Measuring Sleep and Activity (Cycles) Using Wrist Actigraphy

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Workshop on Developing a Methodological Research Program for Longitudinal Studies
The National Academies of Sciences, Engineering, and Medicine
June 5–6, 2017

NSHAP is funded by National Institute on Aging (NIA) R37AG030481 and R01AG033903; Activity and sleep research is funded by NIA and the Basic Behavioral and Social Sciences Research Opportunity Network (OppNet) R01AG042164, R01AG051175 and K23AG049106. Additional support from the Health and Retirement Study and Philips Respironics.

Rationale for Studying Activity and Sleep

Activity and health

- Physical activity plays a role in healthy aging
- Prolonged sedentary time associated with increased risk of chronic illnesses
    - cardiovascular disease
    - cancer
    - diabetes
    - obesity
    - all-cause mortality (recent meta-analysis)
- Biomarker of frailty among older adults; target for interventions

Sleep and health

- Large cohort studies have found short and/or poor sleep to be associated with:
  - higher mortality
  - obesity
  - diabetes
  - hypertension
  - poorer cognitive function
- Sleep deprivation studies show sleep loss associated with metabolic and endocrine alterations (e.g., decreased glucose tolerance, decreased insulin sensitivity, increased cortisol)

Value of survey studies of activity and sleep

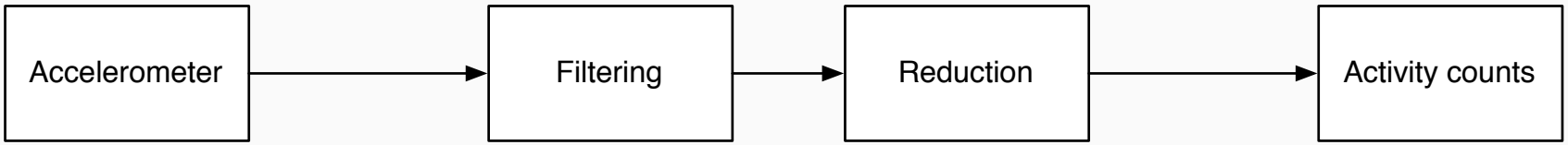
- Large, representative samples
- General, home-dwelling populatin (vs. clinical)
- Ability to study sleep and activity in their natural setting
- Other variables available for analysis
  - Social networks, living arrangements, environment
  - Frailty
  - Wide range of other health outcomes

