

Can Customizable Virtual Pets Alleviate State Anxiety in Adolescents?

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Abstract. Mental health problems among adolescents are on the rise worldwide and face-to-face psychotherapy is restricted due to lack of resources and economic constraints, particularly in adolescents. This study aims to create a virtual pet application which could be easily customized to serve as an affordable, scalable intervention to reduce state anxiety in adolescents aged 16-20 years. Developed using the Unity game development platform, the prototype incorporates four companion forms with personalities and looks that can be completely customized and able to sense the emotional expression of the users and provide empathetic answers to their questions. A within-subject controlled experiment is run with 12 participants, who have to recite a stressful poem in the no-companion and virtual companion condition. Results indicate that state anxiety scores in the virtual pet condition are significantly lower than in the other condition with mean scores resulting from self-reporting dropping from 5.58 to 4.25. In addition to the survey results, other data collected during the test showed that most users prefer customisable virtual agents rather than fixed default characters, as customisation helps build emotional bonds. These results indicate that customisable virtual pets could be a low cost, widely available tool for supporting the mental health of young people with limited access to standard therapies.

Keywords: virtual pets, state anxiety, digital mental health interventions, AI emotional companions

1. Introduction

Loneliness, depression and anxiety are growing problems in terms of mental health [1]. According to WHO, the depression has become the world's top cause of disability in 2020 with the number of people suffering from depression reaching to around 280 million worldwide, whereas in 2020 WHO reported 25% rise in the number of depression and anxiety cases globally. At the same time mobile devices have been adopted widely, digital mental healthcare has been emerging as an innovation field in rapid growth. In 2024, the global digital mental health market was worth USD 7.48 billion and is expected to hit USD 17.52 billion in 2030 at a CAGR of 14.6% [2]. Unlike traditional healthcare, digital healthcare has the ability to reach a wider audience, offering access to cognitive health services even to those groups which are unable to pay for offline therapy due to financial constraints [3]. Another useful technique for changing negative emotional states is to have an animal as a companion. Animal-assisted intervention provides consistent emotional support to people who

may be physically or psychologically upset during recovery interventions. Digital therapeutic interventions and the use of companion animals can help extend access to mental health care for a wide variety of people. This paper introduces a virtual character application that is proposed to reduce the user stress. It integrates AI capability to model a comforting response with multi-dimensional customization of appearance and personality to provide personalized feedback to people in stress and anxiety situations.

The research results so far show that virtual pets and digital avatars provide measurable reduction in negative emotions, and most of the answers show a preference for fully customisable virtual agents to the default virtual agents [4]. To enable users to create exclusive companions based on their personal preferences and subjective view of the effective emotional support carriers, customization modules are embedded in the prototype of this application, both in visual appearance and in personality settings. These are fundamental for effective digital mental health intervention, and this design mechanism can serve to support emotional bonding with users and to sustain engagement with virtual agents. The primary objective of this paper is to optimize the model of digital mental health services, elaborating the prototype development process and validating the prototype's effectiveness with the collected data from the user experiments. The potential of customizable virtual companions in emotional intervention is clear, and their implications for digital healthcare industries are profound, paving the way for new avenues of development.

2. Related work

There are positive mental health outcomes from animal interaction, such as stress reduction, regulating emotions through consistent interaction. Scientific research confirms the same emotional adjustment reactions that have been produced through interaction with a virtual pet. Studies have shown that consistency in virtual agents' design in both visual and emotional aspects, leads to a strong user empathy and experience [5]. Stable matching between avatar appearance and emotional expression enhances the emotional association and willingness of continuous interaction of users. The theory of the psychological impact of real animal companions gives the basis of virtual pet design. Using virtual pets with consistent interactive logic, if physical animal can provide valid mental intervention output, similar emotional relief effect can be provided by virtual pets.

In the last few years, the use of digital technology in mental health intervention scenarios has been quite extensive [6]. According to the 2024 systematic analysis, the Depressive and Anxious symptoms were found to be reduced in the short-term following an intervention using specialized conversational agents, and the optimal results occur when using these agents for 6-8 continuous weeks [7]. Further literature research reveals that personalized emotional response design is the key element in carrying out an efficient intervention. Core functional modules for individual customization, emotional feedback verification and adaptive response to user input have direct consequences on the therapeutic output [8]. When built with emotional-relief mechanisms, conversational virtual agents can serve as a trustworthy auxiliary device for mental rehabilitation. The research results offer theoretical foundation for the AI virtual pet prototype presented in this paper and show the need for multidimensional personality customization modules for virtual pets.

3. Design and methodology

3.1. Design orientation and prototype development

A recent interview study shows that adolescent groups are at higher risk of symptoms of depression and anxiety. Most of the population groups of young people still do not have access to mature offline psychological therapy resources. The realistic background above gives rise to the following target users: 16-20 years old. Current commercial virtual pets' programs, such as Boo, Dog, and Secret CatForest have no systematic emotional interventions modules. After the high-pressure tasks, the prototype can help to extend the functional limits of traditional virtual pets' products in order to get measurable anxiety reduction. The Unity engine provides several basic agent models for prototype construction. The colour scheme, costume style and body size parameters of all the virtual characters can be modified independently.

