Psychiatria Danubina, 2023; Vol. 35, Suppl. 2, pp 15-19

Conference paper
Review

ARTIFICIAL INTELLIGENCE IN PSYCHIATRY

Giovanni Briganti

Chair of Artificial Intelligence and Digital Medicine, Department of Neuroscience, Faculty of Medicine, University of Mons, Mons, Belgium
Department of Clinical Sciences, Faculty of Medicine, Université de Liège, Liège, Belgium
Laboratoire de Psychologie Médicale et Addictologie, CHU Brugmann, Faculté de Médecine, Université libre de Bruxelles, Brussels, Belgium

SUMMARY

Artificial Intelligence (AI) has emerged as a powerful tool in various fields, including psychiatry. This paper explores the potential of AI in the diagnosis, treatment, and understanding of psychiatric conditions. We delve into the role of AI in psychiatry, discussing its applications, challenges, and future directions. We explore how AI techniques such as classification, hypothesis generation, and prediction are being used in psychiatry, with a specific focus on the detection and prediction of psychiatric conditions. We also discuss the ethical considerations and challenges in implementing AI in psychiatry and look towards the future of AI in this field. The paper highlights the potential of AI to enhance our understanding of psychiatric conditions, improve patient care, and drive innovation in psychiatric research. However, it also underscores the need for robust ethical frameworks and stringent data protection measures to ensure the responsible and effective use of AI in psychiatry.

Key words: *machine learning - network models – causality - diagnosis*

* * * * *

INTRODUCTION

The advent of artificial intelligence (AI) has brought unprecedented advancements across various fields of medicine. AI, in its essence, involves the development of computer systems capable of performing tasks that traditionally require human intelligence. These tasks include learning, reasoning, problem-solving, perception, and language understanding (Briganti 2023b).

Psychiatry stands as a prime candidate to benefit from the incorporation of AI, as it grapples with the complexity of mental processes and disorders, the subtlety of symptomatology, the overlap of clinical presentations, and the influence of subjective judgment on diagnosis and treatment. AI has the potential to provide valuable tools to address these challenges (Rogge & Briganti 2022, Till et al. 2022).

The role of AI in psychiatry is a rapidly emerging area of research and clinical application. It encompasses the use of sophisticated algorithms and computerized techniques for the diagnosis, prevention, and treatment of psychiatric disorders. Despite its relatively recent introduction to the field, AI has already begun to shape the landscape of psychiatric practice and holds the promise of significant advances in the near future. However, along with its potential, the use of AI in psychiatry also brings new questions and challenges, particularly related to the interpretability and transparency of AI models, ethical considerations, and the integration of AI tools into existing mental healthcare systems.

This paper aims to provide an overview of the application of AI in psychiatry, discussing its potential, presenting specific use cases, examining the importance of model transparency and interpretability, and exploring the challenges and future directions in this field. It is hoped that this discussion will provide psychiatrists and clinicians with a better understanding of the potential role and impact of AI in psychiatry.

WHY AI IN PSYCHIATRY?

The use of AI in psychiatry has emerged out of a need for more accurate, efficient, personalized, and scalable mental health care. Current approaches to diagnosing psychiatric disorders largely rely on clinical interviews and physician/patient questionnaires. While these methods are the gold standard, they also have their limitations. For instance, they can be time-consuming, rely heavily on the patient's ability to accurately report symptoms, and are susceptible to variability in clinicians' judgment. AI has the potential to augment traditional psychiatric practices in several ways.

The intersection of Artificial Intelligence (AI) and Psychiatry is not a novel concept. In fact, the first book to explore the potential of AI in Psychiatry was published as early as 1985. Authored by Hand, the book delved into the capabilities of algorithms in the realm of mental health, shedding light on how computational techniques could revolutionize psychiatric practices (Hand 1985).