Problems with self-reported measures

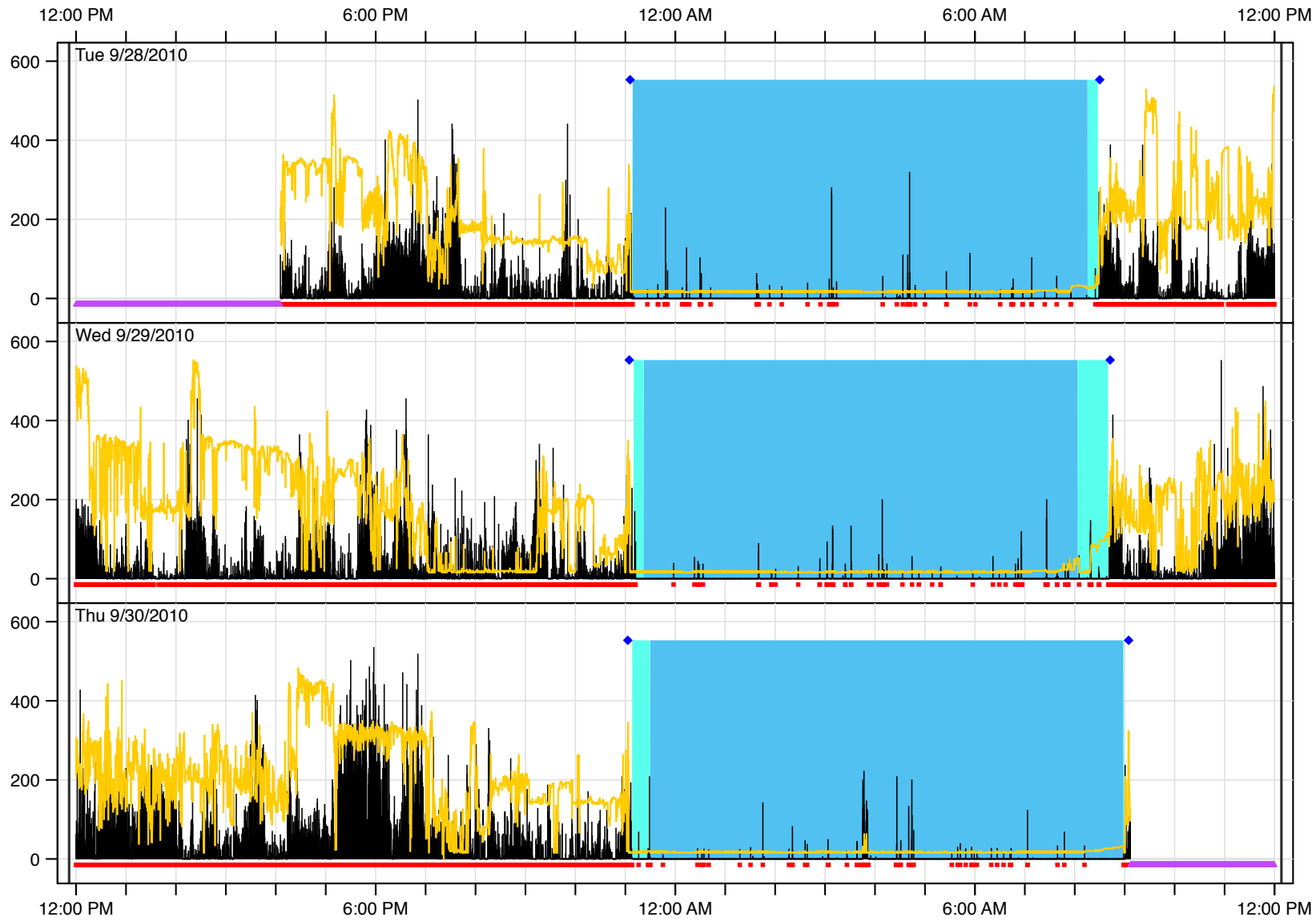
- Although results vary, reliability often found to be moderate or even poor—enough to affect associations with health conditions
- Self-reports of sleep can be biased, and extent of bias associated with personal and sleep characteristics
- Self-reports of physical activity also tend to be biased upward
- Difficult if not impossible to report on sleep quality (e.g., fragmentation, WASO)
- May be more problematic for older adults, due to activity questions being inappropriate and cognitive decline

Actigraphy

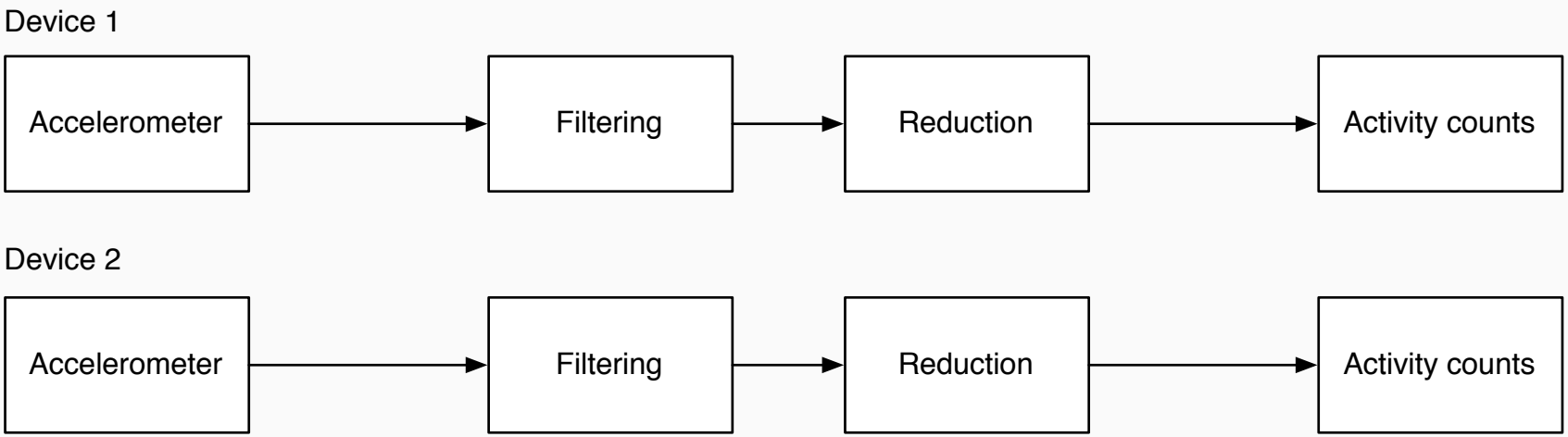
Actigraphy (Overview)



