BIDS extension, from a quantitative MRI perspective

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Declaration of Financial Interests or Relationships

Speaker Name: Mathieu Boudreau

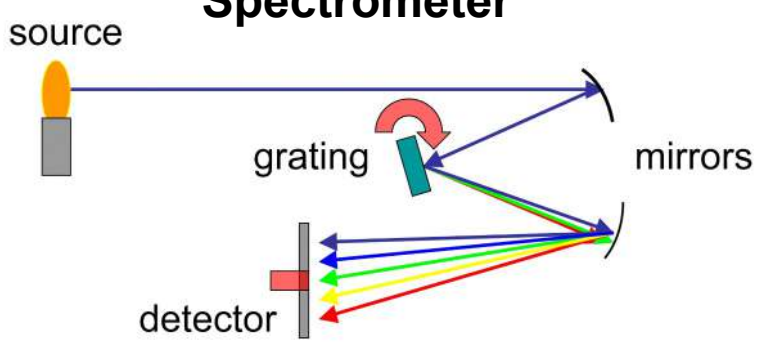
I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

What is Quantitative MRI?

Quantitative MRI aims at converting the MRI machine into a scientific measurement instrument.

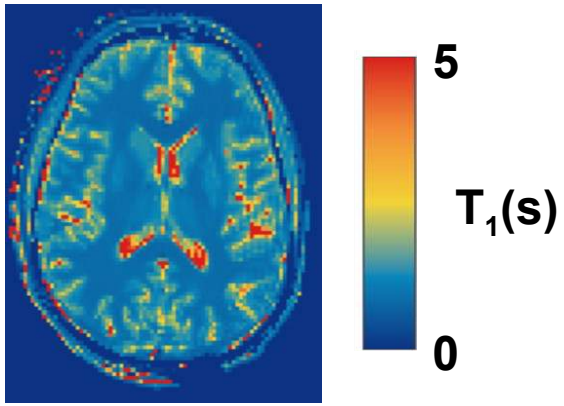
Camera

Spectrometer



MR image

T_1 map



Partial list of quantitative MRI applications

Field Properties	**Relaxometry**	**Diffusion**	**Flow/Perfusion**	**Exchange**	**Hyperpolarized MRI**	**Electromagnetic properties**	**Physical properties**
B_0 field B_1 field Gradient field	T_1 T_2 T_2^* $T_{1,\rho}$ PD	Fiber orientation Fiber tractography Fiber properties e.g. - axon degeneration - demyelination - g-ratio	Dynamic Contrast Enhancement Arterial Spin Labelling Cerebral Blood Flow Quantitative fMRI / calibrated BOLD	MRS/Chemical shift imaging **Magnetization transfer** Chemical Exchange Saturation Transfer Nuclear Overhauser Effect	Pulmonary ventilation Partial pressure of Oxygen Gas transfer Diffusion (alveoli morphometry) Metabolism	Susceptibility Conductivity Permittivity Spectral Absorption Rate	Temperature pH Elasticity

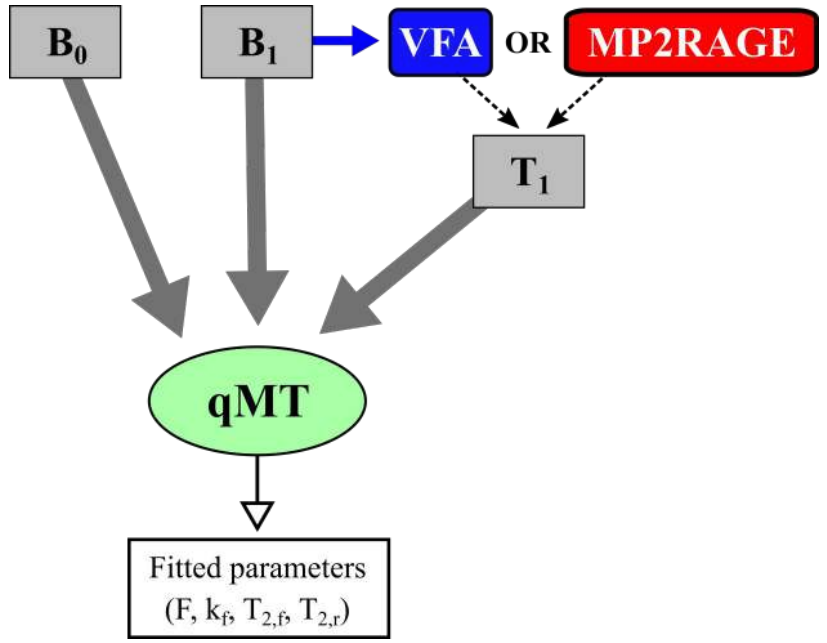
...and then within a single method (e.g. magnetization transfer)

