Additionally, we found a significant positive correlation ($p < 0.01$) between changes in active attentional behavior and changes in anxiety scores, reinforcing the reliability of the eye movement data.

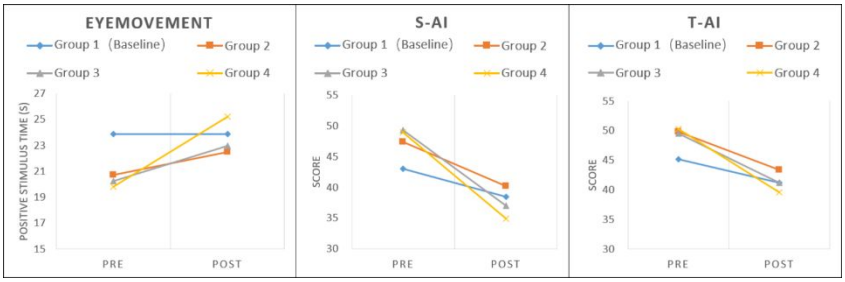

Figure 2: (Left) change in active gaze time across groups before and after the task; (middle & right) change in S-AI and T-AI scores across groups before and after the task.

UEQ: Table 1 presents the mean and standard deviation of the UEQ scores. Between-group comparisons revealed significant differences in attractiveness, excitement, and novelty. Groups incorporating avatar customization (Group 3 and Group 4) performed better in terms of attractiveness ($p < 0.01$), excitement ($p < 0.01$), and meeting user expectations ($p < 0.05$). Adding points to avatars significantly enhanced expectations ($p < 0.01$). Regarding stimulation, adding only avatar (Group 3) was more enjoyable ($p < 0.05$) and favorable to the task ($p < 0.01$) compared to adding only points (Group 2). Combining avatar customization with points offset the negative impact of points on task favorability ($p < 0.05$). Tasks with avatar customization

(Groups 3 and 4) were perceived as more innovative ($p < 0.05$), creative ($p < 0.01$), novel ($p < 0.01$), and original ($p < 0.01$). While tasks with added points (Group 2) lacked user approval in terms of innovativeness, adding avatars to points (Group 4) significantly improved perceptions ($p < 0.01$).

Table 1. Results of statistical tests of motivation scale and UEQ

			Phase 1 Motivation			Phase 2 User Experience										
			Extrinsic Motivation	Intrinsic Motivation	Participation Intention	Enjoyable	Dull	Exciting	Interesting	Conventional	Leading Edge	Demotivating	Does not Meet Expectations	Unfriendly	Unattractive	Innovative
No Avatar Customization	No Points (Group1)	Mean	12.27	11.18	12.82	5.18	4.73	3.70	4.03	3.42	4.36	4.24	2.88	3.00	3.55	4.42
		SD	1.95	2.23	1.72	1.19	1.46	1.19	1.31	0.94	1.270	1.300	0.960	0.90	1.15	1.09
	Points (Group2)	Mean	12.8	10.7	12.3	5.00	4.03	3.94	4.03	3.61	4.39	4.15	2.28	3.12	3.45	4.30
		SD	2.3	2.31	1.95	1.28	1.53	1.44	1.31	1.12	1.06	1.58	1.00	1.14	1.35	1.21
Avatar Customization	No points (Group3)	Mean	12.8	10.7	12.3	5.64	3.09	4.67	4.94	2.79	5.12	3.12	2.30	2.39	2.55	5.15
		SD	2.3	2.31	1.95	0.86	1.26	1.27	1.39	0.78	0.96	1.45	1.10	0.97	1.00	1.90
	Points (Group4)	Mean	13.75	11.17	13.08	5.55	2.85	4.79	5.03	2.85	5.18	3.21	2.09	2.55	2.67	5.06
		SD	1.36	2.59	1.38	1.25	1.37	1.45	1.45	0.91	1.01	1.56	1.04	1.20	1.27	1.27
Statistical Tests	Points	p1	0.605	0.229	0.417	0.524	0.047*	0.464	1.000	0.435	0.910	0.803	0.233	0.643	0.759	0.675
		p3	0.287	0.460	0.898	0.027*	0.008*	0.029*	0.008*	0.001*	0.007*	0.005*	0.283	0.006*	0.003*	0.004*
		p4	0.034*	0.225	0.239	0.057	0.001*	0.011*	0.004*	0.001*	0.004*	0.011*	0.058	0.029*	0.009*	0.010*
	Avatar Customization	p1	0.564	0.648	0.496	0.112	0.000*	0.004*	0.008*	0.007*	0.005*	0.003*	0.025*	0.022*	0.001*	0.013*
		p2	0.287	0.460	0.898	0.027*	0.008*	0.029*	0.008*	0.001*	0.007*	0.005*	0.283	0.006*	0.003*	0.004*
		p4	0.291	0.652	0.296	0.750	0.486	0.714	0.787	0.794	0.820	0.803	0.404	0.562	0.682	0.753
	Interaction	p1	0.096	0.988	0.715	0.203	0.000*	0.001*	0.004*	0.014*	0.003*	0.005*	0.002*	0.084	0.003*	0.029*
		p2	0.034*	0.225	0.239	0.057	0.001*	0.011*	0.004*	0.001*	0.004*	0.011*	0.058	0.029*	0.009*	0.010*
		p3	0.291	0.652	0.296	0.750	0.486	0.714	0.787	0.794	0.820	0.803	0.404	0.562	0.682	0.753

