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POSTER

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Abstract

Depression and loneliness are significant contributors to poor mental health and can potentially develop into severe mental disorders. With the advent of large language model (LLM) technology, health-care applications aimed at improving mental health have become increasingly active, and AI-mediated journaling has garnered attention for its potential in mental health management. However, the impact of AI-mediated journaling on depression and loneliness remains underexplored. To address this, we introduce MyListener, an AI-mediated journaling mobile application that provides context-aware diary prompts and replies based on contextual data collected from the smartphone and the Fitbit Luxe smartband. We conducted a two-week study with 11 university students to evaluate user experiences and observed a reduction in depression and loneliness during its use. This paper outlines our research contributions, discusses future work, and plans for a full-scale experiment.

CCS Concepts

• **Human-centered computing** → **Empirical studies in HCI**; **Ubiquitous and mobile computing**.

Keywords

Human-AI Interaction, AI-mediated journaling, Diary, Mental health

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1 Introduction

Depression and loneliness are significant mental health concerns that are closely interrelated[17]. Temporary depression can diminish the memory of positive experiences[19], while prolonged depression can develop into major depressive disorder[21], and loneliness can escalate to social isolation[27]. In the field of Human-AI interaction (HAI), various studies involving AI agents, such as chatbot[23],

AI carecall[8], AI speaker[16, 22], and AI counseling[2], address these mental health issues. With the advent of large language models (LLMs), these technologies hold promising potential for further advancements.

Journaling is a well-established method for self-management[26], enabling individuals to reflect on their condition and effectively manage their mental health[1, 5]. Current studies are exploring the application of LLMs in AI-mediated journaling to assist with writing and promote the practice of journaling [10, 14]. MindfulDiary[9], an application for monitoring depression through journaling analysis, and MindScope[20], which utilizes smartphone sensors for context-aware journaling to manage anxiety, are recently represented for AI-mediated journaling application for mental healthcare. Despite the progress in LLM-based AI-mediated journaling, not much has been explored on the effectiveness in alleviating depression and loneliness.

In this study, we developed MyListener, an AI-mediated journaling mobile application designed to alleviate depression and loneliness by utilizing contextual data from smartphone, smartband data and past diary records, providing diary prompts to induce journaling and replies to written entries for emotional support. The prompts and replies are crafted to make users feel understood by the AI agent, thereby promoting intimacy with the agent and encouraging self-disclosure during journaling. We conducted a two-week preliminary study with 11 participants who frequently experience depression and loneliness to explore the user experience with MyListener. The result showed that the application was effective in alleviating depression and loneliness, and valuable insights for future work were gained from user feedback. Our study makes the following contributions: (1) Prospects for inducing journaling through leveraging contextual data collected from commercial smart devices, (2) exploration of the effect of AI-mediated journaling and reply on alleviating depression and loneliness, and (3) implications for forming user-AI relationships through HAI in the context of AI-mediated journaling.

2 Application Design

MyListener is an android application, designed to leverage contextual data to generate diary prompts and replies for journaling. GPT-4 model is implemented as an AI agent, comprehending and interacting with the user in a nuanced manner. A reminder notification is implemented to encourage the user to write their diary, notifying 9 P.M. daily.

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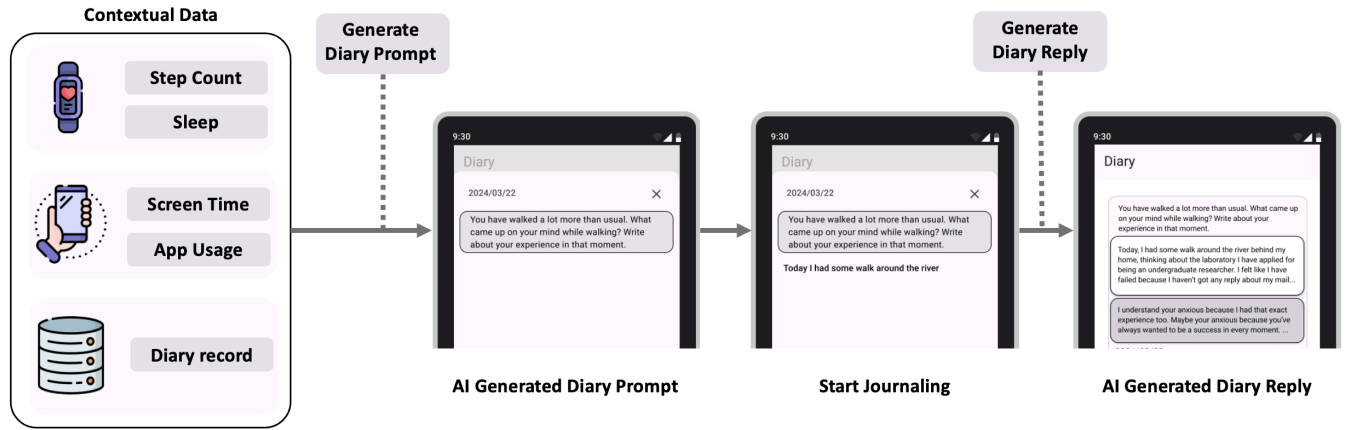