However, the question arises: why should the current decade be any different? Why is there a renewed interest in the amalgamation of AI and Psychiatry now? The answer lies in a confluence of factors that have emerged and evolved over time. Firstly, there has been a significant economic shift in the healthcare sector, with decreased financing in mental health. This has necessitated the search for innovative and cost-effective solutions to provide mental health services, and AI has emerged as a promising candidate. Secondly, the prevalence of mental disorders has seen an alarming increase in recent years (Mahase 2020), as in 2019, 1 in every 8 people is estimate to live with a mental disorder. This escalating crisis calls for robust and scalable solutions, and AI holds the potential to meet this demand. Thirdly, despite advancements in mental health awareness, social stigma associated with mental illness persists (Corrigan & Wassel 2008). This stigma often discourages individuals from seeking help, leading to delayed or no treatment. AI-powered solutions, such as chatbots and online therapy platforms, offer a level of anonymity that can help overcome this barrier. Lastly, the advent of new technologies and the increasing digitization of healthcare have made it possible to reach out to mental health professionals in ways that were not possible before. However, access to in-person mental health services remains a challenge for many, especially in remote or underserved areas. AI can bridge this gap by enabling remote diagnosis and treatment, making mental health care more accessible.

In light of these factors, the current decade presents a unique and critical juncture for the integration of AI in Psychiatry. The potential of AI to transform mental health care is immense, and it is an opportunity we must seize.

DEFINING AI FOR PSYCHIATRY

Artificial Intelligence (AI) is a branch of computer science that aims to create systems capable of performing tasks that would normally require human intelligence. These tasks include learning from experience, understanding natural language, recognizing patterns, and making decisions. AI has the potential to revolutionize various fields, including psychiatry, by automating complex tasks and providing new insights (Briganti 2023b).

Machine Learning (ML)

ML is a subset of AI that involves the development of algorithms that allow computers to learn from and make decisions based on data. In psychiatry, ML can be used to predict the likelihood of a patient responding to a particular treatment based on their medical history and other relevant factors, or investigate the complexity of mental disorders (Briganti et al. 2021). For example, ML algorithms have been used to predict treatment outcomes in patients with depression. Additionally, ML algorithms can help identify a patient as belonging to one disorder spectrum or another.

Natural Language Processing (NLP)

NLP is a subfield of AI that focuses on the interaction between computers and human language. It allows computers to understand, interpret, and generate human language in a valuable way. In psychiatry, NLP can be used to analyze patient speech or text to detect signs of mental health conditions. For instance, NLP techniques have been used to analyze social media posts for signs of depression or suicidal ideation (Coppersmith et al. 2018).

Neural Networks and Deep Learning

These are advanced machine learning techniques that mimic the way the human brain works, and are particularly effective in processing large amounts of data. In psychiatry, deep learning can be used to analyze complex datasets, such as brain imaging data, to identify patterns that might not be detectable by human analysis (Akkus et al. 2017).

Reinforcement Learning

This is a type of machine learning where an agent learns to make decisions by taking actions in an environment to maximize some notion of cumulative reward. In psychiatry, reinforcement learning can be used in the development of personalized treatment strategies and care pathways. The system learns the most effective treatment approach for a particular patient based on feedback and adjusts the treatment plan accordingly (Maia & Frank 2011, Pike & Robinson 2022).

Large Language Models (e.g., GPT or LLaMA)

These models, trained on vast amounts of text data, are capable of generating human-like text, making them particularly useful in mental health settings. For instance, they can be used to power conversational agents (or chatbots). These AI-powered agents can offer immediate, anonymous, and non-judgmental support, making them a valuable resource for individuals who might be hesitant to seek help from human therapists. Furthermore, large language models can analyze patient language to detect subtle changes in mood or mental state, providing valuable insights for diagnosis and treatment. They can also be used to generate therapeutic content, such as mindfulness exercises or cognitive behavioral therapy techniques (Briganti 2023a). However, the use of these models in psychiatry also raises important ethical and privacy considerations, given the sensitive nature of mental health data. As such, it is crucial to ensure that their deployment is guided by robust ethical frameworks and stringent data protection measures.

ACHIEVING AI IN PSYCHIATRY

Implementing Artificial Intelligence (AI) in psychiatry involves a systematic workflow that transforms raw data into actionable insights for risk forecasting and intervention. This process is iterative and dynamic, allowing for continuous model updating and improvement.

