

turning knowledge into practice

Data Collection Platforms for Integrated Longitudinal Surveys of Human Exposure-Related Behavior

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Need for Integrated Data Collection

- **Routes of exposure**
 - Inhalation
 - Ingestion
 - Dermal contact
- **Modifiers of exposure**
 - Breathing rate, exertion, specific activities
 - Food and beverage consumption
 - Use of consumer products
 - Carpet, gloves, open doors/windows, microenvironment)
 - Season, geographical location, temperature, humidity

Overall Objectives

Develop a personal data collection system that:

- integrates data input streams for collection of human exposure-related behaviors
- supports EPA human exposure assessment models
- is easily adapted for other human exposure assessment studies
- has sufficiently low burden that most members of the general household population of the U.S. will be willing to participate in the study for at least 1 week per season for 1 year

Approach

- **Develop diary methodologies for data collection**
- **Develop sensors & automation to reduce burden**
- **Evaluate methods in the general population**
- **Assess, improve, and enhance developments**
- **Re-evaluate methods and technologies**
- **Facilitate system use for other research studies**

Methods

Activity/Location/Exertion/Environment Data Collection

- **Paper diary** – traditional forms and booklets
- **Menu diary** – menus and forms on Pocket PC (PPC)
- **Voice diary** – questions/answers on PPC
- **Photo diary** – periodic photos on PPC
- **Automation**
 - GPS for outdoor location and movement
 - Wireless beacons for indoor residential locations
 - Wireless Polar chest belt for heart rate monitoring
 - Accelerometers for movement and compliance monitoring

Methods

Dietary Data Collection

- **Paper diary** – forms and booklets (24-hour recall)
- **Menu diary** – menus and forms on PPC (real-time)
- **Voice diary** – questions/answers on PPC (real-time)
- **Automation** – none

