АКТУАЛЬНІ ПРОБЛЕМИ ПРАКТИЧНОЇ ПСИХОЛОГІЇ

Збірник наукових праць

Міжнародної науково-практичної інтернет-конференції

17 травня 2024 р., м. Одеса

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
STATE INSTITUTION "SOUTH UKRAINIAN NATIONAL PEDAGOGICAL UNIVERSITY NAMED AFTER K.D. USHYNSKY"
(Department of General and Differential Psychology,
Department of Psychiatry, Medical and Special Psychology,
Department of Theory and Methods of Practical Psychology)
MOLDOVA STATE UNIVERSITY
(Department of Psychology)
UNSVERSITY OF THE NATIONAL EDUCATION COMMISSION, KRAKOW
(Institute of Psychology)
VILNIUS UNIVERSITY
(Institute of Psychology)
JOHNS HOPKINS UNIVERSITY
(Department of Psychology & Brain Sciences)
ODESA NATIONAL ECONOMIC UNIVERSITY
(Department of Language and Psychological and Pedagogical Training)
KHARKIV NATIONAL PEDAGOGICAL UNIVERSITY NAMED AFTER H. S. SKOVORODA
(Department of Psychology)
CLASSICAL PRIVATE UNIVERSITY
(Department of Practical Psychology)
VASYL' STUS DONETSK NATIONAL UNIVERSITY
(Department of Psychology)
ODESA ASSOCIATION OF PSYCHOLOGISTS

ACTUAL PROBLEMS OF PRACTICAL PSYCHOLOGY

Collection of scientific works

International Scientific and Practical Internet Conference

May 17, 2024

Odessa – 2024

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ДЕРЖАВНИЙ ЗАКЛАД «ПІВДЕННОУКРАЇНСЬКИЙ НАЦІОНАЛЬНИЙ ПЕДАГОГІЧНИЙ УНІВЕРСИТЕТ ІМЕНІ К. Д. УШИНСЬКОГО»
(кафедра загальної та диференціальної психології,
кафедра психіатрії, медичної та спеціальної психології,
кафедра теорії та методики практичної психології)
ДЕРЖАВНИЙ УНІВЕРСИТЕТ МОЛДОВИ
(кафедра психології)
УНІВЕРСИТЕТ ІМЕНІ КОМІСІЇ НАРОДНОЇ ОСВІТИ В КРАКОВІ
(Інститут психології)
ВІЛЬНЮСЬКИЙ УНІВЕРСИТЕТ
(Інститут психології)
УНІВЕРСИТЕТ ДЖОНСА ГОПКІНСА
(кафедра психології та досліджень про мозок)
ОДЕСЬКИЙ НАЦІОНАЛЬНИЙ ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ
(кафедра мовної та психолого-педагогічної підготовки)
ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ ПЕДАГОГІЧНИЙ УНІВЕРСИТЕТ ІМЕНІ Г. С. СКОВОРОДИ
(кафедра психології)
КЛАСИЧНИЙ ПРИВАТНИЙ УНІВЕРСИТЕТ
(кафедра практичної психології)
ДОНЕЦЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ІМЕНІ ВАСИЛЯ СТУСА
(кафедра психології)
ОДЕСЬКЕ ТОВАРИСТВО ПСИХОЛОГІВ

АКТУАЛЬНІ ПРОБЛЕМИ ПРАКТИЧНОЇ ПСИХОЛОГІЇ

Збірник наукових праць
Міжнародної науково-практичної інтернет-конференції

17 травня 2024 року

Одеса – 2024

Секція IV.
ОСНОВИ ВЗАЄМОДІЇ ПСИХОЛОГА, УЧИТЕЛЯ І БАТЬКІВ В УМОВАХ ОСВІТНЬОГО ПРОЦЕСУ

EXPLORING SCHIZOPHRENIA: INSIGHTS AND FUTURE DIRECTIONS

Rad A.
University of the National Education Commission (Krakow, Poland)

