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International Parkinson and
Movement Disorder Society

Course Directors:

Thilo van Eimeren

University of Cologne, Germany

Roberto Cilia

Fondazione IRCCS Istituto Neurologico
Carlo Besta Milan, Italy

Neuroimaging and Pathology Biomarkers in Parkinson's disease

Milan PD Biomarkers Initiative



MILAN, SEPTEMBER 12/13 2025

Starhotels Ritz

Via Lazzaro Spallanzani, 40
20129 - MILANO

DAY 1 - Friday, September 12, 2025

- 13.30 **Registration and Course Material pick-up**
- 14.00 **Welcome**
R. Cilia (Milan, Italy), *T. van Eimeren* (Cologne, Germany)
- 14.10 **Institutional greetings from the IRCCS Foundation “Carlo Besta”
 Neurological Institute**
G. Lauria Pinter (Scientific Director), *R. Eleopra* (Director of the Parkinson
 and Movement Disorders Unit)

**SESSION 1 IMAGING NEUROTRANSMITTER DYSFUNCTION:
 DOPAMINE & NORADRENALINE**

14.30-15.30 Chairs: *R. Cilia* (Milan, Italy), *A.P. Strafella* (Toronto, Canada)

- 14.30 **Dopaminergic Dysfunction: Molecular Biomarkers**
R. Ceravolo (Pisa, Italy)
- 14.50 **Dopaminergic Dysfunction: MRI Biomarkers**
S. Lehéricy (Paris, France)
- 15.10 **Noradrenergic Dysfunction: Molecular and MRI Biomarkers**
B. Ballanger (Lyon, France)

15.30 **Coffee Break**

**SESSION 2 IMAGING NEUROTRANSMITTER DYSFUNCTION:
 ACETYLCHOLINE AND SEROTONIN**

16.00-18.00 Chairs: *A. Tessitore* (Naples, Italy), *T. van Eimeren* (Cologne, Germany)

- 16.00 **Cholinergic Dysfunction: Molecular Biomarkers**
J. Horsager (Aarhus, Denmark)
- 16.20 **Cholinergic Dysfunction: MRI Biomarkers**
N. Ray (Manchester, UK)
- 16.40 **Serotonergic Dysfunction: Molecular Biomarkers**
N. Pavese (Newcastle, UK)
- 17.00 **Discussion** (*Chairs and Speakers*)
- 18.00 **Closing Remarks End of 1st Day**
R. Cilia (Milan, Italy), *T. van Eimeren* (Cologne, Germany)

08.45 **Welcome**
R. Cilia (Milan, Italy), *T. van Eimeren* (Cologne, Germany)

SESSION 3 IMAGING BRAIN PATHOLOGY

09.00-10.20 ***Chairs:*** *A.S. Del Sole* (Milan, Italy), *A.P. Strafella* (Toronto, Canada)

9.00 **Imaging Alpha-synuclein Pathology**
H. Endo (Chiba, Japan)

9.20 **Imaging Tau Pathology**
T. van Eimeren (Cologne, Germany)

9.40 **Imaging Amyloid and Copathology**
A.S. Del Sole (Milan, Italy)

10.00 **Imaging Neuroinflammation**
A.P. Strafella (Toronto, Canada)

10.20 **Coffee Break**

SESSION 4 IMAGING PARKINSON'S DISEASE PROGRESSION AND ATYPICAL PARKINSONISMS

10.40-13.00 ***Chairs:*** *R. Eleopra* (Milan, Italy), *I. Rektorova* (Brno, Czech Republic)

10.40 **Imaging Cognitive Impairment**
I. Rektorova (Brno, Czech Republic)

11.00 **Staging Parkinson's Disease: A Network Perspective**
R. De Micco (Naples, Italy)

11.20 **Updates on Neuroimaging Approaches in Deep Brain Stimulation**
M.M. Reich (Würzburg, Germany)

11.40 **Imaging Biomarkers in Atypical Parkinsonian Disorders**
A. Quattrone (Catanzaro, Italy)

12.00 **Discussion** (*Chairs and Speakers*)

