The role of neuroimaging beyond T1-weighted MRI in the diagnosis and prediction of neuropsychiatric disorders

Esten H. Leonardsen

26.10.23

UNIVERSITETET
I OSLO

1. Background: Defining the scope of the lecture.
2. State-of-the-art: How is neuroimaging beyond T1-weighted MRI currently being used with respect to neuropsychiatric disorders.
3. The future: Challenges and opportunities in using neuroimaging for predicting neuropsychiatric disorders moving forward.

☐ The role of neuroimaging beyond T1-weighted MRI in the
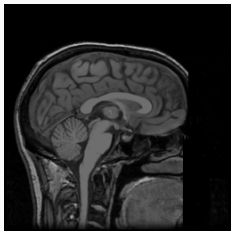diagnosis and prediction of neuropsychiatric disorders

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The role of **neuroimaging** beyond T1-weighted MRI in the diagnosis and prediction of neuropsychiatric disorders
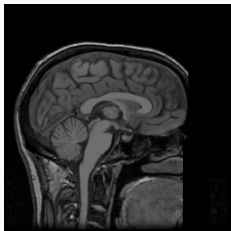
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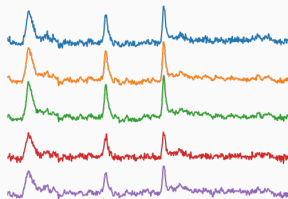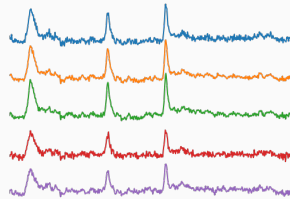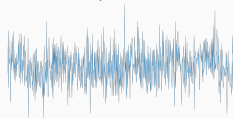

Bert from FreeSurfer 7.3

The role of **neuroimaging** beyond T1-weighted MRI in the diagnosis and prediction of neuropsychiatric disorders

Sample from the MNE library

Bert from FreeSurfer 7.3

The role of **neuroimaging** beyond T1-weighted MRI in the diagnosis and prediction of neuropsychiatric disorders

Sample from the MNE library

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Sample from Tremlay et al., 2016

Tremblay, R., Lee, S., & Rudy, B. (2016). GABAergic interneurons in the neocortex: from cellular properties to circuits. Neuron, 91(2), 260-292

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Sample from the MNE library

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Meta Quest Pro

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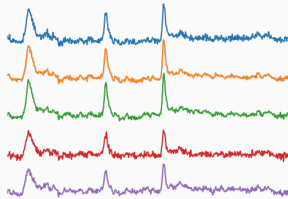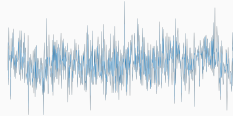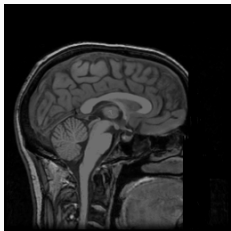
Background

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Bert from FreeSurfer 7.3

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3D

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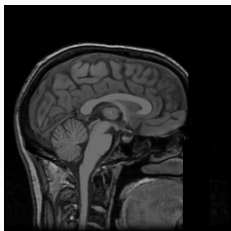

Bert from FreeSurfer 7.3

Saggital, axial

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The role of neuroimaging beyond T1-weighted MRI in the diagnosis and prediction of neuropsychiatric disorders

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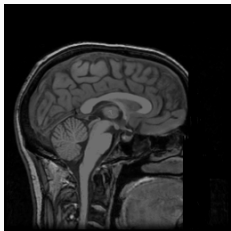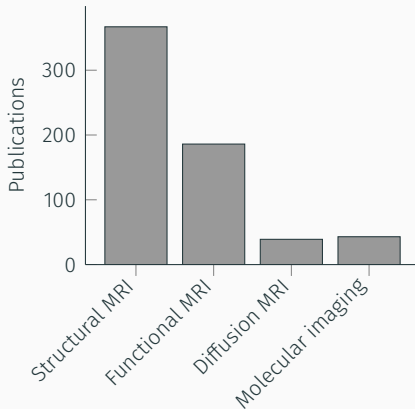The role of neuroimaging beyond T1-weighted MRI in the diagnosis and prediction of neuropsychiatric disorders
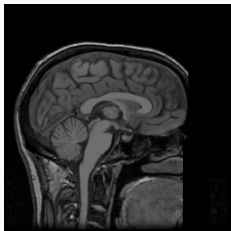