Methods

Consumer Product Data Collection

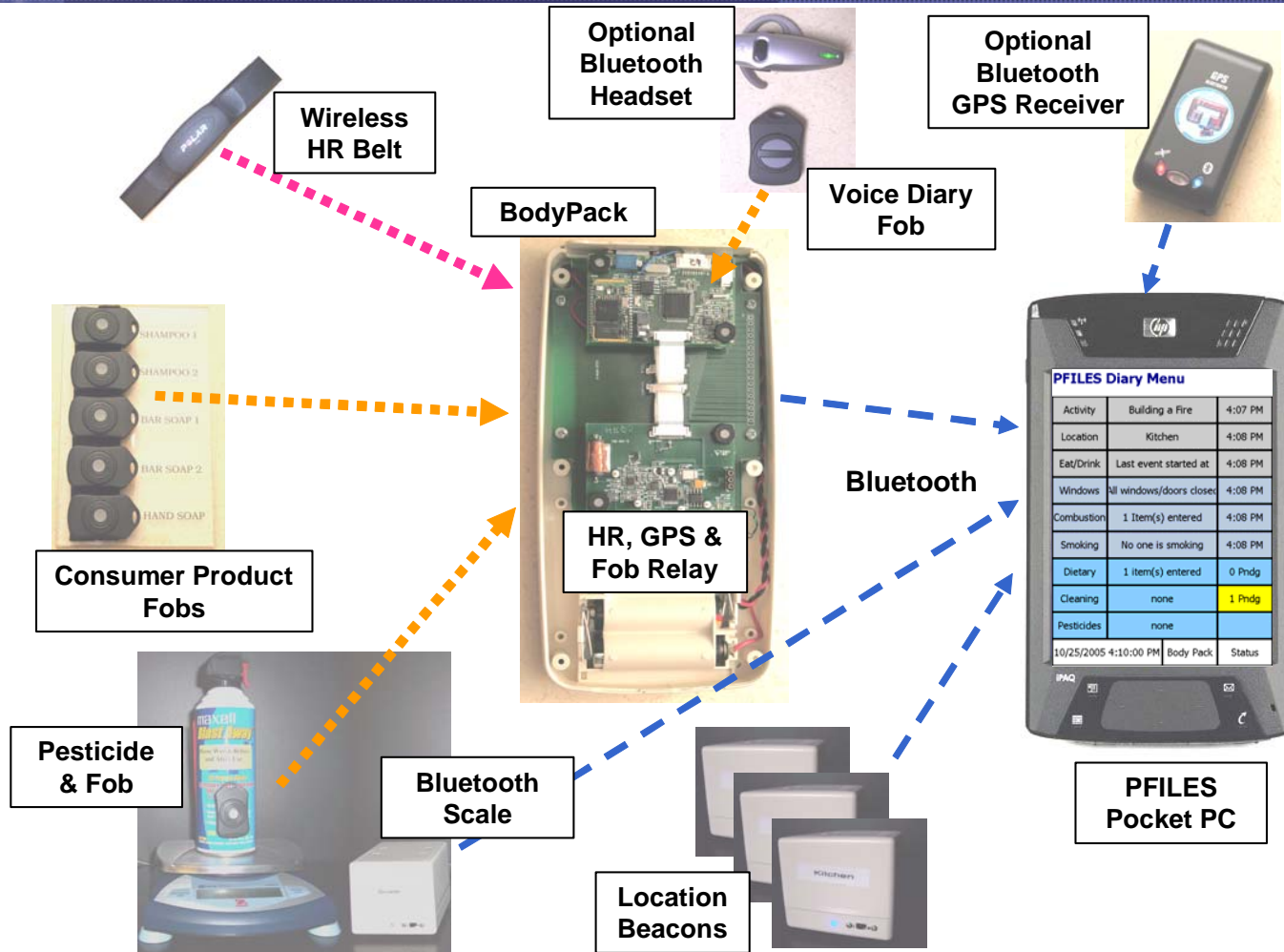
- **Paper diary** – forms and booklets (24-hour recall)
- **Menu diary** – menus and forms on PPC (real-time)
- **Automation** – wireless buttons record each product use event
 - **Personal care products**
 - Soaps and shampoos
 - Fob-initiated time stamp
 - **Household cleaning products**
 - Kitchen and bathroom cleaners and sanitizers
 - Fob-initiated time stamp; then Pocket PC forms/questionnaire
 - **Pesticide products**
 - Fob-initiated time stamp; Pocket PC-based forms/questionnaire
 - Aerosols weighed before and after use; weights sent wirelessly to PPC

Paper Form Diary

START TIME*		STOP TIME*	
1	1	2	3
AM	<input type="checkbox"/>	PM	<input checked="" type="checkbox"/>
0	6	4	6
AM	<input checked="" type="checkbox"/>	PM	<input type="checkbox"/>

