The motivation, limitations, problems and solutions of combined MR and EEG or Optical imaging or PET data acquisitions and radiotherapy

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An increasing interest in simultaneous multimodal data acquisitions of human data is matched by technical developments that make an increasing number of combinations possible. We will start by reviewing the motivations for this general approach to data acquisition with example problems that it can help address, taken from various areas of biomedicine.

We will show how important or necessary simultaneous acquisitions are as a function of the type of scientific question to be addressed or the benefits of simultaneous acquisitions compared to other fusion solutions for data acquired in separate, mono-modality acquisitions, such as post-hoc image data co-registration.

We will then review the specific technical and logistical challenges and solutions for each of the following combinations: EEG-fMRI, Optical imaging-MR, PET-MR and MRI-guided radiation therapy. We will explain the physical principles behind interactions between the combined instruments and possible consequences for patient safety and data quality. Emphasis will be put on the impact of the integration on MR image quality, although data quality for the companion modality will also be discussed. We will describe some of the modifications, adjustments and compromises that may be made to allow simultaneous acquisitions with special focus on the MR RF transmit and receive systems. We will describe how in some circumstances one of the two instruments is adapted to the environment of the other without modification of the latter. We will address this issue of quantifying the data quality cost of fusion.

We will show examples of experimental data obtained using the combined instruments.

**Aim:**

The student should be able to describe the motivations, benefits, challenges and solutions for combining human imaging modalities with MRI.

**Objectives:**

1. Can describe valid reasons for wanting to combine MRI with other imaging or treatment instruments.

2. Can describe the interactions between the instruments being combined and the specific technical challenges associated with combining MRI with EEG, PET, Optical imaging and radiotherapy.

3. Can describe the impact of the combined instruments on MR image quality and methods used to quantify image quality.

4. Can describe representative applications of multimodal imaging with MRI.