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Background

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The role of neuroimaging beyond T1-weighted MRI in the diagnosis and prediction of **neuropsychiatric disorders**

Alzheimer's disease (AD) and other
causes of dementia (DEM)

Multiple Sclerosis (MS)
Parkinson's Disease (PD)

☐

Background

Alzheimer's disease (AD) and other causes of dementia (DEM)

Multiple Sclerosis (MS)

Parkinson's Disease (PD)

Bipolar Disorder (BP)

Schizophrenia (SCZ)

Depressive disorders, including major depressive disorder (MDD)

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   diagnosis and prediction of neuropsychiatric disorders

The role of neuroimaging beyond T1-weighted MRI in the
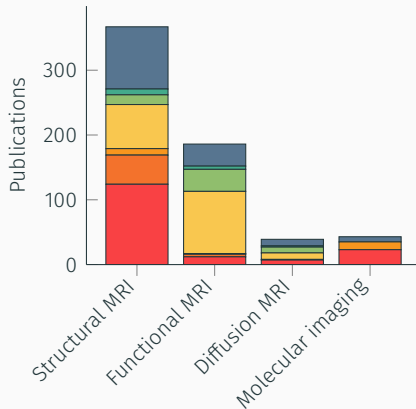**diagnosis and prediction** of neuropsychiatric disorders

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The role of neuroimaging beyond T1-weighted MRI in the **diagnosis and prediction** of neuropsychiatric disorders

Vogel & Black (2024)

Vogel, A. C., & Black, K. J. (2024). Brain Imaging in Routine Psychiatric Practice. Missouri Medicine, 121(1), 37

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diagnosis and prediction of neuropsychiatric disorders

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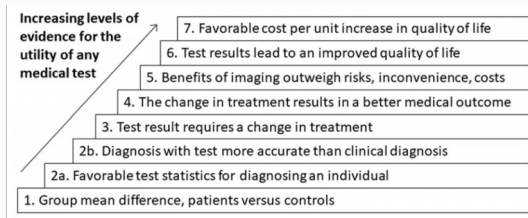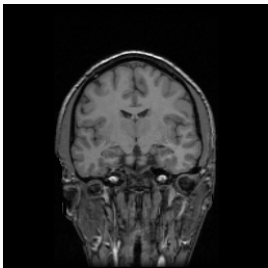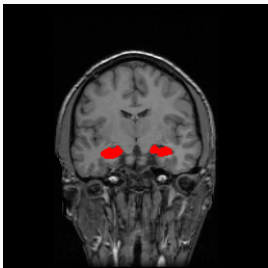diagnosis and prediction of neuropsychiatric disorders

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The role of neuroimaging beyond T1-weighted MRI in the **diagnosis and prediction** of neuropsychiatric disorders

DEM

4,000   7,000   10,000

mm^3

Data from ADNI

Jack Jr, C. R., Bernstein, M. A., Fox, N. C., Thompson, P, Alexander, G., Harvey, D., ... & Weiner, M. W. (2008). The Alzheimer's disease neuroimaging initiative (ADNI): MRI methods. Journal of Magnetic Resonance Imaging: An Official Journal of the International Society for Magnetic Resonance in Medicine, 27(4), 685-691

The role of neuroimaging beyond T1-weighted MRI in the
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DEM
HC

