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Analysis of International Research Hotspots on the Application of Chatbots in the Field of Psychological Counseling—Text Mining Based on LDA Topic Model Analysis

Jingze Li

Institute of Higher Education, Lanzhou University, Lanzhou, Gansu, 730000, China

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Abstract: The application of Chatbots in the field of psychological counseling has demonstrated numerous advantages. Based on the LDA topic model, this study conducted a text mining analysis of 564 relevant papers included in the Web of Science core collection, IEEE, and ScienceDirect peer-reviewed journal collections up to 2025. The findings reveal that international research on the application of Chatbots in psychological counseling primarily focuses on four areas: artificial intelligence and mental health interventions, psychotherapy techniques and clinical practice, accessibility and integration of mental health services with technology, and specific psychological disorders and interdisciplinary applications. Future research should continue to explore the deep integration of advanced technologies with mental health services, aiming to make cost-effective, personalized, and scientific psychological counseling accessible to every individual in need.

1. Introduction

The rapid development of Chatbot has provided innovative tools for mental health services. Leveraging natural language processing (Natural Language Processing, NLP) and large language models (Large Language Model, LLMs), Chatbot offers significant advantages in assessing college students' mental health, monitoring data, and assisting in resolving modifiable psychological issues. As an auxiliary tool, it provides new ideas and opportunities for mental health education among college students [1]. However, its application in the field of psychological counseling still faces multiple challenges, including technical, ethical, and clinical validation issues. To systematically reveal the research hotspots and development trends of Chatbot in the field of psychological counseling abroad, this paper uses the LDA topic model to identify and analyze relevant literature on the application of GenAI in psychological counseling abroad, aiming to provide reference and guidance for domestic research and practice in intelligent psychological counseling.

2. Literature review

With the rapid development of technology, the application of Chatbots in the field of mental health has gradually become a research focus. Foreign researchers have carried out systematic

research on its technical path and application scenarios, and also conducted in-depth discussion on the ethical controversy caused by its application process.

2.1 The technical basis of psychological counseling Chatbots

The most advanced Chatbot technology at present is the Generative Artificial Intelligence model, which is most widely applied in general dialogue scenarios.GenAI is based on the Transformer architecture [2], achieving learning of complex language patterns through pre-training and fine-tuning. Large language models like the GPT series, trained on massive amounts of text data, can generate coherent dialogues [3] that fit the context, providing a technical foundation for psychological counseling scenarios. In addition, the semantic understanding ability of models such as BERT is helpful for identifying users' emotional states[4], for example, by judging depressive tendencies through word choice. Meanwhile, the intervention logic of cognitive behavioral therapy (CBT) and acceptance and commitment therapy (ACT) can also be integrated into AI systems. For instance, the CBT-based Chatbot Woebot guides users to recognize cognitive biases [5] through structured conversations. Reinforcement learning technology further optimizes personalized intervention strategies, enabling AI to dynamically adjust conversation content based on user feedback.

2.2 The application of psychological counseling Chatbots

In terms of application scenarios, the most common use of Chatbot is to provide psychological therapy, counseling training, and disease screening[6]. For example, crisis intervention robots can trigger emergency responses through keyword detection (such as "suicide"). At the same time, Chatbot not only assists in mental health screening through semantic analysis but also monitors the development of users' psychological states by tracking changes in their language patterns over time (such as syntactic complexity and frequency of emotional words)[7]. Additionally, Chatbot is used for simulating social scenarios for training. For instance, virtual humans can help users reduce their fear of self-disclosure through role-playing, thereby obtaining more comprehensive and accurate patient information[8].

2.3 The application controversy of psychological counseling Chatbots

In terms of ethical controversies, Chatbot faces multiple challenges. First, Chatbots have insufficient empathy and are unable to handle complex emotional conflicts, which may damage user trust due to mechanical feedback [9]. Second, mainstream models primarily trained with English data (such as GPT-3) suffer from significant data bias, limiting their applicability in cross-cultural scenarios. Furthermore, given the current computing power systems, Chatbot cannot yet provide entirely accurate psychological assessments, and its misjudgments could lead to psychological harm, yet existing laws lack clear accountability mechanisms. Lastly, the risk of data breaches cannot be overlooked. Conversations in psychological counseling contain sensitive information, necessitating enhanced privacy protection technologies and the establishment of relevant legal frameworks to safeguard user privacy and security[10].