Step 1. Raw, Ecological Momentary Assessment, and Sensor Data

The first step in the workflow involves the collection of data. This can include raw data from various sources such as electronic health records, patient interviews, and clinical observations. Additionally, Ecological Momentary Assessment (EMA) techniques can be used to collect real-time data on patients' symptoms, behaviors, and environmental context. Sensor data from wearable devices or smartphones can also provide valuable information on physical activity, sleep patterns, and other relevant behaviors (Porras-Segovia et al. 2020).

Step 2: Multimodal Feature Extraction

Once the data is collected, the next step is to extract meaningful features from it. This involves processing the raw data to identify and quantify key characteristics or patterns that are relevant to psychiatric conditions. The feature extraction process can be applied to various types of data, including text, images, and sensor data, and often involves techniques from fields such as natural language processing, image processing, and signal processing (Habets et al. 2023).

Step 3: Model Training

With the features extracted, the next step is to train a (predictive) model. This involves using machine learning algorithms to identify patterns in the data and learn how these patterns relate to the outcomes of interest, such as the diagnosis or prognosis of psychiatric conditions. The model training process often involves splitting the data into a training set, used to train the model, and a validation set, used to evaluate the model's performance and tune its parameters (Cearns et al. 2019, Koppe et al. 2021).

Step 4: Risk Forecast and Intervention

Once the model is trained, it can be used to make predictions on new data. This can involve forecasting the risk of a patient developing a psychiatric condition, predicting the course of a patient's condition, or identifying optimal intervention strategies. The predictions made by the model can then be used to inform clinical decision-making and patient care (Cao & Liu 2022).

Step 5: Model Updating

The final step in the workflow is model updating. As new data is collected, the model can be updated to incorporate this new information. This allows the model to adapt to changes over time and improve its performance. The model updating process can involve retraining the model on the combined old and new data, or using techniques such as online learning or transfer learning to update the model incrementally (Stephan & Mathys 2014).

DOMAINS AND USE CASES

Artificial Intelligence (AI) has a wide range of applications in psychiatry, spanning from diagnosis and risk prediction to research hypothesis generation. Here are some key domains and use cases for AI in psychiatry.

Diagnosis, Prediction of Risks and Outcomes

AI can be used to improve the diagnosis of mental disorders by identifying patterns in patient data that might be overlooked by human clinicians. Additionally, AI models can predict risks and outcomes for patients, helping clinicians to personalize treatment plans and monitor progress (Washington et al. 2020).

Studying Complexity and Uncertainty through Network Models

Mental disorders are complex and often involve a multitude of interacting symptoms and factors. AI can help to untangle this complexity by using network models to study the relationships between different symptoms and factors. This can provide insights into the underlying structure of mental disorders and help to identify key targets for intervention (Borsboom 2017).

Studying Temporal and Causal Dependencies among Symptoms of Mental Disorders

AI can also be used to study the temporal and causal dependencies among symptoms of mental disorders. This can involve using machine learning techniques to analyze longitudinal patient data (Briganti et al. 2021) and identify patterns of symptom progression and interaction (Briganti et al. 2020).

Digital Phenotyping

Digital phenotyping involves using data from digital devices, such as smartphones and wearables, to measure behaviors and symptoms in real-time. AI can be used to analyze this data and extract meaningful insights, such as identifying changes in behavior that might indicate a worsening of symptoms (De La Fabián et al. 2023, Washington et al. 2020).

Research Hypothesis Generation in Psychiatry

AI can be used to generate new research hypotheses in psychiatry. For example, machine learning models can identify unexpected patterns in patient data that might suggest new avenues for research. This can help to drive innovation and discovery in the field of psychiatry (Briganti 2022, Tai et al. 2019).

Brain Imaging

AI has significant potential in the analysis of brain imaging data. Machine learning techniques can be used to identify patterns in brain images that are associated with mental disorders. This can help to improve our understanding of the neurological basis of these disorders and could potentially lead to new diagnostic tools (Durstewitz et al. 2019).

Ethical and deontological challenges

While the integration of Artificial Intelligence (AI) in psychiatry holds immense potential, it also brings with it a host of ethical and deontological challenges that must be carefully considered and addressed.

