Real-time assessment of health-relevant activities, locations, and landscapes

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May 9, 2011

Innovations in Real-Time and Mobile Measurement in Health Research, Part 1

Center for Health Behavior Research
Overview

• Self-reported data are heavily relied upon in social and behavioral sciences and biomedical research.
  • Self-reported states, behaviors, characteristics, environmental conditions.
• Our memory is selective.
• The mechanisms we use to recall data vary depending on recent or past memory is involved.
• Intuitively, attractive to think that we get better data by gathering it while it happens.
• Studies find great potential to discover behavioral patterns in our everyday life.
• The most appropriate strategy will depend on the final goal of your study.
Example: a study of daily activities
Fig. 4. School and Playground.

ning games, which are often organized by the children during recess.

Since the school building serves both town and rural children of all ages from the first grade through high school, Raymond comes in contact with town and country children of all ages on the schoolground before and after school.

Raymond walked very briskly onto the schoolgrounds. (See Plate 11.)

8:33. As he came up the walk in front of the school, he saw two dogs barking and snarling at each other by the bush at the corner of the lot, south of the school.
Table 4. Example 24-h recall diary containing beginning and ending times, activity, location, presence of a smoker, and time spent for 22 microenvironments visited on the diary day.

<table>
<thead>
<tr>
<th>Microenvironment number</th>
<th>Starting time</th>
<th>Ending time</th>
<th>Summary</th>
<th>Detailed activity</th>
<th>Simplified activity</th>
<th>Detailed location</th>
<th>Simplified location</th>
<th>Smoker? (1 = Yes)</th>
<th>Time spent (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>00:00</td>
<td>01:45</td>
<td>At night club</td>
<td>77</td>
<td>0</td>
<td>405</td>
<td>90</td>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>2</td>
<td>01:45</td>
<td>02:00</td>
<td>Traveled home after night club</td>
<td>79</td>
<td>0</td>
<td>301</td>
<td>30</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>02:00</td>
<td>11:00</td>
<td>Sleeping or napping</td>
<td>45</td>
<td>0</td>
<td>105</td>
<td>10</td>
<td>0</td>
<td>540</td>
</tr>
<tr>
<td>4</td>
<td>11:00</td>
<td>11:05</td>
<td>Brushed teeth</td>
<td>44</td>
<td>40</td>
<td>104</td>
<td>10</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>11:05</td>
<td>11:15</td>
<td>Preparing meals or snacks</td>
<td>10</td>
<td>10</td>
<td>101</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>11:15</td>
<td>11:25</td>
<td>Eating meals or snacks</td>
<td>43</td>
<td>70</td>
<td>102</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>11:25</td>
<td>11:30</td>
<td>Dressing or personal grooming</td>
<td>47</td>
<td>0</td>
<td>102</td>
<td>10</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>11:30</td>
<td>11:37</td>
<td>Traveling to play football</td>
<td>89</td>
<td>0</td>
<td>306</td>
<td>40</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>11:37</td>
<td>13:37</td>
<td>Playing flag football</td>
<td>80</td>
<td>60</td>
<td>507</td>
<td>50</td>
<td>0</td>
<td>120</td>
</tr>
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<td>10</td>
<td>13:37</td>
<td>13:44</td>
<td>Traveling to home</td>
<td>79</td>
<td>0</td>
<td>306</td>
<td>40</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>13:44</td>
<td>13:54</td>
<td>Preparing meals or snacks</td>
<td>10</td>
<td>10</td>
<td>201</td>
<td>10</td>
<td>0</td>
<td>10</td>
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<td>12</td>
<td>13:54</td>
<td>13:57</td>
<td>Traveling to bar</td>
<td>79</td>
<td>0</td>
<td>301</td>
<td>30</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>13:57</td>
<td>15:30</td>
<td>At bar</td>
<td>77</td>
<td>0</td>
<td>405</td>
<td>90</td>
<td>1</td>
<td>93</td>
</tr>
<tr>
<td>14</td>
<td>15:30</td>
<td>15:33</td>
<td>Traveling from bar</td>
<td>79</td>
<td>0</td>
<td>301</td>
<td>30</td>
<td>0</td>
<td>3</td>
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<tr>
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<td>15:33</td>
<td>16:30</td>
<td>Watching TV</td>
<td>91</td>
<td>0</td>
<td>102</td>
<td>10</td>
<td>0</td>
<td>57</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Cumulative time exposed to secondhand smoke
105 + 93 = 198 out of 1440 minutes = 14%

The respondent, whose diary is shown in this table, was a Hispanic male from Connecticut between the ages of 18 and 24 who was interviewed on a weekend in the fall. See the Sample and Data characteristics section for a description of the simplified (i.e., recoded) locations and activities.
Relationships between available, administered, absorbed, and active doses of an exposure and the factors that intervene between them and their ultimate effects on health

Describe exposure in relation to an exposed subject:

- **Available dose**: is measured in subject's external environment (e.g., asbestos fibers per ml of ambient air).

- **Administered dose or intake**: amount of agent coming into contact with body; depends on physiology and behavior (respiratory volume at rest and during activity, quantities ingested).

- **Intake** is a surrogate for **absorbed dose or uptake**: dose that enters the body (unless dose also affects surfaces it contacts).

- **Absorbed dose** is surrogate for the dose that really matters: **active or biologically effective dose** at sites in the body which are the targets of action of the agent.

