Reducing Friction in Clinical Workflow

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Overview

- Friction in Clinical Workflow
  - It's everywhere we've looked
- Reducing Friction with Sensors
- Project 1
  - RFID-driven smart routing, alerting, and notification
- Project 2
  - Kinect- (3D imaging-) driven Game-based Cognitive assessment

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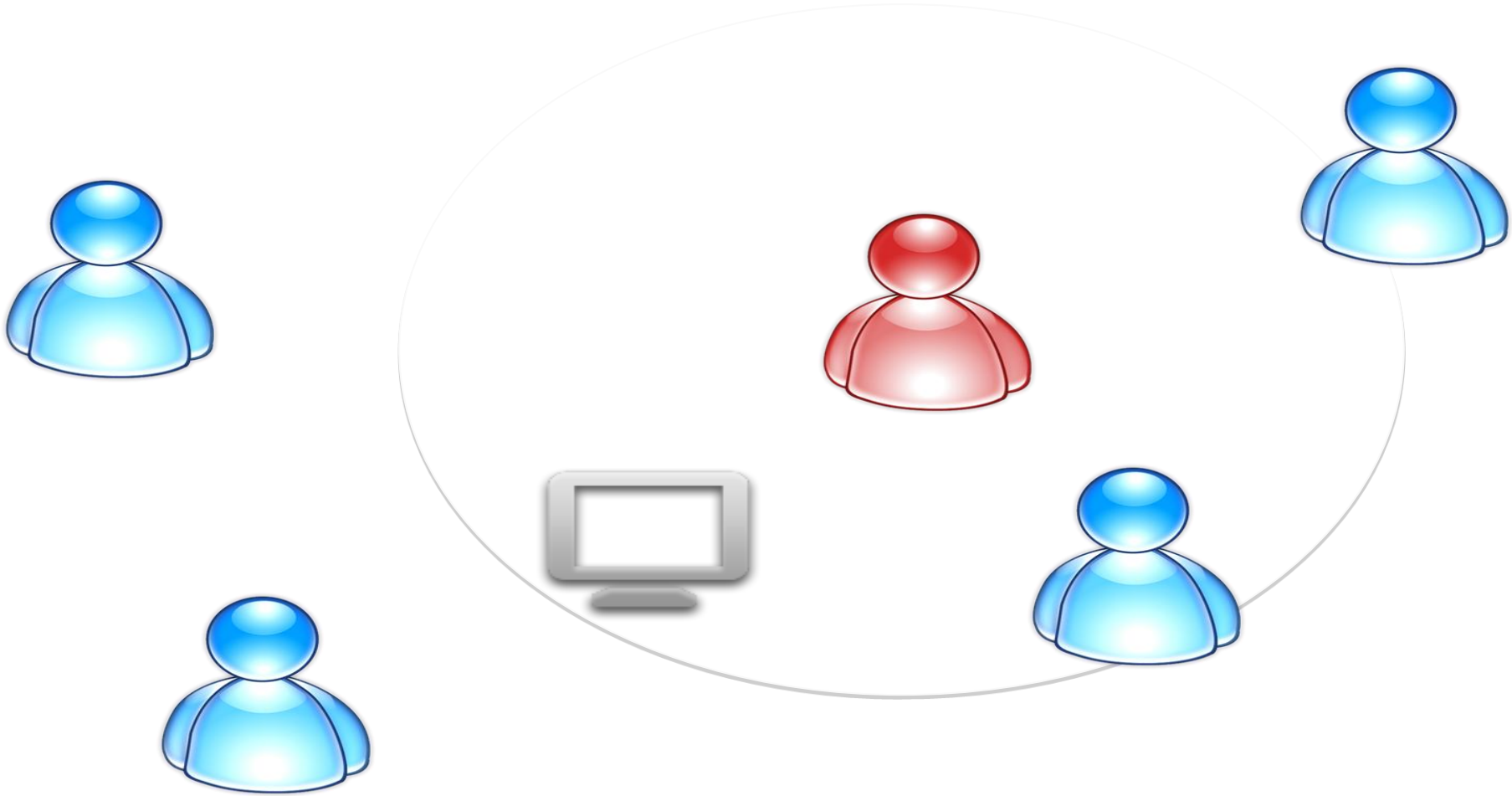
- Project 3
  - Accelerometer driven Gait Based of health status (e.g., falls risk and neuro-rehabilitation)

RFID-Driven Routing and Notification

- Readers in Physician Smartphones
  - Tags on people, in Rooms or Near Equipment
- Transmission of Sensed TagIDs to Intranet/Cloud
- Triangulation/inference of Tag location/Proximity
- Inference
  - Activity
  - Interruptability
- Modification of Device behaviour
  - based on inferred activity and workload
  - Accepting Calls, notifying test results, automated login

Who and what are around the user?