13.00 **Lunch**

SESSION 5 FROM BEDSIDE TO BENCH: FOCUS ON PATHOLOGY**14.00-16.00** **Chairs:** *L. Parkkinen* (Oxford, UK), *F. Tagliavini* (Milan, Italy)14.00 **Alpha-Synuclein: New Discoveries and Potential Therapeutic Applications**
T.F. Outeiro (Göttingen, Germany)14.20 **Alpha-Synuclein Seed Amplification Assay: Present and Future**
F. Moda (Milan, Italy)14.40 **Update on the Role Skin Biopsy in the Diagnosis of Parkinsonism**
M. Nolano (Naples, Italy)15.00 **The Role of Copathology in Parkinson's Disease: the Neuropathologist's Perspective** - *L. Parkkinen* (Oxford, UK)15.20 **Discussion** (*Chairs and Speakers*)

16.00 Coffee Break

SESSION 6 TRACKING THE PROGRESSION OF PARKINSON'S DISEASE**16.30-18.30** **Chairs:** *R. Cilia* (Milan, Italy), *T. van Eimeren* (Cologne, Germany)16.30 **Prodromal Stages of Synucleinopathies: Sleep and Glymphatic Dysfunction**
D. Arnaldi (Genoa, Italy)16.50 **The Concept of Motor and Cognitive Reserve vs. Compensation in Neurodegenerative Disorders** - *M. Höning* (Cologne, Germany)17.10 **Management of Parkinson's Disease: Oral and Infusion Pharmacological Approaches** - *V. Leta* (Milan, Italy)17.30 **Management of Parkinson's Disease: Surgical Approaches**
A. Fasano (Milan, Italy)17.50 **Discussion** (*Chairs and Speakers*)18.30 **Closing Remarks**
R. Cilia (Milan, Italy), *T. van Eimeren* (Cologne, Germany)

Meet the Faculty

Speakers

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Dario Arnaldi

DINOGMI, University of Genoa
IRCCS San Martino Polyclinic Hospital
(Genoa, Italy)

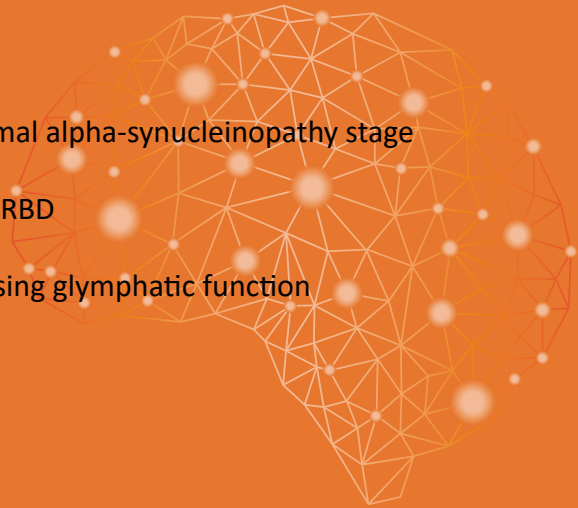
#Prodromal

#Neuroimaging

#Neurodegeneration

Will speak about

- The role of RBD as a prodromal alpha-synucleinopathy stage
- The role of neuroimaging in RBD
- Neuroimaging studies assessing glymphatic function



Instead of Neuroscience/Medicine, what would you be doing?

I would be making a musical actor



Bénédicte Ballanger

Lyon Neuroscience Research Center
(Lyon, France)

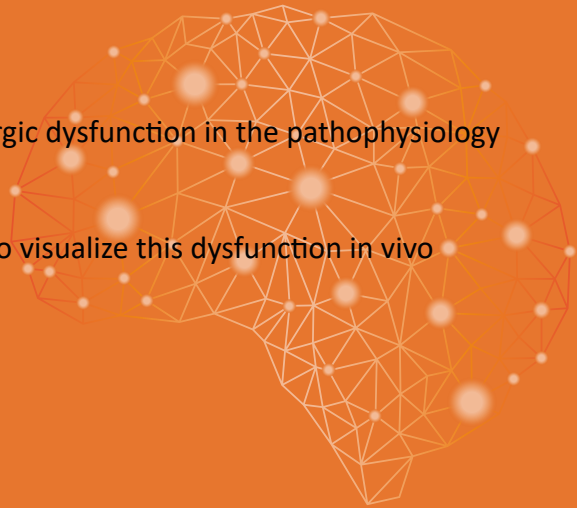
#Noradrenaline

#Neuroimaging

#Parkinson disease

Will speak about

- The relevance of noradrenergic dysfunction in the pathophysiology of Parkinson's disease
- How PET and MRI allow us to visualize this dysfunction in vivo



Instead of Neuroscience/Medicine, what would you be doing?