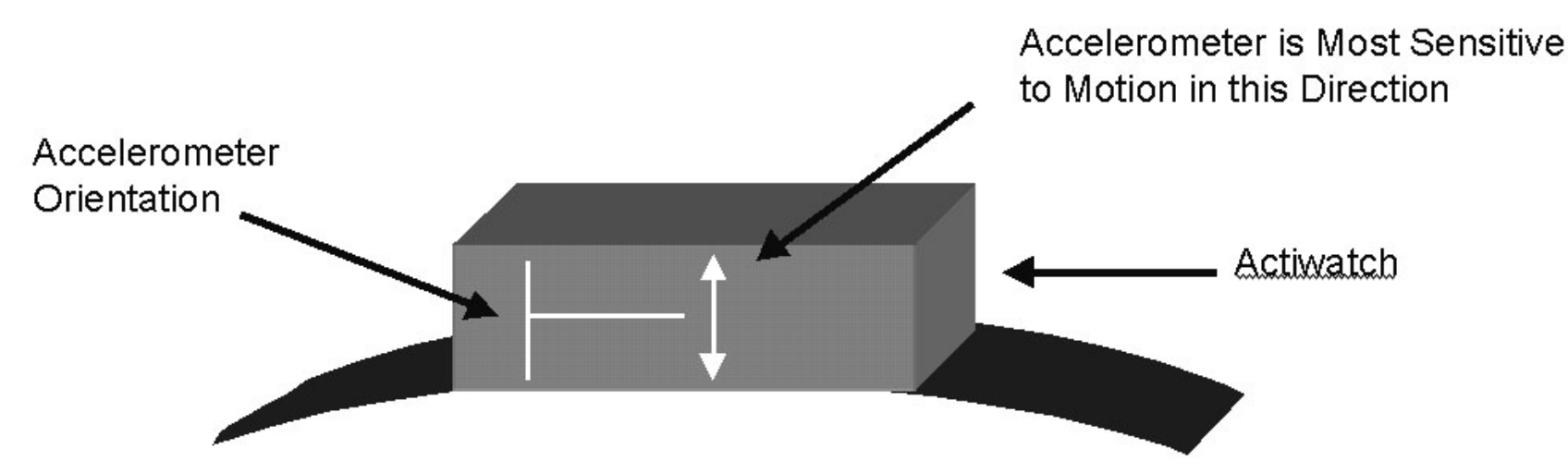
Actigraphy (Example)



