ZzzMate: A Self-Conscious Emotion-Aware Chatbot for Sleep Intervention

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Abstract

Empathy-driven design is increasingly recognized as a key element in behavior change interventions. However, self-conscious emotions such as guilt, shame, embarrassment, and pride are often overlooked. We introduce ZzzMate, an empathetic chatbot designed to detect and address these emotions to support healthy sleep routines. ZzzMate incorporates a novel emotion detection model that identifies self-conscious emotions from user interactions, which then informs a large language model (LLM) to generate empathetic responses. The system combines detected emotions with users' sleep goals and empathy strategies to provide personalized interventions. In a comparative pilot study against a standard GPT, ZzzMate demonstrated better performance in emotional intelligence, self-efficacy and sleep adherence. This late-breaking-work presents our initial findings and system design of ZzzMate, laying the groundwork for future research in self-conscious emotion-aware health intervention technologies.

CCS Concepts

• **Human-centered computing** → **Interactive systems and tools**; *Empirical studies in interaction design.*

Keywords

Sleep, Self-conscious Emotions, Health, Behavioral Change, Chatbot, Empathetic Dialogue

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1 Introduction

Sleep is a vital physiological activity in human life. Evidence indicates that insufficient sleep is associated with a 10%–12% increase in mortality risk [3, 10] and adverse health outcomes, including obesity, metabolic disorders, inflammation, and cardiovascular diseases [12]. While behavioral treatments have demonstrated robust efficacy [14], they traditionally rely on healthcare professionals, making them less accessible to the broader population due to limited availability and high costs. To address this gap, Information and Communication Technologies (ICTs), particularly chatbots, have emerged as promising solutions, offering scalable, personalized, and interactive support for behavioral interventions [8, 38].

Recent studies suggest that emotional experiences can significantly influence intervention outcomes [11, 33]. Self-conscious emotions - including guilt, shame, embarrassment, and pride - emerge as individuals evaluate their progress and adherence against their behavioral goals or societal standards [35]. These emotions crucially shapes motivation, decision-making, and behavioral persistence [13, 23]. While recent work has developed empathetic chatbots that can recognize and respond to basic emotions (e.g., happiness, sadness, anger) [5, 39], they typically overlook self-conscious emotions in the behavior change process. This inspired us to ask: whether an emotionally aware sleep-monitoring chatbot addressing self-conscious emotions could enhance engagement and overall effectiveness in sleep behavior interventions?

Sleep presents an ideal context for studying self-conscious emotions. First, like other health behaviors, people experience both negative self-conscious emotions (e.g., guilt, shame) when failing to meet sleep goals and positive ones (e.g., pride) when achieving them. Second, and unique to sleep, these emotions directly interfere with the target behavior itself - guilt or shame can trigger pre-sleep rumination and anxiety, making it harder to fall asleep. This creates a distinctive feedback loop where self-conscious emotions not only result from sleep behavior but also actively impact sleep quality. This dual role of self-conscious emotions in sleep makes

it an ideal context for developing and evaluating emotion-aware interventions.

We present "ZzzMate", an empathetic chatbot powered by a large language model (LLM) to address self-conscious emotions in sleep behavior change. ZzzMate is built upon cognitive-behavioral therapy (CBT) theory for behavioral interventions, with an additional layer that recognizes users' self-conscious emotions from their input. Based on the causes and categories of self-conscious emotions [35], we designed specialized prompts that guide the chatbot to both address these emotions and provide CBT-based behavioral solutions. Our goal is to help users help users maintain their target sleep schedule, while also supporting emotional regulation that may otherwise interfere with sleep behavior adherence.

This work makes the following contributions. First, we introduce ZzzMate, a chatbot integrating empathy toward self-conscious emotions. Second, we provide empirical evidence from a two-week pilot study demonstrating how empathetic interactions with self-conscious emotions can improve self-efficacy and sleep adherence. Our work expands the current understanding of emotion-aware system design by demonstrating how incorporating self-conscious emotions can enhance behavioral intervention effectiveness and human-AI interaction.