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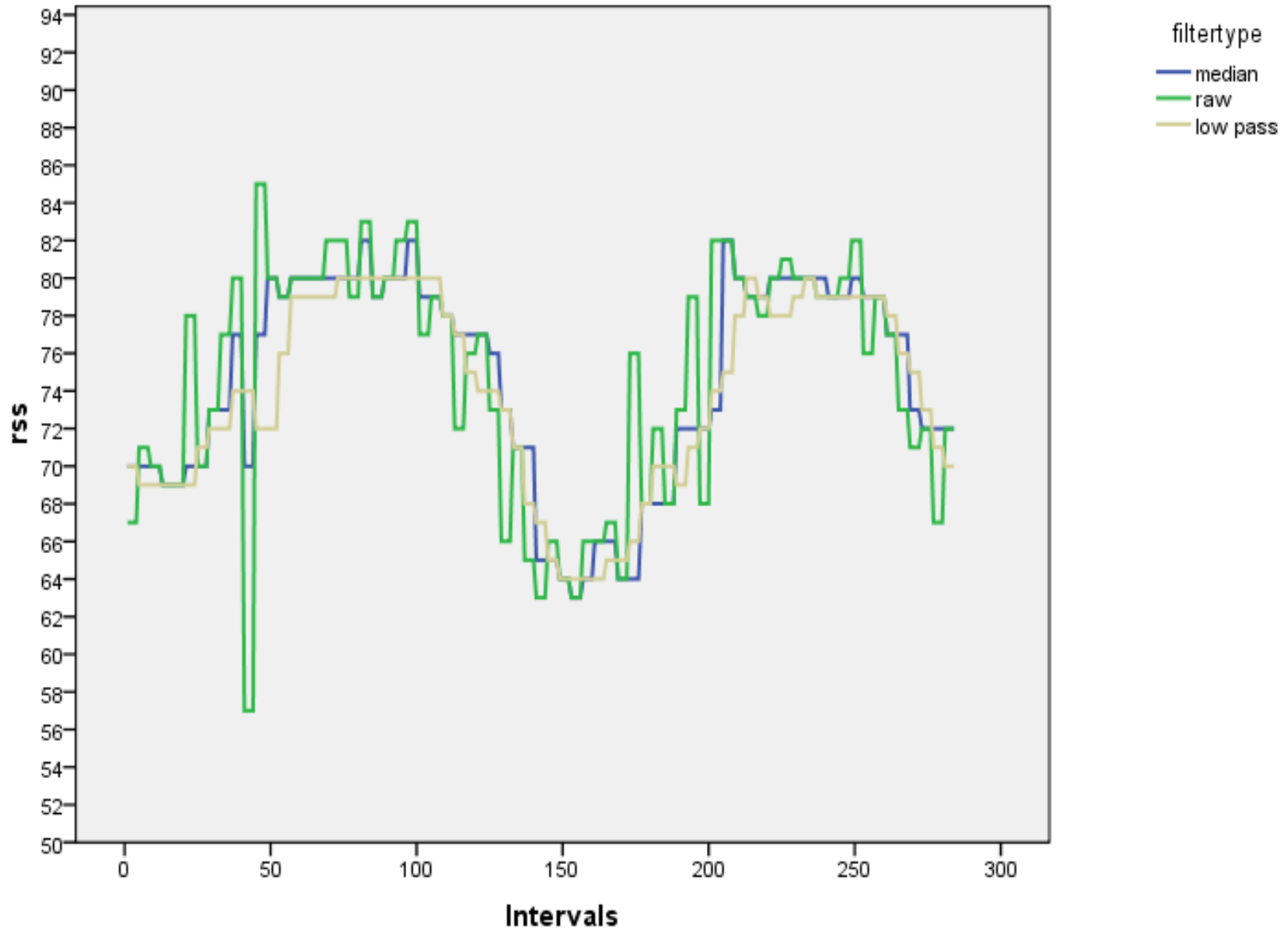
Initial Testing of Filters



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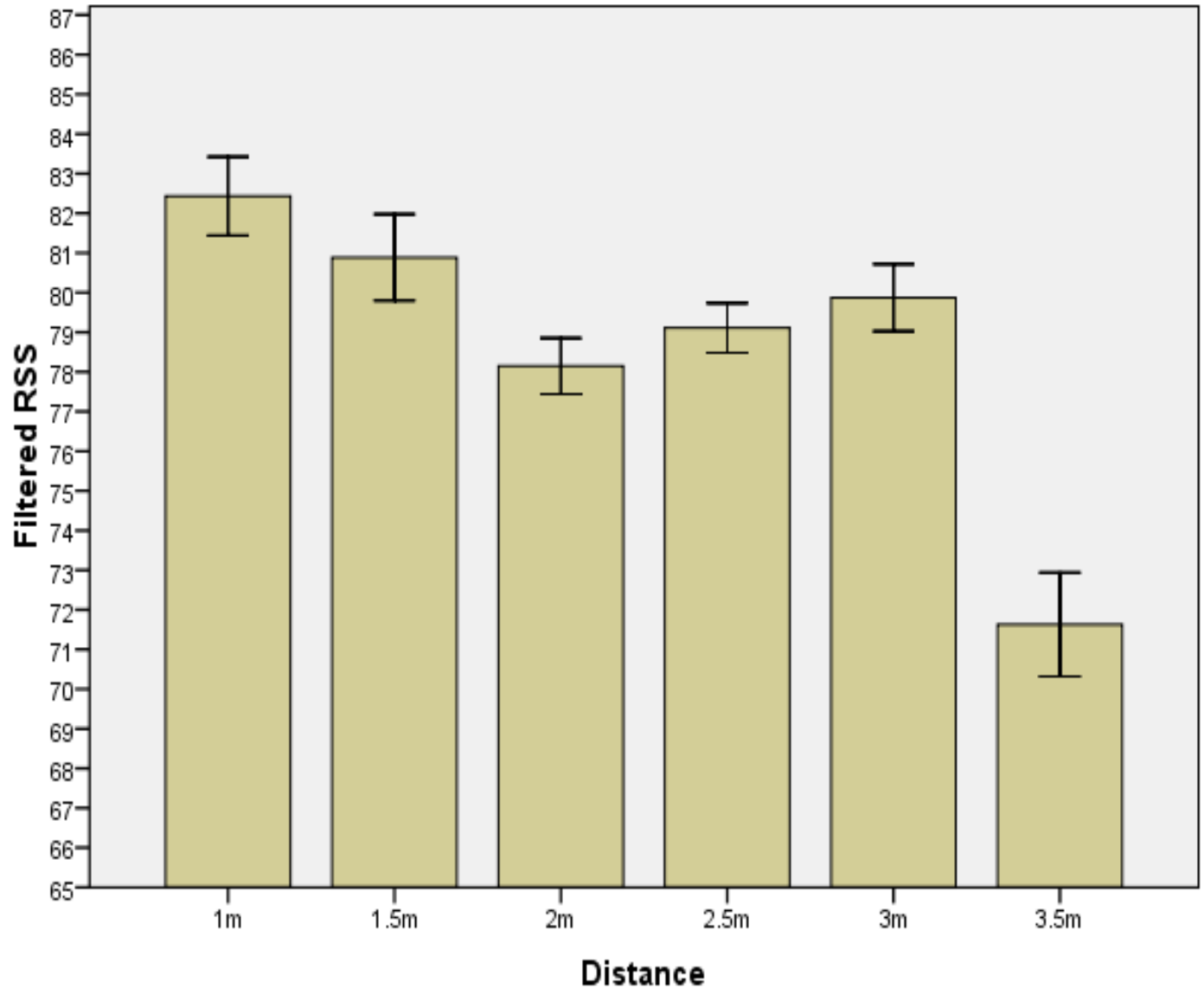
Signal Strength as a Cue for Distance



