Physiological recording in the scanner

Neuroimaging methods workshop
6-23-2011
application of psychophysiological measures

data acquisition and extraction

data analysis demo
Applications

- independent measure of task performance
- orienting heart rate deceleration: attention and cognitive load
- GSR: arousal
- phasic vagal activity: emotion regulation effort
- cortical modulation of autonomic activity
- physiological ‘noise’ reduction
sources of physiologic noise
Periodic motion

- Respiration cycle
- Bulk motion of the head
- Fluctuation in static magnetic field
- Pulsation of the heart
- Fluctuations in blood flow and cerebrospinal fluid flow
Image-based Retrospective correction (RETROICOR, Glover et al., 2000)
Physiological effects

- Respiration volume
  - fluctuation of arterial level of CO$_2$
  - contributes to low frequency variation in BOLD

- Heart rate
  - may affect blood flow, oxygenation and volume, exact mechanism unclear
Respiration response function

(Birn et al., 2008)
Cardiac response function

(Chang et al., 2009)
Choice of measurements

- Electrocardiogram (ECG)
  - very accurate cardiac phase information
  - easily corrupted by MR noise
- Respiration belt
  - proximation of respiration volume
- Pulse oximetry
  - direct assessment of changes in global blood oxygenation
Pulse oximetry signal reflects both cardiac and respiration components of blood oxygenation modulation. 

may use filtered PO signal or raw PO signal to replace ECG and respiration belt measures (Verstynen et al., 2011)
data acquisition -- hardware

Biopac MP 150

MR compatible electrodes and cables
data acquisition -- software

- Acqknowledge
- Sampling rate: >4k Hz
- Data can be saved as .mat or .txt file
synchronization with scanner

- Biopac records analog input via audio jacks
- TTL pulse
  - PC: data acquisition toolbox
  - Mac: psychotoolbox, daq
- beeping sound
Calibration and Data quality control

- **Respiration belt (respitrace)**
  - Relative scale: max. inhale (100%) & exhale (0%)

- **Heart rate**
  - Normal range of heart rate: 60 ± 10 bpm
Demo:

1. data extraction

2. construct data structure with raw data and timing information

3. input data to PhLEM toolbox and construct structure with analyzed event and phase information

https://sites.google.com/site/phlemtoolbox/Home/instructional-wiki

4. generate physiological regressors
a few notes on RETROICOR

- The implementation of RETROICOR in PhLEM toolbox is not exactly the same as Glover paper. It will be added soon.

- order of RETROICOR and other preprocessing steps may make a difference (Jones et al., 2008)

- could also model the interaction between respiration and heart beat (Harvey et al., 2008)
hard to tell which method is best

have fun playing with them!