2 RELATED WORK

In this section, we present related works in sleep technology in Human-Computer Interaction (HCI) and empathetic chatbots for behavioral intervention.

2.1 Sleep Technology in HCI

HCI research is increasingly focusing on sleep and developing sleep technology for improving sleep quality. Early research primarily emphasized tracking sleep behavior. For instance, "Toss 'N' Turn" [20] use sleep diaries and sleep data to infer and evaluate the sleep quality of users. The technology can perceives sleep, and present it to the person thus people can increase their awareness, reflects, and changes behavior. Recent works in the field have expanded to experiential perspective of sleep. "SleepFlora" [17] is based on social interaction to improve sleep quality, as it enables communication between participants to adjust another one's aroma or music to collaboratively create an environment conducive to improved sleep quality. "Inter-Dream" [25] is a novel multisensory interactive artistic experience driven by neurofeedback which improve pre-sleep psychophysiological states necessary for the onset of sleep. The sleep-related interactive experiences provided by these intervention techniques can be used to relax, thereby helping to stabilize their emotions and allow people to improve sleep quality.

Current research has moved toward conversational agents for sleep intervention, but they are mostly based on psychological theories of behavior change that do not take emotional experience into account. For instance, "SleepBot" [22] asks users simple questions, educates them on the consequences of poor sleep, and helps them develop healthy sleep habits. MotivSleep [27] track their sleep in a Withings sleep analyzer and communicate with a WhatsApp chatbot base on their tracking data. While research has established strong links between sleep and emotional health [9], current sleep technologies largely overlook emotional regulation in their interventions.

This evolution reveals a significant gap: while sleep technologies have advanced from basic tracking to conversational approaches, they have yet to effectively integrate emotional support, particularly for managing self-conscious emotions that can significantly impact sleep behavior adherence.

2.2 Empathetic Chatbots for Behavioral Intervention

Chatbots in behavioral interventions have evolved along two main dimensions: therapeutic strategies and emotional capabilities. Early therapeutic chatbots like Todaki [21] incorporated CBT strategies to help users manage panic symptoms through cognitive restructuring and behavioral exercises. In sleep domain, chatbots like "SleepBot" [22] and "Snoozy" [1] focused on education and habit formation, demonstrating the potential of chatbot-based interventions but lacking emotional support.

Recent research has shown that empathic interactions are crucial for behavioral interventions [36]. Zhou et al. [39] developed the Emotion Chatting Machine, which can identify and respond to five distinct emotions including angry, disgust, happy, sad and like, significantly improving user engagement. Advancements in large language models (LLMs) have recently transformed the capabilities of chatbots [31]. Chatbot uses LLM as the base to improve chatbot's language understanding and emotion perception, and a series of optimization methods for LLM generation also make it easier and more effective to control chatbot to generate more empathetic response [29]. Lee et al. [16] demonstrated the effectiveness of prompt-based situational learning in few-shot scenarios to produce empathetic dialogue. These efforts aim to create systems that understand and address users' emotional needs, thereby making interactions more human-like and emotionally engaging.

However, existing empathetic chatbots primarily focus on basic emotions, overlooking self-conscious emotions that significantly influence motivation and behavioral persistence [13, 23]. In the context of behavior change, failure to adhere to a sleep routine may induce guilt or shame, and to be pride due to achieving goal, which may deprive individuals of motivation to improve their behavior [4]. Therefore, self-conscious emotions could be addressed in behavioral interventions to help individuals better understand and regulate their responses to missteps and successes, thereby promoting sustained behavioral change. Our work bridges this gap by integrating CBT-based strategies with empathetic interactions specifically designed for self-conscious emotions, creating a comprehensive approach to sleep behavior change.