<p>A. YOUR CURRENT LOCATION (circle only one)</p> <p><u>IN VEHICLE</u></p> <ul style="list-style-type: none"> - Car, van, or SUV 01 - Pickup or other truck 02 - Bus 03 - Train, trolley, or subway 04 - Other vehicle 05 Specify _____ <p><u>INDOOR LOCATION</u></p> <ul style="list-style-type: none"> - Your residence c kitchen 06 c garage 07 c other room 08 - Other residence c kitchen 09 c garage 10 c other room 11 - Non-medical office building 12 - Manufacturing facility 13 - Restaurant 14 - Store 15 Specify type _____ - School 16 - Spa or exercise facility 17 - Service station or vehicle repair facility 18 - Other indoor location 19 Specify _____ <p><u>OUTDOOR LOCATION</u></p> <ul style="list-style-type: none"> - Your residence c lawn, garden, or natural area 20 c pavement, deck, or porch 21 - Other residence c lawn, garden, or natural area 22 c pavement, deck, or porch 23 - Outdoor restaurant or eating area 24 - School grounds or athletic field 25 - Service station or other vehicle refueling 26 - Parking lot 27 - Parking garage 28 - Other outdoor location 29 Specify _____ 	<p>B. YOUR ACTIVITY (please be specific)</p> <p style="text-align: center;"><u>Sleeping</u></p> <hr/> <p>C. YOUR BREATHING RATE (circle only one)</p> <ul style="list-style-type: none"> - Sleeping or napping 01 - Slow (e.g., sitting, standing, slow walk) 02 - Medium (e.g., brisk walk) 03 - Fast (e.g., running) 04 <p>D. OUTDOORS OR IN VEHICLE WITHIN 30 FEET OF ROADWAY?</p> <ul style="list-style-type: none"> - Yes 01 - No 02 <p>E. SMOKING (circle all that apply)</p> <ul style="list-style-type: none"> - You are smoking 01 - Others are smoking (within 30 feet) 02 - No one is smoking 03 <p>F. OTHER OPERATING COMBUSTION SOURCES WITHIN 30 FEET OF YOUR LOCATION (circle all that apply)</p> <ul style="list-style-type: none"> - Gas stove 01 - Fireplace 02 - Wood stove 03 - Kerosene heater 04 - Other indoor combustion source 05 Specify _____ - Charcoal grill 06 - Gasoline-powered mower 07 - Gasoline-powered tool 08 - Other outdoor combustion source 09 Specify _____ <p>G. WINDOWS AND DOORS TO OUTDOORS (ONLY IF INDOORS OR IN VEHICLE) (circle all that apply)</p> <ul style="list-style-type: none"> - One or more windows are open 01 - One or more doors are open 02 - All windows and doors are closed 03 <p><i>Note: You do not need to report locations or activities that last less than 2 minutes.</i></p>
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Personal Data Collection Platform



Pocket PC Menu Diaries

Activity	Leisure Activities	Home Entertaining/Relaxing
<p>Top Back Start Time: Now</p> <ul style="list-style-type: none">Personal CareCaring for Other PersonMeals or Snacks ActivitiesTravelingWork or Education/Training ActivitiesHousehold ChoresShopping or Obtaining ServicesSleeping/NappingPerforming Project Activities	<p>Top Back Start Time: Now</p> <ul style="list-style-type: none">Entertainment, Religious or Social ActivitiesActive Sports/Leisure/PlayArt and Craft ActivitiesPerforming ArtsOther, specify	<p>Top Back Start Time: Now</p> <ul style="list-style-type: none">Watching TVListening to Radio or MusicUsing ComputerPlaying Other GamesReading/WritingConversing with OthersWatching Activities by OthersRelaxingOther, specify

Multilevel menus are used to capture activity and location data.

Window_Door State	Combustion Source	Smoking
<p>Top Back Start Time: Now</p> <ul style="list-style-type: none">Open windows to outdoorsOpen doors to outdoorsOpen windows and doorsAll windows/doors closedOutdoors	<p>Back Next Start Time: Now</p> <ul style="list-style-type: none"><input checked="" type="checkbox"/> Cooking with gas<input type="checkbox"/> Fireplace in use<input checked="" type="checkbox"/> Wood stove in use<input type="checkbox"/> Kerosene heater in use<input type="checkbox"/> Cooking with charcoal<input checked="" type="checkbox"/> Using gasoline-powered mower<input type="checkbox"/> Using other gasoline-powered tool<input checked="" type="checkbox"/> Within 30 feet of other combustion<input type="checkbox"/> Outdoors within 30 feet of a roadway<input type="checkbox"/> In a vehicle within 30 feet of a roadway<input type="checkbox"/> None	<p>Top Back Start Time: Now</p> <ul style="list-style-type: none">I am smokingOthers are smokingI & others are smokingNo one is smoking

Familiar navigation style to facilitate user interaction and reduce error.

Single and multi-selection menus are used for environmental data.