3. Methodology

3.1 LDA topic analysis

LDA (Latent Dirichlet Allocation) is a full Bayesian probabilistic topic model proposed by Blei

et al. in 2003, widely applied in natural language processing, informatics, and social sciences. The model features efficient sampling inference algorithms and model generalization capabilities, which facilitate the construction of topic-based text models for massive documents at the semantic level, thereby accurately extracting academic paper topics and conducting evolutionary analysis [11].

3.2 Research ideas

This study is based on relevant literature data from the application of GenAI in psychological counseling abroad. First, the text data undergo preprocessing, followed by topic modeling using the LDA topic model. During the model construction process, perplexity is used as an evaluation metric to determine the optimal number of topics. By analyzing the probability distribution of topic words, different research topics are accurately identified, and the strength of each topic is calculated. On this basis, linear regression model fitting analysis is combined to identify hot topics within the research themes. Finally, based on the distribution of these hot topics, a deeper exploration of the research hotspots and development trends of GenAI in the field of psychological counseling abroad is conducted.

3.3 Dataset

This study uses the Web of Science, IEEE, ScienceDirect database as the data source, selecting "Chatbot" "LLM" "Large language model" "Generative Artificial Intelligence" "Generative AI" "GAI" "ChatGPT" "sora" "Gemi" "ERNIE" "AIGC" "Artificial Intelligence Generated Content" "GPT-4" "psychological counseling" "mental health counseling" "Psychotherapy" for topic searching, with the time range limited to before 2025. The literature comes from the Web of Science core database and peer-reviewed articles in IEEE and ScienceDirect. A total of 564 results were obtained through the search. Data cleaning was performed on relevant literature, removing irrelevant or duplicate files, resulting in a final total of 549 valid articles.

When preprocessing the retrieved journal articles, focus on the abstract sections that can express the main content of the literature. First, the researcher should use the NLTK library in Python to segment the text and remove stop words. Second, they should delete numbers, punctuation marks, and meaningless connecting words in the abstract that do not effectively convey the main content. On this basis, by combining word frequency statistics, they must eliminate highly frequent words with a frequency close to 100% and low-frequency words with a frequency below 0.1%. This process ensures that the final extracted vocabulary accurately reflects the core theme of the literature.

4. Results

4.1 Topic distribution

Using the gensim library of Python to train an LDA model on preprocessed abstract texts, the model parameters were set to α=0.1, β=0.01, and the maximum number of iterations max_iter was set to 1000. This study utilized perplexity to identify the optimal number of topics. Perplexity, as a metric for evaluating the model's explanatory power, reflects a lower value indicating better data interpretation by the model. Based on the lda.perplexity function in Python, the perplexity corresponding to 1-10 topic numbers was calculated (as shown in Figure 1).

According to the calculation results of confusion degree, with the increase of the number of topics, the decrease of confusion degree gradually decreases when the number of topics is greater than 4, indicating that the explanatory ability of the model is limited. Therefore, this study chooses

the number of topics corresponding to the slope of confusion degree slowing down as the optimal number of topics.

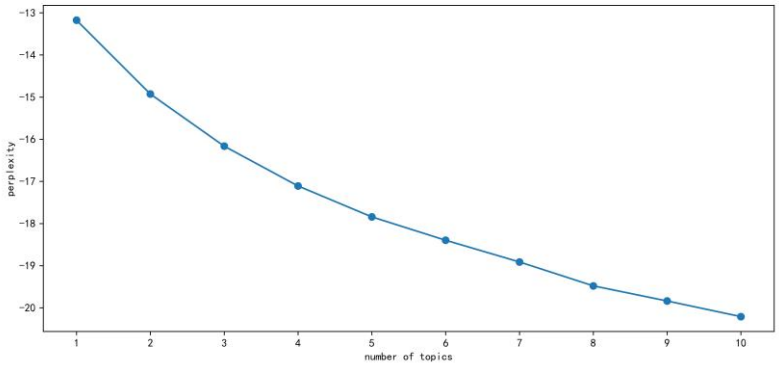

Figure 1 Theme number-confusion degree line graph

4.2 High-frequency word analysis

After training the LDA model, two result files of "theme-word" distribution and "data-theme" distribution were obtained. The "theme-word" distribution table was interpreted to identify the theme content, judge the high-frequency words in the theme content, and then divide the corresponding theme according to the recognition results.

