Beyond the Symptom: The Biology of Fatigue
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Neuroimaging: PET, fMRI, MRS

Jarred Younger, PhD
University of Alabama at Birmingham
Disclaimer
This certifies that the views expressed in this presentation are those of the author and do not reflect the official policy of the NIH.

Disclosure
This certifies that I, Jarred Younger, have no financial relationship that is relevant to the subject matter of this presentation.
Translating basic science fatigue research to humans using neuroimaging
Positron Emission Tomography (PET) – using radioligands

PET showing microglia pro-inflammatory “activation” in multiple sclerosis (MS) fatigue.

Microglia activation in MS group with significant fatigue versus MS without fatigue and healthy controls.

Singhal et al., 2020, Neurol Neuroimmunol Neuroinflamm
Using PET to image hypometabolism in individuals with Long-COVID.

Guedj et al., 2021, Eur J Nucl Mol Imaging
Positron Emission Tomography (PET) – using radiolabeled cells

Leukocytes infiltrating the brain.

Edlow et al., 2018, Journal of Neurotrauma
Magnetic Resonance Spectroscopy (MRS)

Metabolites available for MRS measurement.

Kousi et al., 2012, Proton Magnetic Resonance Spectroscopy of the Central Nervous System
Magnetic Resonance Spectroscopy (MRS) – whole brain

Whole-brain choline in healthy and ME/CFS groups.

Whole-brain temperature in a single participant.
Magnetic Resonance Spectroscopy (MRS) – expanding the analyte list

Measuring glutamate, glutamine, and GABA from MRS.

Strasser et al., 2018, bioRxiv
Magnetic Resonance Spectroscopy (MRS) – expanding the analyte list

New metabolites available when switching to phosphorus-tuned receiving coil.

Das et al., 2020, Frontiers in Aging Neuroscience
Functional Magnetic Resonance Imaging (fMRI)

Romantic love reduces pain via the nucleus accumbens.
Increased connectivity between medial prefrontal cortex and left insula is associated with fatigue in ankylosing spondylitis patients.

Default mode network (DMN) and salience network (SN).

Chen et al., 2020, Diagnostics

Van Ettinger-Vennstra et al., 2019, Journal of Pain Research
Diffusion Tensor Imaging (DTI)

DTI tractography in traumatic brain injury patient and healthy control.

Edlow et al., 2018, Journal of Neurotrauma
Diffusion Tensor Imaging (DTI) – the connectome

https://en.wikipedia.org/wiki/Connectogram
Other uses of MRI – e.g., Arterial Spin Labeling (ASL)

Prescribing ASL for cerebral perfusion in pediatric patient.  
Proisy et al., 2016, AJNR Am J Neuroradiol

Hyperperfusion in single patient with sudden seizures, before and after anti-epileptic treatment.  
Yamamoto et al., 2018, Acute Medicine & Surgery
And many others . . .

Electroencephalogram (EEG)
Functional Near-Infrared Spectroscopy (fNIRS)
Intracortical Neuron Recording (iEEG)
Magnetoencephalography (MEG)
Computed Tomography (CT-Head/CT-Brain)
Pharmacologic MRI (phMRI)
Single Photon-Emission Computed Tomography (SPECT)