Pocket PC Menu Diaries (continued)

<p>Select Food Consumed</p> <p>Top Back</p> <p>Water, Beverages, and Juices Dairy Products Sandwiches, Soups, Stews, and Entrees Meat and Eggs Vegetable, Nuts, Seeds, and Olives Fats and Oils Fruit Grain Products Sweets and Desserts</p>	<p>Select Vegetable, Nuts, Seeds, and Olives</p> <p>Top Back</p> <p>Salads Raw Vegetables Cooked or Canned Vegetables Nuts, Seeds, and Olives</p>	<p>Select Cooked or Canned Vegetables</p> <p>Top Back</p> <p>Beets Broccoli Brussel sprouts Carrots Cauliflower Chickpeas Collard greens, kale, chard, etc. Corn Lentils Mixed vegetables Mushrooms Onions Peppers (all colors)</p>	<p>How many servings of Cauliflower were consumed?</p> <p>Back Done</p> <p><input checked="" type="radio"/> 1 <input type="radio"/> 4 <input type="radio"/> 2 <input type="radio"/> 5 or more <input type="radio"/> 3</p>
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Multilevel menus are used to capture dietary data, with radio-buttons for serving size.

<p>Please indicate the type of pest or pests treated with this application by selecting a code or codes from the list below. Refer to the booklet provided for examples."</p> <p>Back Next</p> <p>MICROORGANISMS</p> <p>Mildew, Mold, Bacteria or Virus Wood decay or rot Plant diseases</p> <p>INSECTS</p> <p>Cockroaches Stored food insect pests Fabric insect pests Termites Other wood destroying insects Fire ants</p>	<p>Please indicate the method of application by choosing a code from the list below."</p> <p>Back Next</p> <p>AEROSOL/SPRAY</p> <p>Aerosol (pressurized spray) Sprayer, finger pump (push down) Sprayer, hand trigger (squeeze) Sprayer, hose-end Sprayer, hand wand/pump/tank <input checked="" type="checkbox"/> Sprayer, backpack</p> <p>BAIT/TRAP</p> <p>Bait box/station/trap Fly strip</p> <p>CANDLE/COIL</p>	<p>Please indicate the site or sites treated with this application by choosing a code or codes from the list below."</p> <p>Back Next</p> <p>Greenhouse Unfinished basement Crawlspace Other indoor area, specify</p> <p>OUTDOORS</p> <p>Shed - not attached to the home Outdoors, deck/patio/porch Outdoors, hot tub Outdoors, swimming pools Outdoors, lawn Outdoors, natural area</p>	<p>Please indicate any safety precautions used during this application by choosing a code or codes from the list below."</p> <p>Back Next</p> <p><input checked="" type="checkbox"/> Mix chemicals outdoors Wash Hands after use <input checked="" type="checkbox"/> Apply when the wind is calm Hold breath Change clothes Cover or remove food Cover or remove non-food items <input checked="" type="checkbox"/> Place area off limits to pets or people Other, please specify None of the above</p>
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A sequence of questionnaire forms are presented in response to a pesticide job event.