Artificial intelligence is increasingly becoming part of our reality. Solutions that previously we could only encounter in sci-fi movies, for many people are already the norm and an integral part of everyday life. From voice-activated personal assistants managing our schedules to advanced automated processes, predictive analytics and machine learning algorithms applied in a wide variety of areas such as medicine and business. Replacing and assisting human labor with artificial intelligence arouses both fascination and increasing controversy, but the fact that such a powerful tool is constantly evolving and becoming more widely available is undeniable. Therefore, we should pay more attention to how to make the best use of this technology and also what risks we may face. In the following paper, I would like to take a more in-depth look at the use of AI in psychology and psychiatry, and more specifically its application to one of the more complex diseases – schizophrenia.

Schizophrenia (SZ) is a complex psychiatric disorder that reflects the combined influence and interaction of genetic, epigenetic, stochastic and non- genetic factors (Braff, Freedman, Schork, Gottesman, 2007). As well as the etiology of schizophrenia is complex, its symptoms are equally varied. It could be characterized by symptoms that may be positive (delusions and hallucinations, disorganized speech) and negative (affective flattening, avolition, impoverishment of speech and language, social withdrawal) in nature, as well as cognitive deficits (attention deficits, impaired executive functions such as planning, abstract thinking, rule flexibility, and inhibition of inappropriate actions and irrelevant sensory information, as well as short-term and long-term memory deficits) (Robertson, Hori, Powell, 2006). Also, the course of the disease in each patient may follow a different course or his body's response to particular forms of treatment. It becomes evident that explaining the entire disease through a singular mechanism or elucidating the relationship between a small group of specific biomarkers is an insurmountable challenge. Herein lies the significance of employing artificial intelligence, a powerful tool, to address this complexity.

The term "artificial intelligence" (AI) originally meant a simple theory of human intelligence demonstrated by machines. Nowadays, AI has transitioned from mere theory to tangible application on an unprecedented scale (Helm, et al., 2020). AI systems are designed to mimic human cognitive functions, such as learning, problem-solving, and pattern recognition, to perform specific tasks efficiently and effectively. AI can be broken down into various subsets, each tasked with slightly different functions. However, for the purposes of this article, I will focus solely on those most commonly discussed in psychology and neuropsychology. These include *machine learning*, which involves the development of algorithms enabling computers to learn from data and make predictions or decisions. Additionally, *deep learning*, a subset of machine learning, is specifically centered on neural networks—algorithms inspired by the structure and function of the brain. Deep learning employs neural networks with numerous layers (hence "deep") to hierarchically process data. It has proven highly successful in tasks such as image and speech recognition.

Until now, schizophrenia has typically been diagnosed following the onset of the first psychotic episode. Diagnosis is typically made by a psychiatrist through observation, patient history, and a battery of psychological tests. Equally important methods in detecting SZ are functional and structural neuroimaging techniques, which provide valuable insight into the underlying brain abnormalities associated with the disorder. Functional neuroimaging methods for SZ diagnosis include electroencephalography (EEG), magnetoencephalography (MEG), functional near-infrared spectroscopy (fNIRS) and functional MRI (fMRI). These techniques measure brain activity and function by detecting changes in blood flow, metabolism or neurotransmitter activity. Structural neuroimaging methods mainly refer to structural magnetic resonance imaging (sMRI) and diffusion tensor imaging (DTI). Those techniques provide detailed images of the brain's anatomy and structure. (Sadeghia, et al., 2021). However, neuroimaging techniques are limited by factors such as cost, availability, and the need for specialized equipment and expertise. Additionally, neuroimaging findings in SZ can be variable and non-specific, making it difficult to distinguish between schizophrenia and other psychiatric disorders or to predict individual treatment response.

Research indicates that early detection of schizophrenia and prompt intervention are associated with a milder disease trajectory later on. Prolonged periods of untreated psychosis have been correlated with poorer symptomatic and functional outcomes, underscoring the importance of timely diagnosis and intervention in improving long-term prognosis (Marshall et al., 2005; Perkins et al., 2005). Therefore, early diagnosis of SZ is particularly important and has become a focus of much research.

