Development and Validation of an E-diary System for Assessing PA and Travel Behaviors

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Examples of Physical Activity Measures
## Advantages and Disadvantages of Commonly Used Physical Activity Measures

<table>
<thead>
<tr>
<th>Activity Measures</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires</td>
<td>Cheap, mass data collection, activity patterns</td>
<td>High subjectivity, a relative measure, recall difficulty, overestimations</td>
</tr>
<tr>
<td>Activity Monitors</td>
<td>Objective and absolute measures</td>
<td>High cost, difficulty for data collection for certain activities; no activity patterns</td>
</tr>
<tr>
<td>Heart Rate Monitors</td>
<td>Objective and absolute measures</td>
<td>Possible impact by psychological factors; no activity patterns</td>
</tr>
<tr>
<td>Doubly Labeled Water</td>
<td>The most accurate energy expenditure measure</td>
<td>Very expensive; no activity patterns</td>
</tr>
</tbody>
</table>
Diary: Another Useful Method

- Participants are asked to recall their activity or behaviors in a predetermined interval (e.g., every 30 minutes)
- Diaries potentially provide highly accurate information regarding people’s activity patterns
- Diaries have been employed in various research areas, such as assessing time usage, travel behavior, diet and physical activity
Challenges/Barriers in Usage of Diaries for PA Assessment

• Scoring such diaries is very labor-intensive activity and, as such is very expensive.

• Raters' objectivity is also sometimes a concern when raters are not carefully trained (Montoye et al., 1996).

• Little is known about the best time interval for an accurate recall.

• Diary, therefore, is used mainly as a criterion measure in physical activity research, and its advantage of providing rich information about physical activity patterns has never been taken.
Measure Activities Using Diaries

- **Way to collect data**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00 am – 6:00 am</td>
<td>Sleeping</td>
</tr>
<tr>
<td>6:00 am – 7:00 am</td>
<td>Got up for 5 min; walking outside 35 min; eating breakfast for 15 min; dress up for 5 min</td>
</tr>
</tbody>
</table>

- **Various formats**: Time to recall, format to record
- **Various areas**: Time usage; travel behaviors
New Technology to Address Challenges: Speech Recognition

- A process of automatically extracting and determining linguistic information conveyed by a speech wave using computers or electronic circuits

- 1952, first digit recognizer Audrey by Davis et al.

- 1992, AT&T introduced its voice-recognition call-processing system

- 1995, voice-activated dialing services offered by most phone companies

- Now, applications in every field
New Technology to Address Challenges: Automatic Scoring Technique

- A computerized, artificial intelligence-based information retrieval system
- 1960s, Page’s works on grading essays using computers
- 1995, introduction of modern computer power and artificial intelligence
- New generation scorers: LSA (Landauer & Foltz, 1997); E-rater at ETS (Burstein, 1998); BETSY (Rudner, 2001)
New Technology to Address Challenges: GPS and Practical Energy Measures

- Global position system
- GeoLogger by GeoStats
- Armband: Practical energy measure
E-diary: An Ongoing Project
(Funded by ALPESP, Robert Wood Johnson Foundation)

- To develop an E-diary system to measure physical activity and travel behaviors using voice-recognition and automatic scoring technologies
- To determine the validity of the E-diary system by correlating it with two criterion measures: (a) Armbend (a field energy expenditure measure) and (b) GeoLoggers, a new GPS device of travel movements
- To determine its reliability by asking participants to record their physical activity and travel behaviors using E-diary system for 21 consecutive days
A Multi-Disciplinary Research Team

- Dr. Weimo Zhu (Measurement)
- Dr. Mark A. Hasegawa-Johnson (Voice recognition)
- Dr. Lawrence M. Rudner (Automatic Scoring)
- Dr. Cesar A. Quiroga (Travel behavior; consultant)
- Dr. Richard A. Washburn (PA assessment; Consultant)
- Dr. John Robinson (Diary assessment, Consultant)
- Dr. Jean Wolf (GPS assessment, Consultant)
Components of $E$-Diary System

- **Voice Recognition**
  An application developed based on Dragon Naturally Speaking software and an interface programmed by Visual Basic

- **Automatic Scoring**
  A program modified from BETSY, a Bayesian essay scoring software developed by Rudner (2002)
How it works? – We hoped

• Participants are reminded to record their physical activities by a programmed “beep” (from a digital recorder);

• They then talk into the digital recorder to record their physical activities during the previous half-hour or 15 minutes, which are then automatically transferred into electronic text.

• Finally, the downloaded electronic text can be analyzed automatically using an E-coder so that an individualized report of physical activity assessment, evaluation and prescription can be generated
Data Collection Using *E*-diary, Armband and Geologger
How is the progress?

• Tried to build our own recorder with a beeper system – too complex and long 😞; so use a watch with beeper and a Sony Memory Stick recorder;

• Developed a voice recognition application using the Dragon Naturally Speaking software 😊

• Examined the error rates for PA assessment in both lab (n = 43; 258 records; C%: M = 92.54, SD=5.88) and field settings (n=3; 85.6%) and the results have been satisfactory 😊

• A combination of GPS technique and objective measure will provide an accurate, objective criterion measure for the E-diary validation 😊
More about Error Rate

• The speech recognition output was organized in the format of “label” file, which are compared with corresponding “reference” files;

• \( \% \text{ Correctness} = 100 x \frac{H}{N}; \ H = N - S - D \)

where \( H = \) the number of correct labels, \( N = \) the total number of labels, \( D = \) deletions, and \( S = \) Substitutions

• I uh… walk for 15 minutes

  I went and walk 15 minutes

• The analyses were completed using Hresults, a Hidden Marko Model Toolkit (HTK) performance analysis tool.
# Preliminary Results

A segment of recently collected pilot data
(the beep interval = 30 min, but the recall intervals were flexible)

<table>
<thead>
<tr>
<th>Record Time</th>
<th>Apparent Start Time</th>
<th>Activity Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:29</td>
<td>12:59</td>
<td>30</td>
<td>I ate lunch for 30 minutes</td>
</tr>
<tr>
<td>14:29</td>
<td>13:29</td>
<td>20</td>
<td>I work on my homework for 20 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>I rode on the bus for 10 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>I walked for 20 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>I packed for 10 minutes</td>
</tr>
<tr>
<td>14:59</td>
<td>14:29</td>
<td>30</td>
<td>I packed for 30 minutes</td>
</tr>
<tr>
<td>15:30</td>
<td>15:00</td>
<td>30</td>
<td>Driving home in a car for 30 minutes</td>
</tr>
</tbody>
</table>
Physical Activity Space (Zhu, 2003)

Physical activity space (PAS) is the area or space where an individual spends time and engages in physical activities;

PAS is a measure that can integrate both the measurements of physical activity behavior and its interaction with surrounding environment;
Challenges and Next Step

• 30-min interval is “Too Much” 😞; so we use 60 min now;
• Travel behavior data collection “from xx to xx” did not work well (Correctness % ranged from 5% to 90%);
• Reexamine the training process and look for travel experts’ help now …
• Just start automatic scoring data analysis
• More data with PA and travel behaviors are need!!!
Thank You!