4,000   7,000   10,000

mm^3

Data from ADNI

Jack Jr, C. R., Bernstein, M. A., Fox, N. C., Thompson, P., Alexander, G., Harvey, D., … & Weiner, M. W. (2008). The Alzheimer's disease
neuroimaging initiative (ADNI): MRI methods. Journal of Magnetic Resonance Imaging: An Official Journal of the International
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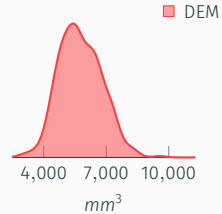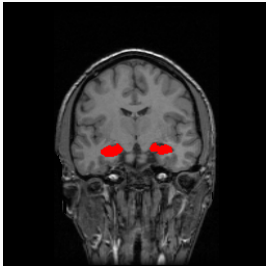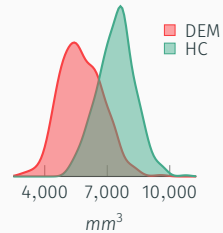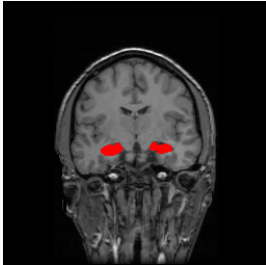
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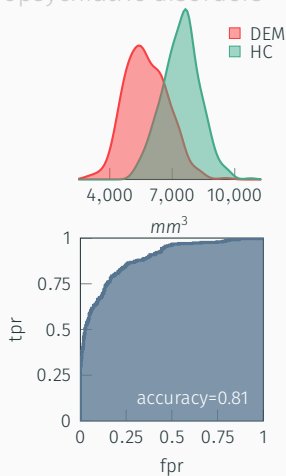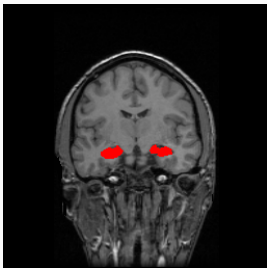**diagnosis and prediction** of neuropsychiatric disorders

Predictive model → Patient

Predictive model → Control

$$\text{accuracy} = \frac{\text{correct predictions}}{\text{all predictions}}$$

Neuroimaging modalities for diagnostic predictions

Non-T1 structural MRI

Diffusion MRI

Functional MRI

Molecular imaging

Non-T1 structural MRI

Diffusion MRI

Functional MRI

Molecular imaging

Dementia

Multiple sclerosis

Parkinson's disease

Schizophrenia

Major depressive disorder

Bipolar disorder

	Dementia	Multiple sclerosis	Parkinson's disease	Schizophrenia	Major depressive disorder	Bipolar disorder
Non-T1 structural MRI						
Diffusion MRI						
Functional MRI						
Molecular imaging						

From estimating activation locality to predicting disorder: A review of pattern recognition for neuroimaging-based psychiatric diagnostics

Thomas Wolfers [a,b], Jan K. Buitelaar [c,d], Christian F. Beckmann [b,c,e], Barbara Franke [a,f], Andre F. Marquand [b,g]

From estimating activation locality to predicting disorder: A review of pattern recognition for neuroimaging-based psychiatric diagnostics

Thomas Wolfers [a] [b] ☆ ✉, Jan K. Buitelaar [c] [d], Christian F. Beckmann [b] [c] [e], Barbara Franke [a] [f], Andre F. Marquand [b] [g]

Single subject prediction of brain disorders in neuroimaging: Promises and pitfalls

Mohammad R. Arbabshirani [a] [b] ☆ ✉, Sergey Plis [e], Jing Sui [e] [c], Vince D. Calhoun [e] [d]
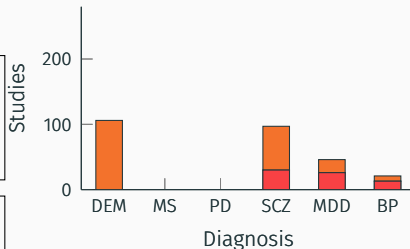
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Towards a brain-based predictome of mental illness

Barnaly Rashid, Vince Calhoun ✉

From estimating activation locality to
predicting disorder: A review of pattern
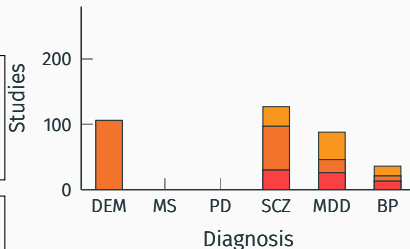recognition for neuroimaging-based
psychiatric diagnostics

Thomas Wolfers [a,b], [jq], [es.], Jan K. Buitelaar [c,d], Christian F. Beckmann [b,c,e], Barbara Franke [d,f],
Andre F. Marquand [b,g]

Single subject prediction of brain disorders
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**Deep learning applications for the classification of
psychiatric disorders using neuroimaging data:
Systematic review and meta-analysis**

