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

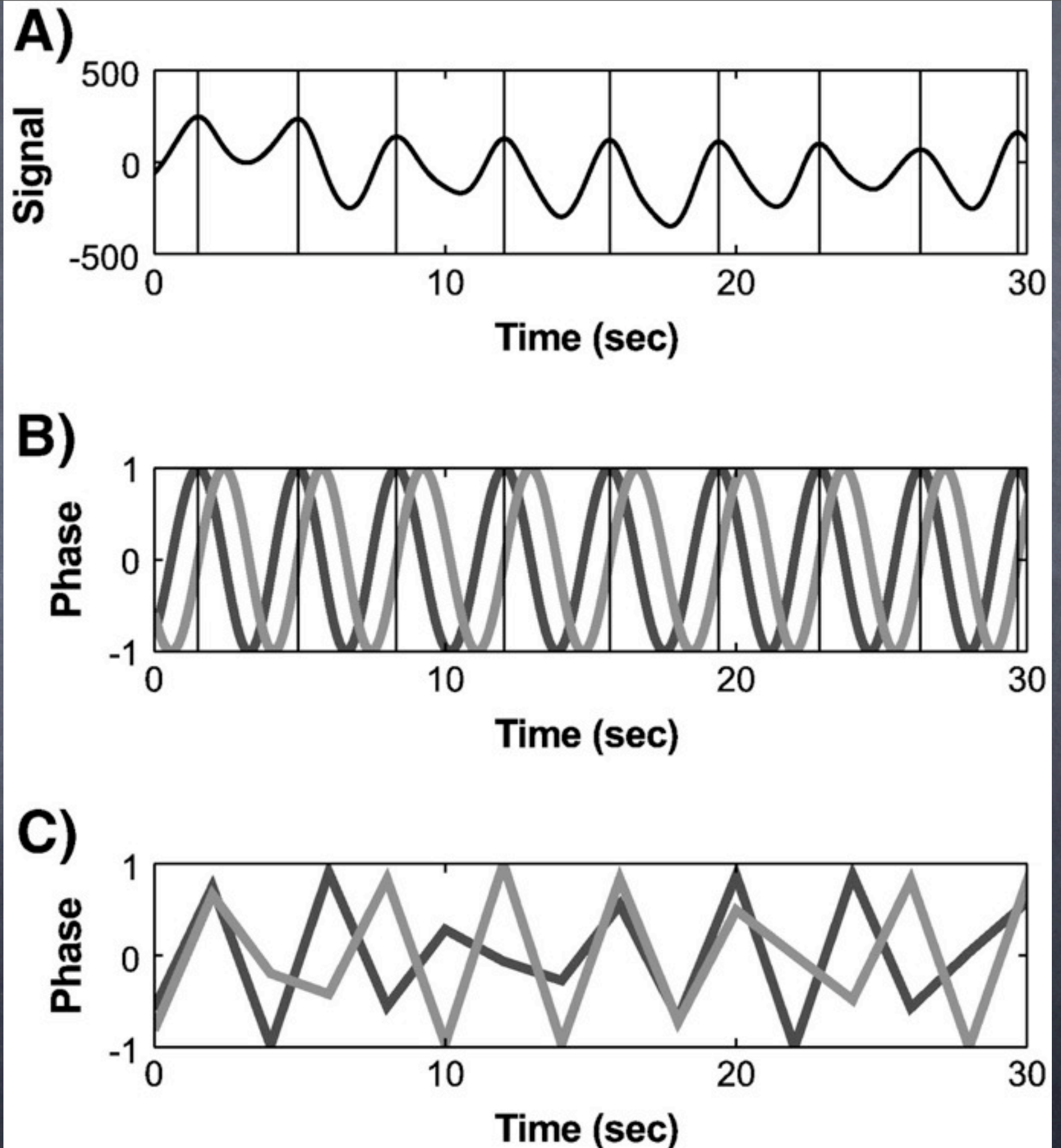sources of physiolocial noise

