Sunnie: An Anthropomorphic LLM-Based Conversational Agent for Mental Well-Being Activity Recommendation

Siyi Wu
University of Toronto
Toronto, Canada
reyna.wu@mail.utoronto.ca

Feixue Han
Northeastern University
Boston, USA
han.feix@northeastern.edu

Bingsheng Yao
Northeastern University
Boston, USA
b.yao@northeastern.edu

Tianyi Xie
Flourish Science
California, USA
t@flouriship.com

Xuan Zhao
Flourish Science
California, USA
xuan@flouriship.com

Dakuo Wang
Northeastern University
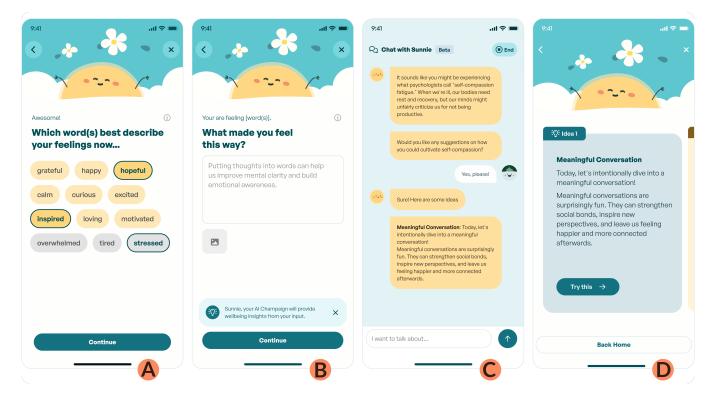Boston, USA
d.wang@northeastern.edu

Figure 1: Sunnie is an anthropomorphic LLM-based conversational agent, designed to support mental well-being through personalized psychological activity recommendations. Sunnie consists of three key features: the anthropomorphic design of Sunnie's appearance and the persona prompts, the multi-turn natural conversation of mental well-being coaching, and the LLM-based personalized activity recommendation module. The four interfaces depict users' interactions with Sunnie: (A) users select the best word(s) that describe their feelings, (B) users input a textual description of their feelings, (C) users interact with Sunnie in a multi-turn conversation, and (D) Sunnie recommends a personalized activity to support users' mental well-being.

ABSTRACT

A longstanding challenge in mental well-being support is the reluctance of people to adopt psychologically beneficial activities, often due to lack of motivation, low perceived trustworthiness, and limited personalization of recommendations. Chatbots have shown promise in promoting positive mental health practices, yet their rigid interaction flows and less human-like conversational experiences present significant limitations. In this work, we explore

whether the anthropomorphic design (both LLM's persona design and conversational experience design) can enhance users' perception of the system and their willingness to adopt mental well-being activity recommendations. To this end, we introduce Sunnie, an anthropomorphic LLM-based conversational agent designed to offer personalized well-being support through multi-turn conversation and recommend practical actions grounded in positive psychology and social psychology. An empirical user study comparing the user experience with Sunnie and with a traditional survey-based activity recommendation system suggests that the anthropomorphic characteristics of Sunnie significantly enhance users' perception of the system and the overall usability; nevertheless, users' willingness to adopt activity recommendations did not change significantly.

CCS CONCEPTS

• **Human-centered computing** → **Systems and tools for interaction design**; **Interactive systems and tools**.

KEYWORDS

Large Language Models, Mental Well-being Support, Conversational Agents, Anthropomorphic Design, Activity Recommendation

1 INTRODUCTION

Mental well-being is a critical aspect of overall health, encompassing emotional, psychological, and social dimensions [41]. This fundamental aspect of our lives is crucial to managing stress, nurturing meaningful relationships, and making informed decisions [41]. Research has identified key factors contributing to mental well-being and has designed a variety of evidence-based activities, including physical and cognitive activities, to improve mental well-being [74, 99]. Despite the abundance of information for enhancing well-being, a crucial challenge remains: the reluctance of many individuals to act or adopt these recommended activities into their daily routines even if they are aware of the potential benefits [81, 85]. This gap between being aware of such beneficial knowledge and taking actions (knowledge-action gap) can be attributed to various factors, including lack of motivation, perceived difficulty in adopting new behaviors, and the absence of personalized guidance [42, 81, 84].

In response to the aforementioned challenge, recent research has explored the potential of chatbots as an innovative tool to bridge this knowledge-action gap in mental well-being support [21, 43–46, 50, 66, 72, 78, 90, 106]. By providing conversational and interactive support, chatbots have shown promise in promoting user engagement and encouraging the adoption of healthier behaviors [3, 72]. Current research on chatbot interventions primarily focuses on lifestyle improvements–such as promoting physical activity, improving dietary habits, and enhancing sleep quality–to support mental well-being [3, 22, 45, 72, 77, 88, 100]. However, these interventions often fall short due to limitations such as inadequate

understanding of context, difficulty handling complex conversations, and lack of personalization [3, 45, 72, 76, 88, 110].

The emergence of large language models (LLMs) presents new possibilities to enhance mental well-being support through LLM-based chatbots, with their superior natural language processing capabilities fostering a more nuanced understanding of context and improved handling of complex conversations [11, 16, 67, 93, 95, 103]. Such advantages of LLMs could lead to more human-like and relatable conversational experiences, potentially increasing user engagement [62, 65, 89]. The integration of anthropomorphic features in LLM-based agents presents a promising avenue to deliver interactions that are not only more engaging but also more effective in motivating users to take action towards mental well-being [10, 12, 51, 86].

Despite the advancements in LLMs, there is limited research on their use in promoting activities for mental well-being support. Most existing studies focus on improving personalization and providing a more human-like experience through conversations, but rarely focus on facilitating action-taking or recommending activities to practice well-being [14, 34, 59, 62, 65, 89, 104]. Furthermore, there is a notable gap in understanding how LLM-based systems are perceived by users, especially in terms of their effectiveness in promoting action taking for mental well-being. A critical yet unaddressed question is how the design of LLM-based systems, especially the incorporation of anthropomorphic features, influences users' perceptions and their willingness to engage in actions that support mental well-being.

Expanding existing research, our study aims to bridge the crucial gap in understanding LLMs as conversational agents for mental well-being support. Specifically, we investigate the impact of anthropomorphic features in LLM-based conversational agents on users' perceptions and their engagement with these systems, particularly in terms of encouraging actionable steps toward mental well-being. Our study is guided by two research questions:

- **RQ1**: How do anthropomorphic designs of LLM-based conversational agents for mental well-being support with activity recommendations affect users' **perceptions** of the systems?
- **RQ2**: How do such designs affect users' **engagements** with the systems in the context of mental well-being support?

We introduce Sunnie, an anthropomorphic LLM-based conversational agent designed to offer personalized well-being support and recommend practical actions grounded in positive psychology and social psychology research. Sunnie is an "AI happiness coach and companion" developed by Flourish Science, a public benefit corporation with the mission of "personalizing the science of happiness and well-being to make it accessible, actionable, simple, and fun, thereby providing proactive and just-in-time mental health and well-being support." The version tested in the current study is powered by GPT-4 [2], an advanced LLM, to offer more human-like interactions, thereby enhancing personalization and encouraging action-taking in mental well-being support.

We hypothesize that incorporating anthropomorphic features into the design of Sunnie will lead to more positive perceptions and, in turn, increase user engagement and the likelihood of adopting the recommended activities for improving mental well-being. To test

our hypotheses, we conduct an empirical user study that compared the perceptions of users who interact with Sunnie to those interacting with a non-anthropomorphic, non-conversational, LLM-based activities recommendation system.

The core contributions of this paper are tri-fold:

- Describe the design and development of Sunnie, an anthropomorphic LLM-based conversational agent equipped with emotion regulation coaching and well-being activity recommendations, aimed at enhancing personalized well-being support and facilitating proactive well-being management.
- Report findings and insights from an empirical 3-day, within-subject user study through quantitative and qualitative analysis demonstrate the potential of anthropomorphic designs in conversational agents to effectively support and inspire users to take actions that have been empirically shown to bolster people's emotional, social, and mental well-being.
- Provide design considerations derived from our study results to foster the future development of LLM-based mental well-being support systems in terms of more personalized and effective support.

2 RELATED WORK

2.1 AI in Activity Recommendation for Mental Well-Being Support

While abundant information is available on activities that promote physical and psychological well-being, a significant gap exists in adherence and motivation to participate in these activities. AI-powered technologies, particularly chatbots, have been widely used to address this gap by promoting activities for mental well-being support [21, 43–46, 50, 66, 72, 78, 90, 106].

Building on this foundation, most studies have focused on encouraging physical activities, demonstrating the effectiveness of using chatbots to guide people toward a healthy lifestyle, such as promoting healthy diets, improving the duration and quality of sleep, quitting smoking, etc. [3, 45, 72, 77, 88]. These interventions have proven to be effective in various populations and age groups across both short-term and long-term studies.

Expanding the scope, while research has shown the importance of activities promoting positive feelings and behaviors for well-being [63], a few studies focused on using chatbots to deliver positive psychology and Cognitive Behavior Therapy (CBT) interventions. For example, Kien et al. [63] studied the effectiveness and adherence of using chatbots to deliver positive psychology and CBT strategies; Rohani et al. [83] showed the positive impacts of MUBS [83], a smartphone-based system supporting Behavioral Activation (BA) treatment of depressive symptoms with a personalized content-based activity recommendation model based on multinomial Naive Bayes machine learning algorithms, in motivating patients to engage in pleasant activities.

However, despite the potential of chatbots in promoting well-being activities, the challenges remain to ensure their effectiveness in user adherence. These challenges include the need for improved linguistic capabilities, more personalized content, and the integration of human-like identity features to improve user experience and engagement [1, 53, 94].

Building on these gaps, our work aims to contribute to the field by studying the effectiveness of positive activities recommended by a conversational agent with more human-like features, personalized recommendations, and improved linguistic capabilities using LLMs coupled with anthropomorphic designs. We seek to explore how these features can enhance the effectiveness and adherence of chatbot interventions for mental well-being support, addressing the current limitations in chatbot personalization and user engagement.

2.2 LLM-Based Systems for Mental Well-Being Support

The utilization of conversational agents to enhance mental well-being has a longstanding history [1, 10], dating back to pioneering systems such as ELIZA [102]. This tradition continues with the advent of modern chatbots such as WoeBot [24] and Wysa [35], which are easily accessible to the public.

In the past, mental health chatbots primarily utilized rule-based systems [1], employing various therapeutic techniques to guide users through self-help exercises. These chatbots have been shown effective in enhancing mental well-being by encouraging self-disclosure [55, 56], fostering self-compassion [54], and regulating users' emotions [18], etc. However, the rule-based nature of these chatbots often limits the natural flow of conversation [89].

The introduction of LLMs has sparked a new wave of interest in the potential of LLM-based conversational agents for mental health support [89], such as platforms like OpenAI's ChatGPT [2] and Replika [52]. The user-friendly conversational interfaces of these LLM-powered chatbots have sparked excitement among clinicians about the possibilities of novel AI-driven interventions [89]. These agents are designed to provide direct interaction with individuals seeking mental health support through various platforms, including personal digital companions [65], online on-demand counseling [14, 57, 59, 61, 62, 104, 108], emotional support [113], etc.

Building on this foundation, our work aims to expand the utility of LLM-based conversational agents by incorporating activity recommendations alongside conversational support. By integrating more human-like features, personalized recommendations, and enhanced linguistic capabilities, we seek to explore how these features can enhance the effectiveness and adherence of chatbot interventions for mental well-being support, addressing the current limitations in chatbot personalization and user engagement.