Photo Diary

120° lens



Pocket PC



Image Censoring & Analysis



Voice Diary

Headset/Fob



Diary request

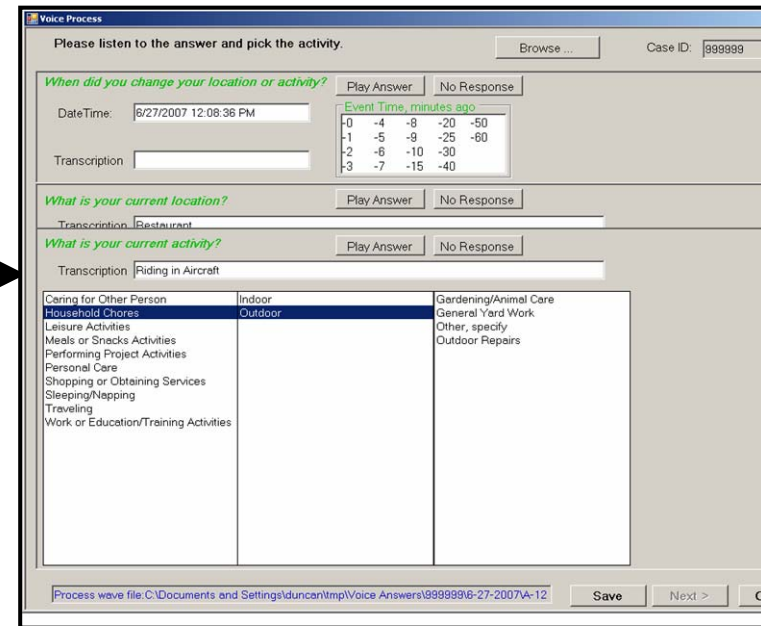
Questions

Responses

Pocket PC

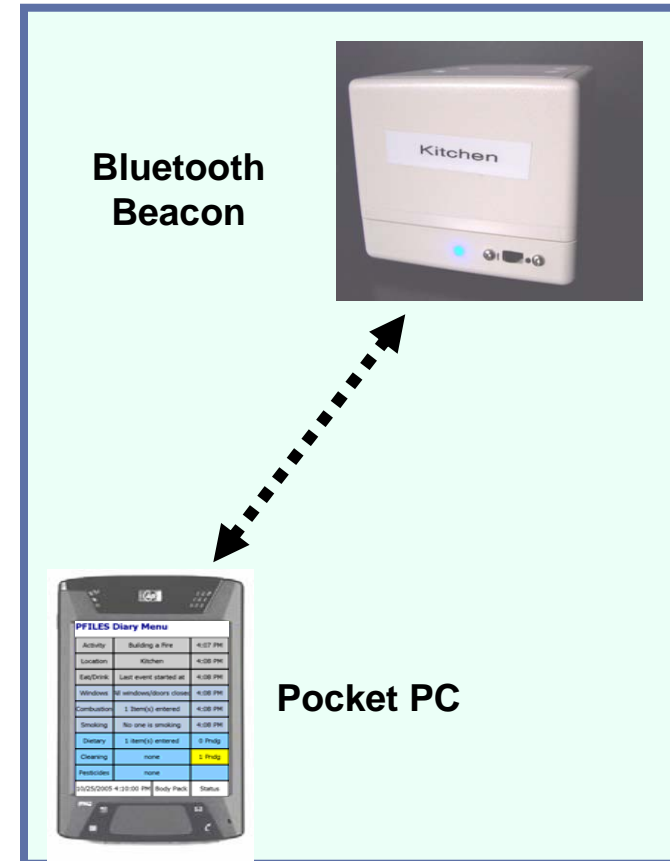


Activity / Location / Diet Coding

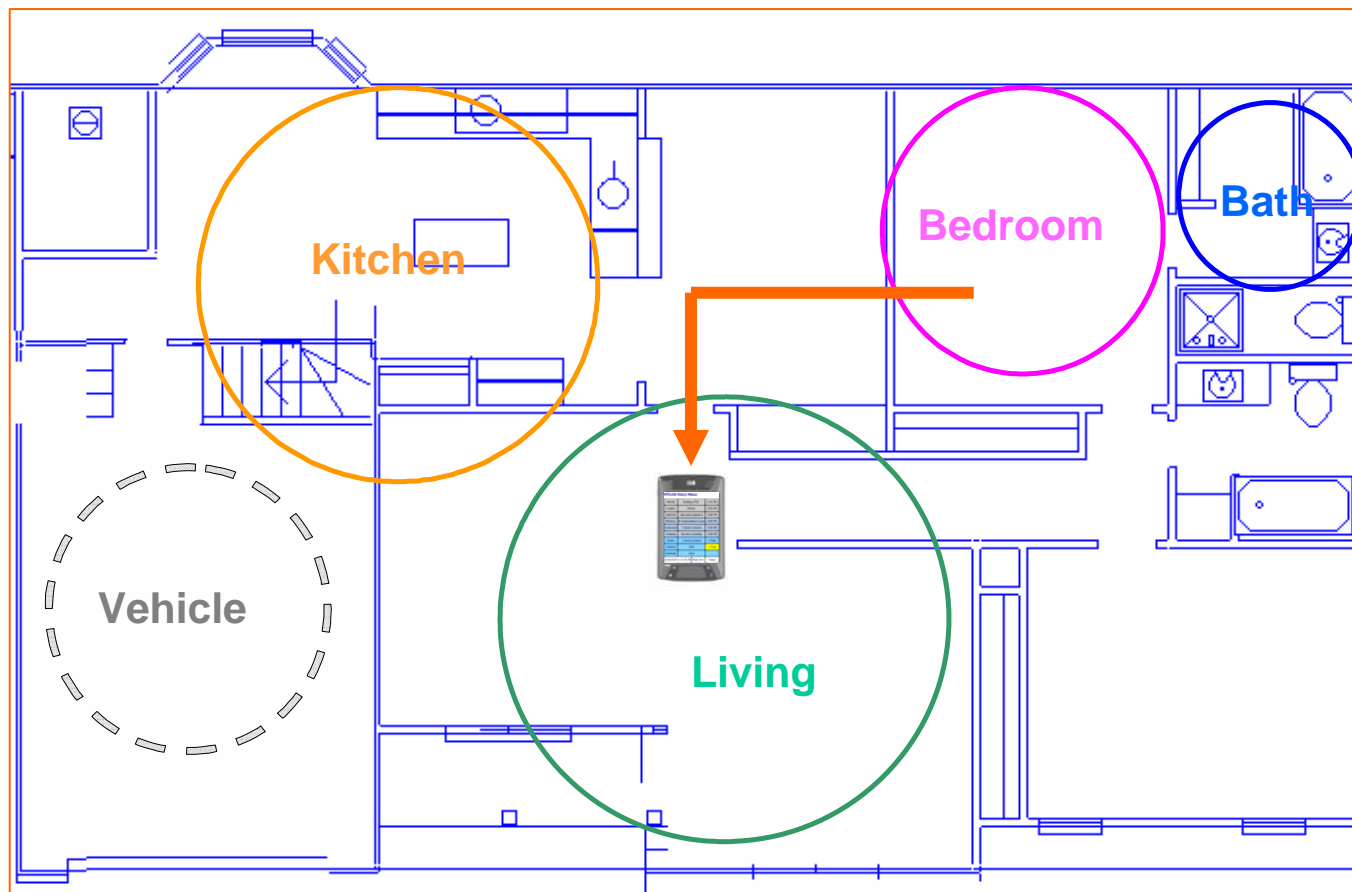


Locator Beacons ...

- **Beacons are placed throughout the residence in study-designated rooms**
- **Each beacon is configured for:**
 - Maximum detection range for designated room
 - Study detection interval (e.g., 60 seconds)
 - Beacon ID code for room identification
 - Designated Pocket PC Bluetooth address
- **Location tracking:**
 - At each interval, the beacon microcomputer powers up the internal Bluetooth module
 - The beacon attempts to establish a Bluetooth connection with the designated Pocket PC
 - If a connection is established, the beacon sends a time/date stamped Beacon ID code to the Pocket PC
 - The internal Bluetooth module is powered down until the next interval



