Actigraphy

Professor Jason Ellis

"It's not what it looks like Laura, I just couldn't sleep."
What is the difference?
What is the difference?

Criminal

Patient
What Can Actigraphy Tell Us?

Courtesy of Prof. Dieter Riemann
THE ROLE OF ACTIGRAPHY DURING CBT-I

PRE TREATMENT
To identify circadian abnormalities
THE ROLE OF ACTIGRAPHY DURING CBT-I

PRE TREATMENT
To identify light influences
THE ROLE OF ACTIGRAPHY DURING CBT-I

PRE TREATMENT

To identify any subjective - objective discrepancies

How discordant does the Sub-Ob have to be to be PI ?!
NOTE:
SOMETIMES IT IS AS THEY SAY
THE ROLE OF ACTIGRAPHY DURING CBT-I

DURING TREATMENT

PTB vs. TTB ?
PTOB vs. TOB ?
WASO-IN vs. WASO-OUT
THE ROLE OF ACTIGRAPHY DURING CBT-I

DURING TREATMENT

IN PLACE OF DIARIES FOR THOSE UNABLE TO KEEP A DIARY

LANGUAGE ISSUES
INTELLECTUAL ISSUES
DISEASE ISSUES
PERCEPTUAL ISSUES
THE ROLE OF ACTIGRAPHY DURING CBT-I

DURING TREATMENT

NANNY CAM EFFECT
So how does it Work?

Principle: When humans sleep they are immobile

- Immobile = no movements = sleep
- Mobile = movements = awake
So how does it Work?

Principle: When humans sleep they are immobile

• Immobile = no movements = sleep
• Mobile = movements = awake
So how does it Work?

Biaxial Polarized Magnets / Triaxial Polarized Magnets
So why would we use it?

- Inexpensive
- Easy to use (record and score)
- Ambulatory (use in home and lab)
- Collect longer-term data
- Easy to interpret
- Non intrusive (for most populations)
So are there limitations?

- Only gross estimations of sleep continuity
- Limited information for assessment of other sleep disorders
- People tend to take them off (newer models correct for this)
- Assumes no movement equals sleep (lying still in bed awake)
- Can’t tell if movement is voluntary or involuntary
So what is available?

Michael A. Grandner PhD
University of Pennsylvania
Center for Sleep and Circadian Neurobiology
Division of Sleep Medicine
Department of Medicine
Micro Motionlogger

- Manufacturer: Ambulatory Monitoring, Inc.
- Cost: $750-$995
- Research Data: Used in many research studies
- Pros: Widely used in sleep research, best validation data
- Cons: No off-wrist detection, not waterproof
Action Software
Actiwatch-64

• Manufacturer:
  – Mini Mitter
• Cost:
  – Not currently available
• Research Data:
  – Several research studies validating actiwatch against PSG
• Pros:
  – Widely used in sleep research
• Cons:
  – No longer being manufactured
  – Calibrations may be out of date
  – No light channel
Actiwatch-L

- Manufacturer: Mini Mitter
- Cost: Not currently available
- Research Data: Several research studies validating actiwatch against PSG
- Pros: Small, inexpensive, includes light, Widely used in sleep research, One of the first small devices
- Cons: Agreement with polysomnography not ideal, No longer manufactured or calibrated
Actiwatch-2

• Manufacturer:
  – Philips-Respironics

• Cost:
  – $800

• Research Data:
  – Several research studies using actiwatch

• Pros:
  – Standard actiwatch technology, waterproof

• Cons:
  – No watch face, no off-wrist detection
Actiwatch Spectrum:

- **Manufacturer:**
  - Philips-Respironics

- **Cost:**
  - Will be replaced by PRO and PLUS models (~$1000 each)

- **Research Data:**
  - See Kripke et al., 2010 and Minier et al., 2013

- **Pros:**
  - Photometers separate red, green, and blue light, has clock face and off-wrist detection
  - Well studied, many features provided

- **Cons:**
  - More expensive
Actiware Software
Actigraph GT3x

- Manufacturer: ActiGraph
- Cost: $225
- Research Data: No published validation studies
- Pros:
  - Frequently used in physical activity research
  - Much less expensive than other models
  - Choose scoring algorithm
  - New bluetooth models
- Cons:
  - Limited validation data, no off-wrist detection
ActiSleep

- Manufacturer: ActiGraph
- Cost: $299
- Research Data: None available
- Key Features: More sensitive for sleep than GT3x and includes actogram data view
- Pros: Less expensive, New bluetooth models, Select scoring algorithm, Includes Actogram view
- Cons: Limited validation data, no off-wrist detection, limited hand scoring
MotionWatch