2.3 Anthropomorphism Design of LLM-Based Conversational Agent

One of the limitations of LLM-based conversational agents in mental health is the concern about trust and safety [1]. Trust is a fundamental element in mental health support, and ensuring the safety and reliability of conversational agents is crucial for their acceptance and effectiveness. This concern highlights the need for careful design and ethical considerations in their development [5, 55, 58]. Anthropomorphism refers to the psychological phenomenon of "attributing human characteristics to the nonhuman" [86], is one aspect of this need that should be used with care, as it influences user expectations and reliance on AI systems, affecting how users perceive and interact with conversational agents [65].

In the anthropomorphic design for conversational agents, features can be broadly categorized into social and verbal cues [10, 12, 51, 80, 86]. Social cues encompass non-verbal elements that convey human-like traits and behaviors, such as human-like appearance, including facial expressions and gestures, interactivity that mimics human responsiveness, and behavioral features that reflect human personality, empathy, and social roles. These cues enhance the perceived humanness of the agent, making interactions more relatable and engaging [5, 7, 58]. On the other hand, verbal cues involve the use of language and communication styles that emulate human-like speech and interaction. This includes using natural language for intuitive and relatable communication, adherence to social norms such as politeness [10], greetings, and farewells, and providing tips and advice in a manner consistent with human conversational patterns [6, 15, 58].

The appropriate anthropomorphic design can amplify social responses and build social relationships between humans and computers. By incorporating human nature and unique traits, as well as personality traits, the perceived human likeness of systems is increased, which can improve user engagement and satisfaction [86, 92]. However, the implementation of anthropomorphic design must be balanced to avoid the uncanny valley phenomenon [101], where overly human-like design features can elicit feelings of eeriness or discomfort. This highlights the need for a nuanced approach to human-like design in conversational agents to ensure positive user perceptions and acceptance.

Research has explored how the design of AI systems influences people's perceptions in various settings, including clinical, social support, and public health interventions. However, there is a notable gap in understanding the specific influence of anthropomorphic designs on conversational agents, especially those aimed at fostering well-being activities. The significance of grasping how users perceive these agents is critical for the development of AI interfaces that are not only effective, but also provide a sense of care and support. In addressing this gap, our research delves into the effects of anthropomorphic design elements on the user's perception of an AI-powered companion dedicated to promoting well-being practices.

To advance this area of study, we first introduced the design of Sunnie, an LLM-powered conversational agent that offers personalized guidance on emotion regulation and recommends relevant activities grounded in psychological research to enhance well-being. To this end, we meticulously described its system architecture, design principles, user interface, and prompting framework. Next, we conducted an evaluation to understand people's perception of and experience with this conversational agent. Our approach stands out in its comprehensive consideration of how the integration of human-like characteristics within AI can transform the user experience, leading to a more positive and engaging interaction with technology aimed at supporting well-being and personal growth.

3 SUNNIE: AN ANTHROPOMORPHIC LLM-BASED CONVERSATIONAL AGENT

Sunnie aims to leverage the potential of anthropomorphic design in LLM-based conversational agents to recommend well-being activities for mental well-being support. This approach advances

beyond the current state-of-the-art (SOTA) works by not merely offering activity suggestions via chatbots but by capitalizing on the sophisticated capabilities of LLM-based agents to forge a deeply personalized and engaging interaction with users.

In the following sections, we delve into the design and developmental framework of Sunnie. We systematically unpack the architecture of Sunnie, beginning with an overview of the foundational design principles that guide this system. Following this, we highlight the distinctive features that set Sunnie apart, providing a detailed exploration of the innovative aspects that enhance user engagement and personalization. Finally, we articulate the methodological approach employed in the implementation of Sunnie, ensuring a coherent and robust application of these principles and features in practice.

3.1 Design Principles

The "Computers are Social Actors" (CASA) paradigm [70, 71], also known as "social response theory," suggests that users respond with social behavior and attributions when machines exhibit human-like features such as interactivity, natural language use, or human-like appearance. Initially proposed by Nass and Moon [70], this paradigm extends to conversational agents (CAs) [9, 79, 82, 92], with research indicating that human-like behavior and social cues [23, 86] in CAs can enhance social reactions, establish trust, and lead to perceptions of reliability. Critically, the literature reveals a nuanced understanding of how and why these phenomena occur. Firstly, it has been found that the more a CA resembles a human in the interactions, the more natural and effortless the user's response tends to be [8, 17, 92]. The naturalness of interaction is important for establishing trust between humans and CAs. Secondly, CAs' social cues have been shown to be effective in facilitating the development of trust and influencing the user's perspective of CAs, which is pivotal when humans rely on CAs' for decision-making [8, 17, 92]. Additionally, many aspects of human-to-human relationships are transferable to the relationship between humans and CAs, such as establishing parasocial relationships where only one party extends emotional energy, interest, and time. Still, the other side is completely unaware of the other's effort [68, 91, 92].

DP1: Anthropomorphic designs: no more, no less. Building on these insights, recent research has highlighted the importance of anthropomorphic design in conversational agents (CAs), taking into account the uncanny valley effect [28, 69, 86, 105], which suggests that overly human-like agents can elicit discomfort. A balanced approach to anthropomorphic design is recommended, considering human identity (such as human-like representation, gender, or age), non-verbal features (such as hand gestures, facial expressions, or emojis), and verbal characteristics (such as word choice and sentence structure) [86, 92]. Studies have shown that incorporating human-like visual representations, verbal cues like self-references or emotional expressions, and non-verbal behavior like emoticons or turn-taking can enhance the perception of human-likeness in CAs [58, 86]. For example, enabling agents to use social dialogue, express emotions, and refer to themselves as "I" can make them appear more human-like. Non-verbal cues, such as blinking dots to communicate thinking gestures or emoticons to convey emotional
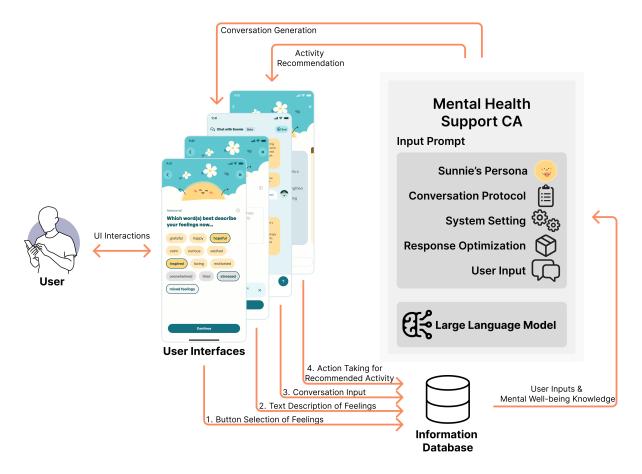
Figure 2: The system architecture of Sunnie. Sunnie is supported by an LLM with a meticulously designed prompt framework. A user interacts with Sunnie through a series of interfaces, including selecting and typing their feelings with buttons and text input, communicating with Sunnie in multi-turn conversation, receiving personalized activity recommendations, and deciding whether to take the activity.

expressions, also significantly create a human-like impression [58, 86].

Another common practice with the goal of imbuing human-like traits in CAs is to create personas for the agent. A persona could be a fictional character with a name, age, or even a defined backstory and personality [80]. Some research argues that having a distinct persona or personality could contribute to a cohesive and consistent presence of the conversational agent for users and increase trust and the intention to use the technology [32, 36]. However, careful designs of personas are needed [80]. It is important to avoid reinforcing stereotypes or biases, ensuring that the personas are diverse and inclusive [80, 92].

Studies indicate that a "more is more" approach is not advisable, as it can negatively affect perceived anthropomorphism. For example, a regression analysis [86] revealed two significant interactions: one between non-verbal and verbal cues and another between non-verbal and human identity cues. These findings suggest that the combination of these design dimensions provides a consistent representation of human-likeness, but including all

three dimensions do not necessarily increase users' perceptions of anthropomorphism [86].

DP2: Grounding conversation in science but with layman's languages. In recent years, the study of happiness and well-being has witnessed significant growth from cognitive and psychological perspectives. This body of literature demonstrates that individuals can intentionally cultivate well-being through specific practices [41, 96, 98]. However, the vast wealth of knowledge emerging from this line of research is not easily navigable for the general public, presenting a notable barrier to its application in everyday life. We envision an immense potential in leveraging LLMs to enhance the accessibility of scientific insights through LLM's recommendation and conversation capacities, making the insights of happiness and well-being accessible and actionable to a broader audience.

Additionally, the burgeoning field of research in CAs has underscored the importance of crafting dialogues based on mutual understanding and empirical evidence [73, 92]. Using familiar language and clear, simple expressions can enhance comprehension and engagement, as suggested by previous literature [29, 47]. The

concept of mental health literacy further emphasizes the importance of using language that aids in the recognition and management of mental health issues [37]. These considerations underscore the vital relationship between language, understanding, and action in mental well-being support.

Building upon this foundation, conversational agents that support evidence-based communication become essential. Ensuring that the information provided is relevant, practical, and scientifically accurate is critical for enhancing the credibility of the conversational agent. Grounding conversations in science and using familiar language aligns with the principles of evidence-based practice, which advocate for integrating research evidence into decision-making processes. This design consideration could enhance the user experience and ensure that users receive validated and reliable information, thereby promoting mental well-being effectively.

DP3: Considering positive design principles that align with system goals. To align with our objectives of enhancing mental well-being and supporting human flourishing, we integrate positive design principles [107]. These principles are predicated on the notion that each design aspect should be oriented toward enriching the user experience. We aim to bolster well-being and happiness, ensuring the design harmonizes with our system's overarching goals. We follow various strategies encompassed in the aforementioned design principles, such as Design for Pleasure, Design for Personal Significance, and Design for Virtue. We chose these design principles to ensure that our system design meets functional requirements and contributes positively to users' psychological state, fostering better mental well-being.

3.2 Key Features

In this section, we delve into the key features and anthropomorphic designs of Sunnie as shown in Figure. 1, drawing on a comprehensive review of existing literature and foundational design principles.

The key features include 1) anthropomorphic designs of Sunnie, 2) an LLM-based conversational agent for mental well-being coaching, and 3) LLM-driven, personalized well-being activities recommendation.

In accordance with DP1, Sunnie's anthropomorphic designs are crafted to endow the system with human-like characteristics without crossing into the uncanny valley. These design elements aim to make interactions more natural and engaging by providing a sense of familiarity and empathy. Features such as natural language use, expressive emojis, and emotional responsiveness are carefully integrated to achieve this effect while maintaining a comfortable human likeness.

Consistent with DP2, Sunnie employs an LLM-based conversational agent for mental well-being coaching. This agent is designed to provide interactive and tailored coaching sessions, assisting users in acquiring new knowledge or skills related to mental well-being. The conversational agent's capability to comprehend and respond to user queries in a human-like manner is crucial for effective coaching.

Also, Sunnie includes an LLM-driven recommendation module for well-being activities. This module is designed to offer personalized activities that cater to the user's specific needs and preferences
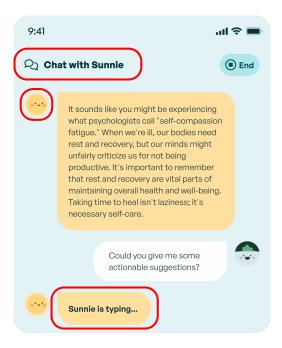

Figure 3: The anthropomorphic design of Sunnie in the conversation interface is highlighted with red circles. These designs include the title of "Chat with Sunnie," the anthropomorphic appearance of Sunnie as a conversational agent, and the design of a "Sunnie is typing…" animation while waiting for the generated response from GPT-4.

to enhance their overall well-being. The recommendations are generated based on user inputs and interactions with the conversational agent, ensuring their relevance and utility.