3 ZzzMate

ZzzMate is an empathetic, text-based chatbot designed to assist users in managing their sleep behaviors. It allows users to set a target bedtime, and in turn, sends notifications and motivational messages to encourage adherence to these sleep goals in a non-intrusive manner. The following day, ZzzMate checks in with users to inquire about their actual bedtime and the emotions they experienced before sleep, in order to provide further guidance and support. The interface of ZzzMate is depicted in Figure 1, while the

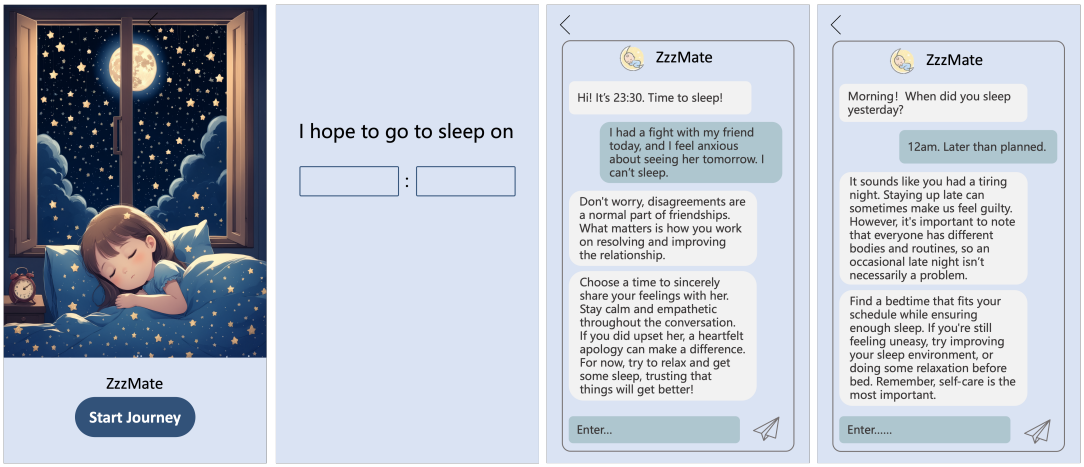

Figure 1: The interface of ZzzMate. The first screen displays the start page, inviting users to begin their journey towards better sleep. The second screen shows that upon entering the app, users are requested to set their target bedtime. The third screen illustrates how, at the set time, the app sends a notification and engages in empathetic conversations to support the user. The final screen demonstrates the app checking in the next day, asking the user what time they actually went to sleep and providing further guidance.

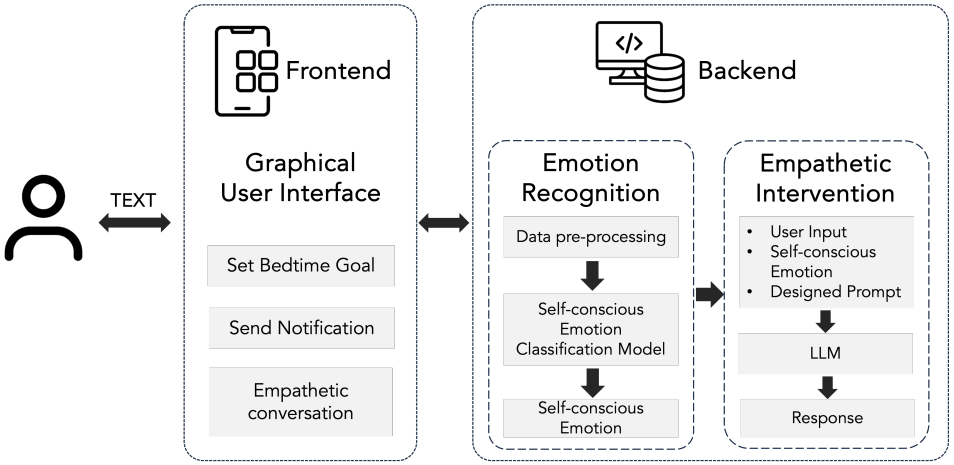

Figure 2: The system diagram of ZzzMate.

system's overall structure is shown in Figure 2. ZzzMate's empathy extends beyond basic emotions, such as happiness and sadness, to include more complex, self-conscious emotions like guilt and shame, enabling users to navigate these feelings as they pertain to their sleep habits.