Due to the heterogeneity of SZ and the diverse range of symptoms affecting various areas of functioning, researchers have sought a tool that can effectively capture the complexity of the disease. Artificial intelligence (AI) is increasingly being used in SZ diagnosis due to its unparalleled ability to analyze large data sets, identify patterns and learn from the results. Most studies have focused on solving the binary classification (pattern recognition) task of distinguishing between SZ patients and healthy control subjects. These studies have used, in descending order of popularity, fMRI, MRI, genomics and EEG data. They used deep learning methods, a type of ML that uses deep neural networks (DNNs), algorithms inspired by the nervous system consisting of multiple interconnected layers of nonlinear processing units called artificial neurons (Cortes-Briones, et al., 2022; Phang, et al., 2019). One advantage of a deep neural network (DNN) with multilayer structures, is that it can learn latent, hierarchical features that are invariant to noise from multidimensional input data such as fMRI scans. This enables more reliable and accurate pattern classification compared to traditional linear and kernel methods (Phang, et al., 2019). In addition, recent results show that DNNs outperformed the support vector machine in SZ classification on structural MRI data (Pinaya, et al., 2016) and connectome fMRI at rest (Kim, et al., 2016). One of the strengths of DNNs is their ability to automatically extract useful features directly from raw data, which comes with the rise of studies using deep learning methods on minimally processed data (Kalmady, et al., 2019). That allows for a more unbiased exploration of the data, enabling researchers to uncover hidden patterns and associations that may not have been apparent using traditional methods. Traditionally, feature engineering, where specific features are manually crafted by researchers based on theories and assumptions about the disorder, has been a common practice. However, deep learning approaches replace these hand- engineered features with data-driven ones. By doing so, deep learning methods have the potential to uncover crucial patterns in the data that may have been overlooked due to pre-existing assumptions and expectations about the disorder. This shift from theory-oriented feature engineering to data-driven feature learning has the potential to revolutionize our understanding of schizophrenia and other complex disorders.

Deep learning has also been used in data modalities other than neuroimaging. There are several studies based on the assumption that key features of mental illnesses are reflected in speech (Wawer, et al., 2022; Corcoran, et al., 2020; Cohen, Elvevåg, 2014). Noticeable may be a reduction in semantic coherence or flow of meaning in speech. In psychotic disorders, especially schizophrenia, there is also a reduction in speech complexity, reflecting the clinical terms of poverty of speech or concreteness (Corcoran, Cecchi, 2020). In one study, researchers compared the performance in diagnosing schizophrenia and autism spectrum disorders, by (1) dedicated diagnostic tools that involve textual data collection, (2) automated methods (based on ML) applied to the data collected by these tools, and (3) psychiatrists. It turned out that the best automated methods outperformed human evaluators (psychiatrists). However, it should be remembered that this is a single study, and diagnosis based on textual data collection, is not a standard method of diagnosis by psychiatrists (Wawer, et al., 2022). In another also promising study Naderi and his colleagues developed a multimodal deep learning structure that automatically extracts not only textual data, but also salient audio features from audio speech samples (e.g. pitch, energy, voice probability) and linguistic cues extracted from their transcribed texts (e.g. vocabulary richness, cohesiveness, average positive/negative sentiment score) to predict a variety of mental disorders (including SZ). The model improves the scalability of speech use in predicting mental health outcomes by effectively learning a nonlinear combination of textual and acoustic modalities using an attention gating mechanism. (Naderi, Soleimani, Matwin, 2019).