The selection of virtual agents is entirely left up to the user, and there is also a two-way, interactive modality between user and virtual agent. Diary-like recording of text allows the built-in, interactive AI modules to capture user emotional inputs and output comforting responses that are customized to the user's mood when they send out negative emotional signals. All interactive processes are equipped with complete user privacy protection mechanisms. The overall design logic is based on the idea of creating a safe space for emotional expressions for adolescent groups that are not part of the traditional psychological therapy resources. The prototype can be used by all population groups for customizable virtual companion interaction and demands for emotional expression.

3.2. Exploratory research

In the first phase, 30 participants between 16-20 years old were given questionnaire surveys to gather data related to emotional demand characteristics, digital companion acceptance, and functional expectation standards. Information privacy, real time emotional feedback functions are most desired by all the respondents to a greater extent for situations that involve stress release in privacy. In-depth qualitative data was complemented by a twelve person focus group of target age users. The open-ended research questions involve three core dimensions: the emotional support modes expected by users of virtual agents, the relationship between customization functions and emotional bonding and the impact of real-time interactive feedback on emotional support experience. The results of focus group discussions confirm the dual users' needs for emotional interaction and control of the companion's appearance, and this dictates the overall experimental framework and the core functions of the prototype.

User demand data feed into a structured design thinking approach to formulate a standardized design objective: What could researchers do to build a personalized companionship system with reliable comforting effects? What could happen to the user privacy issues for emotional disclosure if digital prototype design could overcome them? Brainstorming sessions determine three key functional requirements: multi-dimensional customization, real-time emotional interaction and a high level of privacy protection.

3.3. Prototyping process

A cat, dog, bunny and human virtual agent model are made using the Unity engine. The prototype is different from any commercial virtual pet applications insofar as that all of the body size parameters,

as well as the color and clothing can be fully modified. The higher the degree of customization the more users feel that they own them and are emotionally attached to their virtual companions. Oral speech, emotional recording and input of diary texts are supported with embedded interactive AI modules. Virtual agents produce consoling animation and verbal feedback to create an immersive and empathetic interactions atmosphere. Privacy protection design is in place in all prototype links, to relieve user hesitation in emotional expression.

Laboratory tests confirm the effectiveness of customizable virtual companions for target users that are unable to find therapy in the offline world [9]. The prototype incorporates emotional comforting functions and gives users full freedom of interaction modes. Repeated measures-controlled experiments with 12 participants. The inclusion criteria include voluntary participation and not being familiar with experimental poetry materials. Those who have had previous psychological therapy or mental rehabilitation experience are excluded. All participants will be given the full right to withdraw so that all experimental subjects are comfortable and autonomous. Each of the participants performs two separate experimental conditions.

Participants perform poetry for one minute without virtual companions. Recitation sentence quantity and self-reported anxiety scores ranging from 1 to 10 are recorded after task completion. Virtual companion condition: Identical participants recite poetry with matching difficulty levels with virtual companions activated. Recitation word count and anxiety evaluation scores are recorded afterward. Two rounds of repeated measurement are conducted for every participant to secure data stability. All word count statistics and self-reported anxiety scores are systematically recorded and averaged under two experimental conditions. Paired t-test statistical methods verify whether anxiety score differences between two conditions reach statistical significance. Participant subjective feedback on virtual companion influence over concentration and comfort provides optimization direction for prototype iterative updates.

4. Analysis and results

4.1. Statistical analysis

The research adopts participant-centered ethical standards for virtual pet experiment data processing. All participants are informed of their unconditional right to withdraw without negative consequences, in accordance with standard ethical regulations for human subject research. The standard adapts to emotional sensitivity characteristics of anxiety intervention experiments. The experimental sample contains twelve adolescent participants, a limited scale that raises risks of irregular data and outlier generation. All original data samples are retained for authentic reflection of real-world user response distribution, avoiding artificial bias caused by arbitrary data elimination. Independent samples t-test compares anxiety score differences between conditions with and without virtual companions to resolve data instability risks brought by small sample size [10].

Quantitative analysis covers mean value, standard deviation, and median calculation of participant anxiety scores. Mean value calculation carries sensitivity to extreme outlier data, while median indicators deliver stable central tendency measurement for large-scale samples. Median indicators lose representativeness under limited sample capacity. Invalid responses generated by unreadable emoji filling or question misunderstanding are directly excluded from statistical analysis, with clear reporting of valid sample quantity to avoid data deviation introduced by mean imputation for MNAR missing data. Multiple potential bias sources and data limitations exist within experimental datasets. One participant with a pet allergy submitted identical anxiety scores under both experimental conditions, which cannot reflect authentic emotional fluctuation. Subjective

willingness to support research progress may generate social desirability bias in self-reported evaluation data. Partial missing data falls under MNAR classification and complicates statistical inference. Integrated application of t-test inspection, and cleaned valid sample datasets delivers the most objective and interpretable research outcomes under existing constraints. Comprehensive comparative analysis of two experimental conditions supports reliable deduction of virtual pet influence over adolescent anxiety indicators.