Mirjam Quaak [5], Laurens van de Mortel [5], Rajat Mani Thomas [5], Guido van Wingen [2]
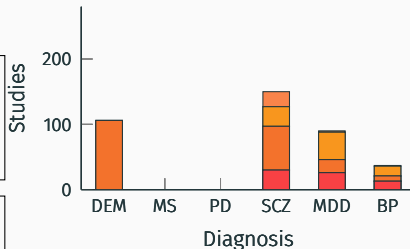
Deep learning to detect Alzheimer's disease from neuroimaging: A systematic literature review
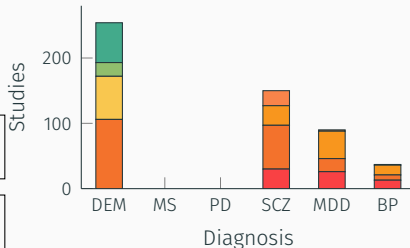Mr Amir Ebrahimighahnavieh [1], Suhuai Luo [3], Raymond Chiong [2]

Machine learning techniques for diagnosis of alzheimer disease, mild cognitive disorder, and other types of dementia
Golrokh Mirzoei [9] , Hojjat Adeli [9]

Early diagnosis of Alzheimer's disease based on deep learning: A systematic review
Sina Fathi [1], Maryam Ahmadi [2], Afsaneh Dehnad [3]

Applications of deep learning techniques for automated multiple sclerosis detection using magnetic resonance imaging: A review

Afshin Shoeibi [1], Marjane Khodatars [2], Mahboobeh Jafari [3], Parisa Moridian [4], Mitra Rezaei [5], Roohallah Alizadehsani [6], Fahime Khozeimeh [6], Juan Manuel Gorriz [7], Jónathan Heras [8], Maryam Panahiazar [9], Saeid Nahavandi [6], U Rajendra Acharya [10]

Multiple Sclerosis Diagnosis Using Machine Learning and Deep Learning: Challenges and Opportunities

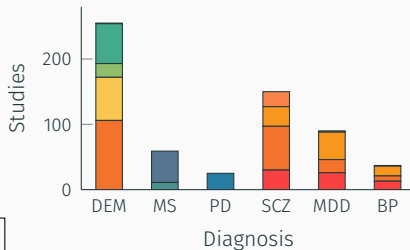by Nida Aslam [1], Irfan Ullah Khan [1], Asma Bashamakh [1], Fatima A. Alghool [1], Menna Aboulnour [1], Noorah M. Alsuwayan [1], Rawa'a K. Alturaif [1], Samiha Brahimi [2], Sumayh S. Aljameel [1] and Kholoud Al Ghamdi [3]
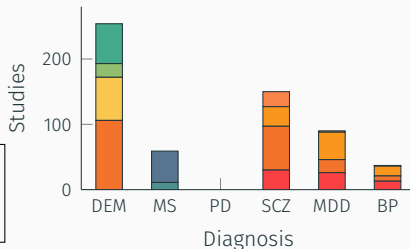
Role of Artificial Intelligence Techniques and Neuroimaging Modalities
in Detection of Parkinson's Disease: A Systematic Review

Nikita Aggarwal[1] · B. S. Saini[1] · Savita Gupta[2]

Machine learning techniques in a structural and functional MRI diagnostic approach in schizophrenia: a systematic review

Renato de Filippis,[a] Elvira Anna Carbone,[a] Raffaele Gaetano,[1] Antonella Bruni,[1] Valentina Pugliese,[1] Cristina Segura-Garcia,[a] and Pasquale De Fazio[1]

Machine learning techniques for the Schizophrenia diagnosis: a comprehensive review and future research directions

Shradha Verma[1] · Tripti Goel[1] · M. Tanveer[2] · Weiping Ding[3] · Rahul Sharma[1] · R. Murugan[1]
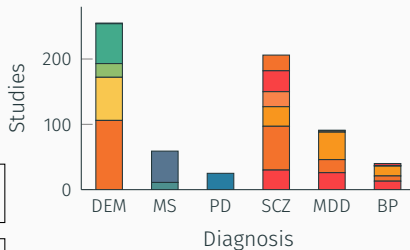
Will machine learning applied to neuroimaging in bipolar disorder help the clinician? A critical review and methodological suggestions

Laurie-Anne Claude, Josselin Houenou✉, Edouard Duchesnay, Pauline Favre