Who knows...



Roberto Ceravolo

AOU Pisana, University of Pisa
(Pisa, Italy)

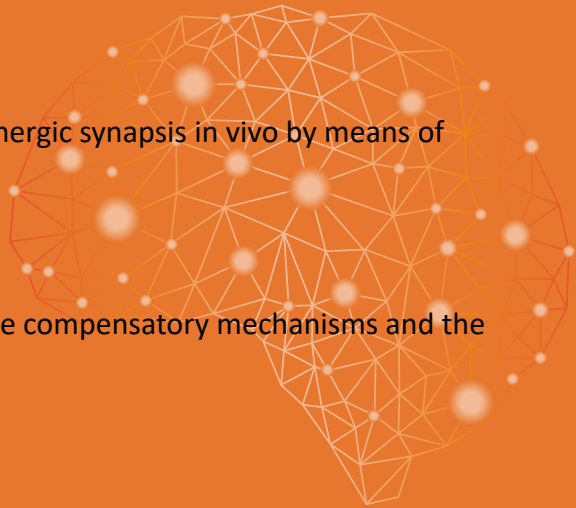
#Neuroimaging

#Dopamine Terminal

#Nuclear Medicine

Will speak about

- The investigation of dopaminergic synapsis in vivo by means of SPECT/PET
- The role in diagnosis
- The role in understanding the compensatory mechanisms and the motor complications



Instead of Neuroscience/Medicine, what would you be doing?

Archeologist



Roberto Cilia

Parkinson & Movement Disorders Unit
National Neurological Institute of Carlo Besta
(Milan, Italy)

#Pathophysiology of PD

#Neuroimaging of movement disorders

#Pharmacological therapy of PD

Will chair the Session:

- Imaging Brain Pathology
- Tracking the progression of Parkinson's disease



Instead of Neuroscience/Medicine, what would you be doing?

Definitely a musician!



Rosa De Micco

Dept. of Advanced Medical and Surgical Sciences
AOU University of Campania Luigi Vanvitelli
(Naples, Italy)

#Neuroimaging

#Connectivity

#Networks

Will speak about

- Recent evidence highlights that PD is a disorder of large-scale brain networks, involving both motor and non-motor domains
- Functional MRI connectivity provides a powerful tool to map how communication between brain regions changes across disease stages. By adopting a network perspective, it becomes possible to better understand disease progression, integrate motor and cognitive symptoms, and move beyond purely region-based models
- This talk will review current neuroimaging evidence on functional connectivity alterations in PD, discuss how they relate to Braak's staging framework, and explore their potential to improve clinical staging and therapeutic strategies

Instead of Neuroscience/Medicine, what would you be doing?

President of the USA



Angelo Del Sole

Dept. of Health Sciences, University of Milan
Italian Diagnostic Centre S.p.A.
(Milan, Italy)

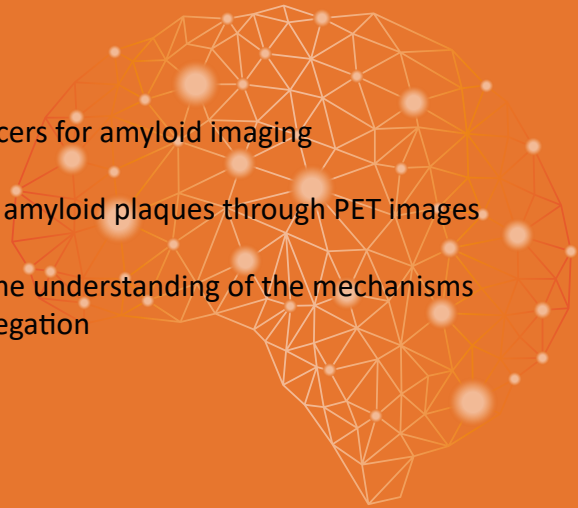
#Neuroimaging

#Positron emission tomography

#Biomarkers

Will speak about

- The development of PET tracers for amyloid imaging
- The role of quantification of amyloid plaques through PET images
- The contribution of PET to the understanding of the mechanisms of pathological protein aggregation



Instead of Neuroscience/Medicine, what would you be doing?