Although AI technology holds promise for improving the diagnosis and prediction of schizophrenia, there are several controversies and challenges associated with its use. One of them is the “Black-Box” problem, which refers to the opacity or lack of transparency in the decision-making processes of AI systems (Melo, Romão, Duarte, 2024). Those methods, like deep neural networks (DNNs) usually take thousands of input variables, which are combined and transformed nonlinearly multiple times using thousands of trainable parameters to generate the outputs. That makes the internal mechanisms underlying DNNs' outcomes either unknown or too complicated to be interpreted in any meaningful way (Lipton, 2018; Cortes-Briones, et al., 2022). AI models trained on one population or dataset may not generalize well to other populations or datasets. This can limit the external validity and generalizability of AI-based diagnostic tools. Moreover, we must take into account that AI algorithms may be trained on biased datasets, which may perpetuate or reinforce existing biases in psychiatric diagnosis. Another issue related to AI technology concerns the ethical collection and sharing of data. On the one hand, to further develop and improve AI methods, it is necessary to acquire huge amounts of data, but we must remember that patients have their rights, and the acquisition and processing of data should be properly secured. In the future, it is necessary to regulate the rules of data privacy.

In summary, the integration of AI has the potential to revolutionize the diagnosis and treatment of schizophrenia by providing more accurate, efficient, and personalized analysis. AI's ability to analyze vast datasets, identify patterns, and continuously learn could lead to a deeper understanding of this complex disease and enable the early detection of its incipient symptoms. Ultimately, this could significantly improve the quality of life for patients. However, we must not forget that there are several controversies and challenges that need to be addressed in order to fully realize the potential of AI in clinical practice. In the future, we should first and foremost create clear rules to protect the well-being and privacy of patients when it comes to obtaining and processing their data, and then focus on conducting further research and introducing more and more new solutions.

Literature

1. Albert, N., & Weibell, M. A. (2019). The outcome of early intervention in first episode psychosis. *International Review of Psychiatry*, *31*(5–6), 413–424. DOI: 10.1080/09540261.2019.1643703
2. Braff, D. L., Freedman, R., Schork, N. J., & Gottesman, I. I. (2007). Deconstructing Schizophrenia: An Overview of the Use of Endophenotypes in Order to Understand a Complex Disorder. *Schizophrenia Bulletin*, *33*(1), 21-32.
3. Cohen, A. S., & Elvevåg, B. (2014). Automated computerized analysis of speech in psychiatric disorders. *Current opinion in psychiatry*, *27*(3), 203-209.
4. Corcoran, C. M., & Cecchi, G. A. (2020). Using language processing and speech analysis for the identification of psychosis and other disorders. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *5*(8), 770- 779.
5. Cortes-Briones, J. A., Tapia-Rivas, N. I., D'Souza, D. C., & Estevez, P. A. (2022). Going deep into schizophrenia with artificial intelligence. *Schizophrenia Research*, *245*, 122-140.
6. Helm, J. M., Swiergosz, A. M., Haeberle, H. S., Karnuta, J. M., Schaffer, J. L., Krebs, V. E., ... & Ramkumar, P. N. (2020). Machine Learning and Artificial Intelligence: Definitions, Applications, and Future Directions. *Current reviews in musculoskeletal medicine*, *13*(1), 69-76.
7. Kalmady, S.V., Greiner, R., Agrawal, R. *et al.* Towards artificial intelligence in mental health by improving schizophrenia prediction with multiple brain parcellation ensemble-learning. *npj Schizophr* **5**, 2 (2019). DOI:10.1038/s41537-018-0070-8
8. Kim, J., Calhoun, V. D., Shim, E., & Lee, J. H. (2016). Deep neural network with weight sparsity control and pre-training extracts hierarchical features and enhances classification performance: Evidence from whole-brain resting-state functional connectivity patterns of schizophrenia. *NeuroImage*, *124*(Pt A), 127– 146. DOI:10.1016/j.neuroimage.2015.05.018
9. Lipton, Z. C. (2018). The mythos of model interpretability: In machine learning, the concept of interpretability is both important and slippery. *Queue*, *16*(3), 31- 57.
10. Marshall, M., Lewis, S., Lockwood, A., Drake, R., Jones, P., & Croudace, T. (2005). Association between duration of untreated psychosis and outcome in cohorts of first-episode