Data Privacy and Confidentiality

AI systems often require large amounts of data for training and validation. In psychiatry, this data is typically sensitive. Ensuring the privacy and confidentiality of this data is paramount. There are also concerns about data security and the potential for data breaches, which could have severe consequences for patients.

Informed Consent

The use of AI in patient care raises questions about informed consent. Patients need to understand how AI is being used in their care, the potential risks and benefits, and any alternatives. This is particularly challenging given the complexity of AI systems and the difficulty in explaining how they work in a way that patients can understand.

Bias and Fairness

AI systems can be biased, reflecting biases in the data they are trained on. This can lead to unfair treatment or outcomes for certain groups of patients.

Transparency and Explainability

AI systems, particularly those based on complex machine learning algorithms, can be opaque, making it difficult to understand how they make decisions. This lack of transparency and explainability can be problematic in psychiatry, where understanding the rationale for a diagnosis or treatment decision is important for patient care and trust.

Responsibility and Accountability

Determining responsibility and accountability when AI is used in patient care can be challenging. If an AI system makes a mistake, it's not clear who should be held responsible - the developers of the system, the clinicians who used it, or someone else.

DISCUSSION

The integration of Artificial Intelligence (AI) in psychiatry presents a promising frontier in the quest to understand, diagnose, and treat mental health conditions. As we have explored in this paper, AI has a wide range of applications in psychiatry, from diagnosis and risk prediction to research hypothesis generation and brain imaging analysis.

The ability to analyze large and complex datasets can provide insights that would be difficult, if not impossible, to obtain through traditional methods. By identifying patterns and relationships in patient data, AI can aid in the diagnosis of mental disorders, predict risks and outcomes, and generate new research hypotheses. Furthermore, the use of AI in brain imaging analysis can enhance our understanding of the neurological basis of mental disorders.

However, the application of AI in psychiatry is not without its challenges. Issues related to data privacy, ethical considerations, and the need for interdisciplinary collaboration need to be addressed. It is crucial that the development and implementation of AI in psychiatry is guided by ethical principles and a commitment to patient welfare.

CONCLUSION

While we are still in the early stages of integrating AI in psychiatry, the potential benefits are immense. AI offers the possibility of more accurate diagnoses, personalized treatment plans, and a deeper understanding of mental disorders. As we continue to advance our technology and knowledge, the role of AI in psychiatry is likely to grow, offering new possibilities for patient care and clinical research.

The current decade presents a unique and critical juncture for the integration of AI in Psychiatry. With the escalating crisis of mental health and the advent of new technologies, the potential of AI to transform mental health care is immense, and it is an opportunity we must seize.

Acknowledgements: *None.*

Conflict of interest: *None to declare.*

References

1. *Akkus Z, Galimzianova A, Hoogi A, Rubin DL & Erickson BJ: Deep learning for brain MRI segmentation: State of the art and future directions. Journal of Digital Imaging 2017; 30:449–459*

