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Editorial: Neuroimaging in psychiatry 2023: schizophrenia

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Editorial on the Research Topic
Neuroimaging in psychiatry 2023: schizophrenia

Schizophrenia is a complex mental condition that affects approximately 1% of the World's population (1). Despite extensive research, the neurobiological mechanisms underlying schizophrenia remain poorly understood (1, 2). It is clear that schizophrenia remains one of the most complex and distressing psychiatric disorders, with a clinical picture characterized by a series of positive symptoms (hallucinations, delusions) (3), negative symptoms (diminished affect, social withdrawal) and cognitive impairments (4–6). Alongside the most significant advances in neurobiological research, it is evident that voxel-based morphometry and high-resolution diffusion imaging have revealed widespread reductions in gray matter volume (GMV) and white matter integrity (7–9). It is recognized that structural deficits, predominantly in the prefrontal cortex, temporal lobes and striatum, are often correlated with disease severity and cognitive decline; in particular, early-onset schizophrenia presents more pronounced structural abnormalities, offering unique insights into its pathophysiological mechanisms (10). Functional imaging studies show reduced activation in the anterior insula and anterior cingulate cortex during socio-cognitive tasks, suggesting a disturbed integration of emotional and cognitive processes; these results are in line with behavioral observations of impaired social functioning, emphasizing the need for targeted and tailored therapeutic interventions with a view to precision medicine (11–13). Machine learning approaches have perfected the prediction of treatment outcomes in schizophrenia (3). Multimodal imaging biomarkers, incorporating structural and functional data, demonstrate high accuracy in identifying treatment-resistant schizophrenia (TRS) and in predicting disease trajectories (14, 15). Individualized network parcellation and advanced classification algorithms achieve robust performance, with predictive accuracies exceeding 90% in some studies; moving forward in this direction, an increasingly exploratory literature on the integration of neuroimaging, computational models, and large-scale data repositories suggests a new era in schizophrenia research (16, 17). Transdiagnostic frameworks that transcend traditional diagnostic boundaries are set to improve our understanding of common and distinct pathophysiological features, facilitating the differential diagnosis of bipolar disorder, and ultimately reducing the stigma associated with the disease and paving the way for integrated management of these clinical aspects (18–20), with a view to increasingly multidisciplinary

rehabilitation through the use of virtual reality techniques, stimulation of mirror neurons, achieving better outcomes with a reduction in the invasiveness of treatments (21–23). Recent advances in neuroimaging techniques may provide new insights and allow for highly specific information on the neural correlates of schizophrenia (5, 24). In this perspective, this Research Topic aims to highlight the latest discoveries in the field of neuroimaging and explore their potential implications for the diagnosis and treatment of schizophrenia, while providing a valuable resource for healthcare professionals, from both a clinical and an etiopathogenetic point of view (25).

Regarding the analysis of the neurobiological heterogeneity of the clinical state at high risk for psychosis, Oliver et al. present a study based on a large neuroimaging dataset of individuals at clinical high risk for psychosis (CHR-P) who meet the brief limited intermittent psychotic symptoms (BLIPS) criteria obtained by combining data from four independently conducted studies. The authors found weak or moderate evidence of no differences in global gray matter (GM), regional cerebral blood flow (rCBF), hippocampal and striatal attenuation of psychotic symptoms (APS) and BLIPS, suggesting based on their results that rCBF alone may not be suitable for risk stratification in CHR-P subjects.

In their study on the differentiation of the trajectories of retinal morphological aging in schizophrenia and their associations with cognitive dysfunction, Domagała et al. demonstrate that, in patients suffering from schizophrenia, the retinal macula undergoes accelerated atrophy starting from the third decade of life, similar to the dynamics of white matter changes analyzed in relation to the hypothesis of accelerated aging. The curves indicating age-related changes in other retinal structures were generally very similar in both groups, only with more pronounced thinning in the patient samples, with associations between the macula, ganglion cell complex and the age of the patients affecting only the middle-aged subgroup, suggesting on the basis of the data presented that retinal abnormalities in schizophrenia do not increase linearly over the course of life.