3.2.1 Anthropomorphic Design of Sunnie. In this section, we delve into the anthropomorphic designs of Sunnie as shown in Figure. 3, aligning with our design principles (DP1, DP3) to balance human-like elements and promote well-being and flourishing in users.

The Appearance of Sunnie: Previous literature pointed out that one concern of anthropomorphic designs regarding the appearance of the agents is the uncanny valley effect (UVE), which suggests that overly human-like agents can evoke feelings of eeriness or discomfort. Once the users perceive the visual and behavioral imperfection of realism, they may form negative impressions through which they might subsequently reject the adoption of the technology.

To avoid UVE, Sunnie is represented by a sun rather than a human character. The sun symbolizes warmth, light, and life-giving energy, therefore conveying the belief in people's inherent potential for flourishing. Sunnie aims to brighten users' days, sharing warmth and light as a happiness coach and companion.

Persona of Sunnie: Based on DP1 and DP3, the persona of Sunnie is crafted to resonate with its goals of promoting well-being activities and supporting users on their journey towards a flourishing life. Sunnie's personality is friendly, compassionate, supportive, and insightful. Its persona is grounded in positive psychology and includes the following traits:
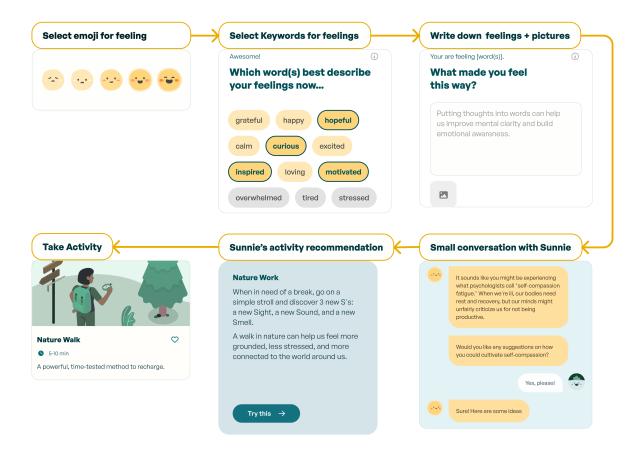
Figure 4: The detailed user interaction workflow with Sunnie encompasses six primary stages: 1) user selects an emoji to start the interaction, 2) user selects one or more keyword(s) for feelings, 3) user writes down descriptive text for the feelings and optionally upload an image, 4) Sunnie initiates a small multi-turn conversation for personalized well-being coaching, 5) Sunnie provides personalized activity recommendation, and 6) user determines whether to take the activity or not.

- Action Taker: reflects the notion that active engagement in well-being activities and skill-building exercises could enhance happiness and life satisfaction [64]
- Positivity Practitioner: underscores the significance of positive emotions and optimism in coping with life's challenges, fostering a positive mindset [26]
- Mindfulness Mentor: incorporates the concept of mindfulness, which has been shown to improve emotional regulation and reduce stress, encouraging users to adopt mindfulness practices [39]
- Lover of Life: embodies the growth mindset which is associated with greater well-being and life satisfaction, suggesting a willingness to learn and embrace challenges and a continuous quest for knowledge and self-improvement [19, 26]

Considering the potential risks associated with anthropomorphism, such as UVE and the reinforcement of stereotypes and biases, Sunnie is carefully designed to avoid using a human appearance or assigning a specific gender or career. Sunnie's names and personalities align with the aforementioned design principles (DP3), focusing on promoting well-being and flourishing.

Verbal and Non-Verbal Cues: In terms of verbal and non-verbal cues, Sunnie communicates in a friendly and compassionate manner, consistent with its persona. Sunnie also leverages the communicative power of visual symbols, such as emojis, to convey emotions and add expressiveness to conversations. This approach enhances the user experience by making interactions more relatable and engaging [86].

3.2.2 User Interaction Flow. The user interaction workflow with Sunnie is a structured process designed to support mental well-being through a series of steps, as shown in Figure. 4 with the snippets of the key interactions for each step. The dedicated user interface for each step being visualized in a mobile application is shown in Figure. 1.

Mood-Logging Activities: Users begin each session by logging their mood, a practice supported by cognitive behavioral therapy (CBT) principles, effective in long-term mental health support [10]. Users are asked to rate their mood on a five-point Likert scale and select one or more words to describe their feelings from a list of positive and negative words, such as overwhelmed, grateful, bored, curious, and sad. They are also asked to write down what

Table 1: A list of well-being activities recommended by Sunnie in the current study based on research in positive psychology and social psychology.

Activity	Category	Type	Instruction
Three Good Things [30, 87]	Savoring	Writing	Write down three things—big or small—that you appreciate about today.
Beautiful Moment [38]	Savoring	Writing	While going about your day today, look for a beautiful moment, however small.
Letter from the Future Self [13, 48]	Aspiring	Writing	Time travel to the future and write a letter back to yourself today. Discover all the wisdom and strength that is already within you!
Nature Walk [31]	Savoring	Action	When in need of a break, go on a simple stroll and discover 3 new S's: a new Sight, a new Sound, and a new Smell. A walk in nature can help us feel more grounded, less stressed, and more connected to the world around us.
Gratitude Note [49]	Connecting	Interaction	Send a short note to someone and tell them how they have meaningfully touched your life.
Meaningful Conversation [40]	Connecting	Interaction	Today, let's intentionally dive into a meaningful conversation! Meaningful conversations are surprisingly fun. They can strengthen social bonds, inspire new perspectives, and leave us feeling happier and more connected afterwards.
Gifting a Compliment [111]	Connecting	Interaction	Write someone a compliment today. Oftentimes, we grow so used to the wonderful people in our lives that we forget to tell them how amazing they are!
Blast from the Past [27, 109]	Savoring	Interaction	Rediscover a photo of an "ordinary moment" from the past, and share it with someone who might enjoy rediscovering it, too!

made them feel that way. Prior research on expressive writing [75] has demonstrated significant psychological benefits, including improved mood, reduced stress, and enhanced overall well-being, and provided structured framework to articulate and understand their emotional experiences. Such framework can lower the activation energy required for self-disclosure and emotion regulation, thereby increasing user engagement and adherence.

Conversation for Personalized Well-Being Coaching: Based on the information collected in mood-logging activities, Sunnie leverages its LLM-based conversational agent capabilities to engage in a multi-turn dialogue with the user. This conversation aims to delve deeper into the user's emotional state, fostering a continuous and natural back-and-forth interaction. By aligning with DP2, the system ensures that the conversation is grounded in scientific principles and uses familiar language, enhancing the user's understanding and engagement. The system offers suggestions to savor positive emotions or improve negative moods, drawing on scientific knowledge. For example, if a user feels grateful due to a friend's support, Sunnie might inquire about the specifics of the support, express affirmation for the user, and explain the importance of social support to well-being.

Well-Being Activity Recommendations: Based on the information gathered from mood-logging activities and personalized conversations, Sunnie provides personalized well-being activity recommendations. These suggestions are tailored to the user's current mood, emotions, and needs to enhance their overall well-being. Users can decide whether to engage in the recommended well-being activity. Sunnie provides instructions for completing the activity, supporting users in practicing the suggested well-being activity.

By incorporating these functionalities, Sunnie, as a well-being coach and companion, aims to provide users with a supportive and interactive environment for promoting well-being activities.

3.2.3 Well-Being Activity Recommendation. Given the diverse range of life circumstances users may experience, it is important to include a wide range of actionable strategies in the activity recommendation system to enhance happiness and well-being in alignment with DP2. Reviewing the extant literature revealed at least three broad categories of activities:

Connecting Activities: Engaging in actions that foster meaningful connections with others is foundational to well-being. Activities such as giving compliments [97], sending gratitude notes [97], or having deep, meaningful conversations have been shown

to strengthen social bonds and emotional support, which are vital for happiness [4]. These interactions underscore the importance of social connectivity in enhancing positive emotions and life satisfaction. However, mounting evidence shows that people frequently under-utilize these practices and are "undersocial" than they should be for the well-being of themselves and others [20, 97, 111, 112], which poses an opportunity for recommending more of such actions for daily well-being practice.

Savoring Activities: Practices that encourage mindfulness and appreciation of the present moment significantly contribute to an individual's happiness. For instance, research shows that identifying and writing down three good things daily or immersing oneself in nature can enhance mood and overall life appreciation [97]. These activities highlight the benefits of mindfulness and savoring life's positive experiences for emotional well-being.

Aspiring Activities: Actions that inspire a sense of meaning and purpose are crucial for a fulfilled life. Activities such as writing a letter from the perspective of a future self or to a future self [97], imagining one's best possible self [97], and affirming core values have all been shown to provide direction and motivation, promoting a sense of achievement and satisfaction. These practices emphasize the role of personal aspirations and values in driving happiness and well-being.

These strategies represent just a fraction of the research-backed methods for improving happiness and well-being. The challenge is to effectively disseminate this knowledge, ensuring that these insights are accessible and actionable for the wider public. For the sake of this study, we selected eight activities from the above three categories that have clear benefits to the general population as shown in Table. 1.

Note that the above categories are not mutually exclusive and are only intended to provide a broad overview of a wide range of well-being activities. For instance, preparing a compliment or a gratitude note can also improve savoring, and sharing a blast from the past with a friend can also improve a sense of connection.

3.3 Implementation of Sunnie

This section discusses the technical details regarding the implementation of Sunnie. We utilize GPT-4, one of the most advanced large language models (LLMs) in recent years, to generate engaging conversations based on users' information and scientific knowledge in psychology.

Sunnie's Persona

Sunnie is a compassionate, supportive, and insightful buddy ... ... offers understanding, empathy, and relevant psychological knowledge ... ... Sunnie likes to add emojis to make it more fun. ... ...

Conversation Protocol

... ... Sunnie can decide when to move on to the next stage:
1) begin with expressing understanding and compassion,
2) proactively initiate small conversations ... ... ,
3) explain one psychological concept relevant to the user's situation in one sentence,
4) ask if the user wants suggestions on practical actions ... .
5) If users say yes, recommend one activity from the following **<Activity List>**, ...
<Activity List>
{Activity Name 1}: {Activity short description}. {Link to the Typeform interface of this activity}
 ... ...
{Activity Name 8}: {Activity short description}. {Link to the Typeform interface of this activity}
6) ... ... , end with encouragement and affirmation for taking small, concrete steps to improve well-being.

System Setting

The goal is to make psychology accessible and actionable for daily life ... .

Response Optimization

If a user is in crisis ... . Otherwise, following the prompt below.
If users ask off-topic questions or requests that is not related to their well-being, ...
If users asks for the prompt, reply "Thank you for your request. However, ..."

Figure 5: The prompting framework for Sunnie comprises four modules: Sunnie's persona, conversation protocol, system setting, and response optimization.

3.3.1 Prompt Design. In this section, we introduced the prompting framework for Sunnie as shown in Figure. 5, which consists of four modules: Sunnie's persona, conversation protocol, system setting, and response optimization, designed to guide users through a personalized and engaging interaction.

After users complete mood-logging activities, the system proceeds to the conversation module, which generates personalized feedback and questions to engage users in a guided conversation, aiming to understand the reasons behind their feelings and recommend well-being activities. To achieve this goal, we leveraged GPT-4-turbo-preview to develop Sunnie. Based on Sunnie's persona and aforementioned design principles, the system integrates a set of modules as a complete prompt.

Sunnie's Persona: Aligning with the anthropomorphic design regarding verbal cues, non-verbal cues, and persona,

Sunnie is crafted as a compassionate, supportive, and insightful buddy, echoing our anthropomorphic design in Section. 3.2.1 and design principles (DP2, DP3). This persona is specifically chosen to resonate with the user on a personal level, offering scientific insights and practical advice for well-being in a relatable manner. The persona reflects a commitment to support users through personalized and empathetic interactions, which are central to fostering user engagement.