3.1 Design Considerations

To develop ZzzMate, we focused on the following design decision.

3.1.1 Persuasive Strategy and Prompt Design. The main objective of ZzzMate is to assist users in consistently adhering to their target bedtimes through tailored, empathetic, and persuasive responses. To achieve this, we established a foundational prompt (see Table 1). labeled **Persona**, which is not just beneficial but critical for LLM-base conversational agents [28], positions the LLM as a caring, empathetic AI assistant. In addition to the foundational strategy, we recognized the importance of incorporating specific persuasive techniques within conversations to foster behavioral change. After reviewing various approaches, we opted to implement Motivational Interviewing (MI), a widely recognized psychological method that has shown effectiveness in promoting behavior change [2, 15, 19]. Based on MI principles [26, 32], three primary strategies were identified as crucial: **Affirmation**, **Persuasion**, and **Reflection**.

3.1.2 Empathetic Strategy for Addressing Self-Conscious Emotion. In addition to incorporating persuasive strategies, our chatbot is designed to be empathetic, particularly in addressing nuanced self-conscious emotions like guilt, shame, embarrassment, and pride [34]. This aspect has been relatively underexplored in chatbot design, and no existing framework directly supports generating

Table 1: The prompt design based on Motivational Interviewing Codes

Code	Description	Prompt Design
Persona	Framing the LLM's responses by setting a clear persona	You are a helpful AI assistant with understanding and empathy.
Affirmation	Validating and supporting the user's feelings	Please express recognition for user.
Persuasion	Using encouraging language that motivates without being forceful or overly directive	Please provide supportive suggestions that motivate the user.
Reflection	Mirroring user statements to show understanding	Acknowledge and restate user emotions or behaviors.

Table 2: Prompt design for addressing self-conscious emotions

Prompt Design	Target Emotion
Provide emotional support to users.	Guilt, Shame, Embarrassment
Provide advice while supporting autonomy in their behavioral choices.	Guilt, Shame, Embarrassment
Encourage users to believe in their abilities despite the mistake.	Shame
Remind the user that the situation is just a momentary setback and does not define their overall value in social settings.	Embarrassment
Encouraging positive changes instead of dwelling on past mistakes.	Guilt
Acknowledge the user's positive actions or achievements while gently encourage humility and reminding them of staying grounded.	Pride

prompts for these emotions. To bridge this gap, we drew on psychological research regarding the origins of such emotions [35] and developed corresponding strategies (Table 2).

3.2 Implementation

We implemented an emotion recognition module based on the BERT model [7], which was trained using the GoEmotions dataset [6]. This module employs a two-step classification process to detect self-conscious emotions. The initial step involves a binary classification to determine if self-conscious emotions are present in the user's input. If positive, the second stage applies a four-class classifier to identify the self-conscious emotions. This two-stage approach was carefully designed to balance the complexity of training with the accuracy of the model. By first deploying a binary classifier to detect the presence of self-conscious emotions, we reduced the complexity for the second four-class classifier, which then identifies the specific emotion. Two classifiers achieved a combined accuracy of 68%, which outperformed direct multi-class approaches and enhanced the stability of the system. Both classifiers were trained using an A40 GPU and subsequently deployed on an RTX 3080 GPU to enable real-time emotion classification. Once the emotion recognition is completed, the detected emotion labels are integrated with predesigned prompts before being processed by the Qwen1.5 large language model [37], which generates empathetic and contextually relevant responses. Finally, the generated response is sent back to the ZzzMate mobile app for display to the user.