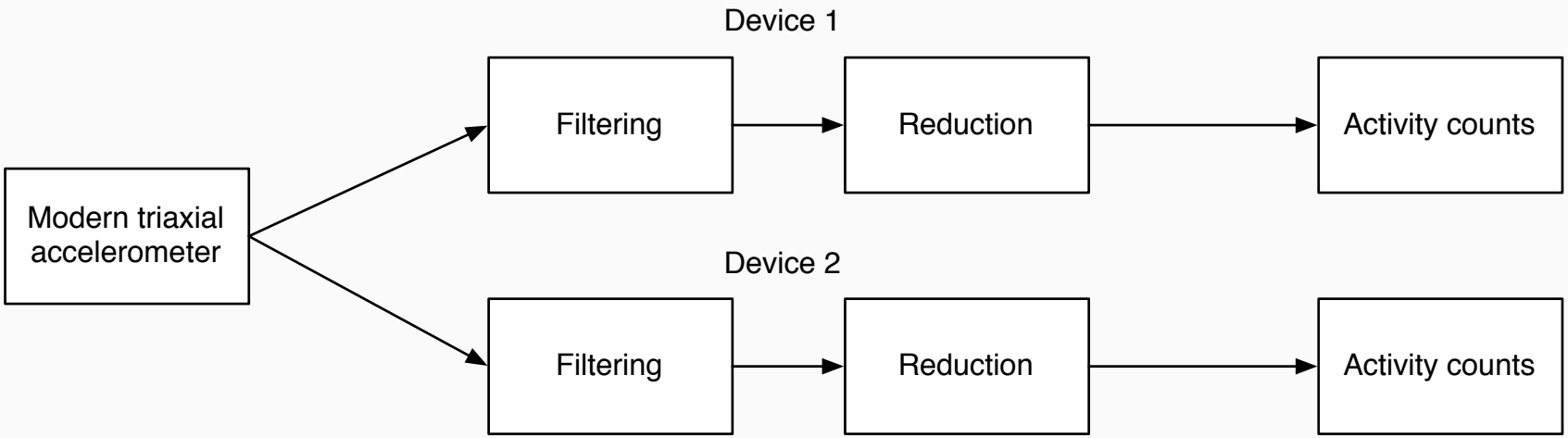
Actigraphy (Overview, cont.)



Actigraphy (Overview, cont.)



Actigraphy (Overview, cont.)



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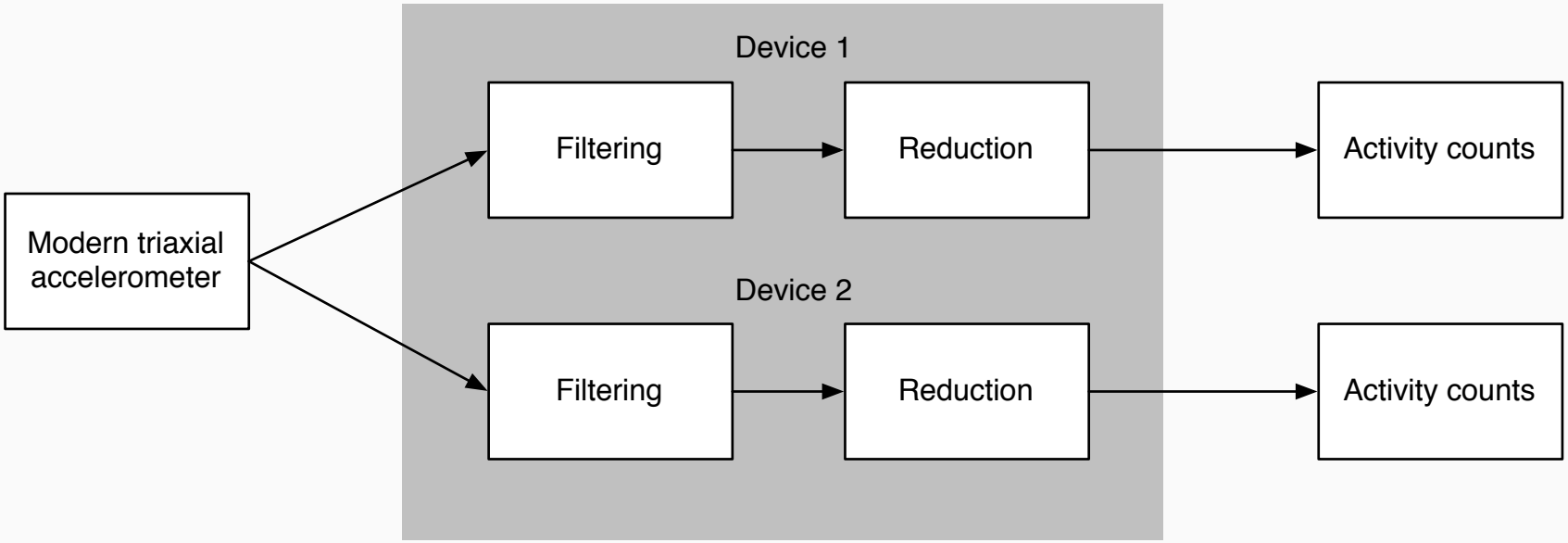