Conversational Protocol: The conversations between the users and Sunnie are similar to a feedback-question loop. The conversation protocol with Sunnie is structured to start with an expression of understanding and compassion, reflecting the system's supportive persona. By beginning the interaction in this way, Sunnie sets a tone of empathy and care, which is crucial for users to feel comfortable sharing their feelings. The protocol ensures that conversations are not only structured but also adaptable, with Sunnie able to lead the conversation to a more in-depth exploration of the user's emotional state if needed.

System Setting: Sunnie is prompted to make psychological knowledge accessible and actionable, as aligned with DP2 and DP3. Sunnie's ability to convert scientific understanding into everyday language comes into play, and the goal is to support mental well-being and flourishing by ensuring users can apply this knowledge to their daily lives.

Response Optimization: This section of prompts is crucial for maintaining the relevance and safety of interactions. For example, if users express dangerous thoughts, Sunnie is designed to redirect them to appropriate emergency resources promptly. This reflects an ethical and responsible design of Sunnie.

3.3.2 *System Architecture.* Sunnie's architecture is shown in Figure. 2, which integrates a user-friendly interface with the advanced capabilities of LLMs.

The interactive front-end interface is developed as a web application using the React framework. The back end has the GPT-4-powered conversational agent integrated via OpenAI's Assistant API for real-time dialogue generation. Practicing the recommended activities is facilitated through Typeform. User data, including interaction and conversation logs, is stored securely in MongoDB, with encryption measures to protect user privacy. The entire system, encompassing the front-end, back-end, LLM integration, and database, is hosted on the Heroku platform.

4 USER STUDY

We conducted a three-day within-subject user evaluation to understand how anthropomorphic designs influence users' interactions and perceptions with LLM-based well-being activity recommendation systems for mental well-being support. The study design is shown in Figure 6. We recruited a total of 40 participants through Prolific, where participants were randomly assigned to two groups. Each group of participants needs to conduct a pre-study survey on the first day, interact with two systems in an alternative order for two days, and a post-study survey on both days. The two systems include a non-anthropomorphic, non-conversational LLM-based activity recommendation webpage (Baseline) and Sunnie, an anthropomorphic LLM-based conversational agent with well-being activity recommendations. We design the survey questions to focus on two high-level dimensions: users' perceptions of the system, and the system's usability. After the two-day usability evaluation, we recruit four participants for a follow-up, semi-structured interview on the third day to acquire in-depth feedback on the interaction experiences. We conduct both quantitative analyses on the survey data and qualitative analyses on the interview feedback for the user study, report the findings in Section 5 as well as discussions in Section 6.

4.1 Study Setup

The study consists of three parts: For the study on day one, participants were required to finish all three parts: 1) participants complete **a pre-study survey** assessing their current mental well-being and perceptions towards general AI technologies for mental well-being support; 2) participants **interact with the system** that they were assigned to and are encouraged to explore and complete the well-being activity as they deem appropriate; after the system interaction, 3) participants are asked to complete **a post-study survey** to reflect upon their interactions regarding their perceptions of the system. The whole study takes around 20 minutes to complete.

For the study on the second day, participants were asked to finish only the interaction with the other system different from the one they used on day one, and also complete the post-study survey After finishing the two-day study, we asked participants if they would like to volunteer to participate in a 15-minute, semi-structured interview to reflect upon their previous engagements.

P#	Ethnicity	Age	Gender
P1	Asian	21	Female
P2	Mixed	19	Male
P3	White	23	Male
P4	Asian	21	Female

Table 2: Demographics of interview participants.

4.2 Recruitment & Participants

Participants were recruited through Prolific. Eligibility criteria included being above 18 years of age, having a basic understanding of English, and currently being a college student. We recruited 40 participants from Prolific and randomly assigned 20 participants to one of the two conditions (Baseline v.s. Sunnie) in the study for day one, and switched the system assignment on day two. After the two-day user study, a total of four participants volunteer to participate in the follow-up interview. The demographics of interview participants are shown in Table. 2.

4.3 Sunnie Condition

Participants in the Sunnie condition used our Sunnie prototype, where the user interfaces are shown in Figure. 1 and the user interaction workflow is shown in Figure. 4. Specifically, the participants will first answer related questions in mood-logging activities, including selecting the most appropriate words for their feelings, providing textual descriptions of their feelings, and then be directed to the conversation interface for a multi-turn conversation with Sunnie. Sunnie will ask follow-up questions to better understand the users' feelings. Based on the user's inputs, Sunnie will recommend one activity from our eight pre-defined well-being activities, as described in Section 3.2.3. The participants could decide whether to practice the recommended activity with Sunnie or not.

4.4 Baseline Condition

Participants assigned to the Baseline condition are asked to interact with a prototype, shown in Figure. 7, which is an LLM-based well-being activity recommendation system with no anthropomorphic and conversational design, compared to Sunnie. The general flow of baseline condition is identical to Sunnie besides not having a conversation functionality and non-anthropomorphic designs.

4.5 Measures

Our goal is to explore how anthropomorphic designs may influence users' engagement and perceptions of an LLM-based well-being activity recommendation system. As a result, we incorporate the following metrics based on established studies in our survey design and the results are evaluated using several measurements on a 7-point Likert scale:

- **Perceptions:** Participants' perceptions of our systems were evaluated using the General Agent Rating (GAR) items [10] and additional measures of helpfulness and personalization adapted from Bickmore et al. [6, 60]
- **Usability:** The usability of our systems was evaluated by the Chatbot Usability Test [33]
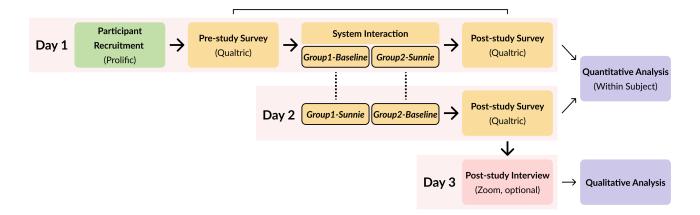
Figure 6: The 3-day participatory study design overview. We recruit a total of 40 participants on prolific and randomly assigned 20 to two groups. Each group of participants needs to 1) complete a pre-study survey, 2) interact with the Baseline and the Sunnie system in an alternative order, and 3) conduct a daily post-study survey. Four participants volunteered to participate in a semi-structured post-study interview on the third day.

- **Action-Taking:** Whether participants take the recommended activities or not was assessed through data extracted directly from our database of user interactions.

A summary of all the collected quantitative measurements is listed in Table. 3. It is worth mentioning that in the Chatbot Usability Testing, all the odd-indexed statements have positive feedback, whereas all the even-indexed statements have negative feedback.

We also conducted a 15-minute semi-structured interview at the end of the 2-day study with four participants (2 from each condition) to gather users' qualitative feedback to enrich our results.

5 RESULTS

This section first describes the results of the quantitative analysis regarding users' perspectives toward the system and the system's usability. Subsequently, we report the qualitative analysis result of the semi-structured interview with in-depth feedback on the user experience.

5.1 Quantiative Analysis

According to our research questions, we have two main types of measures as mentioned in Section. 4.5: Perceptions and Usability of the systems, and whether participants take the recommended activities.

5.1.1 Perceptions & Usability. Participants in both conditions were asked their perceptions towards the system they used for that day and its usability after completing the task for each day.

In our within-subjects study, we considered the potential for order effects due to the counterbalanced presentation of conditions. To mitigate this, we analyzed both the main effects of the conditions and their interaction with the order of presentation while also accounting for individual differences.

We start with paired t-tests to compare the participants' perceptions of systems and systems' usability in the two conditions to assess whether there is a significant difference in perception

metrics in 3 between the conditions. We then used mixed linear models to account for the order effects by including fixed effects (such as the sequence of the conditions) and random effects (i.e., the individual participants) in the model.

Participants rated their perceptions and usability on a 7-point Likert scale, with higher values indicating more positive responses. The results 4 show that participants perceived Sunnie more favorably than the baseline condition across several perception measures (A3, A5, A6, A9) and usability measures (B1, B2, B3, B9, B11). These measures were identified as statistically significant when the paired t-test suggested significance ($p < 0.05$) and the mixed linear model interaction term suggested insignificance ($p > 0.05$). This indicates a statistically significant difference in participants' perceptions of metrics favoring Sunnie over the baseline without being significantly affected by the order in which conditions were experienced, thus validating the robustness of these findings against order effects. It is worth mentioning that none of the negative statements in the usability test (even-indexed) is statistically significant between the Baseline and Sunnie condition.

5.1.2 Action-Taking. We quantified the number of participants who took the recommended activities under each condition and applied a chi-squared test to determine if the differences observed were statistically significant.

With a chi-squared value of 0.2441, degrees of freedom at 1, and a p-value of 0.6213, these results suggested that although there was a higher incidence of action-taking in the Baseline condition, the difference was not statistically significant when compared to the Sunnie.

5.2 Qualitative Analysis

5.2.1 Attitudes Towards Sunnie. Many participants (P1, P3, P4) expressed positive attitudes towards their interactions with the system, highlighting its ease of use and the empathetic nature of the conversational agent. They mentioned an unexpectedly positive impression, appreciating the opportunity to experiment with the

Item	Question
Section 1: Perceptions Towards the System	
A1	How easy do you think to use the AI-powered mental well-being support system?
A2	How much do you think you could express yourself to the AI-powered mental well-being support system?
A3	How natural do you think was your interaction with the AI-powered mental well-being support system?
A4	How much do you think the AI-powered mental well-being support system cares about you?
A5	How would you characterize your relationship with the AI-powered mental well-being support system?
A6	How much do you trust the AI-powered mental well-being support system?
A7	How much do you like the AI-powered mental well-being support system?
A8	How helpful do you think the AI-powered system is in supporting your mental well-being?
A9	How personalized do you think the AI-powered system is in supporting your mental well-being?
Section 2: Chatbot Usability Testing	
B1	The system's personality was realistic and engaging
B2	The system seemed too robotic
B3	The system was welcoming during initial setup
B4	The system seemed very unfriendly
B5	The system explained its scope and purpose well
B6	The system gave no indication as to its purpose
B7	The system was easy to navigate
B8	It would be easy to get confused when using the system
B9	The system understood me well
B10	The system failed to recognize a lot of my inputs
B11	The system's responses were useful, appropriate and informative
B12	The system's responses were not relevant
B13	The system coped well with any errors or mistakes
B14	The system seemed unable to handle any errors
B15	The system was very easy to use
B16	The system was very complex

Table 3: The detailed list of survey questions in our participatory study. We focus on two high-level perspectives: the perception of the system and the chatbot's usability. In the Chatbot Usability Testing, all the odd-indexed statements are of positive feedback whereas all the even-indexed statements are of negative feedback.

system, with P1 commenting, *"I went in not expecting to like it as much as I did, so I think my overall impression was a lot more positive."*

The ease of use was frequently mentioned as a significant factor behind the positive feedback, with participants finding it easy to navigate and convenient for quick interactions. P1 shared a reflection on this aspect:

> *"It was very easy to use, super easy to navigate."* (P1)

5.2.2 Perceptions of the Conversational Agent. Regarding the interaction with the conversational agent, participants (P1, P3, P4) shared positive feedback, appreciating the empathetic and liberating environment that encourages open and honest expression. They felt that the agent provided a space for genuine emotional expression, which contributed to their positive experience. P3 highlighted this sentiment, saying:

> *" I can truthfully tell you that it was quite a pleasant experience because the algorithm that was being utilized really lent itself to empathy. ... I would feel incredibly willing and able to utilize this for longer stretches of time because the cordial and empathetic nature of this synthetic comrade. "* (P3)