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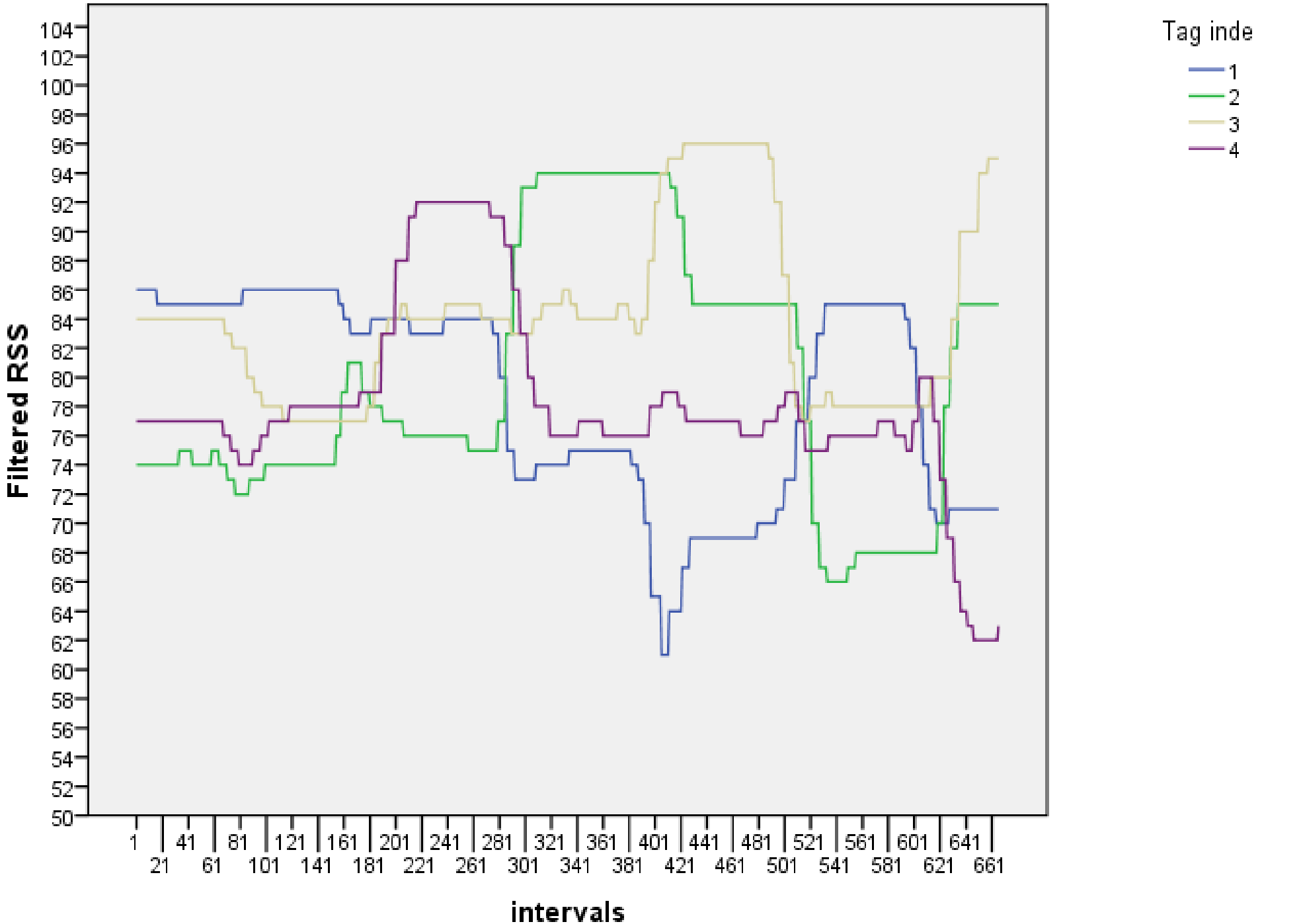

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Video Demo

(thanks Phil, Hao, David, Mehdi and Mahsa)

