Common Artifacts in MRI

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Outline

1. Hardware artifacts, i.e. $B_0$, $B_1$, etc.

2. Reconstruction artifacts

3. Patient/sample artifacts

4. Misc. / grab-bag
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1. Hardware artifacts, i.e. $B_0$, $B_1$, etc.

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Hardware imperfections
Hardware imperfections

- Distortions usually come from $B_0$ or gradient issues.
Hardware imperfections

- Distortions usually come from $B_0$ or gradient issues.

- Image shading/intensity problems usually come from $B_1$ issues.
Distortion issues

\[ \omega_0 = \gamma B_0 \]
Distortion issues

Larmor equation ⇒
Distortion issues

Larmor equation ⇒

$$\omega_0 = \gamma B_0$$
Geometric distortion - Extreme example
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Geometric distortion - Extreme example
More common, less extreme, distortion examples
More common, less extreme, distortion examples
More common, less extreme, distortion examples
More common, less extreme, distortion examples
More common, less extreme, distortion examples
More common, less extreme, distortion examples
More common, less extreme, distortion examples
Even more subtle distortion issues
Even more subtle distortion issues
Even more subtle distortion issues
Even more subtle distortion issues
Even more subtle distortion issues
Even more subtle distortion issues
Even more subtle distortion issues
Even more subtle distortion issues
Very exotic, very troublesome, distortion issue
Very exotic, very troublesome, distortion issue

Data provided by J. Sarlls
Very exotic, very troublesome, distortion issue

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Very exotic, very troublesome, distortion issue

Data provided by J. Sarlls
Very exotic, very troublesome, distortion issue
Issues with image intensity, shading, noise
Issues with image intensity, shading, noise

Problems with image intensity variation, noise, etc
Issues with image intensity, shading, noise

Problems with image intensity variation, noise, etc

⇒ problems along the RF chain
Issues with image intensity, shading, noise

Problems with image intensity variation, noise, etc

⇒ problems along the RF chain

⇒ limitations imposed by physics (geometry, sensitivity).

e.g. RF Coils, RF amplifiers, etc.
Failing hardware - single-channel coil
Failing hardware - single-channel coil
Failing hardware - single-channel coil
Failing hardware - multi-channel array coils
Failing hardware - multi-channel array coils
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Coil Sensitivity
Dielectric Effects / a.k.a. $B_1$ Inhomogeneities
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Accelerated Reconstruction artifacts
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Accelerated Reconstruction artifacts
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Error combining data
Error combining data
Error combining data
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Patient/sample artifacts

Probably hardest class of artifacts to deal with.

Ethical responsibility toward your patients, volunteers, and animals.

Experimental validity - not supposed to change the state of the thing you are measuring.
Patient/sample artifacts

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- Ethical responsibility toward your patients, volunteers, and animals.
Patient/sample artifacts

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- Ethical responsibility toward your patients, volunteers, and animals.
- Experimental validity - not supposed to change the state of the thing you are measuring.
B_0 uniformity
B₀ uniformity

Basic premise of MRI - VERY uniform magnetic field, distorted in a controlled fashion to provide spatial information.
Basic premise of MRI - *VERY* uniform magnetic field, distorted in a controlled fashion to provide spatial information.

⇒ Have to revise this assumption when imaging.
B₀ uniformity in the human brain
B₀ uniformity in the human brain
$B_0$ uniformity in the human brain
$B_0$ uniformity in the human brain
$B_0$ uniformity in the human brain
$B_0$ uniformity in the human brain
Different tissue types, namely fat
Different tissue types, namely fat
Different tissue types, namely fat
FIG. 3.  a: Correlation between the phase of one voxel (diamonds) and the (scaled) respiratory signal (solid line), both of which were filtered between 0.11 and 0.49 Hz, for 1 min of data. b: Location of the voxel used for the plot in a, indicated on a slice from the first EPI volume in the series.
Motion
Motion
Motion
Motion

[Image of a circular object with a crosshair and waveforms]

Vinai R. (FMRIF/NIMH/NIH/DHHS)  MR Artifacts  2015.06.19
Motion
Motion
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EPI Nyquist Ghosting
EPI Nyquist Ghosting
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Saturation effects
Saturation effects
Saturation effects
Saturation effects
Saturation effects
Pop-quiz

How to differentiate fat shift artifact from Nyquist ghost shift?
Pop-quiz

- How to differentiate fat shift artifact from Nyquist ghost shift?
Pop-quiz
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