I'd rather go Cross-country skiing

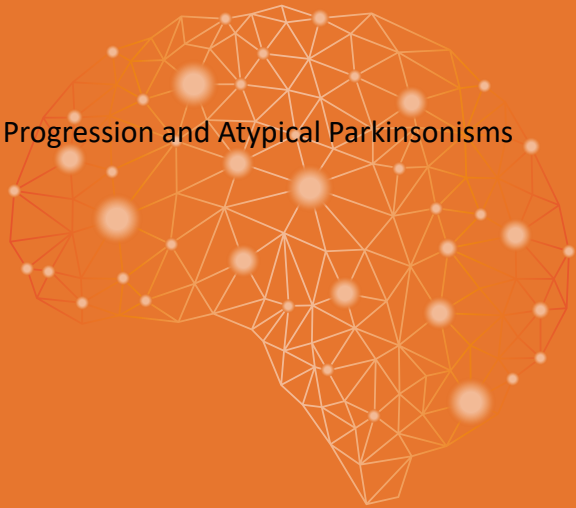


Roberto Eleopra

SC Neurology 1
Parkinson's Disease and Movement Disorders
IRCCS Neurological Institute Foundation
Carlo Besta
(Milan, Italy)

Will chair the Session:

- Imaging Parkinson's Disease Progression and Atypical Parkinsonisms



Instead of Neuroscience/Medicine, what would you be doing?

Theatre (Cabaret)



Hironobu Endo

National Institutes for Quantum Science and
Technology (QST)
(Chiba-shi, Japan)

#Neuroimaging

#AlphaSynuclein

#Imaging biomarkers

Will speak about

- Alpha-synuclein pathology in α -synucleinopathies (PD, DLB, MSA)
- Development of alpha-synuclein PET probes
- Current status for in vivo alpha-synuclein imaging



Instead of Neuroscience/Medicine, what would you be doing?

I imagine I would have aimed to become a professional investor specializing in the life sciences and medical fields



Alfonso Fasano

Toronto Western Hospital, Toronto
Canada & Humanitas University
(Milan, Italy)

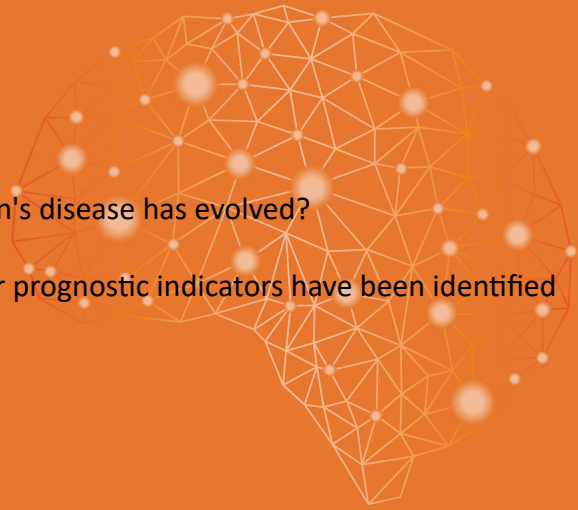
#dbs

#Parkinson

#biomarkers

Will speak about

- What is DBS?
- How treatment for Parkinson's disease has evolved?
- Which biomarkers and other prognostic indicators have been identified so far?



Instead of Neuroscience/Medicine, what would you be doing?