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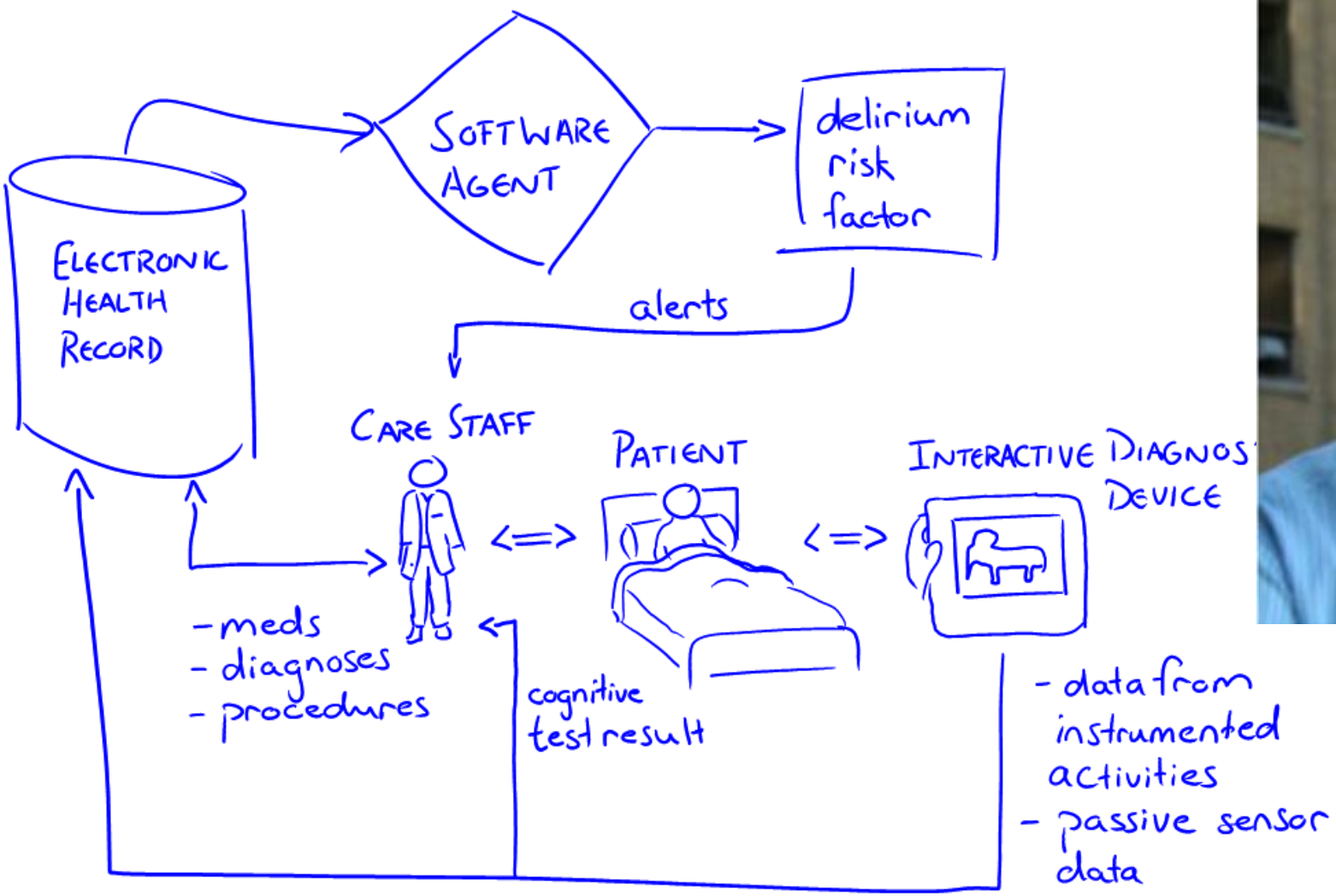
Game-Based Cognitive Assessment

(Phil Lam with Dr. Jaques Lee, Delirium in the Emergency Room Application)



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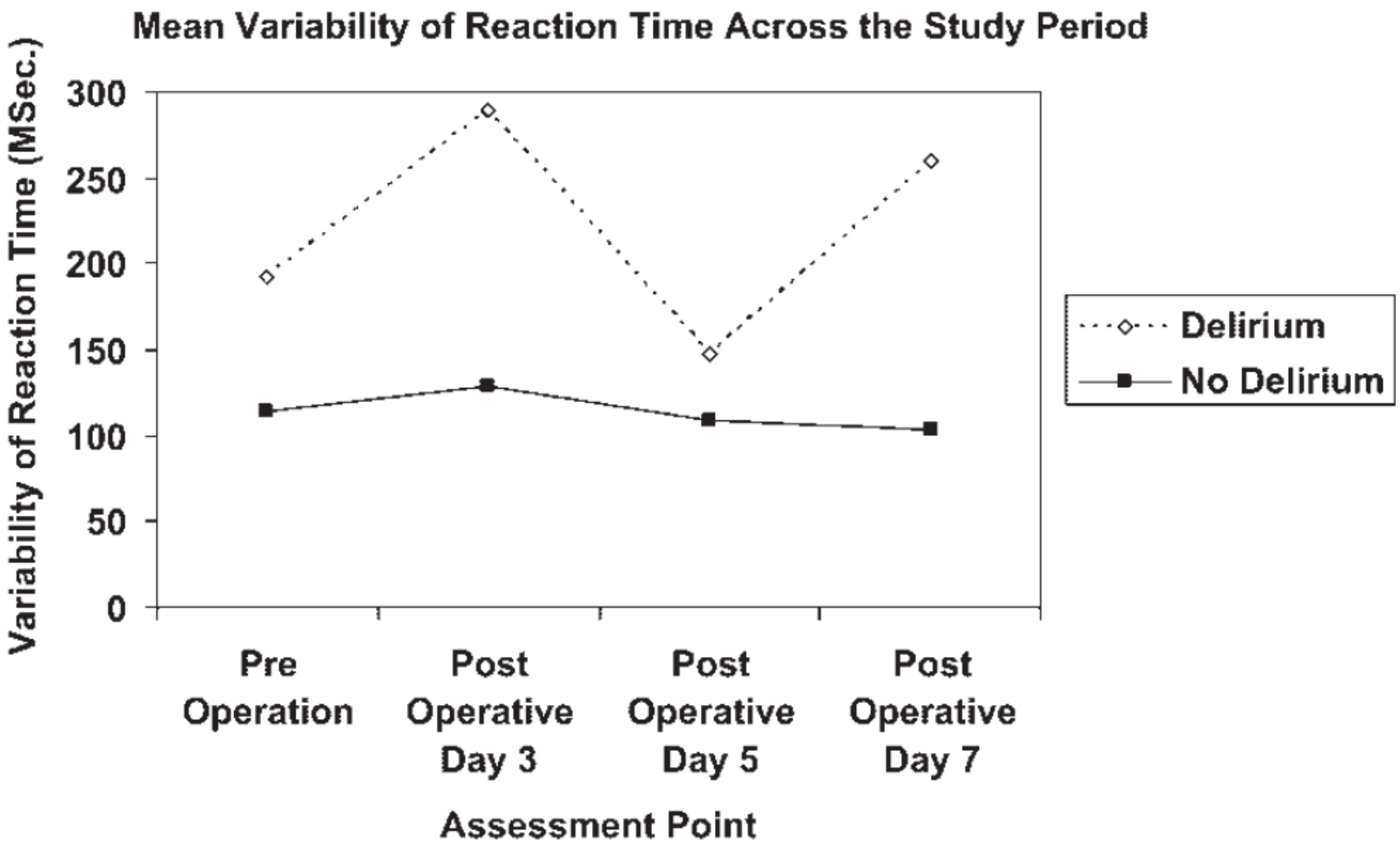
Delirium (short version)