  The relationship of the active dose to the absorbed dose is complex, depending on the transport of the agent in the body, its distribution among different body compartments, its metabolism to both active and inactive forms, and its excretion from the body.

Interviewer’s heart rate (actual and fitted) during a 150-minute interview trip from campus to a subject’s home and back

Note: Fitted results were derived from an autoregressive integrated moving average (ARIMA) (1,0,0) model (φ=0.2, p<0.05; constant=91.8, p<0.001) that produced white noise residuals (Q=27.3 at 24 lags).

† Gradual, permanent heart rate change modeled with a first order transfer function applied to a step variable. Denominator was constrained to 0.7.
‡ Abrupt, temporary heart rate change modeled with a first order transfer function applied to a pulse variable. Denominator was constrained to 0.7.
* p<0.05
Activities, locations, landscapes

• What are they doing, where are they doing it, what is there?
• Proliferating technology has created opportunities to capture health experience data in real time in the real world.
  • Devices range from paper and pencil questionnaires, electronic handheld devices, PDA programmed to beep, motion detection, geographic location, physiological monitoring, electronic bottle caps.

• Ecological Momentary Assessment – EMA
  • Characterized by repeated collection of real-time data on participants’ momentary states in the natural environment.
  • Precursors are behavioral observation, diaries, time budgets.
• Great promise and opportunity; challenges and difficulties.
<table>
<thead>
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<th>Time</th>
<th>Lat Degrees</th>
<th>Long Degrees</th>
<th>HeartRateBpm</th>
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<td>4:36:01 PM</td>
<td>39.9463678</td>
<td>-75.1965459</td>
<td>86</td>
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<td>4:36:03 PM</td>
<td>39.9461718</td>
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<td>82</td>
</tr>
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<td>4:36:17 PM</td>
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<td>82</td>
</tr>
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<td>4:36:22 PM</td>
<td>39.9447566</td>
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</tr>
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<td>85</td>
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<td>4:36:47 PM</td>
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<td>86</td>
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<td>4:36:51 PM</td>
<td>39.944593</td>
<td>-75.1979365</td>
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<td>7:06:48 PM</td>
<td>39.9483675</td>
<td>-75.1972006</td>
<td>100</td>
</tr>
</tbody>
</table>
Multiple measures per minute

Mean

Median

Maximum

Beats per minute

Time

One measure per minute

One measure per minute
4 types of geographic data

Points (disease occurrences, health facilities, residences)

Lines (transportation routes, power lines)

Polygons (rooms in a floor plan, census tracts, parks)

Grids/matrix (can represent points, lines, and polygons)

FIGURE 1.1. Digital geographic databases registered to a common geographic reference system. A composite of two or more layers can be produced because the geographic references match.
Philadelphia Neighborhood Information System

parcelBase is a tool for researching individual properties in Philadelphia. You can find property profiles by address, search by characteristics, or browse an interactive map.

parcelBase is available to city employees and non-profits who have been approved by the Office of Housing and Community Development.

In parcelBase you will find property data on:
- Ownership
- Sales History
- Taxes
- Building Type
- Fire History
- Vacancy
- Assessment History
- Utilities Shutoff
- Housing Violations
- Seals & Demolitions
- and more...

Home
Where Do I Start?
Training
NIS Information
Funders
Additional Resources
Contact
Applications
neighborhoodBase
parcelBase
crimeBase
muralBase

How is NIS being used?
Featured Projects
List of other NIS Users
Rationale for real-time assessment

Three key benefits

1. Avoidance of recall bias, by measuring momentary states.
   • Poor recall of past experiences, especially those that are frequent, mundane, irregular.
   • Substantially inaccurate; systematically inaccurate.
   • Memory is reconstructive; recall is heuristic: Frequency of taking pain med?
   • Good recall on current here-and-now experiences and observations.

2. Ecological validity by collecting data in the real world.
   • Alternative is to model real world in laboratory setting. But imagine one’s reaction to a simulated stressor in the lab vs real world. Context matters.
   • Global, retrospective reports suggest full coverage; EMA derives snapshots.

3. Temporal resolution, detecting dynamic processes.
   • Temporal data enable testing associations that unfold over time.
   • High resolution needed to understand how thoughts precede behaviors.

Stone, Shiffman, Atienze, Nebeling 2007
Rationale for real-time assessment

Limitations

• Not for experiences that are rare and important (eg, graduations, weddings, birth).
• Some retrospective reports may better predict health or behavioral outcomes than real-time assessments, if subsequent behavior is influenced by the recalled experience rather than the momentary experience.
• May be most useful for those willing to use technology or those willing to enroll in studies requiring intensive assessments.
• Fine motor skills may be required.
Two patients rating pain (0-10) at 1-min intervals during colonoscopy.

Both experienced similar peak pain; but patient B’s colonoscopy lasted more than twice as long, resulting in an overall experience of more pain.

A few minutes after completion, patient B rated the overall experience as less painful.

Peak-and-end heuristic: *How bad did it get? How does it end?* Hence, patient B was left with a memory of less pain that patient A (despite similar peak and longer duration).

Two implications:
1. Duration of experiences is not well represented in memory.
2. Retrospective reports of intensity are based on two distinct moments.

Concurrent pain provides more accurate picture of experiences. But, retrospective measure may be desired (eg, to predict compliance with subsequent colonoscopy).

Schwartz 2007
References


Cartographic Modeling Lab  http://cml.upenn.edu/


Wiebe DJ: Stress associated with public health field research. AJPH 2010, 100(12):2332-3.

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