Through the text analysis of document summaries, it is evident that mental health, as a core theme spanning multiple research fields, covers a wide range of aspects from diagnosis to treatment. In this domain, Chatbots, as the primary application form of artificial intelligence technology in mental health, have garnered significant attention and research for their effectiveness across various psychological interventions. Meanwhile, psychotherapy, such as the integration of cognitive-behavioral therapy with emerging technologies, has also become a current research hotspot. The application of AI technology in mental health, particularly in automated psychological support and data analysis, has demonstrated significant research value.

In terms of intervention measures, researchers have explored various forms, including digital interventions, pharmacological interventions, and psychological interventions, aiming to effectively improve individuals' mental health. Among these, depression and anxiety, as the most common mental health issues, have become the focus of research. To address these problems, researchers continuously seek effective treatment methods, which not only include traditional pharmacological and psychological treatments but also cover emerging digital treatment forms.

Figure 2. WordCloud of high-frequency words

In addition, the application of digital technology in mental health services has become an

important direction of current research. The introduction of digital technologies such as telemedicine and counseling has opened up new avenues for providing mental health services. In this context, the digitization and automation of psychological counseling services have also become one of the key focuses of research. At the same time, the needs and experiences of patients are placed at the core of the research to ensure that the ultimate beneficiaries of mental health services can receive more efficient, convenient, and personalized services. In summary, research in the field of mental health is moving towards diversification, technologization, and personalization. As shown in the Figure 2.

4.3 Topic analysis

According to the LDA topic analysis results, the document mainly covers the following four hot topics:

4.3.1 Artificial intelligence and mental health intervention

In the field of mental health intervention, Artificial Intelligence (AI) technology is demonstrating tremendous potential. This topic focuses on the application of AI technology, particularly the integration of Chatbots and natural language processing (NLP), in providing automated and personalized psychological support. Researchers are dedicated to using machine learning models to identify users' emotional states, combined with affective computing techniques, to enhance the quality of dialogue and emotional recognition capabilities of AI systems. Currently, AI Chatbots such as ChatGPT and Woebot have been widely used for mental health support, offering immediate and anonymous counseling services. Additionally, digital therapies, like digital versions of cognitive behavioral therapy (CBT), are becoming a new trend in delivering psychological interventions through digital platforms.

4.3.2 Psychotherapy techniques and clinical practice

Traditional psychological therapies, particularly cognitive behavioral therapy (CBT), play a significant role in clinical practice. The integration with emerging technologies has also opened up new possibilities for treatment. This topic focuses on the application and effectiveness of methods like CBT in various mental disorders, including depression, anxiety, and post-traumatic stress disorder (PTSD). Researchers have explored the feasibility of providing therapy through online platforms or mobile applications, as well as comprehensive treatment approaches that combine pharmacological interventions with psychotherapy to transform CBT into digital formats. In the treatment of specific conditions such as PTSD, the effectiveness of CBT and other psychological therapies has been thoroughly investigated. Therefore, developing intelligent psychological therapy systems that integrate AI technology to provide personalized treatment recommendations and support for patients will be a key direction for future development in this field.

4.3.3 Accessibility and integration of mental health services with technology

Improving the accessibility of mental health services, especially in resource-scarce areas, is one of the key focuses of current research. This topic explores the application of telemedicine, online counseling, and mobile health technologies in mental health services. Telemedicine breaks geographical barriers through video conferencing and phone calls, providing online psychological counseling; online platforms offer convenient psychological support via the internet; mobile health apps enhance users' mental health awareness through features such as mood monitoring and psychological education. Researchers evaluate the effectiveness of different technological

approaches in improving service accessibility and pay attention to issues of technological ethics and privacy protection. Despite challenges in technology adoption and ethical privacy concerns, combining AI and big data technologies to provide more extensive mental health services will be an important trend, given the shortage of mental health resources and uneven distribution of personnel.