- Brain stops functioning properly
- Happens quickly (onset over hours/days), and fluctuates.
- Symptom of a medical emergency (very long list of possible causes)

- **Definition currently fluid (subject to further research)**

Hypothesis



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Prototype

KINECT
for XBOX 360.

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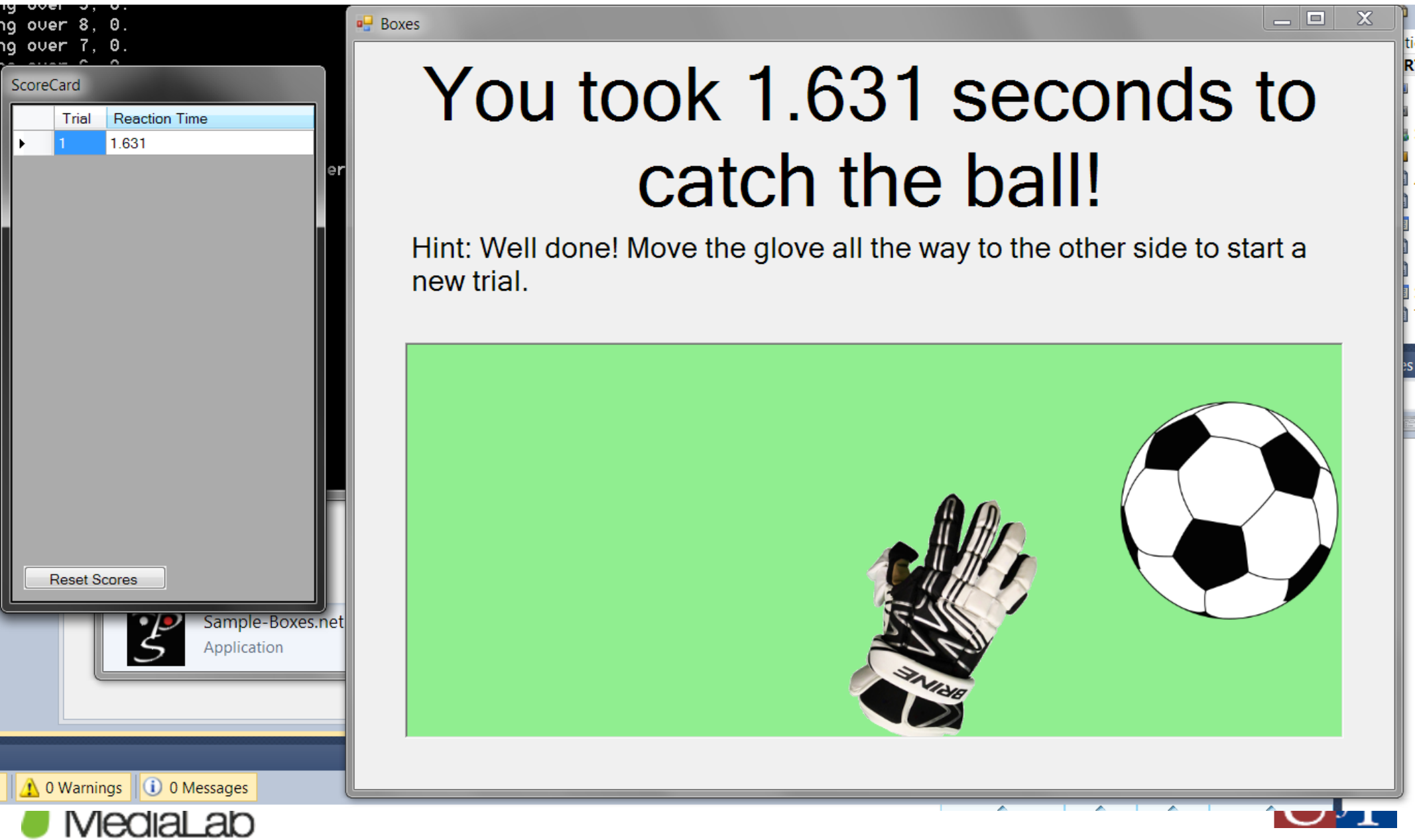
Prototype


ng over 8, 0.
ng over 7, 0.
ScoreCard
Trial
Reaction Time
1
1.631
Reset Scores
Sample-Boxes.net
Application
0 Warnings
0 Messages
Boxes
You took 1.631 seconds to catch the ball!
Hint: Well done! Move the glove all the way to the other side to start a new trial.
BRINE

Sensor-Based Evaluation of Neuro-Rehab

(Anito Ko with Dr. Tammy Sieminowski)

- Recovery
  - from Brain or Stroke Injury
- Ambulatory Gait Analysis over six weeks
- Reduction in Gait Abnormality
  - as a measure of recovery
  - Comparison with Existing Clinical Measures
  - Relative Effectiveness across Different Diagnoses
- Usability Study
  - at Bridgepoint Hospital Fall 2010
- Shoe mounted sensor package developed by Phil Lam