Differences in … **specificity**	… in **pulse sequences**	… in **fitting models**	… in **other required maps**
MTR MTsat ihMT **qMT**	**SPGR** bSSFP Selective inversion recovery	**Sled & Pike** Ramani Yarnykh	B_0 B_1 T_1

Common characteristics of qMRI methods

Often used for small studies (~1-20 subjects)

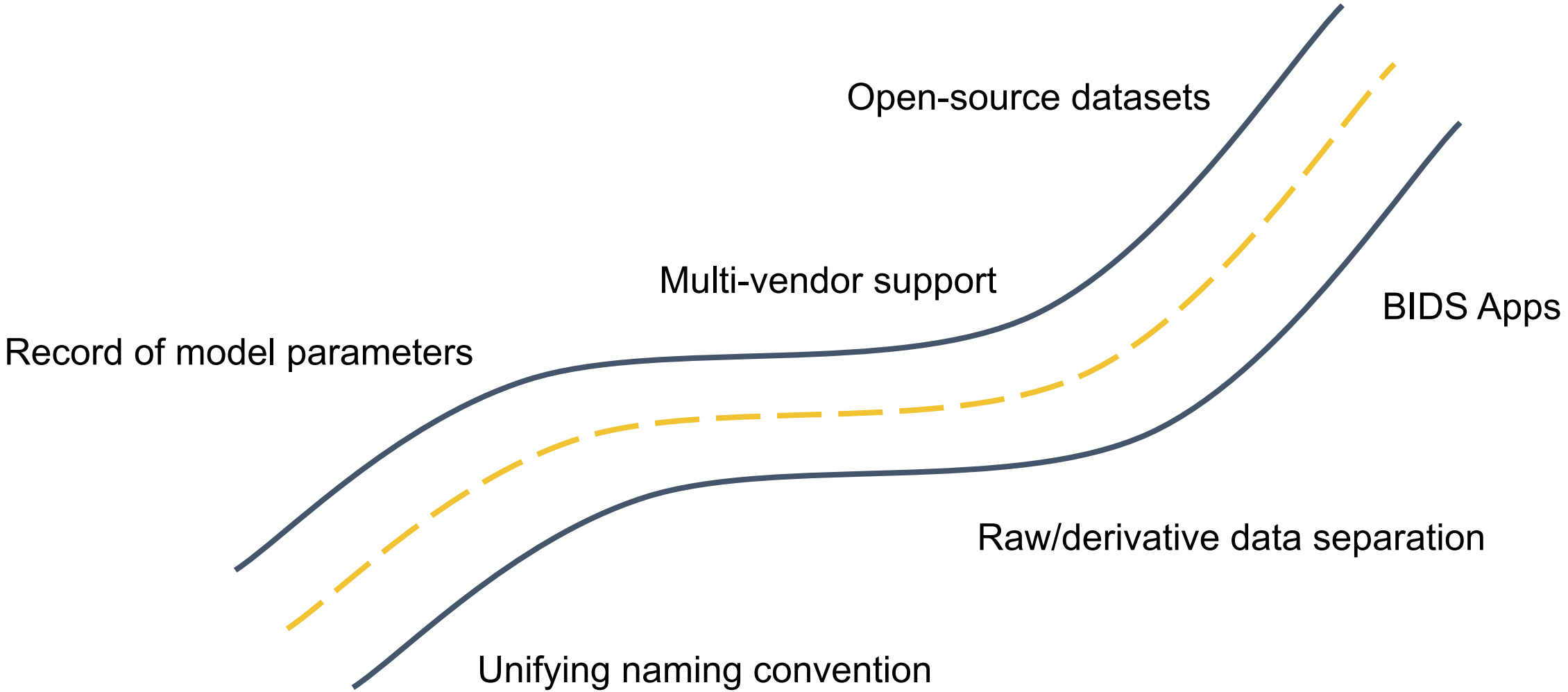
Many depend on other qMRI maps



Most of them acquire several contrasts to fit a mathematical model

Falls within the scope of **BIDS Extension Proposal 001 (BEP001)**

Advantages of BIDS & qMRI
Road to standardization



Advantages of BIDS & qMRI
Potential for BIDS apps

Will encourage people to **reuse** or **share** qMRI code already available

Will encourage **standardization** and improve **reproducibility**

Several open-source qMRI software packages have already expressed an interest in BIDS

hMRI

github.molgen.mpg.de/hMRI-group/Toolbox

qMR Lab
Quantitative MRI. Under one umbrella.