Objective Measurement of Physical Activity: Best Practices and Future Directions (2009, sponsored by NCI, NHLBI, NIEHS and ACSM)

Validation

- Sleep start and stop versus polysomnography (PSG)
- Association between actigraphy and Metabolic Equivalent of Task (MET) variable
- Wrist versus hip for measurement of sedentary time

Studies Including Actigraphy

U.S. population-based studies using actigraphy (partial list)

- Baltimore Longitudinal Study of Aging (wrist)
- Coronary Artery Risk Development in Young Adults (wrist)
- Fragile Families Study (wrist and hip)
- National Health and Nutrition Examination Survey (hip)
- National Social Life, Health and Aging Project (wrist)
- Study of Osteoporotic Fractures (wrist)
- Study of Women's Health Across the Nation (wrist)
- Midlife in the United States (wrist)

Plus many European studies (e.g., Whitehall II, UK Biobank Study, Newcastle 85+ Study, German Health Study, etc.)

NSHAP (Wave 2)

The National Social Life, Health and Aging Project (NSHAP) is a NIA-funded U.S. national longitudinal study of aging and health fielded by the National Opinion Research Center (NORC)

- Wrist actigraphy administered to random 1/3 of respondents (approx. 800 respondents) in Wave 2 (2010-11); 3 days and nights weartime
- Actiwatch Spectrum provided by Philips Respironics

- Additional financial support provided by the Health and Retirement Study

NSHAP Wave 2 Results

- Sleep
  - Self-report duration measures are associated with self-rated health, depressive symptoms, stress, frailty, olfaction and cognition (but not cortisol or CRP); mostly with quadratic effects
  - Actigraph duration has almost no associations
  - However, actigraph measures of sleep quality (WASO and fragmentation) are associated with nearly all outcomes
- Physical activity
  - Adjusting for age and comorbidity burden, higher frailty scores are associated with a modest reduction in activity, with each frailty point (0–4) corresponding approximately to a 5% reduction in the mean hourly count

NSHAP (Wave 3)

- Worked with Gulf Coast Data Concepts to develop case for their miniature USB Accelerometer (X16-mini)

- Triaxial, recording at 25 Hz
- Administered in home

Measurement and Analytic Issues

Devices

- Most important is that they have a high quality, triaxial accelerometer capable of recording raw data at high resolution
- GENEActiv by Activinsights

- Commercial devices (e.g., Fitbit, Apple Watch, etc.)
- Location on body (e.g., wrist versus hip)

Activity and sleep measurement study

NIA funded study to develop actigraphy and self-report measures of activity and sleep for use in HRS family of studies

- Phase I: Cognitive interviewing
- Phase II: Device calibration
- Phase III: Pilot study including both (n = 500)

Collaborators: Aron Buchman (Rush), Andrew Lim (Toronto), Howie Litwin (Hebrew University of Jerusalem)

Activity and sleep measurement study (Device calibration)