4.3.4 Research and interdisciplinary application of specific mental diseases

Specific mental illnesses, such as suicide and adolescent mental health issues, have long been a focus of research. This topic centers on the neuroscientific mechanisms, genetic associations, and interdisciplinary applications of these conditions. Researchers explore the neurobiological foundations of mental disorders through neuroscience studies, examining the roles of neurotransmitters; they investigate the interactions between genetic and environmental factors through genetic association studies. At the same time, they combine biosensing and big data analysis technologies to study early diagnosis and intervention methods for mental disorders. In suicide prevention and adolescent mental health, the application of interdisciplinary technologies is providing new insights into disease prevention and treatment.

4.4 Topic correlation analysis

In the field of mental health research, Topic 0 and Topic 1, though both focusing on psychotherapy, highlight different emphases. Topic 0 focuses on the application of technology-driven interventions in psychotherapy, with particular attention to artificial intelligence (AI) technologies, such as automated and personalized psychological counseling support through the integration of Chatbots and natural language processing (NLP). This theme emphasizes the innovative application of technology and its potential and effectiveness in mental health interventions. In contrast, Topic 1 places more emphasis on traditional psychotherapeutic methods, such as the clinical practice of cognitive behavioral therapy (CBT) and their effectiveness and application in various mental disorders. It delves into comprehensive approaches that combine pharmacotherapy with psychotherapy, as well as how standardized assessment tools can evaluate patients' mental health status and treatment outcomes, highlighting the importance and value of traditional methods in clinical practice.

On the other hand, Topic 0 and Topic 2 intersect in the application of digital technology, but Topic 0 focuses on the technology itself, particularly the specific applications and implementation methods of AI and NLP technologies in mental health interventions. The core of its research is how to enhance the emotional recognition capabilities and dialogue quality of AI systems to provide more precise psychological support. In contrast, Topic 2 has a broader focus on how digital technology can improve the accessibility of mental health services, especially in resource-scarce areas. It examines the role of telemedicine, online counseling, and mobile health technologies in breaking geographical barriers and providing convenient psychological support, while delving into issues of technological ethics and privacy protection. It emphasizes the social significance and impact of technology in enhancing the accessibility of psychological support services.

Finally, while both Topic 1 and Topic 3 involve the treatment of mental disorders, their focus differs. Topic 1 emphasizes the exploration of treatment methods, particularly the clinical practice and effectiveness evaluation of traditional psychological therapies like CBT in various mental illnesses. It highlights the selection, adjustment, and optimization of treatment methods, as well as how to enhance therapeutic outcomes through comprehensive treatment plans. In contrast, Topic 3 places greater emphasis on the mechanisms of mental disorders and the application of interdisciplinary techniques. It explores the neurobiological foundations of mental disorders through neuroscience research, examines the interaction between genetic and environmental factors via

genetic association studies, and combines biometric sensing and big data analysis to study early diagnosis and intervention methods for mental disorders. This theme underscores the critical role of interdisciplinary collaboration and technological innovation in advancing the treatment of mental disorders.

A systematic interpretation of the results from LDA topic analysis reveals that the main trends in current mental health research focus on the intersection of technological innovation and mental health services. AI-driven mental health interventions and digital therapies are at the core of research, while the integration of traditional psychological treatments with emerging technologies, the accessibility of mental health services, and the mechanisms of specific mental disorders are also significant research areas.

5. Conclusion

As artificial intelligence, big data, and interdisciplinary technologies continue to advance, mental health research will place greater emphasis on personalization, precision, and intelligence. The deep application of AI technology is expected to bring higher efficiency and broader coverage to mental health services. In-depth interdisciplinary research will help uncover the complex mechanisms of mental disorders, leading to the development of more effective intervention methods. Future research should continue to explore the deep integration of technology with mental health services, while also paying attention to ethical issues and social impacts, ensuring that technological progress truly benefits every individual in need.

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