www.qmrlab.org

QUANTITATIVE IMAGING TOOLS

github.com/spinicist/QUIT

Potential challenges of BIDS, from a qMRI perspective

BIDS's "dibs" system

BIDS naming conventions guarantees retrocompatibility: early adopters rewarded.

Example: BIDS was first developed by/for fMRI users, leading to this definition of TR in the BIDS specification:

> Required fields:
>
> - `RepetitionTime`: The time in seconds between the beginning of an acquisition of one volume and the beginning of acquisition of the volume following it (TR).

Result: Mismatch between BIDS and literature naming conventions

Example: BEP001 proposed additional parameters.

> Here we adjust the definition of `RepetitionTime` in section 8.3.3 and add `RepetitionTimeExcitation` and `RepetitionTimeInversion` as two additional terms

Potential challenges of BIDS, from a qMRI perspective

qMRI-related BIDS efforts are scattered

Folder structure and (BIDS extension proposals groups)

subject/ → “raw data”

- anat/ → T_1, T_2, T_2*, PD, MT, QSM (BEP001)
- func/
- dwi/ → diffusion (BIDS v.1.0, BEP016)
- fmap/ → B_0 (BIDS v.1.0), B_1^+ and B_1^- (BEP001)
- swi/ → susceptibility weighted images (BEP004)

Potential challenges of BIDS, from a qMRI perspective

Finding a balance clarity and flexibility

Case 1

```
source/
   sub-01/
        anat/
          sub-01_FLASH.json
          sub-01_fa-1_FLASH.nii.gz
          sub-01_fa-1_FLASH.json
          sub-01_fa-2_FLASH.nii.gz
          sub-01_fa-2_FLASH.json
deriv/
   sub-01/
          sub-01_T1map.nii.gz
          sub-01_T1map.json
```

sub-01_FLASH.json

```
{"RepetitionTimeExcitation": 0.015
 "PulseSequenceDetails": Standard Siemens a_gre sequence
distributed with the VB17 software with an added VFA-
optimized spoiler gradient. Sequence written by Mathieu
Boudreau using a version compiled on 2018/10/04.}
```

sub-01_fa-1_FLASH.json

```
{"FlipAngle": 3}
```

sub-01_fa-2_FLASH.json

```
{"FlipAngle": 20}
```

Potential challenges of BIDS, from a qMRI perspective
Finding a balance clarity and flexibility

Case 1

```
source/
   sub-01/
        anat/
          sub-01_FLASH.json
          sub-01_fa-1_FLASH.nii.gz
          sub-01_fa-1_FLASH.json
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          sub-01_fa-2_FLASH.json
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```

sub-01_fa-1_FLASH.json

```
{"FlipAngle": 3}
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sub-01_fa-2_FLASH.json

```
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```

Case 2

```
source/
   sub-01/
        anat/
          sub-01_VFA.json
          sub-01_fa-1_VFA.nii.gz
          sub-01_fa-1_VFA.json
          sub-01_fa-2_VFA.nii.gz
          sub-01_fa-2_VFA.json
deriv/
   sub-01/
          sub-01_T1map_VFA.nii.gz
          sub-01_T1map_VFA.json
```

sub-01_VFA.json

```
{"RepetitionTimeExcitation": 0.015,
 "PulseSequenceDetails": Standard Siemens a_gre sequence distributed with the VB17 software.}
```

sub-01_fa-1_VFA.json

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sub-01_fa-2_VFA.json

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```

Open question: How to resolves these concerns?

Get a broader involvement from the ISMRM community

Bids Extension Proposal 001: https://tinyurl.com/ycl7tses

INCF2018 BIDS meeting discussion : https://tinyurl.com/ybhcyd8d

Leads: Agah Karakuzu and Prof. Ali Khan

Table of qMRI techniques compatible with stock-sequences: https://tinyurl.com/yc24zazb

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www.qmrlab.org

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