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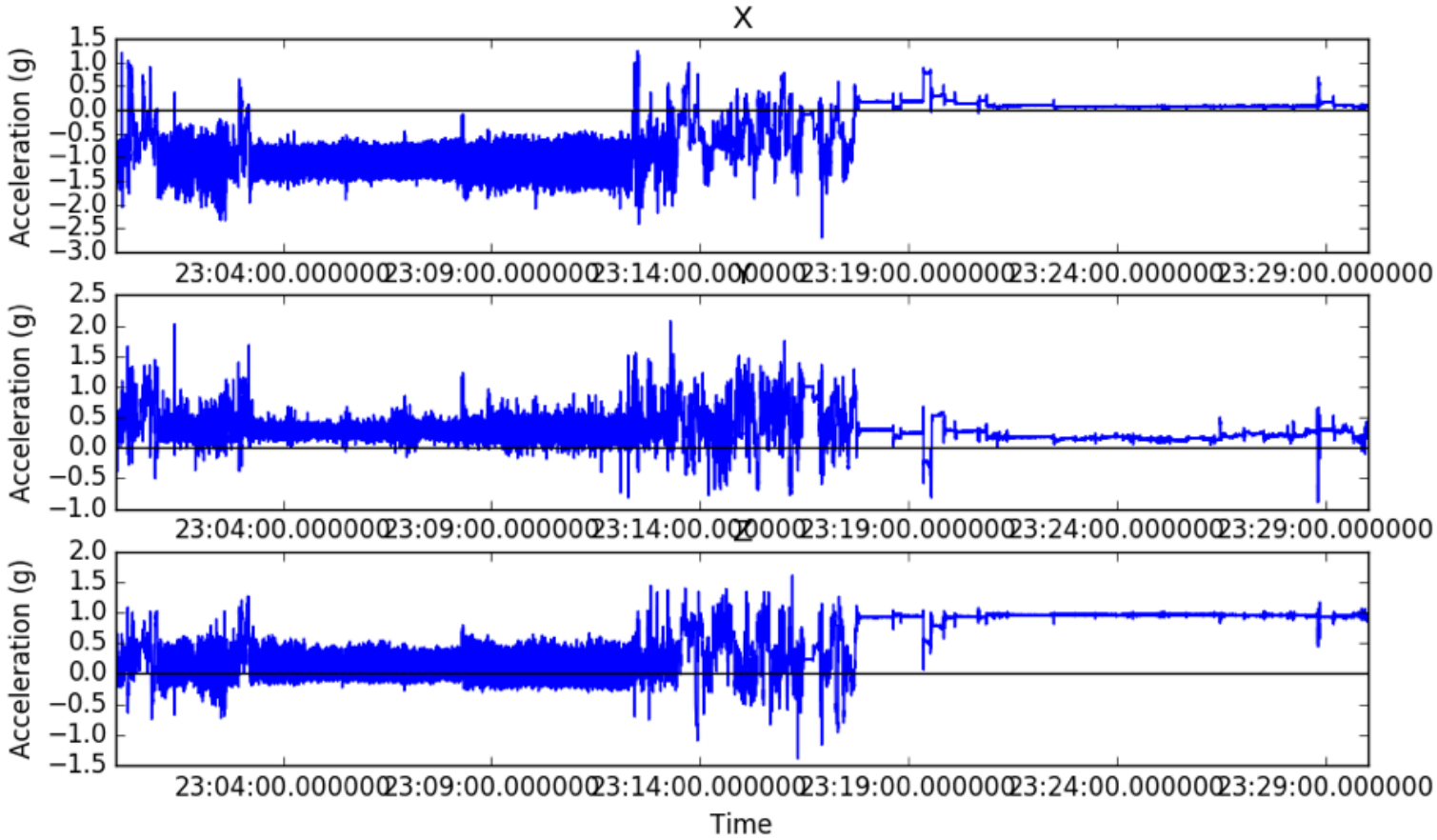
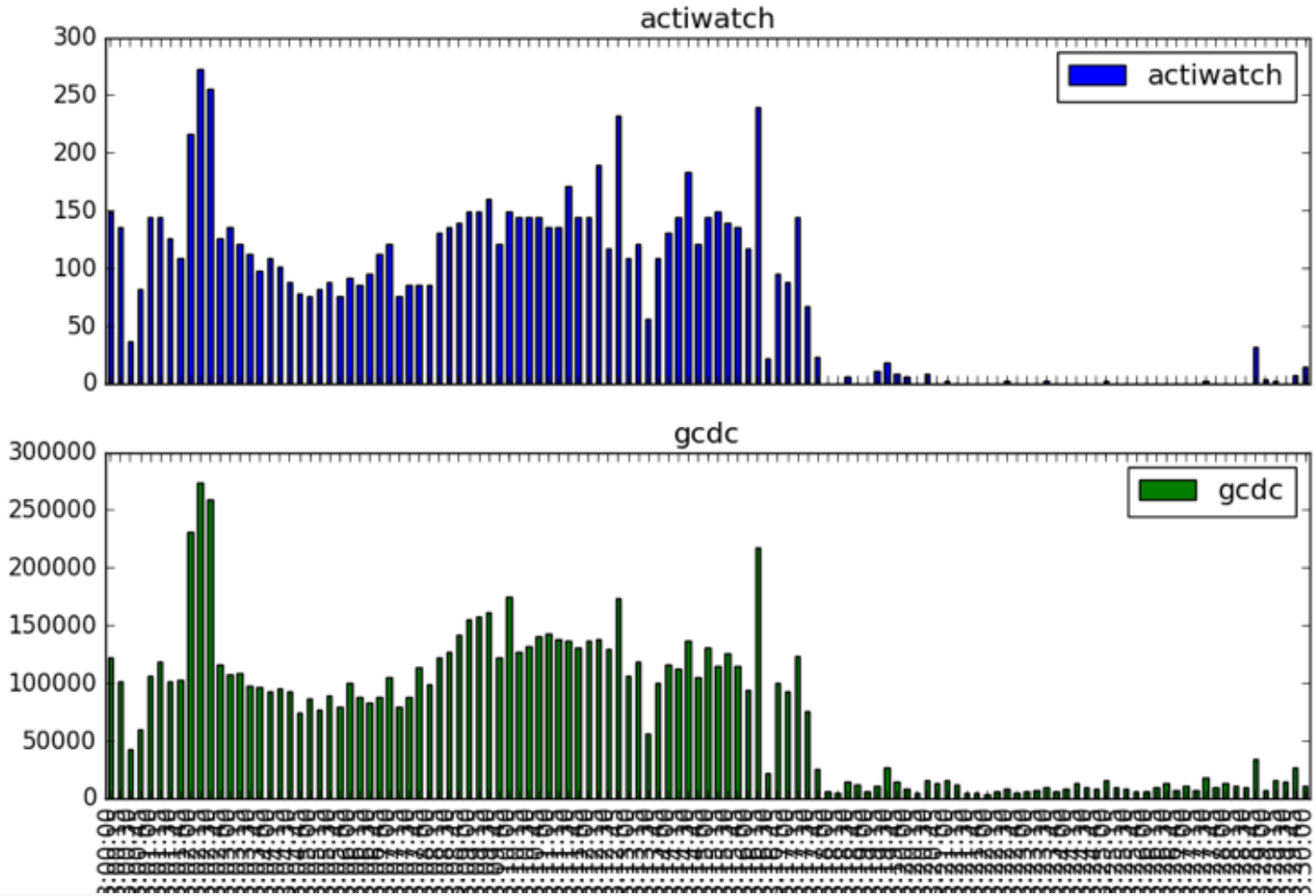


Activity and sleep measurement study (Device calibration)



Analytic issues

- New methods for extracting additional features
  - Better determination of sleep
  - Step counts
- Functional data analysis
  - Data are effectively continuous in time
  - Rythmic variation (circadian variation)
  - Potentially better at capturing important differences between older individuals (e.g., napping)

Conclusions

Conclusions

- Strong scientific rationale for including actigraphy in longitudinal studies (for both activity and sleep)
- Latest generation of devices are considerably cheaper, more capable, and can be shared across studies
- Devices should record raw 3-dimensional data, and these data should be shared along with summaries
- Work on new methods for extracting features is proceeding quickly and spans discipines; need to make this more available to population-based researchers
- Also need to focus on new functional analysis approaches to the study of activity (and possibly sleep) throughout the entire day