Example Residential Beacon Use



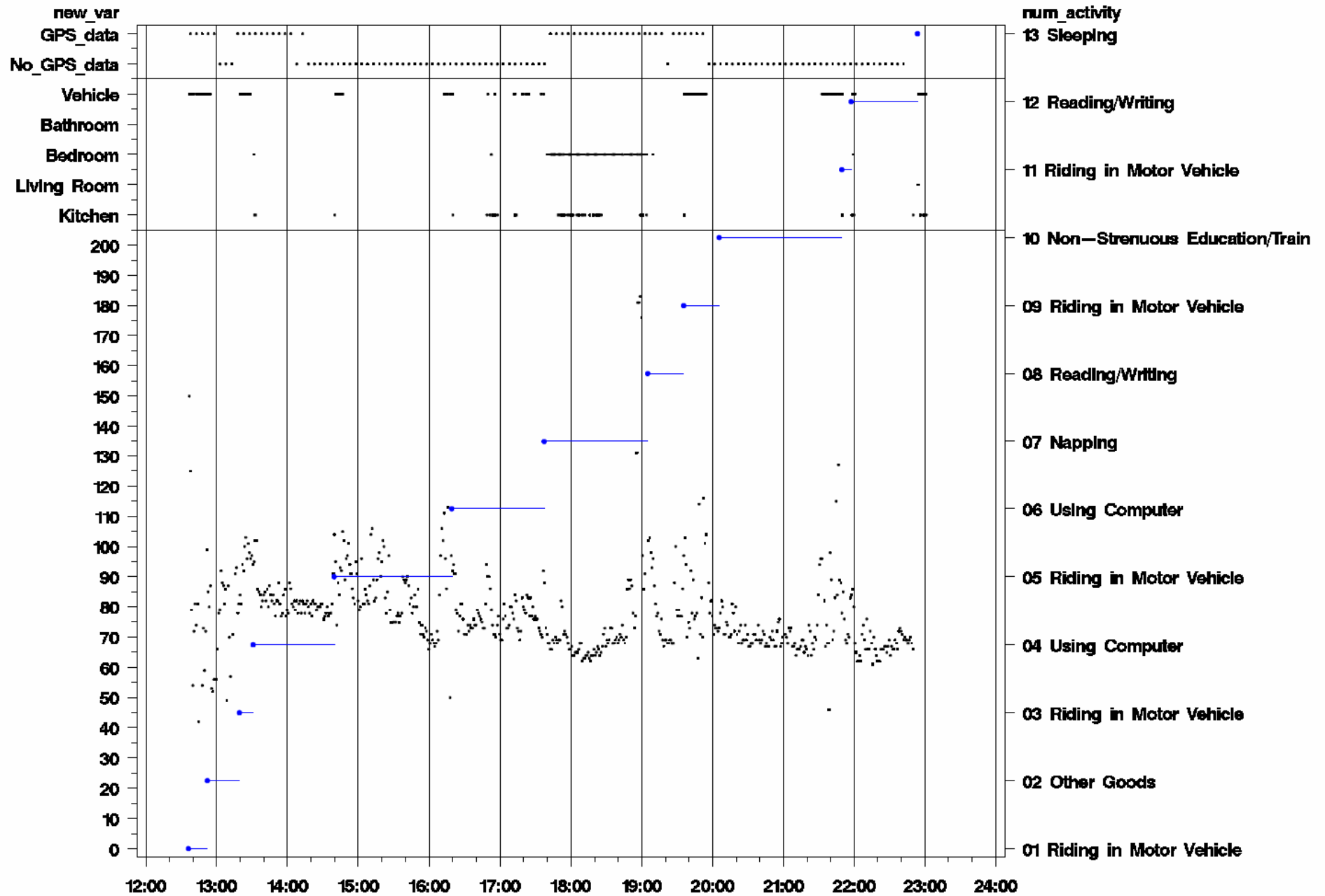
Pilot Evaluation of Technologies

- **Purpose:**
 - Evaluate technical performance of technologies & systems
 - Evaluate participant & analyst burden for various diary modes
- **Participants (N=48)**
 - Gender: Female (N=35); Male (N=13)
 - Age: 18-34 (N=14); 35-65 (N=25); >64 (N=9)
 - Ed: HS/GED (N=14); some college (N=16); college grad. (N=18)
- **Field study design**
 - Four data collection modes: Paper, PPC menu, PPC voice, PPC photo
 - All had heart rate and residential location beacon monitoring
 - All use wireless fobs to record product use events
 - Each participants used the data collection system for 7 days

Example activity and dietary data

Time	Activity
12:00:44	Grooming/Dressing
15:24:06	Wash/Dry/Sort/Iron Clothes
15:25:40	Riding in Motor Vehicle
15:26:40	Clothes
16:42:33	Eating/Drinking
16:44:44	Picking up/Putting Away Items
18:23:56	Household Paperwork
18:24:57	Relaxing or Resting
19:38:21	Picking up/Putting Away Items
19:39:52	Preparing Food
19:40:33	Watching TV
23:14:07	Other Washing
23:14:38	Sleeping