The neomelodic singer



Merle Hönig

Research Center Juelich
Institute for Neuroscience and Medicine II,
Jülich, Germany & University Clinic Cologne,
Dep. of Nuclear Medicine, Cologne, Germany
(Cologne, Germany)

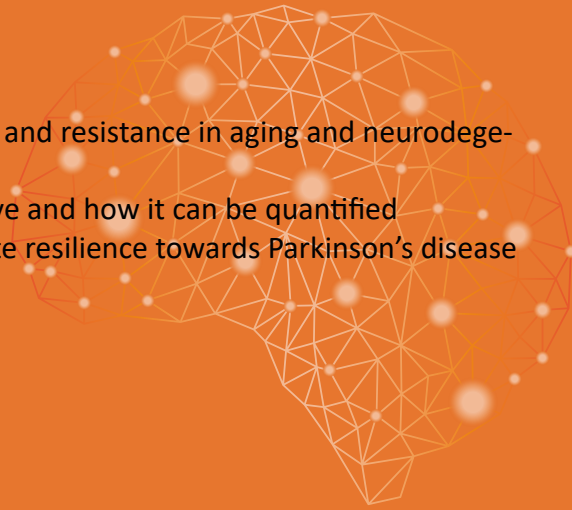
#Lifestyle

#Resilience

#MotorReserve

Will speak about

- The framework of resilience and resistance in aging and neurodegenerative disorders
- The concept of motor reserve and how it can be quantified
- Lifestyle factors that promote resilience towards Parkinson's disease



Instead of Neuroscience/Medicine, what would you be doing?

Pyrotechnician



Jacob Horsager

Dept. of Nuclear Medicine
Aarhus University Hospital, Denmark
Dept. of Clinical Medicine, Aarhus University
(Aarhus, Denmark)

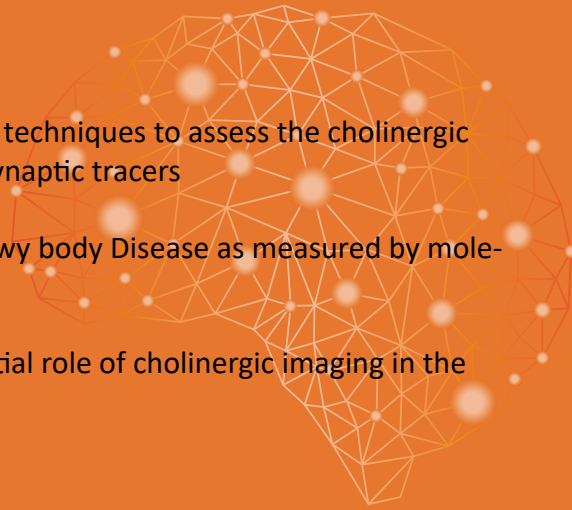
#Neuroimaging

#PET

#Cholinergic

Will speak about

- Different molecular imaging techniques to assess the cholinergic nervous system - focus on synaptic tracers
- Cholinergic alterations in Lewy body Disease as measured by molecular imaging
- Perspectives, i.e., the potential role of cholinergic imaging in the future



Instead of Neuroscience/Medicine, what would you be doing?

Singer-songwriter



Stephane Lehericy

Sorbonne University
Paris Public Hospital System (APHP)
Paris Brain Institute
(Paris, France)

#MRI

#Neuromelanin

#Biomarker

Will speak about

- MRI biomarkers of the substantia nigra
- Neuromelanin-sensitive MRI
- Iron-sensitive MRI



Instead of Neuroscience/Medicine, what would you be doing?

More neuroscience



Valentina Leta

IRCCS Carlo Besta Neurological
Institute Foundation
(Milan Italy)

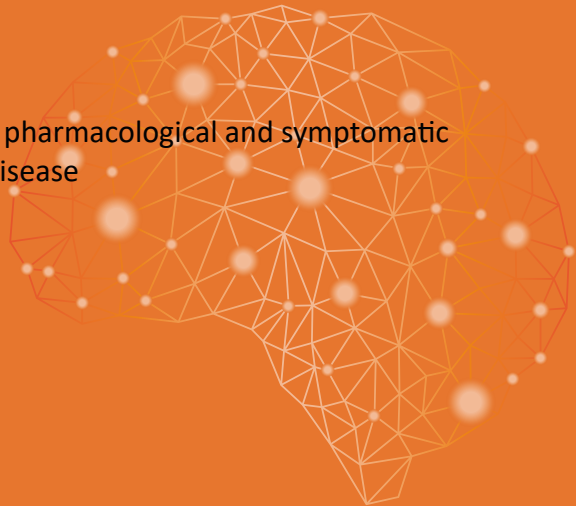
#Parkinson

#Pharmacological treatments

#Updates

Will speak about

- The most recent updates on pharmacological and symptomatic treatments for Parkinson's disease



Instead of Neuroscience/Medicine, what would you be doing?