3.3 Pilot Study

To evaluate the user experience of ZzzMate, we conducted a comparative pilot study. We invited 4 participants (2 females and 2 males, no non-binary as self-reported, age M ± SD = 23.75 ± 0.83 years) to experience two different conversational agents: one being the standard GPT model without designed prompts and the other our ZzzMate. All participants were volunteers interested in improving their sleep quality or sleep habits. We have obtained approval from the local ethics committee.

During the study, each participant experienced both conversational agents in a randomized order without knowing which one was used, with each experience limited to 1 week. At the end of every week, each participant was asked to complete a Self-Efficacy questionnaire [24], a 10-item questionnaire rated on a 5-point scale, and an Emotional Intelligence questionnaire [18], 20 items rated on a 5-point scale, to assess the impact of different conversational agents on user motivation and their emotional perception and feedback capabilities. And they were asked to report sleep adherence result, which indicates the number of days in a 7-day week that they sleep before their set sleep time. Additionally, a brief interview of approximately 40 minutes was conducted with each participant. The interviews explored users' experience of the system's ability to provide empathetic interactions, recognize and respond to self-conscious emotions, and provide advice for addressing sleep behaviors that went against their goals. We also asked participants to report any psychological discomfort they may have encountered during their interactions with the system.

In the quantitative statistical stage, we take the average score of each self-efficacy item, and then divide the 20 items of Emotional Intelligence questionnaire into 4 parts, with 5 items in each part (that is, the maximum score of each part is 20 points) and then take the average of 4 parts. In the two-week user experiment, users exhibited higher levels of self-efficacy when using ZzzMate ($M = 3.25, SD = 0.43$) compared to a standard GPT ($M = 2.75, SD = 0.43$). Additionally, ZzzMate ($M = 16.75, SD = 1.48$) enabled users to perceive a significantly greater emotional value in the interactions with the

conversational agent than the standard GPT ($M = 12.75, SD = 0.83$). For sleep adherence result, We take the average of all the user data. when using ZzzMate ($M = 4.50, SD = 1.12$), users are better able to achieve the goal of going to bed on time compared to the standard GPT ($M = 3.75, SD = 0.83$).

Our qualitative data suggests that all participants appreciated that Zzzmate could combine tracking sleep data and interacting with empathy response to make themselves aware of their sleep behavior and give them good advice via human-chatbot conversations. One participant shared: "This system that asked my sleep time and emotions made me pay more attention to my sleep. It helped me improve my sleep quality." Another participant shared: "It always tried to give me advice to help me get out of my awful situation. I took its advice such as drinking some milk and avoid exciting activity before sleep to get to sleep better."

Participants appreciated ZzzMate's emotional intelligence. Participants found that ZzzMate effectively recognized and responded to their emotional states during interactions. One participant shared: "I can definitely feel that interacting with ZzzMate was more comfortable compared to a standard GPT model. During communication, if I expressed self-conscious emotions, ZzzMate could pick it up and give me feedback and suggestions to regulate my emotions." When discussing ZzzMate's capability in handling emotions, another participant noted: "I can sense that ZzzMate's responses were aligned with my emotions and exhibited a certain level of logic. Its comforting replies were empathetic, and after offering comfort, it provided reasonable suggestions." The understanding and empathy further positively influenced individuals' receptiveness to chatbot's advice. A participant shared: "It tried to encourage me or soothe me, made me more willing to try the advice it gave me. I believe this can have a positive impact on my sleep." During our study, no participant reported any psychological harm or issues arising from the text generated by the LLM.

However, users also identified some experiential limitations. One user mentioned, "I think sometimes the advice it gave is a bit too long and lacks warmth. Even though it seemed to consider my emotions, I still recognized that it was a robot, which created a bit of a disconnect." Another participant noted: "I had a sense that it could recognize my emotions, but sometimes it could not express exactly which emotion I was experiencing. This made me question my trust in the chatbot."