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
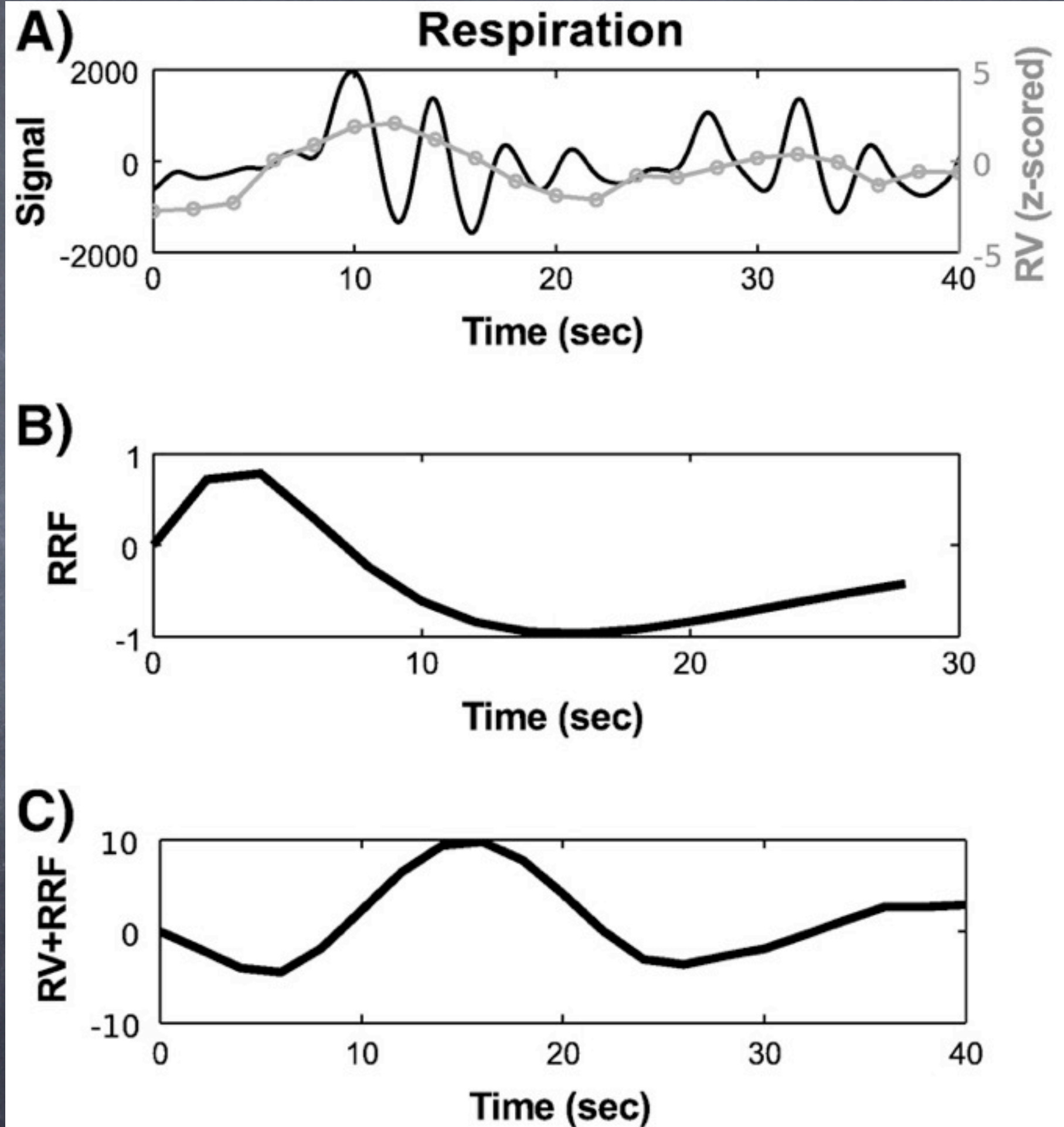
(RETROICOR, Glover et al., 2000)