2. Borsboom D: A network theory of mental disorders. World Psychiatry 2017; 16:5–13. https://doi.org/10.1002/wps.20375
3. Briganti G: On the Use of Bayesian Artificial Intelligence for Hypothesis Generation in Psychiatry. Psychiatr Danub 2022; 34(Suppl 8):201–206
4. Briganti G: A Doctor's Guide to Foundation Models. OSF Preprints. 2023a. https://doi.org/10.31219/osf.io/5zg3q
5. Briganti G: Intelligence artificielle: Une introduction pour les cliniciens. Revue des Maladies Respiratoires. 2023b. https://doi.org/10.1016/j.rmr.2023.02.005
6. Briganti G, Kornreich C & Linkowski P: A network structure of manic symptoms. Brain and Behavior 2021; e02010
7. Briganti G, Scutari M & Linkowski P: A Machine Learning Approach to Relationships Among Alexithymia Components. Psychiatr Danub 2020; 32(Suppl 1):180–187
8. Cao X-J & Liu X-Q: Artificial intelligence-assisted psychosis risk screening in adolescents: Practices and challenges. World Journal of Psychiatry 20221; 2:1287
9. Cearns M, Hahn T & Baune BT: Recommendations and future directions for supervised machine learning in psychiatry. Translational Psychiatry 2019; 9:271
10. Coppersmith G, Leary R, Crutchley P & Fine A: Natural language processing of social media as screening for suicide risk. Biomedical Informatics Insights 2018; 10:1178222618792860
11. Corrigan PW & Wassel A: Understanding and influencing the stigma of mental illness. Journal of Psychosocial Nursing and Mental Health Services 2008; 46:42–48
12. De La Fabián R, Jiménez-Molina Á & Pizarro Obaid F: A critical analysis of digital phenotyping and the neuro-digital complex in psychiatry. Big Data & Society 2023; 10:20539517221149096
13. Durstewitz D, Koppe G & Meyer-Lindenberg A: Deep neural networks in psychiatry. Molecular Psychiatry, 2019; 24:1583–1598
14. Habets PC, Thomas RM, Milaneschi Y, Jansen R, Pool R, Peyrot WJ, Penninx BW, Meijer OC, van Wingen GA & Vinkers CH: Multimodal Data Integration Advances Longitudinal Prediction of the Naturalistic Course of Depression and Reveals a Multimodal Signature of Remission During Two Year Follow-Up. Biological Psychiatry 2023
15. Hand DJ: Artificial intelligence and psychiatry (Vol. 1). Cambridge University Press 1985
16. Koppe G, Meyer-Lindenberg A & Durstewitz D: Deep learning for small and big data in psychiatry. Neuropsychopharmacology 2021; 46:176–190
17. Mahase E: Covid-19: WHO declares pandemic because of "alarming levels" of spread, severity, and inaction. BMJ (Clinical Research Ed.) 2020; 368:m1036. https://doi.org/10.1136/bmj.m1036
18. Maia TV & Frank MJ: From reinforcement learning models to psychiatric and neurological disorders. Nature Neuroscience 2011; 14:154–162
19. Pike AC & Robinson OJ: Reinforcement learning in patients with mood and anxiety disorders vs control individuals: A systematic review and meta-analysis. JAMA Psychiatry 2022
20. Porras-Segovia A, Molina-Madueo, RM, Berrouiguet S, López-Castroman J, Barrigón ML, Pérez-Rodríguez MS, Marco JH, Díaz-Oliván I, de León S & Courtet P: Smartphone-based ecological momentary assessment (EMA) in psychiatric patients and student controls: A real-world feasibility study. Journal of Affective Disorders 2020; 274:733–741
21. Rogge E & Briganti G: The Borders of Mental Illness: Investigating Clusters of Diagnostic Criteria in Acute Presentations of Psychiatric Disorders. Psychiatr Danub 2022; 34(Suppl 8):220–230
22. Stephan KE & Mathys C: Computational approaches to psychiatry. Current Opinion in Neurobiology 2014; 25:85–92
23. Tai AM, Albuquerque A, Carmona NE, Subramanieapillai, M, Cha DS, Sheko M, Lee Y: e learning and big data: Implications for disease modeling and therapeutic discovery in psychiatry. Artificial Intelligence in Medicine 2019; 99:101704
24. Til AC, Florquin R, Christensen AP, Golino H, Kornreich C, Delhaye M & Briganti G: Unique Variable Analysis of Redundancy in ADHD Items from the Conners Teacher Rating Scale - Revised: Short. Psychiatr Danub 2022; 34(Suppl 8):214–219
25. Washington P, Park N, Srivastava P, Voss C, Kline A, Varma M, Tariq Q, Kalantarian H, Schwartz J & Patnaik R: Data-driven diagnostics and the potential of mobile artificial intelligence for digital therapeutic phenotyping in computational psychiatry. Biological Psychiatry 2020; Cognitive Neuroscience and Neuroimaging 2020; 5:759–769

Correspondence:
Giovanni Briganti, MD, PhD
Chair of Artificial Intelligence and Digital Medicine, Department of Neuroscience,
Faculty of Medicine, University of Mons
Avenue du Champs de Mars 6, 7000 Mons, Belgium
E-mail: giovanni.briganti@hotmail.com