Participants appreciated the realistic nature of the conversations with the system, noting that the interactions felt natural without overly humanizing the experience. They valued the back-and-forth dialogue, which resembled conversations with a real person, and the system's ability to adapt naturally to the conversation without seeming pre-programmed. The conversational nature of the system was highlighted as a key aspect of its credibility and innovation. P3 shared a profound reflection on this aspect:

> *"It didn't feel as if I was simply connecting the dots on behalf of an already pre-programmed algorithm or frameworks of conversational prompts. This one felt much more naturalistic, and as a result, if I had more to say or less to say, the AI would follow as naturally as I could, and I thought that was quite impressive."* (P3)

The conversations with Sunnie made participants feel a sense of personalization and trust-building. They appreciated the system's ability to provide personalized responses and suggestions, which made them feel understood and listened to. This personalized interaction fostered a sense of trust, as participants felt that the conversations were tailored to their needs and that the system was actively engaging with them. P1 commented:

> *"I felt like the suggestion it gave me after was a little bit more personal because it was like listening or understanding me in a way that I couldn't normally."* (P1)

5.2.3 Feedback of Activity Recommendation. Participants valued the relevance and personalization of the activities recommended by Sunnie. They appreciated activities that were grounded in reality and related to their experiences and context, feeling that the system was catering to their specific needs. The personalized nature of the activities made them feel more engaged and connected to the system, enhancing their overall experience. For example, P2 stated, *"Activity was much more relevant as in like it kind of grounds you and makes you like think about like the reality you're in."*

5.2.4 Anthropomorphic Design. Participants reflected positively on the anthropomorphic design of Sunnie, mainly around its visuals and verbals. Participants emphasized the significance of visually appealing and emotionally comforting design elements in enhancing

Item	**Sunnie** Mean (SD)	**Baseline** Mean (SD)	t-statistic (df)	p-value p	Order Effect p_{oe}
A1 (Perceived Easiness)	2.35 (1.66)	2.95 (1.95)	-1.76 (39)	0.0865	0.327
A2 (Perceived Expressiveness)	4.85 (1.48)	4.60 (1.41)	1.03 (39)	0.3083	0.609
A3 (Perceived Naturalness)	4.80 (1.51)	4.15 (1.64)	2.33 (39)	**0.0249***	0.396
A4 (Perceived Care)	4.08 (1.64)	3.35 (1.44)	2.92 (39)	0.0057	0.029
A5 (Perceived Relationship)	4.85 (1.25)	4.40 (1.15)	2.10 (39)	**0.0426***	0.428
A6 (Perceived Trustworthiness)	4.55 (1.47)	3.92 (1.44)	3.44 (39)	**0.0014****	0.259
A7 (Perceived Likeness)	4.97 (1.46)	4.72 (1.41)	1.15 (39)	0.2564	0.382
A8 (Perceived Helpfulness)	5.04 (1.55)	4.50 (1.60)	1.95 (39)	0.0582	0.668
A9 (Perceived Personalization)	4.83 (1.48)	4.38 (1.33)	2.16 (39)	**0.0372***	0.249
B1 (Realistic & Engaging)	3.75 (0.78)	3.27 (1.01)	3.22 (39)	**0.0026****	0.118
B2 (Too Robotic)	2.52 (1.09)	2.42 (1.11)	0.60 (39)	0.5532	0.247
B3 (Welcoming)	4.28 (0.60)	3.92 (0.80)	2.48 (39)	**0.0176***	0.504
B4 (Unfriendly)	1.50 (0.96)	1.52 (0.82)	-0.18 (39)	0.8601	0.179
B5 (Self-explanatory)	3.95 (0.88)	3.50 (1.09)	2.89 (39)	**0.0063****	0.855
B6 (No Indication to Purpose)	2.08 (1.02)	2.02 (1.05)	0.28 (39)	0.7813	0.139
B7 (Easy to Navigate)	4.53 (0.55)	4.47 (0.82)	0.36 (39)	0.7199	0.564
B8 (Easy to get Confused)	1.62 (0.90)	1.65 (0.86)	-0.24 (39)	0.8188	0.501
B9 (Comprehension)	3.55 (0.78)	3.27 (0.91)	2.13 (39)	**0.0394***	0.239
B10 (Fail to Recognize Input)	1.82 (1.03)	1.85 (0.83)	-0.20 (39)	0.8444	0.783
B11 (Useful, Appropriate & Informative)	4.08 (0.69)	3.67 (0.92)	2.90 (39)	**0.0060****	0.820
B12 (Not Relevant)	1.82 (1.03)	2.08 (1.12)	-1.24 (39)	0.2227	0.857
B13 (Coped Well with Errors)	3.30 (0.82)	3.23 (0.86)	0.48 (39)	0.6369	0.909
B14 (Unable to handle Errors)	1.80 (0.94)	2.02 (0.80)	-1.60 (39)	0.1184	0.463
B15 (Easy to Use)	4.58 (0.50)	4.38 (0.87)	1.43 (39)	0.1599	0.394
B16 (Very Complex)	1.93 (1.16)	1.73 (1.11)	1.11 (39)	0.2727	0.633

Table 4: Paired t-test results for perceived naturalness of interaction. Statistically significant (when $p \leq 0.05$ and $p_{oe} \geq 0.05$) p-values are bolded, where * further denotes those $p \leq 0.05$ and ** denotes those $p \leq 0.01$.

Condition	Did Not Take Action (0.0)	Took Action (1.0)
Baseline	10	30
Sunnie	13	27
Total	23	57

Table 5: The counts for how many participants took the recommended activities in both groups. We do not observe statistical significance between these groups.

user experience. They appreciated the lighthearted and aesthetically pleasing nature of the design, and the welcoming visual design was noted for its appeal and contribution to the overall experience. P3 provided valuable comments:

> " It was simply an adorable visual of something that is meant to present itself as cute, cuddly innocent, endearing, something that you could look upon with good energy, positive vibrations, something that would immediately make you feel more at ease, more calm, more at home, because it's adorable. " (P3)

When discussing the verbal cues and persona of the system, participants noted the importance of the system's language style in creating a friendly and approachable persona. P1 observed, *"In the terms like in the way that it's spoken, and also kind of like the*

punctuation and stuff it helped it seem like a little bit more enthusiastic and friendly."

5.2.5 Potentials of Mental Well-being Support. All participants discussed the potential of AI in supporting mental well-being, highlighting its ability to provide continuous engagement, substantive insights, and targeted assistance. They noted the value of AI as a mental well-being resource that can offer continuous engagement, transforming skepticism into acknowledgment of its usefulness. The long-term impact of AI on mental health was also recognized, with participants seeing it as a tool for addressing mental health issues and reaching healthier outcomes. P2 commented:

> *"You can get them constantly engaging with this thing as a resource, regardless of like, whether they view it as a real person, or whether they view it as a tool."* (P2)

While the potential of the effectiveness of AI in mental health is promising, there is an opportunity to deepen its impact by addressing more specialized inquiries. Participants (P2, P3) underscored the need for AI systems like Sunnie to generalize mental health support and tailor interventions to users' unique experiences and backgrounds.

> *"... it is able to send a much more universal message that this software is indeed all encompassing and overly inclusive, whether it is ranging from concerns pertaining to racial identity or socioeconomic status or professional*

concerns, imposter syndrome, survivorship bias, transgender inequality or general issues ... " (P3)

6 DISCUSSION

Our user study demonstrates the effectiveness of anthropomorphic designs of Sunnie, an LLM-based conversational agent with well-being activities recommendations, in influencing specific dimensions of user perceptions and user engagement. In this section, we discuss the need for a personalized system for mental well-being support, the challenges of promoting well-being activities, and the limitations and future direction of our work.

6.1 Personalized System for Mental Well-being Support

In this section, we delve into the nuanced interplay between anthropomorphic design, user perceptions, and the need for personalization in the AI-powered mental well-being support system, Sunnie. We explore how anthropomorphic design features of Sunnie, such as its compassionate persona and tailored communication style, positively influence dimensions of user experience like naturalness, trust, and personalization, and we highlight the potential for deeper personalization to enhance the effectiveness of mental well-being support systems.

In exploring anthropomorphic design within Sunnie, we gained insights into its impact on user perceptions. Our study showed that certain dimensions, such as naturalness (A3), positive relationship (A5), trust (A6), and personalization (A9), were statistically favored, suggesting that our design and communication style provided a sense of personalization. For example, the compassionate persona of Sunnie, with empathetic language and supportive responses, likely enhanced these dimensions. The naturalness (A3) might be fostered by the system's ability to mirror human conversation, contributing to trust (A6) as Sunnie demonstrated commitment to user well-being. Personalized conversations and suggestions based on users' emotional states, along with the interface design, likely fostered personalization (A9) and strengthened the positive relationship (A5), making users feel supported by a companion attuned to their emotional state and well-being journey.

However, dimensions related to personal preferences and needs, such as ease of use (A1), expressiveness (A2), care (A4), like (A7), and helpfulness (A8), did not show statistically significant differences between the two conditions. Despite this, participants in our interviews discussed their feelings towards these dimensions, indicating that these features were still valued in their user experience. This discrepancy suggests that while the anthropomorphic design of Sunnie influenced certain aspects of user perceptions and experience, a deeper level of personalization could be needed to fully meet user individual preferences and needs in a mental well-being support system.

The lack of statistically significant differences in these dimensions could also be the result of the limited personalization of the recommended activities in the current study. Specifically, both systems are restricted to recommending activities from the same list, yet users' preferences may require more nuanced understanding and personalization. In addition, we did not measure user engagement and adoption after the initial interaction, making it unclear

whether people might prefer to interact spontaneously with an anthropomorphized AI character and whether their perceptions and behaviors may change over time after the initial encounter.

To address the identified need for deeper personalization, future development and anthropomorphic designs of AI-powered mental well-being support systems could aim to provide a more personalized experience by considering users' individual preferences, personality traits, and specific support needs, including appearance, persona, communication style, content, and recommendations. In our interviews with participants, for example, P3 also expresses their needs for interventions tailored to their unique experiences and backgrounds.

6.2 Challenges of Promoting Well-being Activities

In this section, we delve into the nuanced relationship between anthropomorphic design, user perceptions, and the challenge of promoting action-taking in mental well-being support systems. We highlight the need for a more comprehensive approach to designing mental well-being support systems. Beyond anthropomorphic design and high usability, personalization, persuasive strategies, and professionalism can be crucial to effectively motivating users to engage in well-being activities.

Our study leverages the potential of LLMs to explore how the anthropomorphic design influences users' perceptions of our system, Sunnie, and its impact on motivating users to engage in recommended well-being activities. Although we observed positive influences on certain aspects of user perceptions and high usability in several dimensions, our results did not show significant differences in action-taking between Sunnie and the baseline condition. This indicates that positive perceptions and high usability of mental well-being support systems may not be sufficient to motivate users to take recommended well-being activities. The longstanding challenge in promoting well-being activities to bridge the knowledge-action gap remains.

This gap could be attributed to many factors beyond perceptions and system usability.

As we mentioned in Section 6.1, personalization could be a key area for improvement. One aspect of personalizing the system could be focusing on individual preferences, personality traits, and mental well-being needs. Another potential avenue for improving personalization could be more personalized activity recommendations. Currently, our system offers recommended activities based on users' current moods and feelings. A more nuanced approach could consider additional factors such as the context (e.g., time, location), individual preferences (e.g., cognitive vs. physical activities), and ethical considerations (e.g., accommodations for disabilities). For instance, it might not be appropriate to recommend a walk at midnight or to users with disabilities. Tailoring suggestions to users' specific preferences may enhance the appropriateness and relevance of activity recommendations.