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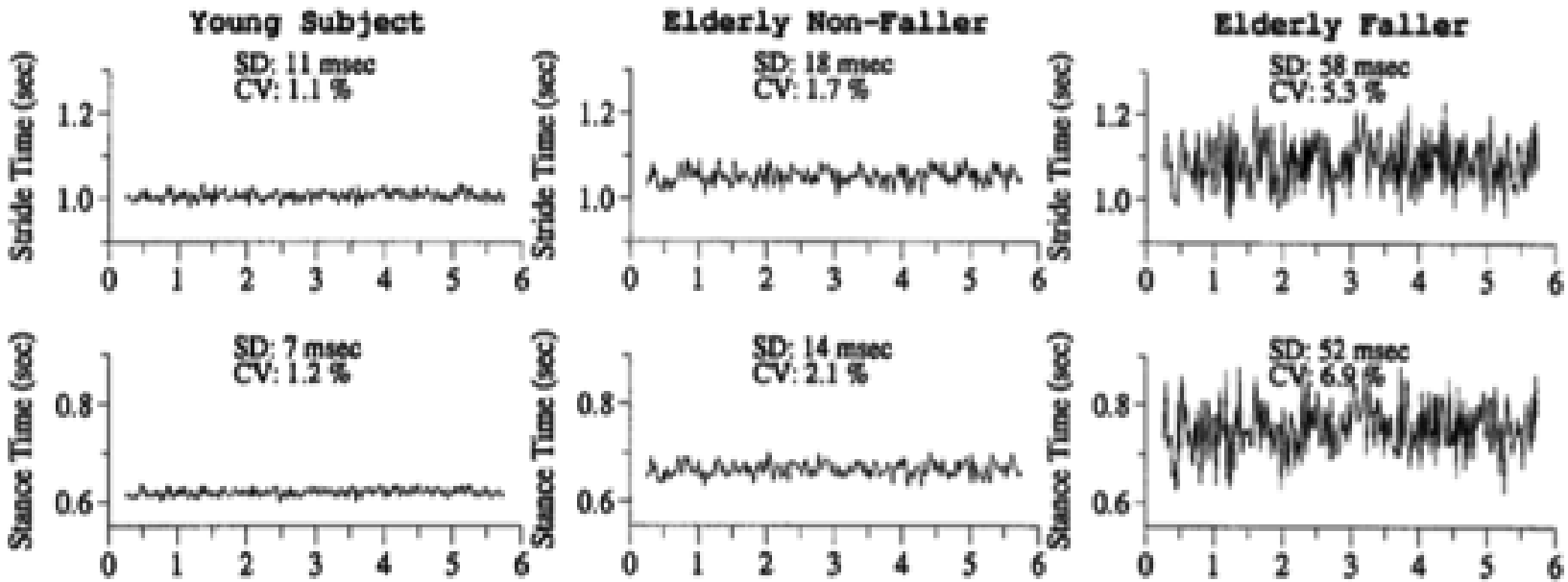
Stride Variability

Hausdorff et al (1997):



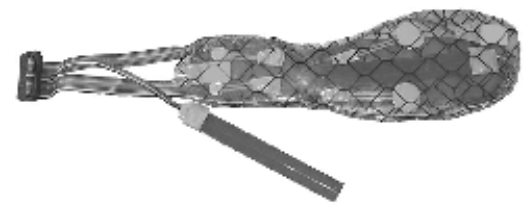
People who fall have greater stride variability (unsteadiness) and spend more time with their feet on the ground

Targetted Ambulatory Gait Analysis

- Inference of gait features from combination of gyroscope and accelerometer data
- Use of clock to synchronize left and right feet
- Small package mounted on top of patient's shoe/slipper)
  - (no need to wear purpose built shoes)
- Targetted features (using findings in research literature)
  - Stride length variability (suspected cognitive component)
  - Foot flat (vertical) acceleration (aging related)
  - Stride width (disease related, e.g., Parkinsons)