Additionally, in an analysis of white matter tracts in schizophrenia, bipolar disorder, aging and dementia using high spatial and directional resolution image diffusion, Mamah et al. provide preliminary data comparing image diffusion metrics between younger psychiatric populations and older cohorts using an automated trait-based analysis. The study shows that white matter tract volumes did not differ significantly between the groups evaluated, while there were significant differences in fractional anisotropy of the tracts in the various tracts studied. The authors, using an automated tractography tool, showed white matter integrity significantly compromised with aging, suggesting demyelination.

Shifting the focus to empathy in schizophrenia, Knobloch et al. analyze the neural alterations during emotion recognition and affective sharing. From a behavioral point of view, the patients only showed a prolonged response time in the age discrimination tests, while in the emotion processing tests, the patients showed a difference in neural response, without an observable behavioral correlate. The study suggests that the patients have deficits in processing complex visual information regardless of the emotional content at a behavioral level, and that these deficits coincide with aberrant neural activation patterns in the emotion processing networks.

Furthermore, in their systematic review Merola et al. examine transdiagnostic markers in the psychosis continuum, highlighting results that provide preliminary evidence for potential transdiagnostic alterations in brain activity in specific regions associated with psychosis, although they are not confirmed by survival to correction for multiple comparisons.

In an in-depth study of illness-related variables and resting-state brain activity abnormalities in schizophrenia, Giuliani et al. emphasize how attention/vigilance deficits were negatively associated with the dorsal resting-state (RS) activity of the anterior cingulate and, together with depression, were positively associated with the RS activity of the right dorsolateral prefrontal cortex. These deficits, along with the impairment of reasoning/problem-solving and conceptual disorganization, were associated with RS activity of the right inferior parietal lobe and right parietal temporal junction, highlighting how neurocognitive deficits and negative symptoms are associated with different neural markers.

Delving into brain structure, Zhang et al. present a study describing how individualized multimodal biomarkers obtained from magnetic resonance imaging predict the one-year clinical outcome in first-episode, non-medicated patients with schizophrenia; the study evaluated the structural morphology and functional topological characteristics related to treatment response using an individualized parcellation analysis in combination with machine learning (ML). This allowed us to highlight the potential of individual-specific network parcellation in the prediction of treatment-resistant schizophrenia, emphasizing the crucial role of feature attributes in the accuracy of the predictive model.

Finally, Wang et al. provide a meta-analysis of structural and functional brain abnormalities in early-onset schizophrenia; their work revealed that certain regions in the EOS showed significant structural or functional abnormalities, such as the temporal gyri, prefrontal cortex and striatum. These results may help to deepen our understanding of the pathophysiological (26) mechanisms underlying EOS and provide potential biomarkers for the diagnosis or treatment of EOS.

In conclusion, although progress in neuroimaging is extremely promising, challenges remain, including the need for larger and more diverse data sets and ethical considerations regarding data privacy (27). Despite these limitations, the integration of neuroimaging with computational methods continues to shape the future of schizophrenia research, fostering a deeper understanding of this enigmatic disorder (28). A combined approach based on neuroimaging, the latest machine learning techniques and evidence of improvements in the final outcome of the most modern rehabilitative integrations with the most traditional methods, is leading us toward emerging transdiagnostic frameworks that challenge traditional diagnostic

boundaries and support a continuum-based approach to psychosis (29). Neuroimaging studies reveal pathophysiological characteristics common to all conditions, such as interrupted connectivity and abnormalities in neurological development (30). These insights pave the way for integrative models that take into account genetic, environmental and developmental factors, filling in the gaps in our understanding and ultimately enabling us to achieve results that pave the way for future innovations in the research and treatment of psychosis.

Author contributions

MT: Conceptualization, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. SD: Conceptualization, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Generative AI was used in the creation of this manuscript.