Figure 1: Use flow of MyListener: User can access journaling page by engaging writing button in the main page. After journaling, the main page displays diary prompt, written diary entry, and diary reply.

2.1 User Interface

The application consists of two pages: the main page and the journaling page. The main page displays past diary records, including the diary prompt, written diary entry, and diary reply, and features a button to access the journaling page. The journaling page presents AI-generated diary prompt and provides a text field for journaling (Figure1).

2.2 Features

The application features are consist of contextual data, diary prompt, and diary reply.

Contextual Data involves user profile, smartphone, smartband, and past diary records. The user profile is a pre-entered user input data (i.e. usual step count, bedtime, wake-up time, sleep duration, smartphone screen time) and is used to compare data collected from the smartphone and the smartband. The smartphone data involves screen time and the top 3 most used application data (i.e. application name, category, and usage time), and the smartband data involves step count and sleep context (i.e. bedtime, wake-up time, sleep duration) through sensors. All the daily data, except sleep, are designed to initialize after the day starts, and the daily valid sleep data is data recorded within 24 hours prior to the current time.

Diary Prompt is a phrase that encourages users to write in their diaries, generated by the AI agent based on contextual data through user context-awareness. There are five types of prompts: step count, sleep, screen time, app usage and retrospect (Table 1). Prompts, except the retrospect type, the agent uses randomly selected one type of contextual data and compares with the user’s profile data to infer the user’s status, designed to provide individually tailored prompt. For the retrospect type, the prompt applies ‘*cognitive restructuring*’, enabling the user to reminisce about past events while minimizing emotional disturbance[4].

A single contextual data for diary prompt generation is randomly selected to explore participants’ experiences with various prompt types, aiming to minimize bias toward any particular prompt. If the

initially chosen contextual data has no record, the application randomly selects an alternative data with available records, excluding previous chosen one.

Diary reply is an AI’s encouragement to the user based on the interpretation of the written diary. AI self-disclosure is applied by expressing sympathy through own experience to promote user self-disclosure in writing[13] and provide emotional support message (i.e. “*I’ve had days like that, and I think it’s important to do nothing and just relax. It’s a break for yourself, so enjoy it!*”), designed to build up user-AI relationship by developing intimacy toward the AI agent. The reply is implemented to show immediately after finish journaling.

3 Preliminary Study

Eleven university students (female: 3, age mean: 22.4) using Android smartphones and did not interfere with wearing a smartband were recruited to the study. All participants completed the PHQ-9 test before enrollment[11], with individuals scoring above 14, which indicates moderate to severe depression, excluded for ethical considerations. Participants meeting the inclusion criteria underwent the PHQ-9 assessment at three points: before the study, after the one-week study, and after the study, to monitor any potential risks. If a participant’s PHQ-9 score exceeded 14, the experiment was promptly discontinued to address the potential risk of obsessive use of the application as a means to alleviate depression, which could result in inappropriate treatment timing. Participants who met this criterion were referred to a psychotherapist for counseling. Furthermore, in-app PHQ-2 scores were monitored daily to track changes in participants’ mental health.