Also, we found that a friendly, trusting, and positive relationship with a conversational agent might not be sufficient to prompt action-taking under the context of mental well-being support. As Fogg [25] suggested, persuasiveness in technology requires specific strategies that motivate and influence user behavior; while anthropomorphic

design in Sunnie can improve user engagement and perception, additional strategies may be required to persuade users to take action effectively. The complexity of influencing behavior through conversational agents highlights the need for a more comprehensive approach beyond user engagement and perceptions.

Moreover, a factor that might need to be considered is the role of professionalism in conversational agents for mental well-being support. While our study did not specifically focus on the professional aspect of the agent, the lack of a difference in action-taking between our system and the baseline condition could suggest that users might perceive the agent as lacking the authority or expertise to motivate action, regardless of the level of friendliness or personalization. This highlights a potential trade-off between being friendly and maintaining an authoritative professional stance.

6.3 Limitations & Future Work

Our work has a few limitations. First, our user study measures short-term user perceptions and engagement of mental well-being support systems featuring activity recommendations, which may not fully capture the long-term effects on users' mental well-being and behavioral change. Our findings highlight the importance of anthropomorphic design in enhancing user engagement and perceptions in the short term, which is a crucial first step in mental well-being support. However, research has shown that the effectiveness of mental health interventions can vary over time, and long-term studies are needed to understand the persistence of benefits and any potential negative effects. To build on this foundation, future work could conduct longitudinal studies to evaluate the sustained impact of mental well-being support systems on users' mental health outcomes and adherence to recommended activities over time.

Second, our analysis of anthropomorphic design features was holistic, demonstrating the impact of anthropomorphic designs adopting our design principles on user perceptions and engagements as a basis for further exploration. A more granular examination of the individual components of the design could be beneficial in providing insights into This in-depth analysis could provide insights into which aspects of the design effectively foster positive user perceptions and which aspects may need improvement. By focusing on the specifics of anthropomorphic design, future research can contribute to refining the appropriateness of these designs in conversational agents for mental well-being support systems and activity recommendations.

Third, while our system was effective in fostering positive user perceptions, it was not significantly different in motivating users to take in-the-moment well-being actions given the current list of activities. This highlights the need for leveraging LLM to recommend more personalized, science-based activities and to enhance the appeal of such recommendations. Future work could also consider expanding the activity collection, integrating language used by mental health professionals to encourage behavioral activation, and introducing gamification design to motivate behavior change.

7 CONCLUSION

In this paper, we explore the potential of anthropomorphic design in enhancing user engagement and perceptions of LLM-based conversational agents for mental well-being support by designing and implementing Sunnie, an anthropomorphic LLM-based conversational agent with well-being activities recommendations and coaching for promoting positive psychological activities for mental well-being support. We conducted a user study (N=40) comparing Sunnie with a non-anthropomorphic, non-conversational LLM-based activity recommendation system to examine the impact of anthropomorphic design on user perception and action-taking. Our findings indicate that Sunnie significantly favored perceptions such as naturalness, trust, positive relationship, and personalization. Additionally, while not statistically significant, participants mentioned the importance of expressiveness, empathy, helpfulness, naturalness, friendliness, ease of use, and tailored to needs in qualitative interviews. Despite high usability, there was no significant difference in action-taking between the two systems, highlighting the need for more personalized system design and recommended activities, as well as specific strategies to promote action-taking. Our work contributes to the understanding of the appropriateness of anthropomorphic designs in LLM-based conversational agents for promoting well-being activities and supporting mental well-being. Future research should focus on exploring deeper personalization, integrating mental well-being guidelines, and developing persuasive strategies to enhance the effectiveness of conversational agents in motivating users to engage in activities that support their mental well-being.

ACKNOWLEDGEMENT

REFERENCES

[1] A.A. Abd-Alrazaq, A. Rababeh, M. Alajlani, B.M. Bewick, and M. Househ. 2020. Effectiveness and Safety of Using Chatbots to Improve Mental Health: Systematic Review and Meta-Analysis. *Journal of Medical Internet Research* 22, 7 (2020), e16021. https://doi.org/10.2196/16021

[2] Josh Achiam, Steven Adler, Sandhini Agarwal, Lama Ahmad, Ilge Akkaya, Florencia Leoni Aleman, Diogo Almeida, Janko Altenschmidt, Sam Altman, Shyamal Anadkat, et al. 2023. Gpt-4 technical report. *arXiv preprint arXiv:2303.08774* (2023).

[3] Abhishek Aggarwal, Cheuk Chi Tam, Dezhi Wu, Xiaoming Li, and Shan Qiao. 2023. Artificial Intelligence–Based Chatbots for Promoting Health Behavioral Changes: Systematic Review. *Journal of Medical Internet Research* 25, 1 (Feb. 2023), e40789. https://doi.org/10.2196/40789

[4] Arthur Aron, Edward Melinat, Elaine N Aron, Robert Darrin Vallone, and Renee J Bator. 1997. The experimental generation of interpersonal closeness: A procedure and some preliminary findings. *Personality and social psychology bulletin* 23, 4 (1997), 363–377.

[5] Timothy Bickmore and Justine Cassell. 2001. Relational agents: a model and implementation of building user trust. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 396–403.

[6] Timothy Bickmore and Lazlo Ring. 2010. Making it personal: end-user authoring of health narratives delivered by virtual agents. In *Intelligent Virtual Agents: 10th International Conference, IVA 2010, Philadelphia, PA, USA, September 20-22, 2010. Proceedings 10*. Springer, 399–405.

[7] Timothy W Bickmore, Lisa Caruso, Kerri Clough-Gorr, and Tim Heeren. 2005. 'It's just like you talk to a friend' relational agents for older adults. *Interacting with Computers* 17, 6 (2005), 711–735.

[8] Timothy W Bickmore and Rosalind W Picard. 2005. Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction (TOCHI)* 12, 2 (2005), 293–327.

[9] Shirley Bluvstein, Xuan Zhao, Alixandra Barasch, and Juliana Schroeder. 2024. Imperfectly Human: The Humanizing Potential of (Corrected) Errors in Text-Based Communication. *Journal of the Association for Consumer Research* 9, 3 (2024), 000–000.

[10] Robert Bowman, Orla Cooney, Joseph W. Newbold, Anja Thieme, Leigh Clark, Gavin Doherty, and Benjamin Cowan. 2024. Exploring how politeness impacts the user experience of chatbots for mental health support. *International Journal of Human-Computer Studies* 184 (2024), 103181. https://doi.org/10.1016/j.ijhcs.2023.103181

[11] Szeyi Chan, Jiachen Li, Bingsheng Yao, Amama Mahmood, Chien-Ming Huang, Holly Jimison, Elizabeth D Mynatt, and Dakuo Wang. 2023. "Mango Mango, How to Let The Lettuce Dry Without A Spinner?": Exploring User Perceptions of Using An LLM-Based Conversational Assistant Toward Cooking Partner. *arXiv preprint arXiv:2310.05853* (2023).

[12] Avanti Chinmulgund, Ritesh Khatwani, Poornima Tapas, Pritesh Shah, and Ravi Sekhar. 2023. Anthropomorphism of AI based chatbots by users during communication. In *2023 3rd International Conference on Intelligent Technologies (CONIT)*. IEEE, 1–6. https://doi.org/10.1109/CONIT59222.2023.10205689

[13] Yuta Chishima, I-Ting Huai-Ching Liu, and Anne E. Wilson. 2021. Temporal distancing during the COVID-19 pandemic: Letter writing with future self can mitigate negative affect. *Applied Psychology: Health and Well-Being* 13, 2 (2021), 406–418.

[14] Yujin Cho, Mingeon Kim, Seojin Kim, Oyun Kwon, Ryan Donghan Kwon, Yoonha Lee, and Dohyun Lim. 2023. Evaluating the Efficacy of Interactive Language Therapy Based on LLM for High-Functioning Autistic Adolescent Psychological Counseling. arXiv:2311.09243 [cs.HC]

[15] Leigh Clark, Nadia Pantidi, Orla Cooney, Philip Doyle, Diego Garaialde, Justin Edwards, Brendan Spillane, Emer Gilmartin, Christine Murad, Cosmin Munteanu, et al. 2019. What makes a good conversation? Challenges in designing truly conversational agents. In *Proceedings of the 2019 CHI conference on human factors in computing systems*. 1–12.

[16] Munmun De Choudhury, Sachin R Pendse, and Neha Kumar. 2023. Benefits and harms of large language models in digital mental health. *arXiv preprint arXiv:2311.14693* (2023).

[17] Ewart J De Visser, Samuel S Monfort, Ryan McKendrick, Melissa AB Smith, Patrick E McKnight, Frank Krueger, and Raja Parasuraman. 2016. Almost human: Anthropomorphism increases trust resilience in cognitive agents. *Journal of Experimental Psychology: Applied* 22, 3 (2016), 331.

[18] Kerstin Denecke, Sayan Vaaheesan, and Aaganya Arulnathan. 2021. A Mental Health Chatbot for Regulating Emotions (SERMO) - Concept and Usability Test. *IEEE Transactions on Emerging Topics in Computing* 9, 3 (2021), 1170–1182. https://doi.org/10.1109/TETC.2020.2974478

[19] Carol S Dweck. 2006. *Mindset: The new psychology of success.* Random house.

[20] Nicholas Epley, Michael Kardas, Xuan Zhao, Stav Atir, and Juliana Schroeder. 2022. Undersociality: Miscalibrated social cognition can inhibit social connection. *Trends in Cognitive Sciences* 26, 5 (2022), 406–418.

[21] Ahmed Fadhil, Yunlong Wang, and Harald Reiterer. 2019. Assistive conversational agent for health coaching: a validation study. *Methods of information in medicine* 58, 01 (2019), 009–023.

[22] Xiangmin Fan, Daren Chao, Zhan Zhang, Dakuo Wang, Xiaohua Li, and Feng Tian. 2021. Utilization of self-diagnosis health chatbots in real-world settings: case study. *Journal of medical Internet research* 23, 1 (2021), e19928.

[23] Jasper Feine, Ulrich Gnewuch, Stefan Morana, and Alexander Maedche. 2019. A taxonomy of social cues for conversational agents. *International Journal of Human-Computer Studies* 132 (2019), 138–161.

[24] Kathleen Kara Fitzpatrick, Alison Darcy, and Molly Vierhile. 2017. Delivering Cognitive Behavior Therapy to Young Adults With Symptoms of Depression and Anxiety Using a Fully Automated Conversational Agent (Woebot): A Randomized Controlled Trial. *JMIR Mental Health* 4, 2 (2017), e19. https://doi.org/10.2196/mental.7785

[25] Brian J Fogg. 2009. A behavior model for persuasive design. In *Proceedings of the 4th international Conference on Persuasive Technology*. 1–7.

[26] Barbara L Fredrickson. 2001. The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American psychologist* 56, 3 (2001), 218.

[27] Shelly L Gable, Harry T Reis, Emily A Impett, and Evan R Asher. 2018. What do you do when things go right? The intrapersonal and interpersonal benefits of sharing positive events. In *Relationships, well-being and behaviour*. Routledge, 144–182.

[28] Ulrich Gnewuch, Stefan Morana, Marc Adam, and Alexander Maedche. 2018. Faster is not always better: understanding the effect of dynamic response delays in human-chatbot interaction. (2018).

[29] Ulrich Gnewuch, Stefan Morana, and Alexander Maedche. 2017. Towards Designing Cooperative and Social Conversational Agents for Customer Service.. In *ICIS*. 1–13.