Musician



Fabio Moda

University of Milan, Dept. of Medical Biotechnology and Translational Medicine
Fondazione IRCCS Istituto Neurologico Carlo Besta, Unit of Laboratory Medicine, Laboratory of Clinical Pathology
(Milan, Italy)

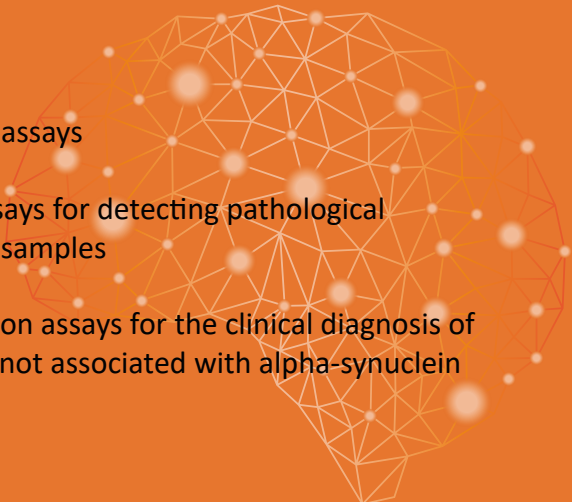
#seedamplificationassay

#aggregation

#alphasynuclein

Will speak about

- What are seed amplification assays
- Use of seed amplification assays for detecting pathological alpha-synuclein in biological samples
- Extension of seed amplification assays for the clinical diagnosis of neurodegenerative diseases not associated with alpha-synuclein



Instead of Neuroscience/Medicine, what would you be doing?

Musician (piano players)



Maria Nolano

University of Naples “Federico II”
Dept. of Neurosciences, Reproductive Sciences
and Odontostomatology
Skin Biopsy Lab, Istituti Clinici Scientifici Maugeri,
IRCCS Institute of Telese Terme
(Naples, Italy)

#Skin biopsy

#Posphorilated AlphaSynuclein

#cutaneous biomarkers

Will speak about

- To assess peripheral sensory and autonomic nerve involvement in parkinsonism
- To identify in vivo biomarkers for the diagnosis of synucleinopathies
- To monitor disease progression and treatment response



Instead of Neuroscience/Medicine, what would you be doing?

Chef. Science in the kitchen, instant gratification!



Tiago F. Outeiro

Dept. of Experimental Neurodegeneration
University Medical Center Göttingen
(Göttingen, Germany)

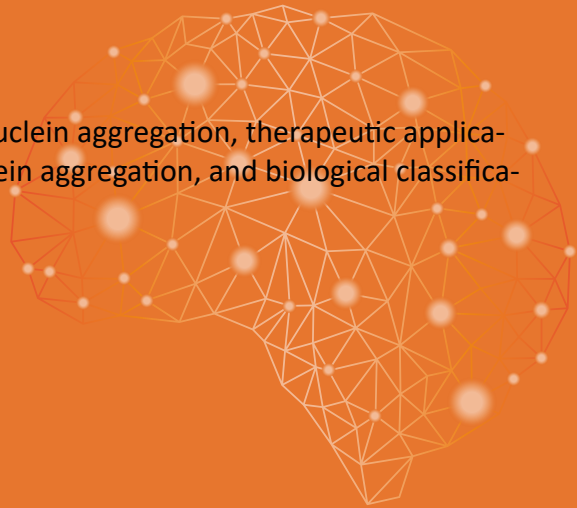
#AlphaSynuclein

#BiologicalClassification

#ProteinAggregation

Will speak about

- I will speak about alpha-synuclein aggregation, therapeutic applications based on alpha-synuclein aggregation, and biological classification of Parkinson's disease



Instead of Neuroscience/Medicine, what would you be doing?

I would be traveling the world and doing photography



Laura Parkkinen

Translational Neuropathology
Oxford Brain Bank
(Oxford, U.K.)