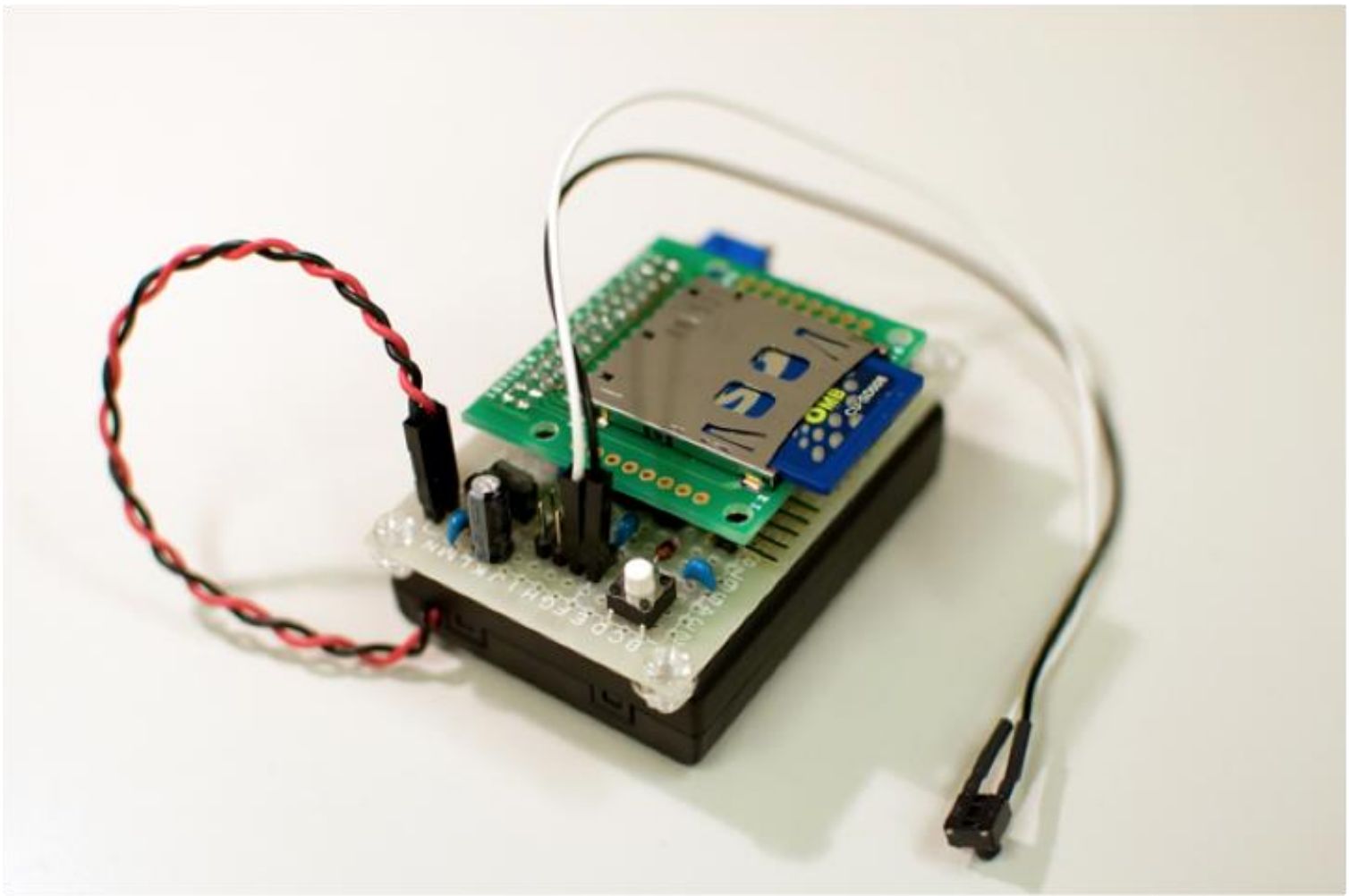
Existing Work

- GaitShoe (Bamberg 2008)
  - Sensors (accelerometers, gyroscopes, force, pressure, height sensors) attached to shoe
  - Measured heel strike - toe off timing, pitch, velocity, stride length
  - Complicated sensors



- GAITRite (Titianova 2004)
  - Portable walkway with pressure sensitive sensors
  - Measured location of foot, dynamic pressure, heel strike - toe off timing
  - Requires a gait lab

Equipment



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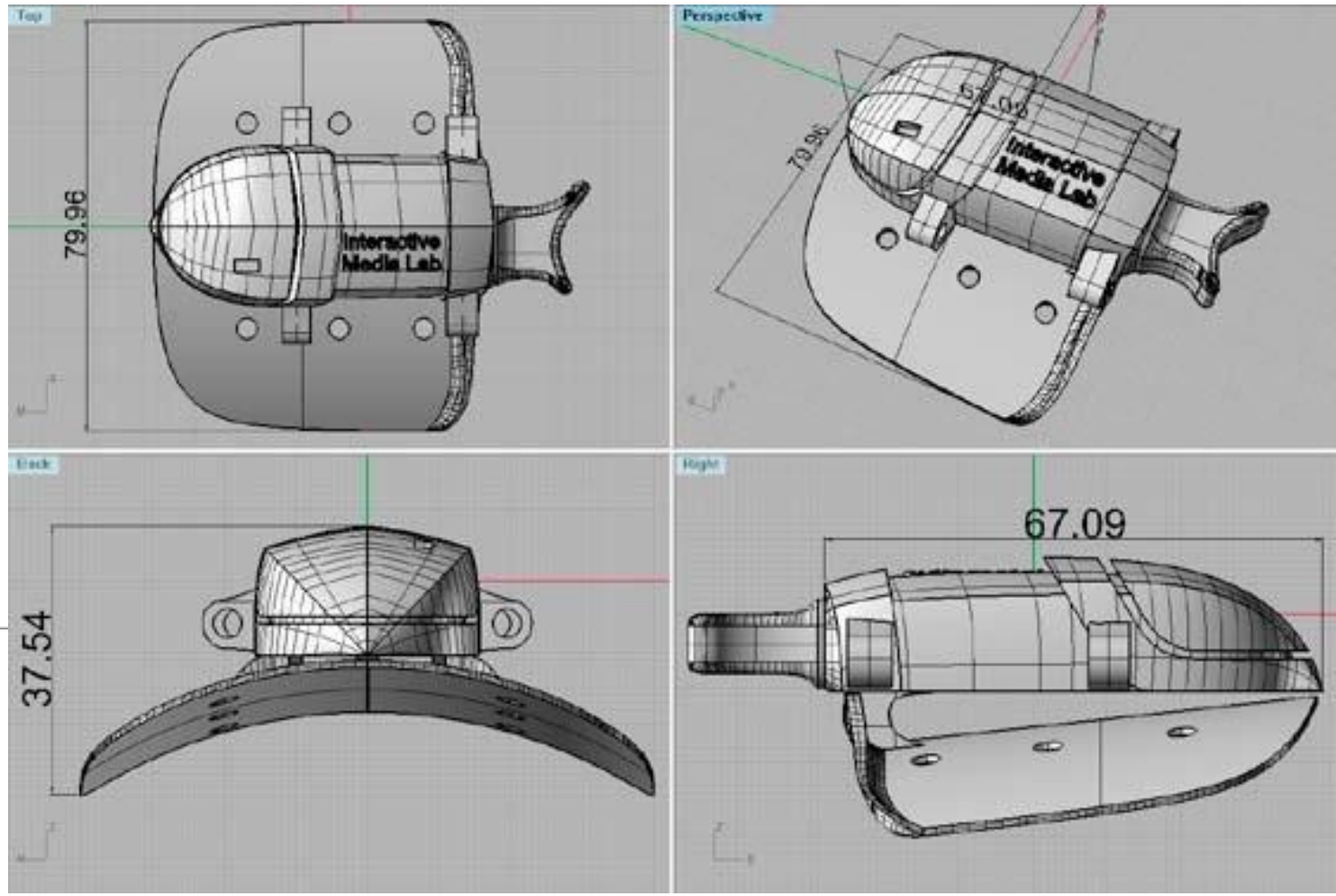
Sensor Package



