**Research question**: How do auditory deviant tones and standard tones differ in evoked responses (MMN) and induced oscillatory power?

**Data**: An auditory event-related MEG dataset from the Montreal Neurological Institute.

* The experiment presents a series of tones: most are standard (440 Hz), and some are deviant (554 Hz, four semitones higher).
* When people hear these deviant tones, their brains automatically generate a response known as Mismatch Negativity (MMN), which is a negative deflection in the auditory evoked field that occurs around 100 to 200 ms after the sound.
* It reflects the brain’s detection of a “prediction error,” when something unexpected happens in a repeating sequence.

**Project goal**:

* Learn how to process, analyze, and visualize MEG data using the MNE-Python library.
* Learn how to analyse time–frequency decomposition using Morlet wavelets.

**Method**:

* Follow the MNE tutorial on the preprocessing of MEG data to gain an idea about the general layout of the dataset
  + loading the data
  + filtering and artifact rejection
  + epoching for standard and deviant tones
  + averaging to produce evoked responses (ERFs)
  + visualizing and quantifying the MMN effect (the difference wave between deviant and standard)
* Examine induced oscillatory power in theta (4-8 Hz) and gamma (30-40 Hz) bands
  + MMN is a type of evoked response that shows *phase-locked* brain activity. Every time the tone is played, neurons fire in roughly the same time pattern. The response shows up when averaging across the trials.
  + Non–phase-locked activity contains rhythmic fluctuations that don’t line up perfectly across trials. They carry important information about attention, prediction, and sensory processing but disappear when averaging the trials in the usual ERF.
  + Time–frequency analysis is a method that looks at how power in different frequency bands (e.g., theta, alpha, beta, gamma) changes over time relative to the event.
  + In auditory MMN research, theta (4–8 Hz) power often increases around 100–300 ms after deviant tones, which is linked to attention reorientation and mismatch detection. Gamma (30–40 Hz) power sometimes rises later and is associated with integrating prediction errors or higher-level processing of the deviant.
  + Computing time-frequency maps:
    - Comparing differences between deviant tones and standard tones
    - Visualising by plots of scalp topographies (which sensors, what time, what frequency)