#AlphaSynuclein

#Amyloid

#Tau

#TDP43

#co-pathology

Will speak about

- Co-pathologies associated with Alzheimer's disease (β -amyloid/tau)¹ and
- LATE (TDP43) that often co-exist with classical Lewy pathology (α -synuclein, α -syn) in Parkinson's disease (PD) brains. I will also include neuroinflammation which may also worsen disease progression. Finally, I will focus on α -syn accumulation in PD glial cells, changes that are often overlooked due to lack of appropriate tools

Instead of Neuroscience/Medicine, what would you be doing?

Restaurant critic



Nicola Pavese

Clinical Neuroscience,
Translational and Clinical Research
Institute, Newcastle University
(Newcastle, U.K.)

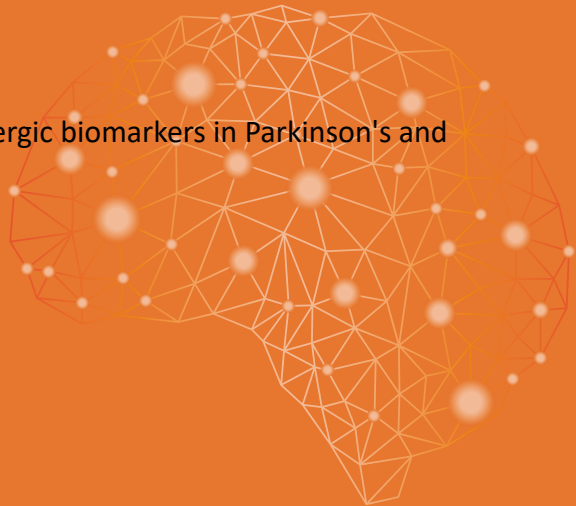
#Neuroimaging

#Serotonin

#biomarkers

Will speak about

- I will speak about serotonergic biomarkers in Parkinson's and prodromal parkinsonisms



Instead of Neuroscience/Medicine, what would you be doing?

Biology



Andrea Quattrone

Institute of Neurology Magna Graecia
University of Catanzaro
(Catanzaro, Italy)

#Neuroimaging

#Biomarkers

#Parkinsonism

Will speak about

- Structural MRI biomarkers to support the differential diagnosis among parkinsonian syndromes, with a focus on PSP. I will cover different biomarkers, from complex measures suitable for research purposes to simple measurements which can be used in routine clinical practice. Finally, I will talk about new insights on disease staging and tracking disease progression using structural MRI in atypical parkinsonism

Instead of Neuroscience/Medicine, what would you be doing?

Food blogger



Nicola Jane Ray

Dept. Neuroscience
Manchester Metropolitan University
(Manchester, U.K.)

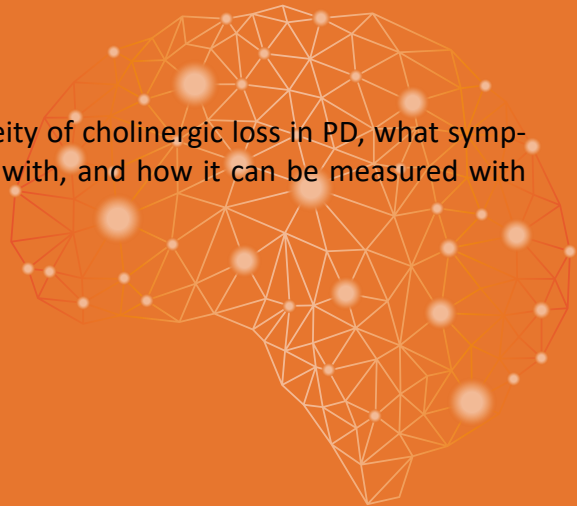
#Cholinergic

#MRI

#biomarkers

Will speak about

- I will discuss the heterogeneity of cholinergic loss in PD, what symptoms this loss is associated with, and how it can be measured with MRI



Instead of Neuroscience/Medicine, what would you be doing?