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References

1. McCutcheon RA, Reis Marques T, Howes OD. Schizophrenia—An overview. *JAMA Psychiatry*. (2020) 77:201–10. doi: 10.1001/jamapsychiatry.2019.3360

2. Ross CA, Margolis RL, Reading SAJ, Pletnikov M, Coyle JT. Neurobiology of schizophrenia. *Neuron*. (2006) 52:139–53. doi: 10.1016/j.neuron.2006.09.015

3. Madububambachu U, Ukpebor A, Ihezue U. Machine learning techniques to predict mental health diagnoses: A systematic literature review. *Clin Pract Epidemiol Ment Health*. (2024) 20:e17450179315688. doi: 10.2174/0117450179315688240607052117

4. Miyamoto S, LaMantia AS, Duncan GE, Sullivan P, Gilmore JH, Lieberman JA. Recent advances in the neurobiology of schizophrenia. *Mol Interventions*. (2003) 3:27. doi: 10.1124/mi.3.1.27

5. Meyer-Lindenberg A. From maps to mechanisms through neuroimaging of schizophrenia. *Nature*. (2010) 468:194–202. doi: 10.1038/nature09569

6. Pearlson GD. Neurobiology of schizophrenia. *Ann Neurol*. (2000) 48:556–66. doi: 10.1002/1531-8249(200010)48:4<556::AID-ANA2>3.0.CO;2-2

7. Chaves C, Dursun SM, Tusconi M, Hallak JEC. Neuroinflammation and schizophrenia – is there a link? *Front Psychiatry*. (2024) 15:1356975. doi: 10.3389/fpsyt.2024.1356975

8. Tusconi M, Dursun SM. Editorial: Further findings in the role of inflammation in the etiology and treatment of schizophrenia. *Front Psychiatry*. (2024) 15:1349568. doi: 10.3389/fpsyt.2024.1349568

9. Correll CU, Tusconi M, Carta MG, Dursun SM. What remains to be discovered in schizophrenia therapeutics: contributions by advancing the molecular mechanisms of drugs for psychosis and schizophrenia. *Biomolecules*. (2024) 14:906. doi: 10.3390/biom14080906

10. O'Callaghan C, Bertoux M, Hornberger M. Beyond and below the cortex: the contribution of striatal dysfunction to cognition and behaviour in neurodegeneration. *J Neurol Neurosurg Psychiatry*. (2014) 85:371–8. doi: 10.1136/jnnp-2012-304558

11. Billeke P, Aboitiz F. Social cognition in schizophrenia: from social stimuli processing to social engagement. *Front Psychiatry*. (2013) 4:4. doi: 10.3389/fpsyt.2013.00004

12. Kittleson AR, Woodward ND, Heckers S, Sheffield JM. The insula: Leveraging cellular and systems-level research to better understand its roles in health and schizophrenia. *Neurosci Biobehav Rev*. (2024) 160:105643. doi: 10.1016/j.neubiorev.2024.105643

13. Alba-Ferrara L, Hausmann M, Mitchell RL, Weis S. The neural correlates of emotional prosody comprehension: disentangling simple from complex emotion. *PloS One*. (2011) 6:e28701. doi: 10.1371/journal.pone.0028701

14. MacKay M-AB, Paylor JW, Wong JTF, Winship IR, Baker GB, Dursun SM. Multidimensional connectomics and treatment-resistant schizophrenia: linking phenotypic circuits to targeted therapeutics. *Front Psychiatry*. (2018) 9:537. doi: 10.3389/fpsyt.2018.00537

15. Panula JM, Gotsopoulos A, Alho J, Suvisaari J, Lindgren M, Kieseppä T, et al. Multimodal prediction of the need of clozapine in treatment resistant schizophrenia; a pilot study in first-episode psychosis. *Biomarkers Neuropsychiatry*. (2024) 11:100102. doi: 10.1016/j.bionps.2024.100102

16. Du Y, Fu Z, Calhoun VD. Classification and prediction of brain disorders using functional connectivity: promising but challenging. *Front Neurosci*. (2018) 12:525. doi: 10.3389/fnins.2018.00525