4 Discussion and Future Work

ZzzMate addresses self-conscious emotions and provides empathetic responses dealing with sleep intervention. Our pilot study demonstrated positive user experiences, particularly in the system's ability to recognize and respond to emotions despite the despite moderate classification performance of the emotion recognition model in controlled testing with pre-labeled datasets. Both our quantitative analysis of Emotional Intelligence scores and qualitative feedback from participants confirmed the system's effectiveness in recognizing and responding appropriately to their self-conscious emotions during real-world interactions. This effectiveness can be attributed to how users naturally express emotions in conversation using clear linguistic patterns and emotion-specific vocabulary. For example, expressions like "I forgot to do..." when feeling guilt or "This made me uncomfortable/embarrassed" when feeling embarrassment provided strong contextual cues that enhanced the system's ability to identify and respond appropriately. Meanwhile, in model testing, the input usually consisted of isolated sentences without sufficient emotional context or natural conversational cues. The effective recognition of self-conscious emotions, coupled with the application of appropriate strategies to address them enables the system to deliver empathetic interactions, which further influenced individuals' receptiveness to the chatbot's advice and promoted positive behavioral changes, as evidenced by improvements in sleep adherence results. Overall, our pilot study demonstrated that the design of the ZzzMate system might be effective in producing empathetic responses tailored to self-conscious emotions and has the potential for improving sleep quality through behavior change intervention.

For the next steps, we plan to iterate on the system and conduct user research. we will refine ZzzMate in two key areas: guiding the LLM to generate more concise, persuasive responses, and implementing clearer feedback mechanisms that explicitly communicate which emotions the system has identified. These improvements aim to enhance user understanding and build greater trust in the system [30].

We will then conduct a formal study with at least 20 participants to meet statistical power requirements. This three-week experiment will compare three conditions: notifications for sleep time only, interaction with the standard GPT, and interaction with ZzzMate. We will collect quantitative data focusing on sleep adherence, emotional intelligence, and sleep quality through questionnaires administered at the beginning and end of each experimental week, complemented by in-depth interviews after the entire experiment concludes. We will perform statistical analysis on quantitative data and conduct thematic analysis to extract meaningful insights from the interview data. Through a deeper examination of the design process and our findings, we aim to develop a set of design guidelines for creating emotionally intelligent AI systems that can effectively recognize and respond to self-conscious emotions in behavior change interventions.

In the long term, we aim to address several limitations of this work. First, the sleep data collected in this study largely relies on self-reported recall. While this method has enhanced some users' awareness of their sleep habits, it also introduces cognitive load. Future research could integrate objective measurement tools, such as wearable devices, to complement the self-reported data. Second, to assess the system's effectiveness across diverse populations, we plan to conduct studies with participants from various age groups, cultural backgrounds, and sleeping habits. Third, although we have established safeguards to prevent the generation of content that could harm users' mental well-being, with no negative feedback reported in the pilot study, a more standardized framework that addresses ethical concerns is still required. Future work could explore a framework that outlines the guidelines for designing effective and ethically responsible empathetic chatbots in behavior intervention.

5 Conclusion

In this work, we introduce ZzzMate, a chatbot powered by a large language model designed to support users in maintaining healthy

sleep habits through personalized and empathetic interactions. The innovation of ZzzMate lies in its ability to understand and respond to self-conscious emotions, such as shame, guilt, embarrassment, and pride—emotions that are critical in behavior change interventions. We found that these emotions frequently arise when users either achieve or fail to meet their sleep goals, or when events in their daily lives indirectly affect their sleep quality. We conducted a pilot study to evaluate the impact of the system. The initial results revealed a positive user experience and highlighted the beneficial role of integrating empathy recognition and feedback, particularly in addressing self-conscious emotions, in enhancing user motivation and interactions with AI. Looking forward, we hope this work will underscore the pivotal role of self-conscious emotions in empathetic design, thus advancing technology toward a more human-centered approach.

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