I'd be a failed artist



Martin M. Reich

Molecular Neuroimaging
University of Würzburg
(Würzburg, Germany)

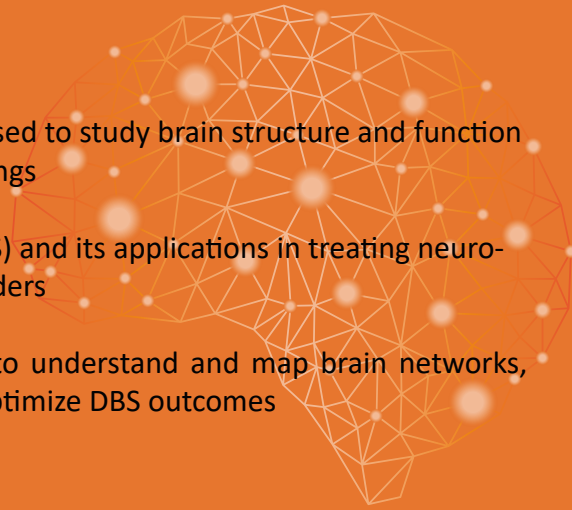
#Neuroimaging

#DBS

#Connectomics

Will speak about

- Neuroimaging techniques used to study brain structure and function in clinical and research settings
- Deep Brain Stimulation (DBS) and its applications in treating neurological and psychiatric disorders
- Connectomics approaches to understand and map brain networks, and how they inform and optimize DBS outcomes



Instead of Neuroscience/Medicine, what would you be doing?

Enjoying Italian food and surfing



Irena Rektorova

Dept. of Neurology, St. Anne University Hospital
Faculty of Medicine and CEITEC
Masaryk University in Brno
(Brno, Czech Republic)

#Neuroimaging, cognitive, MRI

Will speak about

- MRI imaging of cognitive impairment and dementia in PD and DLB. I will show which MRI sequences may be used to depict cholinergic, dopaminergic and noradrenergic neuronal losses associated with cognitive decline. I will also touch upon microstructural changes of various subcortical structures as assessed by free water imaging and how structural T1 weighted imaging and particularly deformation based morphometry can monitor progression of various disease subtypes.

Instead of Neuroscience/Medicine, what would you be doing?

I would have liked to be a musician



Antonio P. Strafella

Division of Neurology, Medicine
University of Toronto
(Toronto, Canada)

#Neuroimaging

#Parkinson

#Biomarkers

Will speak about

- The role of PET in quantifying neuroinflammation
- Its current limitations
- Recent development



Instead of Neuroscience/Medicine, what would you be doing?

Being an astronaut



Fabrizio Tagliavini

IRCCS Neurological Institute Foundation
Carlo Besta
(Milan, Italy)

Will chair the Session:

- From bedside to bench: focus on pathology



Instead of Neuroscience/Medicine, what would you be doing?

Musician

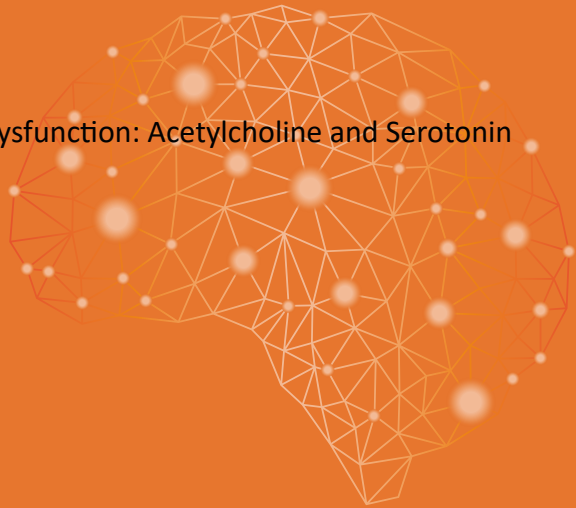


Alessandro Tessitore

UOC I Neurology and Physiopathology
AOU - University of Campania "L. Vanvitelli"
(Naples, Italy)

Will chair the Session:

- Imaging Neurotransmitter Dysfunction: Acetylcholine and Serotonin



Instead of Neuroscience/Medicine, what would you be doing?

Communications and marketing sector



Thilo van Eimeren

Dept. of Nuclear Medicine
& Dept. of Neurology, University of Cologne
(Cologne, Germany)

#Neuroimaging

#Parkinson

#PSP

Will speak about

- Tau PET, 4R-Tauopathies, AD-copathology



Instead of Neuroscience/Medicine, what would you be doing?

Be miserable as a marketing guru

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Note



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