17. Voineskos AN, Hawco C, Neufeld NH, Turner JA, Ameis SH, Anticevic A, et al. Functional magnetic resonance imaging in schizophrenia: current evidence, methodological advances, limitations and future directions. *World Psychiatry*. (2024) 23:26–51. doi: 10.1002/wps.21159

18. Angermeyer MC, Carta MG, Matschinger H, Millier A, Refaï T, Schomerus G, et al. Cultural differences in stigma surrounding schizophrenia: Comparison between Central Europe and North Africa. *Br J Psychiatry*. (2016) 208:389–97. doi: 10.1192/bjp.bp.114.154260

19. Carta MG, Ouali U, Perra A, Ben Cheikh Ahmed A, Boe L, Aissa A, et al. Living with bipolar disorder in the time of covid-19: biorhythms during the severe lockdown in cagliari, Italy, and the moderate lockdown in tunis, Tunisia. *Front Psychiatry*. (2021) 12:634765. doi: 10.3389/fpsyt.2021.634765

20. Al-Awad F. Perceived burden and quality of life in caregivers of patients with schizophrenia in Saudi Arabia's eastern province: a cross-sectional study. *Clin Pract Epidemiol Ment Health*. (2024) 20:e17450179314013. doi: 10.2174/0117450179314013240417105321

21. Chaves C, dos Santos RG, Dursun SM, Tusconi M, Carta MG, Brietzke E, et al. Why N,N-dimethyltryptamine matters: unique features and therapeutic potential beyond classical psychedelics. *Front Psychiatry*. (2024) 15:1485337. doi: 10.3389/fpsyt.2024.1485337

22. Tusconi M, Sanchez-Gutierrez T. Editorial: reviews in psychiatry 2022: schizophrenia. *Front Psychiatry*. (2023) 14:1237676. doi: 10.3389/fpsyt.2023.1237676

23. Tusconi M, Kätzel D, Sánchez-Gutiérrez T. Editorial: Reviews in psychiatry 2023: schizophrenia. *Front Psychiatry*. (2024) 15:1444818. doi: 10.3389/fpsyt.2024.1444818

24. Kraguljac NV, McDonald WM, Widge AS, Rodriguez CI, Tohen M, Nemeroff CB. Neuroimaging biomarkers in schizophrenia. *AJP*. (2021) 178:509–21. doi: 10.1176/appi.ajp.2020.20030340

25. Tusconi M, Nibbio G, Gupta R, Carr E. Editorial: Case reports in schizophrenia and psychotic disorders. *Front Psychiatry*. (2023) 14:1282780. doi: 10.3389/fpsyt.2023.1282780

26. Baydili İ, Tasci B, Tasci G. Artificial intelligence in psychiatry: A review of biological and behavioral data analyses. *Diagnostics*. (2025) 15:434. doi: 10.3390/diagnostics15040434

27. Kellmeyer P. Big brain data: on the responsible use of brain data from clinical and consumer-directed neurotechnological devices. *Neuroethics*. (2021) 14:83–98. doi: 10.1007/s12152-018-9371-x

28. Mäki-Marttunen T, Kaufmann T, Elvsåshagen T, Devor A, Djurovic S, Westlye LT, et al. Biophysical psychiatry—How computational neuroscience can help to understand the complex mechanisms of mental disorders. *Front Psychiatry*. (2019) 10:534. doi: 10.3389/fpsyt.2019.00534

29. Nelson B, McGorry PD, Fernandez AV. Integrating clinical staging and phenomenological psychopathology to add depth, nuance, and utility to clinical phenotyping: a heuristic challenge. *Lancet Psychiatry*. (2021) 8:162–8. doi: 10.1016/S2215-0366(20)30316-3

30. Hallett M, de Haan W, Deco G, Dengler R, Di Iorio R, Gallea C, et al. Human brain connectivity: Clinical applications for clinical neurophysiology. *Clin Neurophysiol*. (2020) 131:1621–51. doi: 10.1016/j.clinph.2020.03.031