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Bridgepoint Health

- “chronic disease prevention and management”
- Comprised of Bridgepoint Hospital, Bridgepoint FHT, Bridgepoint Collaboratory for Research and Innovation, Bridgepoint Health Foundation
- Hospital provides short-term care to patients living with disabilities, multiple diseases, and those seeking rehabilitation after sudden illness
- Neurorehabilitation service provides care for patients recovering from stroke or acquired brain injury

Experimental Design

- Population
  - mean age 61 years old (sd 18.2, range 18-93)
  - mean length of stay 41 days (sd 25, range 0 - 148)
  - diagnosis: stroke (53%), traumatic brain injury (16.4%), subarachnoid hemorrhage (5.7%), subdural hematoma (3.7%), other (21.1%)
- Inclusion criteria
  - Older than 18
  - Capable of consent
  - Able to communicate in English
  - Independently ambulatory (with or without aids)

Example Patient Footwear

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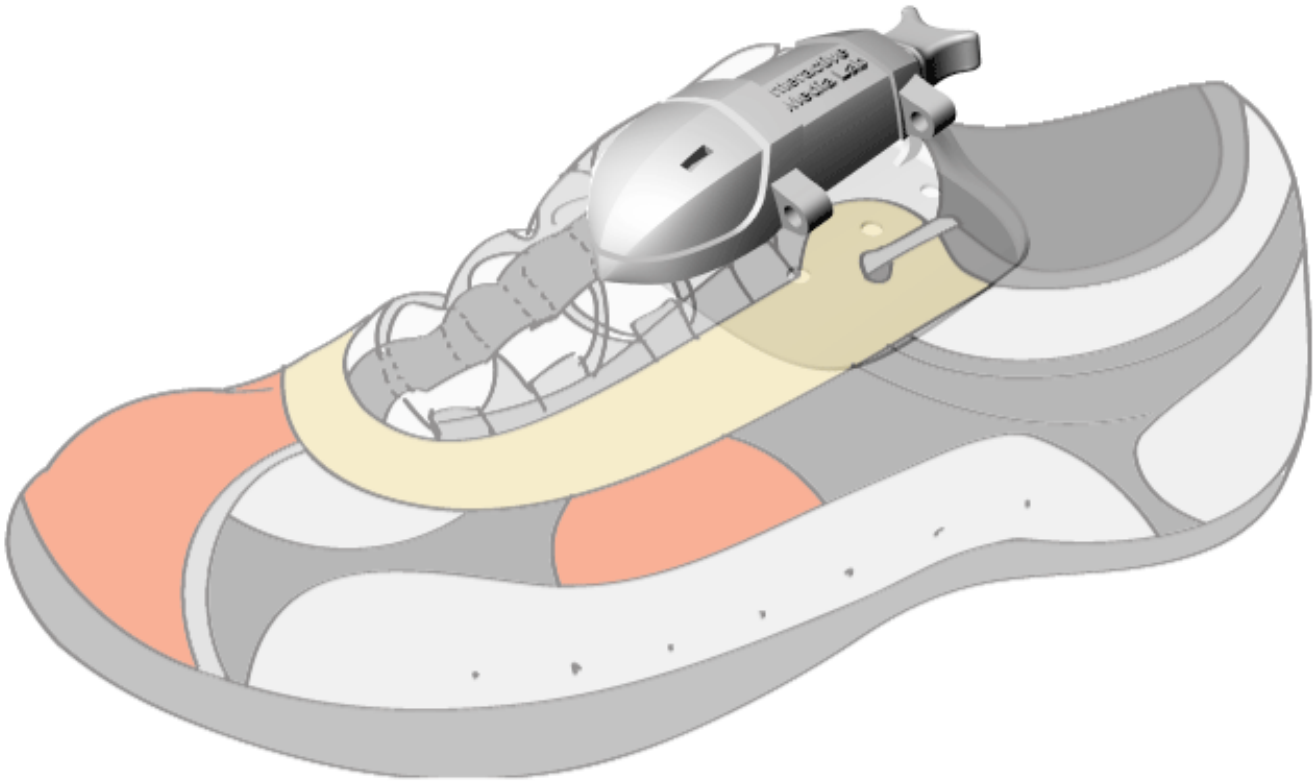
Equipment set up



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Data collected

- 3 patients
- 3 weeks each patient, one sensor on each shoe
- Instead of learning about ambulatory gait we mostly learned about usability problems associated with the sensor package and our research methodology

Issues Encountered

- Inappropriate footwear
- Patients unwilling to participate
- Patients in hospital for only a short time
- Time required to attach / detach sensors
- Incomplete EMR records (inconsistent across pts, checkups, some information missing)

Next Steps

- Phase 2 of experiment at Bridgepoint
  - Redesigned sensor package (fourth generation!!)
    - Magnetometers for orientation
    - Ground (IR) proximity sensor for footfalls
    - Variable battery sizes
    - Flexible body sites
  - Usability study (where to put the package?)
    - Shoe
    - Anklet
    - Small of back?
  - More controlled setting
    - Collect data in cooperation with physiotherapists (e.g., walking to appointment)

Conclusions

- Huge Potential for Sensor Driven Reduction of Friction in Clinical Workflow
  - But….
- No easy wins
- Each Application Requires
  - Careful Task Analysis
  - Extensive Human Factors Engineering
  - Innovation Technology Development and User Interface Design
  - Management of Socio-technical Systems