To ensure privacy, contextual data, survey response, diary prompts, and diary replies were collected anonymously in an online database. Contextual data containing diary content, which is retrospect entries, were not stored in the database. Additionally, diary content from every process was designed not to be stored. The number of words in each diary entry was collected to analyze individual journaling tendencies. All participants were informed of these practices prior to the field study.

Table 1: Diary Prompt Examples

Type	Diary Prompt Example
Step Count	You're taking a few more steps than usual today. Was it a nice day for walking, or did you do anything extra to get active? Tell us about your active day.
Sleep	You slept a little longer today. I'm curious to know if you woke up feeling more refreshed. Write in your day about how comfortable you felt in bed and any other thoughts you have.
Screen Time	You've spent less time on your phone today than usual, and I'm curious to know how you've spent your free time. Tell me about it.
App Usage	You've been watching a lot of YouTube today. What content did you find most interesting? Share your experience to me.
Retrospect	Think back to your diary from March X, 202X. You spent the day watching video content and felt unproductive and in a bad mood afterward. What lessons did you learn from this experience and what has changed since then? Tell me about it.

3.1 Study Design

All participants completed the PHQ-9 and UCLA-3[25] tests to assess their levels of depression and loneliness, and participated in the onboarding process prior to the two-week field study. Each participant was provided with a 'Fitbit Luxe' smartband and the developed application was installed for use during the study. Following the field study, participants were re-assessed using the PHQ-9 and UCLA-3 test, and user experience interview were conducted. The interview was recorded with the participant's consent and subsequently transcribed.

The Experience Sampling Method (ESM) was employed to gather user experience data on the application features, involving conducting a survey before journaling, and pre-post diary reply check. The pre-journaling survey assessed the current levels of depression and loneliness, while the pre-diary reply check survey evaluated the perceived AI comprehension to user through diary prompt and the level of self-disclosure in the current diary entry. The post-diary reply check survey reassessed the level of depression and loneliness. Modified PHQ-2 was used to measure depression[12], and all questionnaires utilized a 4-point Likert scale for consistency. To minimize the potential disruption in ESM survey responses, the surveys were designed to be completed up to the after reply check, and diaries without immediate response to the post-diary reply check survey were excluded from the analysis.

3.2 Results

A total of 153 diary entries were collected after the study, with 9 entries excluded from the analysis due to errors and non-responses to the final ESM survey. Consequently, 144 diary entries were analyzed. On average, each diary contained 28.3 words and the distribution of diary prompts was as follows: step count($n=19$), sleep ($n=13$), screen time ($n=41$), app usage ($n=13$), and retrospect ($n=28$). The average PHQ-9 score was decreased from 8.27 ($SD=3.05$) in pre-study to 6.09 ($SD=3.15$) in post-study, and similarly the average UCLA-3 score decreased from 50.18 ($SD=5.47$) in pre-study to 47.27 ($SD=5.77$) in post-study. (Table2)

We conducted a paired-sample test to investigate the impact of application use on depression, as measured by PHQ-2 response in ESM surveys. As the data did not meet normality assumptions, we employed the Wilcoxon signed-rank test. Results indicated a significant reduction in PHQ-2 scores from before journaling to

Table 2: Participant's Before-After PHQ-9 / UCLA-3 Score and Diary Entries

ID	PHQ-9		UCLA-3		Diary Entries
	Before	After	Before	After	
P1	3	1	44	34	16
P2	8	7	62	55	11
P3	12	2	50	46	14
P4	6	14	40	48	14
P5	7	10	50	44	11
P6	6	5	54	54	15
P7	11	12	54	50	12
P8	13	6	52	49	13
P9	11	9	47	43	13
P10	9	5	48	44	13
P11	5	6	51	53	12
Mean	8.27	6.09	50.18	47.27	13.09
SD	3.05	3.15	5.47	5.77	1.50

after the diary reply check ($Z=-4.121$, $P<.001$), suggesting that the application effectively mitigates depression.

A paired-sample test was conducted to examine the effect of the application on loneliness, based on ESM survey responses. Due to the data not meeting the normality assumptions, the Wilcoxon signed-rank test was adopted. The results showed a significant decrease in the loneliness scale from before journaling to after the diary reply check ($Z=-3.414$, $P=.001$), suggesting that the application effectively reduces feeling of loneliness.