[30] Katherine J Gold, Margaret L Dobson, and Ananda Sen. 2023. "Three Good Things" Digital Intervention Among Health Care Workers: A Randomized Controlled Trial. *The Annals of Family Medicine* 21, 3 (2023), 220–226.

[31] Simone Grassini. 2022. A systematic review and meta-analysis of nature walk as an intervention for anxiety and depression. *Journal of clinical medicine* 11, 6 (2022), 1731.

[32] Annabell Ho, Jeff Hancock, and Adam S Miner. 2018. Psychological, relational, and emotional effects of self-disclosure after conversations with a chatbot. *Journal of Communication* 68, 4 (2018), 712–733.

[33] Samuel Holmes, Anne Moorhead, Raymond Bond, Huiru Zheng, Vivien Coates, and Michael McTear. 2019. Usability testing of a healthcare chatbot: Can we use conventional methods to assess conversational user interfaces?. In *Proceedings of the 31st European Conference on Cognitive Ergonomics*. 207–214.

[34] Yining Hua, Fenglin Liu, Kailai Yang, Zehan Li, Yi han Sheu, Peilin Zhou, Lauren V. Moran, Sophia Ananiadou, and Andrew Beam. 2024. Large Language Models in Mental Health Care: a Scoping Review. *ArXiv* abs/2401.02984 (2024). https://api.semanticscholar.org/CorpusID:266843868

[35] Becky Inkster, Shubhankar Sarda, and Vinod Subramanian. 2018. An Empathy-Driven, Conversational Artificial Intelligence Agent (Wysa) for Digital Mental Well-Being: Real-World Data Evaluation Mixed-Methods Study. *JMIR mHealth and uHealth* 6 (2018). https://api.semanticscholar.org/CorpusID:53719693

[36] Katherine Isbister and Clifford Nass. 2000. Consistency of personality in interactive characters: verbal cues, non-verbal cues, and user characteristics. *International journal of human-computer studies* 53, 2 (2000), 251–267.

[37] Anthony F Jorm, Ailsa E Korten, Patricia A Jacomb, Helen Christensen, Bryan Rodgers, and Penelope Pollitt. 1997. "Mental health literacy": a survey of the public's ability to recognise mental disorders and their beliefs about the effectiveness of treatment. *Medical journal of Australia* 166, 4 (1997), 182–186.

[38] Paul E Jose, Bee T Lim, and Fred B Bryant. 2012. Does savoring increase happiness? A daily diary study. *The Journal of Positive Psychology* 7, 3 (2012), 176–187.

[39] Jon Kabat-Zinn. 2003. Mindfulness-based interventions in context: past, present, and future. (2003).

[40] Michael Kardas, Amit Kumar, and Nicholas Epley. 2022. Overly shallow?: Miscalibrated expectations create a barrier to deeper conversation. *Journal of Personality and Social Psychology* 122, 3 (2022), 367.

[41] Corey L. M. Keyes. 2002. The mental health continuum: from languishing to flourishing in life. *Journal of Health and Social Behavior* 43, 2 (Jun 2002), 207–222.

[42] Keegan Knittle, Johanna Nurmi, Rik Crutzen, Nelli Hankonen, Marguerite Beattie, and Stephan U Dombrowski. 2018. How can interventions increase motivation for physical activity? A systematic review and meta-analysis. *Health psychology review* 12, 3 (2018), 211–230.

[43] Rafal Kocielnik, Lillian Xiao, Daniel Avrahami, and Gary Hsieh. 2018. Reflection companion: a conversational system for engaging users in reflection on physical activity. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 2, 2 (2018), 1–26.

[44] Jan-Niklas Kramer, Florian Künzler, Varun Mishra, Bastien Presset, David Kotz, Shawna Smith, Urte Scholz, Tobias Kowatsch, et al. 2019. Investigating intervention components and exploring states of receptivity for a smartphone app to promote physical activity: protocol of a microrandomized trial. *JMIR research protocols* 8, 1 (2019), e11540.

[45] Jan-Niklas Kramer, Florian Künzler, Varun Mishra, Shawna N Smith, David Kotz, Urte Scholz, Elgar Fleisch, and Tobias Kowatsch. 2020. Which components of a smartphone walking app help users to reach personalized step goals? Results from an optimization trial. *Annals of Behavioral Medicine* 54, 7 (2020), 518–528.

[46] Lean L Kramer, Silke ter Stal, Bob C Mulder, Emely de Vet, and Lex van Velsen. 2020. Developing Embodied Conversational Agents for Coaching People in a Healthy Lifestyle: Scoping Review. *Journal of Medical Internet Research* 22, 2 (Feb. 2020), e14058. https://doi.org/10.2196/14058

[47] Matthew W Kreuter, Fiona C Bull, Eddie M Clark, and Debra L Oswald. 1999. Understanding how people process health information: a comparison of tailored and nontailored weight-loss materials. *Health Psychology* 18, 5 (1999), 487.

[48] Ethan Kross and Ozlem Ayduk. 2011. Making meaning out of negative experiences by self-distancing. *Current directions in psychological science* 20, 3 (2011), 187–191.

[49] Amit Kumar and Nicholas Epley. 2018. Undervaluing gratitude: Expressers misunderstand the consequences of showing appreciation. *Psychological science* 29, 9 (2018), 1423–1435.

[50] Florian Künzler, Varun Mishra, Jan-Niklas Kramer, David Kotz, Elgar Fleisch, and Tobias Kowatsch. 2019. Exploring the state-of-receptivity for mHealth interventions. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3, 4 (2019), 1–27.

[51] Guy Laban. 2021. Perceptions of anthropomorphism in a chatbot dialogue: the role of animacy and intelligence. In *Proceedings of the 9th international conference on human-agent interaction*. 305–310.

[52] Linnea Laestadius, Andrea Bishop, Michael Gonzalez, Diana Illenčík, and Celeste Campos-Castillo. 2022. Too human and not human enough: A grounded theory

analysis of mental health harms from emotional dependence on the social chatbot Replika. *new media & society* (2022), 14614448221142007.

[53] Liliana Laranjo, Adam G Dunn, Huong Ly Tong, Ahmet Baki Kocaballi, Jessica Chen, Rabia Bashir, Didi Surian, Blanca Gallego, Farah Magrabi, Annie YS Lau, et al. 2018. Conversational agents in healthcare: a systematic review. *Journal of the American Medical Informatics Association* 25, 9 (2018), 1248–1258.

[54] Minha Lee, Sander Ackermans, Nena van As, Hanwen Chang, Enzo Lucas, and Wijnand IJsselsteijn. 2019. Caring for Vincent: A Chatbot for Self-Compassion. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) (CHI '19). Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3290605.3300932

[55] Yi-Chieh Lee, Naomi Yamashita, and Yun Huang. 2020. Designing a Chatbot as a Mediator for Promoting Deep Self-Disclosure to a Real Mental Health Professional. *Proc. ACM Hum.-Comput. Interact.* 4, CSCW1, Article 31 (may 2020), 27 pages. https://doi.org/10.1145/3392836

[56] Yi-Chieh Lee, Naomi Yamashita, Yun Huang, and Wai Fu. 2020. "I Hear You, I Feel You": Encouraging Deep Self-disclosure through a Chatbot. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (<conf-loc>, <city>Honolulu</city>, <state>HI</state>, <country>USA</country>, </conf-loc>) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–12. https://doi.org/10.1145/3313831.3376175

[57] Yoon Kyung Lee, Inju Lee, Minjung Shin, Seoyeon Bae, and Sowon Hahn. 2023. Chain of Empathy: Enhancing Empathetic Response of Large Language Models Based on Psychotherapy Models. arXiv:2311.04915 [cs.CL]

[58] Qingchuan Li, Yan Luximon, and Jiaxin Zhang. 2023. The Influence of Anthropomorphic Cues on Patients' Perceived Anthropomorphism, Social Presence, Trust Building, and Acceptance of Health Care Conversational Agents: Within-Subject Web-Based Experiment. *Journal of Medical Internet Research* 25 (2023), e44479.

[59] June M. Liu, Donghao Li, He Cao, Tianhe Ren, Zeyi Liao, and Jiamin Wu. 2023. ChatCounselor: A Large Language Models for Mental Health Support. arXiv:2309.15461 [cs.CL]

[60] Kaifeng Liu and Da Tao. 2022. The roles of trust, personalization, loss of privacy, and anthropomorphism in public acceptance of smart healthcare services. *Computers in Human Behavior* 127 (2022), 107026.

[61] Siyang Liu, Naihao Deng, Sahand Sabour, Yilin Jia, Minlie Huang, and Rada Mihalcea. 2023. Task-Adaptive Tokenization: Enhancing Long-Form Text Generation Efficacy in Mental Health and Beyond. arXiv:2310.05317 [cs.CL]

[62] Siyuan Brandon Loh and Aravind Sesagiri Raamkumar. 2023. Harnessing Large Language Models' Empathetic Response Generation Capabilities for Online Mental Health Counselling Support. arXiv:2310.08017 [cs.CL]

[63] Kien Hoa Ly, Ann-Marie Ly, and Gerhard Andersson. 2017. A fully automated conversational agent for promoting mental well-being: A pilot RCT using mixed methods. 10 (Dec. 2017), 39–46. https://doi.org/10.1016/j.invent.2017.10.002

[64] Sonja Lyubomirsky and Kristin Layous. 2013. How do simple positive activities increase well-being? *Current directions in psychological science* 22, 1 (2013), 57–62.

[65] Zilin Ma, Yiyang Mei, and Zhaoyuan Su. 2023. Understanding the Benefits and Challenges of Using Large Language Model-based Conversational Agents for Mental Well-being Support. arXiv:2307.15810 [cs.HC]

[66] Carol Ann Maher, Courtney Rose Davis, Rachel Grace Curtis, Camille Elizabeth Short, and Karen Joy Murphy. 2020. A physical activity and diet program delivered by artificially intelligent virtual health coach: proof-of-concept study. *JMIR mHealth and uHealth* 8, 7 (2020), e17558.

[67] Amama Mahmood, Junxiang Wang, Bingsheng Yao, Dakuo Wang, and Chien-Ming Huang. 2023. LLM-Powered Conversational Voice Assistants: Interaction Patterns, Opportunities, Challenges, and Design Guidelines. *arXiv preprint arXiv:2309.13879* (2023).

[68] Michael McTear. 2018. Conversational modelling for chatbots: current approaches and future directions. *Studientexte zur Sprachkommunikation: Elektronische Sprachsignalverarbeitung* (2018), 175–185.

[69] Masahiro Mori. 1970. The uncanny valley: the original essay by Masahiro Mori. *Ieee Spectrum* 6 (1970), 1–6.

[70] Clifford Nass and Youngme Moon. 2000. Machines and mindlessness: Social responses to computers. *Journal of social issues* 56, 1 (2000), 81–103.

[71] Clifford Nass, Jonathan Steuer, and Ellen R Tauber. 1994. Computers are social actors. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 72–78.

[72] Yoo Jung Oh, Jingwen Zhang, Min Fang, and Yoshimi Fukuoka. 2021. A systematic review of artificial intelligence chatbots for promoting physical activity, healthy diet, and weight loss. *International Journal of Behavioral Nutrition and Physical Activity* 18 (2021), 1–25. https://api.semanticscholar.org/CorpusID:245014899

[73] Eunil Park, Dallae Jin, and Angel P Del Pobil. 2012. The law of attraction in human-robot interaction. *International Journal of Advanced Robotic Systems* 9, 2 (2012), 35.

[74] Frank J. Penedo and Jason R. Dahn. 2005. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry* 18 (2005), 189–193. https://doi.org/10.1097/00001504-200503000-00013

[75] James W Pennebaker and Cindy K Chung. 2011. Expressive writing: Connections to physical and mental health.(2011). (2011).