- Manufacturer: CamNtech
- Cost: $1500
- Research Data: Limited but growing
- Key Features:
  - Pros: Based on standard actiwatch technology
  - Waterproof, very light, replaceable battery, exportable data
- Cons: No off-wrist detection
GENEActiv Asleep

- Manufacturer:
  - GENEActiv Asleep

- Cost:
  - $375

- Research Data:
  - Used in 11 research studies (1 sleep validation)

- Pros:
  - Continuous, unfiltered data for ~1 month
  - Includes skin temperature

- Cons:
  - Limited sleep validation
GENEActiv software
GENEActiv physical activity report

Wednesday (2012-06-27)
GENEActiv sleep report

Friday night (2012-06-22)

<table>
<thead>
<tr>
<th>Sleep period start</th>
<th>00:30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep period end</td>
<td>08:27</td>
</tr>
<tr>
<td>Elapsed sleep period</td>
<td>8.0 hrs</td>
</tr>
<tr>
<td>Total sleep time</td>
<td>7.7 hrs</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>96.4%</td>
</tr>
<tr>
<td># Activity periods</td>
<td>5</td>
</tr>
<tr>
<td>Median activity period</td>
<td>3.0 mins</td>
</tr>
</tbody>
</table>
FitBit

- Manufacturer: FitBit
- Cost: $130
- Research Data: None
- Key Features: Inexpensive, sync with app. Steps, calories, and sleep. Adds altimeter for better activity measurement and clock face.
- Pros: Inexpensive, waterproof, vibrating alarms.
- Cons: Insufficient validation data. No data export. Algorithms and recording modes are proprietary.
FitBit App

Connected to your Flex
Tracker synced today at 12:11 PM

**Steps**
2,719
of goal 10,000

**Distance**
1.21 mi
of goal 8.05 mi

**Calories burned**
1,149
of goal 2,843

**Logged activities**
No activities logged on this day

**Logged sleep**
6h 22min
2:42 AM - 9:57 AM

**Sleep pattern**
23 May
• Manufacturer:  
  – Jawbone
• Cost:  
  – $130
• Research Data:  
  – None
• Key Features:  
  – Inexpensive, sync with app. Steps, calories, and sleep.
• Pros:  
  – Inexpensive, waterproof.
• Cons:  
  – Insufficient validation data. No data export. Algorithms and recording modes are proprietary.
UP App
ActiCal

• Manufacturer:
  – Philips-Respironics

• Cost:
  – $600

• Research Data:
  – Weiss et al., 2010.

• Pros:
  – Lightweight, less expensive than actiwatch.

• Cons:
  – Calibrated for energy expenditure, not sleep.
Sleep Cycle app

My Sleep Graph for Nov. 6

Awake
Dreaming
Deep Sleep

TIME: 23 00 01 02 03 04 05 06

Went to bed / woke up 10:55 / 06:58
Total time 6h 53m
Average total time 7h 04m (23 nights)

Share by e-mail
Share on Facebook

Instructions Test Settings Alarm Statistics
Sleep Time app

**ALARM TIME**
6:30

**DETAILS**
- Bed Time: 02:28 AM
- Duration: 4:52
- Efficiency: 74%

**Sleep Depth**
- Awake: 26%
- Light: 22%
- Deep+REM: 52%
- Efficiency: 74%

**Instructions**
Put your phone on your bed face down. Display will turn off automatically.
So how do I use it?

• Step 1: Determine data quality
• Step 2: Determine missing intervals
• Step 3: Set intervals for time in bed
• Step 4: Automated scoring algorithm
• Step 5: Correction with hand scoring
So what should I get?

- Sleep latency
  - [Time sleep onset] – [Time into bed]
- Wake After Sleep Onset
  - [Awakening1] + [Awakening2] …
- Early Morning Awakening
  - [Time out of bed] – [Time final awakening]
- Time in bed
  - [Time out of bed] – [Time into bed]
- Total Sleep Time
- Sleep Efficiency
  - \([ \frac{[Time in bed]}{[Total Sleep Time]} \] * 100\)
What happens after autoscore?

The most accepted hand scoring rules to be done after autoscoring
Webster’s Rules

• If you have 4-9 mins of wake, recode the first 1 min of sleep as wake

• If you have 10-14 mins of wake, recode the first 3 min of sleep as wake

• If you have 15+ mins of wake, recode the first 4 min of sleep as wake
Webster’s Rules

- If you have **10-19 mins** of wake surrounding a period of sleep, any sleep period of 6 mins or less should be recoded as wake.

- If you have **20 mins** of wake surrounding a period of sleep, any sleep period of 10 mins or less recoded as wake.
How long is long?

- Baseline
  - Minimum three days
  - Standard one week
  - Best practice two weeks