4 Discussion

The result suggests journaling through diary prompt and receiving a reply significantly alleviates depression and loneliness. The diary reply encouraged participants to write briefly about situational context and deeply about their emotional states, distinguishing the journaling experience from a typical diaries without replies. The reply reflected the AI agent's role as a listener to the participants, whose emotions are not considerate, promoting self-disclosure[7], and influenced emotion management and organization of personal thoughts[18]. Some participants reported increased feelings of depression and loneliness when the AI agent provided unexpected replies due to incorrect interpretation of user's diary (P5, P7, P11).

Therefore, a diary reply that correctly interprets the diary entry and deeply understands the user may enhance self-disclosure during journaling, leading to the alleviation of depression and loneliness.

4.1 Diary Prompts and Feeling Understood

The diary prompt facilitated participants' self-reflection during journaling, and among the various prompt types, participants referred to retrospect to past diaries as particularly effective in making participants feel understood by the AI agent (P1, P4, P6, P7, P9, P10). P6 noted the feeling of communication with someone, enhancing the sense of interaction with a consistent AI agent compared to other prompt types. This suggests addressing past experience in HAI can mitigate issues related to the AI agent's perceived inconsistency[8], which can otherwise degrade the user-AI relationship. However, P2 reported increased depression when reminiscing about unpleasant past events, indicating the retrospect prompt type needs careful adaptation to consider the sentiment expressed in the diary, aiming to minimize negative emotions during retrospective journaling.

In other types of diary prompts, unlike the retrospective prompt, the users respond to the prompt very briefly in one or two sentences and then changed the journaling topic. Since most participants viewed diary-keeping as a once-a-day activity, these prompts had limitations in representing the entire day with a single data type. This approach was less impactful in making users feel understood and was often perceived as merely providing information to the writer. To enhance the sense of feeling understood, it would be beneficial to periodically inform that the agent is context-aware based on real-time data [20]. Additionally, as sensors can be found in commercial smart devices can biometrically and physically identify user daily statuses[3, 15, 28], thereby adding various types of sensor data and incorporating multiple data in generating a diary prompt can enhance users' perception of feeling understood.

4.2 AI Self-Disclosure in Diary Reply: A Double-Edged Sword

The inclusion of AI self-disclosure in the diary reply helped foster user empathy and strengthen the user-AI relationship. Despite the AI experience not being real, P1, P2, and P11 indicated that AI self-disclosure contributed to creating empathy, with P2 and P4 perceiving it as more affable and softer than typical AI textual outputs. However, P6 and P8 felt the AI's attempts to appear human were contrived, and P7 perceived constant AI self-disclosure as a formulaic, which decreased the perceived empathy from the replies. This suggests that AI self-disclosure should be strategically employed when empathy and encouragement are contextually necessary, rather than used consistently. As the emotional alignment between AI agent's tone and user's emotion affects the user's openness toward AI agent's opinions and influences decision making[24], aligning the diary reply tone with emotion embedded in the diary can alternate the consistent use of AI self-disclosure.

Additionally, participants who focused on the AI agent's tone (P1, P5, P8) perceived interactions with multiple AI agents due to occasional tone changes during interactions. This led P5 to state "It was a little bit less trustworthy after the sudden change...", indicating a deterioration in the user-AI relationship. Given the critical

role of language style in HAI[6], it is essential to implement a consistent language style for the AI agent to strengthen the user-AI relationship. Alternatively, representing a consistent character image during interaction may reduce the focus on the AI agent's tone, thereby lessening the considerations in maintaining consistency in maintaining the user-AI relationship.

5 Conclusion

We designed a LLM-powered AI-mediated journaling application for alleviating depression and loneliness. Diary prompts were generated using the user's physical activity, sleep, screen time, app usage, and journaling history based retrospective content. The results indicate that the diary prompts and replies significantly alleviated both depression and loneliness by eliciting feelings of understanding and empathy by the AI agent. However, the nuanced characteristic of the LLM-generated prompts and replies may easily degrade user experience leading to increased depression or loneliness. A longitudinal study with a greater number of participants needs to be conducted for evaluating the long-term efficacy of our approach. We expect our work to foster discussions and explorations toward AI-mediated journaling as a mental health supporting tool.

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