*represents significant results

DISCUSSION

The study found that ABMT effectively improved S-AI, in line with prior research (Li, 2023). Avatar customization significantly boosted the intervention's impact on S-AI, while points did not yield significant effects. Despite points typically enhancing task enjoyment, they seemed to hinder intervention effectiveness in ABMT tasks. However, reintroducing avatar customization alongside points significantly outperformed the control group, suggesting a mixed feedback approach might be more beneficial. Participants perceived points as stressful, akin to exam pressure, and were ineffective in motivating anxiety intervention participants, especially students facing academic stress (Zhang, 2020). Therefore, caution is needed when using points in anxiety interventions in the future.

Combining avatars with points mitigates the negative effects of points on anxiety intervention, and the interaction between the two enhances the user's experience. Interview results suggest some changes in their functioning when both types of feedback are present. The avatar still had a motivational effect, while the points acted more as behavioral cues. The avatar was more appealing to users as positive feedback, with most participants stating that the avatar customization was their ideal look or favorite character, and that this identification helped to reduce defensiveness and receive health information more effectively (Kang, 2020). Users paid more attention to textual prompts than scores, which may be disturbing at first contact, and the addition of textual prompts is necessary to make the feedback mechanism more complete; scores are not essential, and future intervention tasks may consider removing points and using only textual prompts.

ABMT had limited effectiveness in improving T-AI compared to its primary association with S-AI. Our task aimed to reduce attentional bias by encouraging users to focus on positive stimuli, resulting in a reduction of

T-AI relative to S-AI, which aligns with prior findings. The avatar notably reduced T-AI levels by enhancing feedback recognition and increasing user attention. T-AI relates to difficulties in attentional distraction, and recognizable positive stimuli improved these problems. The positive expressions or actions provided through avatar served as additional intervention strategies. Eye movement revealed a strong correlation between changes in attentional tendencies and anxiety scores, indicating the efficacy of attentional modification in alleviating anxiety, consistent with previous research. External interventions can disrupt the cycle of anxiety and threatening attentional tendencies, preventing anxiety from persisting (Nelson, 2015).

Our results diverged from prior research as the introduction of points did not increase users' extrinsic motivation to engage in the task. Conversely, incorporating avatar customization along with points notably elevated extrinsic motivation levels. While points seemed ineffective in providing rewards or facilitation, avatars played a motivational role. Through UEQ and user interviews, we discovered that avatars significantly enhanced the attractiveness, excitement, and novelty of the tasks. Adding avatar customization to baseline or point tasks made them more appealing, interesting, engaging, and innovative. Our initial experiment results suggest that avatar boosts extrinsic motivation due to its inherently entertaining nature. Users actively participate in creating images, fulfilling psychological needs and enhancing user experience, consistent with other task findings (Peters, 2018). Previous studies indicate that points are typically used as extrinsic rewards to meet users' external needs (Yang, 2021). However, for anxious groups, points lose their rewarding aspect and may even induce stress.

Compared to the baseline task, the introduction of feedback did not significantly alter extrinsic motivation, intrinsic motivation, or willingness to participate. This could be attributed to the ABMT's lack of inherent interest and the feedback's limited ability to fulfill autonomy needs. The level of personalization may not be sufficient to enhance appeal. Simple feedback designs may not fundamentally change the task's nature, hindering the internalization of extrinsic motivation and lacking complete feedback closure, thus failing to stimulate strong participation willingness. Hence, future research should focus on enhancing task feedback design and exploring additional methods to boost participation willingness.

CONCLUSION

Addressing global mental health issues is an urgent task, and the promotion of digital psychotherapy is crucial in this context. In this backdrop, user experience design plays a critical role in digital therapy. Our study aimed to assess the impact of different feedback on intervention effect, motivation, and user experience in anxiety intervention tasks, while elucidating the reasons behind these effects. The results indicate that caution is warranted in using points in anxiety intervention tasks, as they may add extra pressure to anxious individuals. In contrast, avatar customization emerges as a highly promising feedback, enhancing task emotional, innovative experiences and attractiveness, and serves as a secondary intervention. Combining both feedback resulted in better task performance. Future research should focus on

refining task interaction design to stimulate long-term user engagement and achieve more significant therapeutic effects.

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