Time	Food / Beverage
17:01:43	Tea
18:05:59	Cheese (plain or as part of dish)
18:05:59	Crackers, any kind
18:03:02	Beef or veal
18:03:02	Potatoes, any other
18:03:02	Other salad
13:06:20	Nuts (peanuts, etc.)
13:06:20	Coffee
21:59:52	Tea
13:15:03	Banana
13:15:03	Chicken, turkey or other poultry
17:51:26	Beans, green
17:51:26	Potatoes, any other



Participant reporting compliance

	Diary Mode	Activities per hour	Locations per hour
	Paper	1.42	0.95
	PPC	1.12	0.75
	Voice	1.29	1.34
	Photo	2.69	2.59

Top 15 activities reported by mode

Activity	PPC (%)	Paper (%)	Voice (%)	Photo (%)
Riding in Motor Vehicle	23.0	22.4	21.9	16.2
Eating/Drinking	11.7	8.4	5.9	3.2
Non-strenuous Work	8.1	8.2	7.8	4.4
Sleeping	6.2	4.2	2.9	0.0
Watching TV	5.6	4.5	4.9	9.2
Walking	3.8	6.5	8.0	17.6
Grooming/Dressing	3.6	5.0	2.4	4.1
Visiting with Others	2.7	1.0	1.0	5.8
Picking up/Putting Away Items	2.5	1.3	0.9	2.4
Preparing Food	2.5	3.9	4.9	5.8
Tub Bath	2.5	0.1	0.0	0.0
Relaxing or Resting	2.2	2.0	3.4	2.8
Reading/Writing	2.1	2.1	1.2	1.8
Using Computer	2.0	1.6	1.2	3.2
Moderately Strenuous Work	1.6	0.1	1.4	0.00

Data Entry Burden (median)

Time to complete entry in seconds

	Measured Menu	Perceived		
		Menu	Voice	Paper
Act/Loc/Environ	28	45	60	60
▪ Activity	11			
▪ Location	9			
▪ Combustion	1			
▪ Smoking	3			
▪ Windows/doors	4			
Cleaning products	36	60	n/a	60
Pesticides	131	60	n/a	120

Burden for each entry of an activity/location and for each product use questionnaire

Data Coding Burden (median)

	Analyst hours	Study hours	Analyst hours per 24-hr day
Menu¹	00.0	630.1	0.00
Photo²	58.5	282.4	4.97
Voice²	87.4	427.0	4.91
Paper³	69.7	979.7	1.71

1. Pocket PC menu diary is self-coded by the participant
2. Time for coding by a single analyst.
3. Included time for 100% re-key verification.

Top 10 food items reported by mode

Order	Paper food item	Paper (%)	PPC food item	PPC (%)	Voice food item	Voice (%)
1	Tap water	6.5	Tea	8.2	Bottled water	10.5
2	Bottled water	6.3	Tap water	8.0	Tap water	7.9
3	Soft drink	5.1	Bottled water	6.2	Soft drink	4.7
4	Coffee	3.1	Soft drink (soda, cola, etc.)	5.6	Chicken, turkey or other poultry	4.2
5	Other grain product	2.9	Chicken, turkey or other poultry	3.8	Other grain product	3.9
6	Chicken, turkey or other poultry	2.6	Chocolate / candy	3.1	Rice and rice mixtures	3.7
7	Cheese	2.4	Beef or veal	2.5	Coffee	2.9
8	Tea	2.3	Juice mixtures	2.5	Cheese	2.6
9	Potatoes, any other	2.2	Lettuce salad with assorted vegs.	2.2	Other non-alcoholic drink	2.4
10	Butter	2.0	Other sweets or dessert	2.2	Pork or ham	2.4

Comments / Conclusions

- The burden for menu-based activity and location data entry is low; however several expressed difficulty with the menus.
- Activity and location reporting was lower than in previous studies.
- Participants liked using the voice diary, although technical issues affected recording quality.
- While most liked the photo diary, some participants expressed privacy issues in their workplace.
- Some participants reported avoiding activities and limiting diet to reduce entries for paper, voice, and menu diaries
- Further improvement in menu structures, prompting, and automation may help to improve compliance and avoid behavior modifications