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
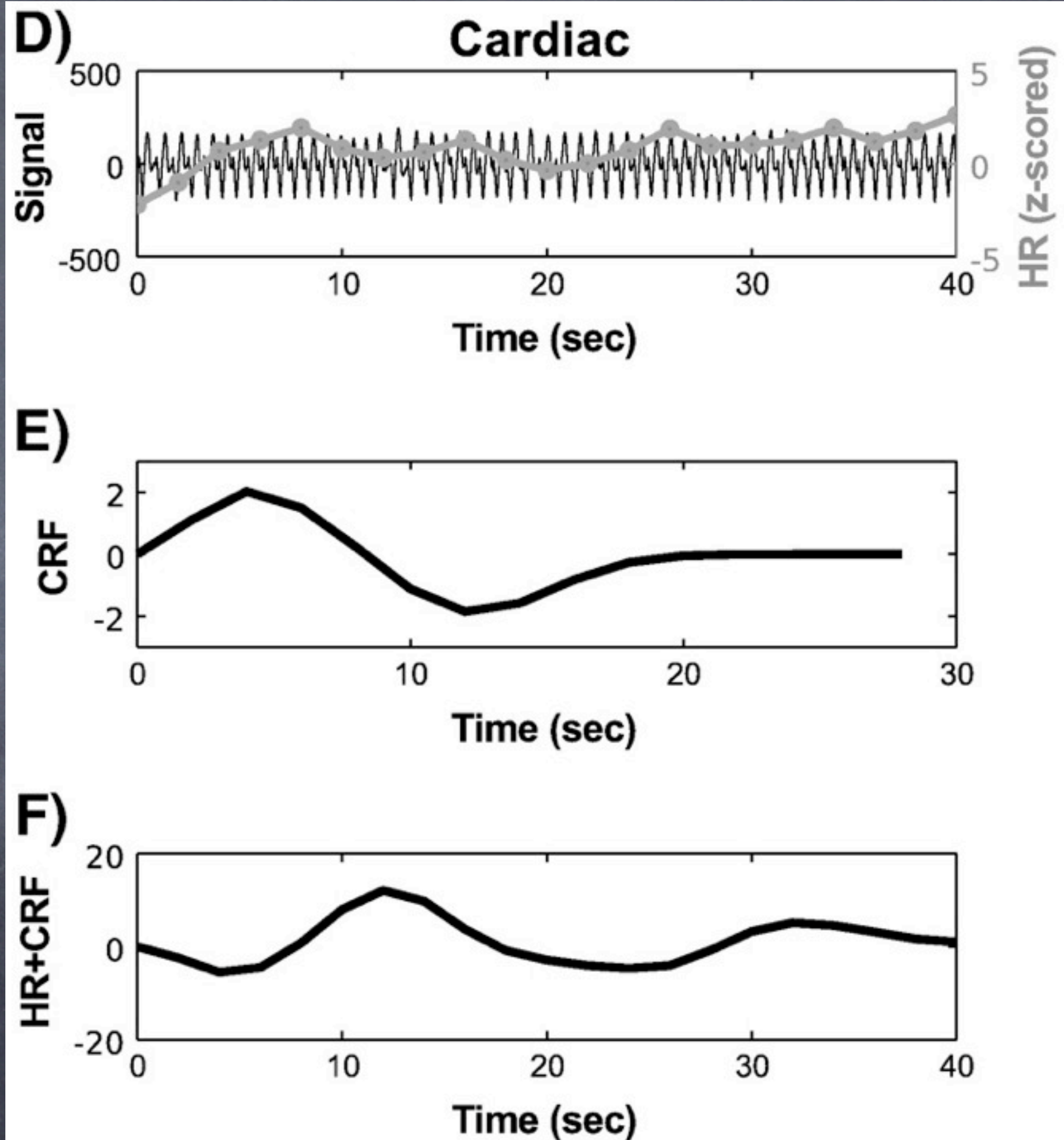
Respiration response function

(Birn et al., 2008)

Cardiac response function

(Chang et al., 2009)

Choice of measurements

- Electrocardiogram (ECG)