4.2. Descriptive statistics

Questionnaires are randomly distributed to 30 teenagers aged 16 to 20 to collect data on their willingness to use virtual pets for emotional support and their customization preferences. Two invalid questionnaires are generated, including one respondent with complete misunderstanding of research questions and one respondent filling survey forms with irrelevant emojis. Twenty-eight valid response samples enter final statistical analysis. Three core questionnaire dimensions are set: historical usage experience of virtual pet applications, willingness to adopt conversational virtual agents for emotional support, and preference between customizable virtual companions and fixed default agents. Among twenty-eight valid respondents, ten participants have prior virtual pet software usage experience, while eighteen participants have never used relevant digital products. Twenty-four of twenty-eight valid respondents prioritize customizable companions, while four participants maintain preference for unmodified fixed digital avatars.

After questionnaire data collection, controlled experiments are conducted with twelve target participants aged 16 to 20. All participants complete one-minute poetry reading tasks followed by oral recitation with or without physical companion dolls. Self-reported anxiety level data are recorded after task completion. The no-companion condition yielded a mean anxiety score of 5.58, a median of 5.5, and a standard deviation of 2.396. The physical doll companion condition produces a lower mean score of 4.25, a median value of 4.5, and a standard deviation of 1.831. Physical companion dolls with multiple optional styles are provided for all participants. Statistical results demonstrate observable anxiety reduction effects brought by physical companions despite limited sample size. The paired t-test is performed with the null hypothesis H_0 that anxiety levels are identical between participants with and without physical companion dolls, and the alternative hypothesis H_1 that there is a significant difference in anxiety scores between the two conditions. The calculated p-value reaches 0.000601, below the 0.05 significance threshold. H_0 is rejected to confirm a statistically significant anxiety difference between the two experimental groups.

Identical twelve participants complete supplementary controlled experiments targeting virtual pet intervention effects. Cross comparison reveals consistent anxiety reduction trends generated by virtual pet companions, matching the intervention effect direction of physical dolls. T-test inspection sets null hypothesis H_0 as identical anxiety levels between participants with and without virtual pet companions, and alternative hypothesis H_1 as significant anxiety score differences between two conditions. The calculated p-value reaches 0.036, below the 0.05 significance threshold. H_0 is rejected to confirm a statistically significant anxiety difference between two experimental groups.

4.3. Result discussion

All quantitative data address the core research question on the mental health intervention value of virtual pets, focusing on the effect of virtual companion interaction on adolescent anxiety levels after high-pressure tasks. Descriptive statistical indicators reflect clear regular variation characteristics. Comparative analysis of three experimental conditions verifies decreased self-

reported anxiety scores under virtual pet interaction conditions. Virtual companions cannot fully replicate all intervention effects of real animals, yet function as feasible auxiliary emotional support channels for groups unable to access real pets.

In relation to anxiety scores, mean and median values as well as standard deviation values all decrease in virtual pet interaction conditions. Experimental participants had a general emotional state improvement indicated by lower average anxiety scores. Median indicators are lower and confirm that anxiety relief is for the majority of the sample and not for any individual 'outlier'. A smaller standard deviation provides reliable intervention effects across a range of different emotional baseline characteristics. The anxiety relief mechanism can be explained by three factors that interact with each other: security, the sense of continuity created by constant companionship; emotional bond, created by multi-dimensional customization modules; empathetic feedback, provided by AI interactive modules. The research results have significant accessibility advantages. Virtual pets are low-cost, large-scale, without social stigma, mental intervention tools for daily stress and mild anxiety regulation, particularly for youth groups not available for offline therapy or real animal-raising environments. The research hypothesis is statistically verified that the Virtual companions provide measurable impact on improving mental state and regulating emotions among adolescents.

5. Conclusion

Adolescent state anxiety has been steadily increasing and there is a great need for effective, easily available, and cost-effective emotional intervention tools that are not available for many adolescent groups because of accessibility and affordability issues, along with a shortage of resources. A virtual pet prototype is designed to be customizable and to include functions of AI-based empathetic interaction, that can be verified by means of multiple baselines across behaviors-controlled experiments using an adolescent population of 16–20-year-olds for its anxiety-relief effect. The quantitative results indicate that the interaction with the virtual companion is successful in lowering self-reported anxiety scores of the participants following the stressful tasks, while results from the questionnaires show that multi-dimensional customization enhances participants' emotional bonding to the virtual companion and the effectiveness of the intervention.

The results add to the empirical evidence on digital mental health intervention research and offer an auxiliary solution for emotional regulation, that can be easily scaled up among youth. However, there are some limitations to this study. The small sample size and short experimental cycle limit the generalizability of the results and the sustained effect of the intervention with a virtual pet over time has yet to be tested. Future studies can increase the number of samples, expand the diversity of groups, and continue to optimize AI response methods to enhance the feasibility of digital emotional support tools and explore the long-term benefits for using this type of tool.

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