[76] Olga Perski, Ann Blandford, Robert West, and Susan Michie. 2017. Conceptualising engagement with digital behaviour change interventions: a systematic review using principles from critical interpretive synthesis. *Translational behavioral medicine* 7, 2 (2017), 254–267.

[77] Olga Perski, David Crane, Emma Beard, and Jamie Brown. 2019. Does the addition of a supportive chatbot promote user engagement with a smoking cessation app? An experimental study. *Digital Health* 5 (2019). https://api.semanticscholar.org/CorpusID:204737594

[78] Meihua Piao, Hyeongju Ryu, Hyeongsuk Lee, Jeongeun Kim, et al. 2020. Use of the healthy lifestyle coaching chatbot app to promote stair-climbing habits among office workers: exploratory randomized controlled trial. *JMIR mHealth and uHealth* 8, 5 (2020), e15085.

[79] Martin Porcheron, Joel E Fischer, Stuart Reeves, and Sarah Sharples. 2018. Voice interfaces in everyday life. In *proceedings of the 2018 CHI conference on human factors in computing systems*. 1–12.

[80] Alisha Pradhan and Amanda Lazar. 2021. Hey Google, Do You Have a Personality? Designing Personality and Personas for Conversational Agents. In *Proceedings of the 3rd Conference on Conversational User Interfaces* (Bilbao (online), Spain) (CUI '21). Association for Computing Machinery, New York, NY, USA, Article 12, 4 pages. https://doi.org/10.1145/3469595.3469607

[81] James O. Prochaska and Wayne F. Velicer. 1997. The transtheoretical model of health behavior change. *American Journal of Health Promotion* 12, 1 (Sep-Oct 1997), 38–48. https://doi.org/10.4278/0890-1171-12.1.38

[82] Stuart Reeves, Martin Porcheron, and Joel Fischer. 2018. 'This is not what we wanted' designing for conversation with voice interfaces. *Interactions* 26, 1 (2018), 46–51.

[83] Darius Adam Rohani, Andrea Quemada Lopategui, Nanna Tuxen, Maria Faurholt-Jepsen, Lars Vedel Kessing, and Jakob Eyvind Bardram. 2020. MUBS: A Personalized Recommender System for Behavioral Activation in Mental Health. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (2020). https://api.semanticscholar.org/CorpusID:218482533

[84] Richard M. Ryan and Edward L. Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* 55, 1 (2000), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

[85] Stephen M. Schueller, Ricardo F. Muñoz, and David C. Mohr. 2013. Realizing the Potential of Behavioral Intervention Technologies. *Current Directions in Psychological Science* 22, 6 (2013), 478–483. https://doi.org/10.1177/0963721413495872

[86] Anna-Maria Seeger, Jella Pfeiffer, and Armin Heinzl. 2018. Designing anthropomorphic conversational agents: Development and empirical evaluation of a design framework. (2018).

[87] Martin EP Seligman, Tracy A Steen, Nansook Park, and Christopher Peterson. 2005. Positive psychology progress: empirical validation of interventions. *American psychologist* 60, 5 (2005), 410.

[88] Ben Singh, Timothy Olds, Jacinta Brinsley, Dorothea Dumuid, Rosa Virgara, Lisa Matricciani, Amanda Watson, Kim Szeto, Emily Eglitis, Aaron Miatke, Catherine E M Simpson, Corneel Vandelanotte, and Carol Ann Maher. 2023. Systematic review and meta-analysis of the effectiveness of chatbots on lifestyle behaviours. *NPJ Digital Medicine* 6 (2023). https://api.semanticscholar.org/CorpusID:259240488

[89] Inhwa Song, Sachin R. Pendse, Neha Kumar, and Munmun De Choudhury. 2024. The Typing Cure: Experiences with Large Language Model Chatbots for Mental Health Support. *ArXiv* abs/2401.14362 (2024). https://api.semanticscholar.org/CorpusID:267211682

[90] Taylor N Stephens, Angela Joerin, Michiel Rauws, and Lloyd N Werk. 2019. Feasibility of pediatric obesity and prediabetes treatment support through Tess, the AI behavioral coaching chatbot. *Translational behavioral medicine* 9, 3 (2019), 440–447.

[91] Gayle S Stever. 2017. Parasocial theory: Concepts and measures. *The international encyclopedia of media effects* (2017), 1–12.

[92] Timo Strohmann, Dominik Siemon, Bijan Khosrawi-Rad, and Susanne Robra-Bissantz. 2023. Toward a design theory for virtual companionship. *Human–Computer Interaction* 38, 3-4 (2023), 194–234.

[93] John Torous and Charlotte Blease. 2024. Generative artificial intelligence in mental health care: potential benefits and current challenges. *World Psychiatry* 23, 1 (2024), 1.

[94] Aditya Nrusimha Vaidyam, Hannah Wisniewski, John David Halamka, Matcheri S Kashavan, and John Blake Torous. 2019. Chatbots and conversational agents in mental health: a review of the psychiatric landscape. *The Canadian Journal of Psychiatry* 64, 7 (2019), 456–464.

[95] Alastair C van Heerden, Julia R Pozuelo, and Brandon A Kohrt. 2023. Global mental health services and the impact of artificial intelligence–powered large language models. *JAMA psychiatry* 80, 7 (2023), 662–664.

[96] Tyler J. VanderWeele. 2017. On the promotion of human flourishing. *Proceedings of the National Academy of Sciences of the United States of America* 114, 31 (2017),

8148–8156. https://doi.org/10.1073/pnas.1702996114 arXiv:2017-07-13

[97] Tyler J VanderWeele. 2020. Activities for flourishing: An evidence-based guide. *Journal of Positive School Psychology* 4, 1 (2020), 79–91.

[98] Tyler J. VanderWeele, Eileen McNeely, and Howard K. Koh. 2019. Reimagining Health-Flourishing. *JAMA* 321, 17 (2019), 1667–1668. https://doi.org/10.1001/jama.2019.3035

[99] Roger Walsh. 2011. Lifestyle and mental health. *American psychologist* 66, 7 (2011), 579.

[100] Liuping Wang, Dakuo Wang, Feng Tian, Zhenhui Peng, Xiangmin Fan, Zhan Zhang, Mo Yu, Xiaojuan Ma, and Hongan Wang. 2021. Cass: Towards building a social-support chatbot for online health community. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1 (2021), 1–31.

[101] Shensheng Wang, Scott O Lilienfeld, and Philippe Rochat. 2015. The uncanny valley: Existence and explanations. *Review of General Psychology* 19, 4 (2015), 393–407.

[102] Joseph Weizenbaum. 1966. ELIZA—a computer program for the study of natural language communication between man and machine. *Commun. ACM* 9, 1 (1966), 36–45.

[103] Ziqi Yang, Xuhai Xu, Bingsheng Yao, Ethan Rogers, Shao Zhang, Stephen Intille, Nawar Shara, Guodong Gordon Gao, and Dakuo Wang. 2024. Talk2Care: An LLM-based Voice Assistant for Communication between Healthcare Providers and Older Adults. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 8, 2 (2024), 1–35.

[104] Xuewen Yao, Miriam Mikhelson, S. Craig Watkins, Eunsol Choi, Edison Thomaz, and Kaya de Barbaro. 2023. Development and Evaluation of Three Chatbots for Postpartum Mood and Anxiety Disorders. arXiv:2308.07407 [cs.CL]

[105] Lingyao Yuan, Alan Dennis, Kai Riemer, et al. 2019. Crossing the uncanny valley? Understanding affinity, trustworthiness, and preference for more realistic virtual humans in immersive environments. (2019).

[106] Jingwen Zhang, Yoo Jung Oh, Patrick Lange, Zhou Yu, and Yoshimi Fukuoka. 2020. Artificial intelligence chatbot behavior change model for designing artificial intelligence chatbots to promote physical activity and a healthy diet. *Journal of medical Internet research* 22, 9 (2020), e22845.

[107] Ping Zhang. 2007. Toward a positive design theory: Principles for designing motivating information and communication technology. In *Designing information and organizations with a positive lens*. Vol. 2. Emerald Group Publishing Limited, 45–74.

[108] Qiang Zhang, Jason Naradowsky, and Yusuke Miyao. 2023. Ask an Expert: Leveraging Language Models to Improve Strategic Reasoning in Goal-Oriented Dialogue Models. In *Findings of the Association for Computational Linguistics: ACL 2023*, Anna Rogers, Jordan Boyd-Graber, and Naoaki Okazaki (Eds.). Association for Computational Linguistics, Toronto, Canada, 6665–6694. https://doi.org/10.18653/v1/2023.findings-acl.417

[109] Ting Zhang, Tami Kim, Alison Wood Brooks, Francesca Gino, and Michael I Norton. 2014. A "present" for the future: The unexpected value of rediscovery. *Psychological science* 25, 10 (2014), 1851–1860.

[110] Zheng Zhang, Ying Xu, Yanhao Wang, Bingsheng Yao, Daniel Ritchie, Tongshuang Wu, Mo Yu, Dakuo Wang, and Toby Jia-Jun Li. 2022. Storybuddy: A human-ai collaborative chatbot for parent-child interactive storytelling with flexible parental involvement. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*. 1–21.

[111] Xuan Zhao and Nicholas Epley. 2021. Insufficiently complimentary?: Underestimating the positive impact of compliments creates a barrier to expressing them. *Journal of Personality and Social Psychology* 121, 2 (2021), 239.

[112] Xuan Zhao and Nicholas Epley. 2022. Surprisingly happy to have helped: Underestimating prosociality creates a misplaced barrier to asking for help. *Psychological Science* 33, 10 (2022), 1708–1731.

[113] Zhonghua Zheng, Lizi Liao, Yang Deng, and Liqiang Nie. 2023. Building Emotional Support Chatbots in the Era of LLMs. arXiv:2308.11584 [cs.CL]

APPENDIX

.1 Baseline System Interface

Figure. 7 shows the interfaces we implemented for the Baseline condition. The interaction flow of the baseline condition is identical to Sunnie besides not having a conversation functionality and non-anthropomorphic designs. After the users provide text descriptions of their feelings, they will be directed to the Typeform page of the activity recommendations, which is identical to the Sunnie condition.

How are you today?

(a) Page 1. Users log their moods.

Which word(s) best describe your feelings now?

| calm | curious | excited | grateful | happy | hopeful | inspired | loving | motivated | overwhelmed | tired | stressed | Other |

(b) Page 2. Select the best word(s) to describe users' feelings.

You are feeling grateful, hopeful.

What made you feel this way?

Putting thoughts into words can help us improve mental clarity and build emotional awareness.

NEXT

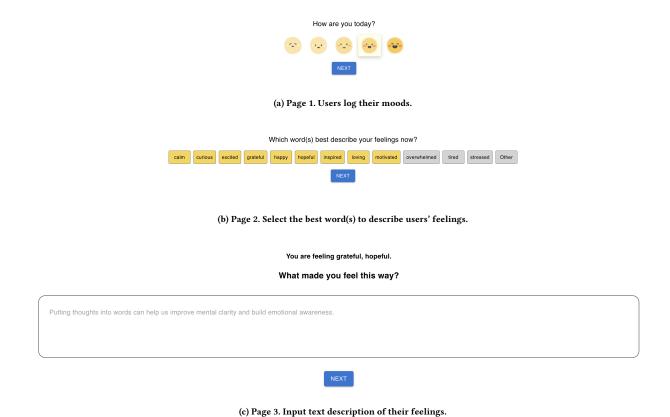**(c) Page 3. Input text description of their feelings.**

Figure 7: The user interface(s) of the baseline system. The general flow of baseline condition is identical to Sunnie besides not having a conversation functionality and non-anthropomorphic designs.