  - very accurate cardiac phase information

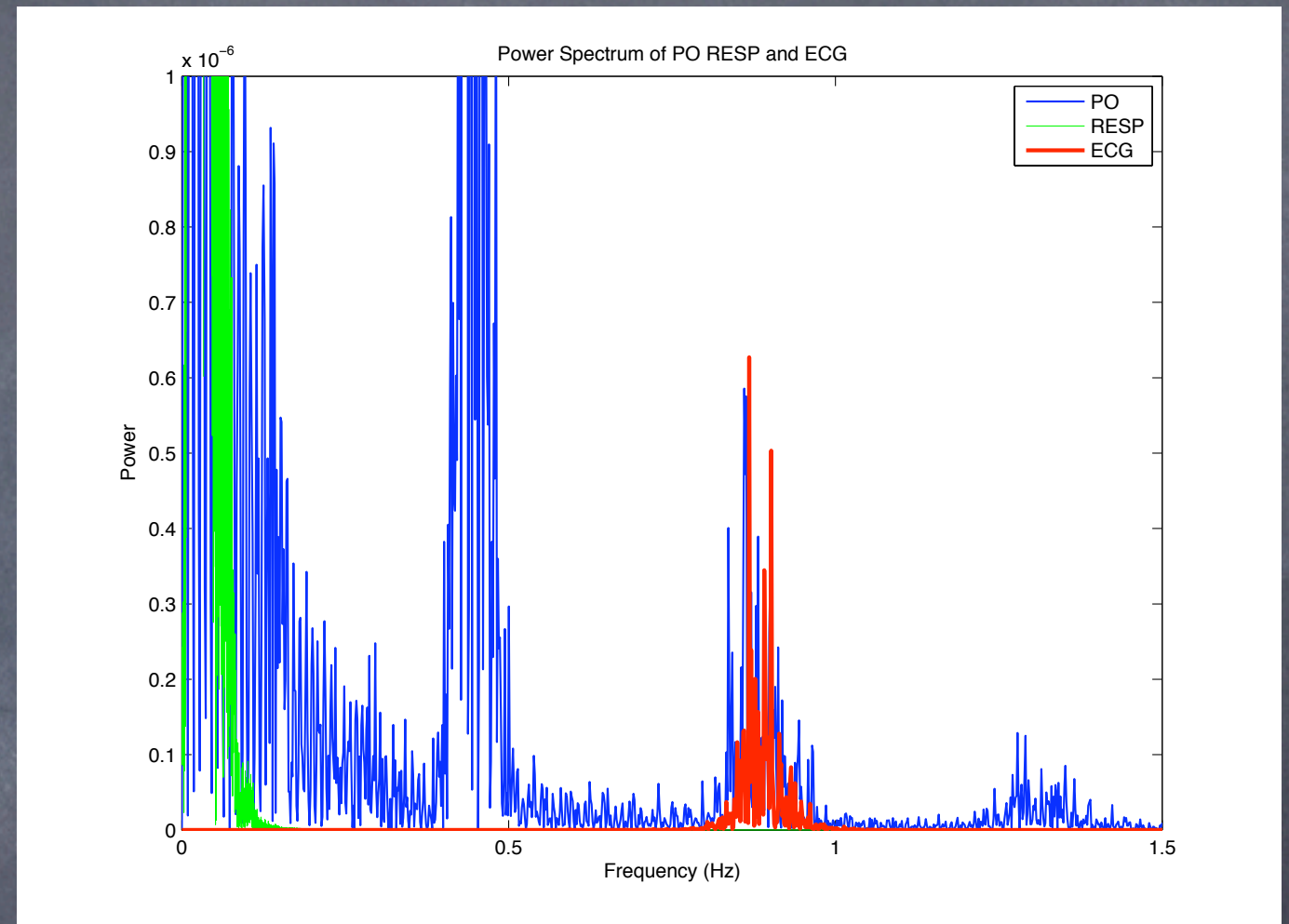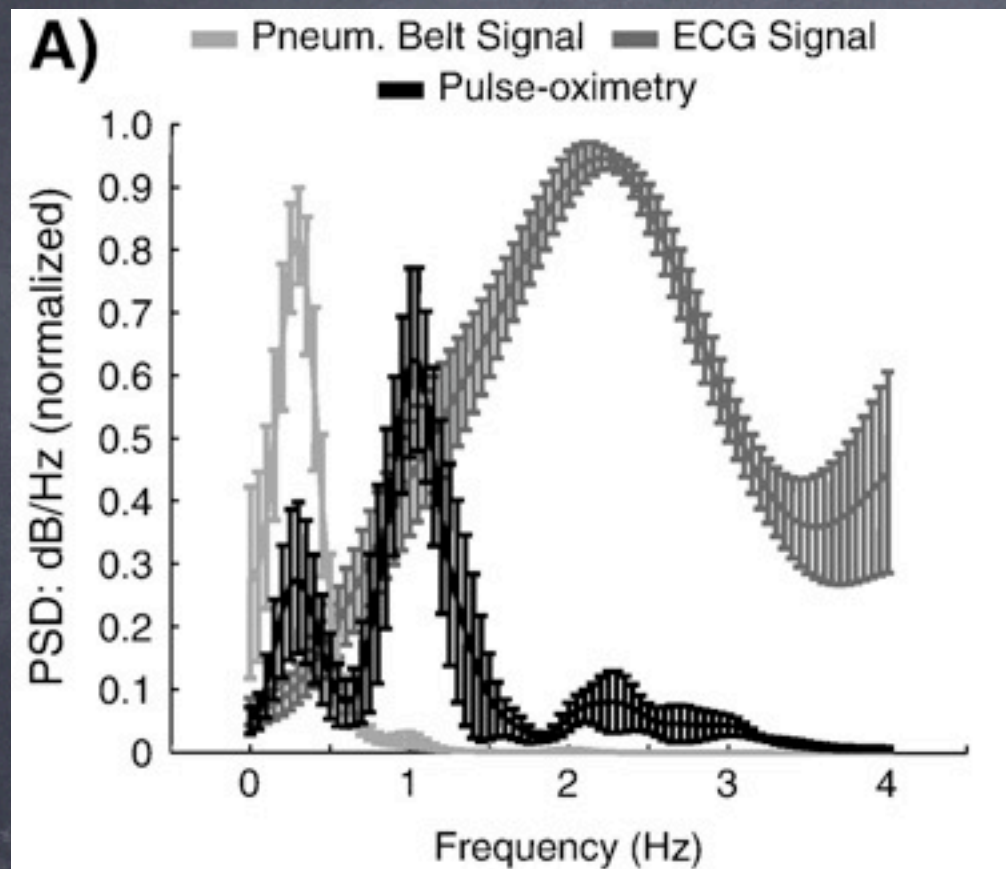 - easily corrupted by MR noise

- 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!