Passive and Situated Data Collection

Fundamentals of Data Collection II
January 27, 2025
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Outline

1. Situated Self-reports (EMAs) and Passive (Sensor-based) Measurement (Fred)
2. Studies that integrate situated and passively collected data (Heidi)
3. Case Study (Heidi)
4. Class exercise (Fred)

Limits of self-reports in conventional surveys

- Survey research relies on self-reports – primarily answering survey questions
- Self-reports in sample surveys have provided invaluable information to researchers for almost 100 years
- Nonetheless, the data are inherently retrospective
  - Not informative about in the moment experience
  - Silent about context of responding
- And they include measurement error, e.g., forgetting

Measurement Error

- Recall error inherent in lag between occurrence of to-be-reported event and administration of *Q*
  - The greater the lag the more error (both forgetting and telescoping) that is likely to occur
- Reducing reference period can help
  - Time diaries (e.g., in American Time Use Survey) usually concern "yesterday," but *R's* sometimes rely on *routines* rather than recalling specific events, and misreport details if different from routine
- Eliminating lag should virtually eliminate memory error: focus on current moment

Context

- Much research on effects of *questionnaire* context, especially question order effects
  - e.g., part-whole context effects
- Very little research on how *R's internal state and social context* at the time of measurement can affect reports
- Knowledge of data collection contexts e.g., *R*'s mood or location when answering, can enrich conventional self-reports and interpretation/analysis of survey data

Granularity of Measurement

- In panel surveys, repeated measurement is typically monthly but can occur annually or less frequently
- Theoretically-relevant events can occur between measurement occasions – waves – and change population attributes without being detected
  - e.g., in close, high visibility electoral campaign, news events can change public opinion between polling waves, but what's causing the change must be inferred
- Intensive longitudinal measurement
  - Collecting data from *several times a day* on several days per week up to *continuously* allows researchers to track change within individuals in detail
    1. Ecological Momentary Assessment (EMA) (also known as Experience Sampling Method [ESM]) – multiple short, situated* questionnaires each day
    2. Sensor measurement via device like smart phone or smart watch; *passive* in that no special action required by participant to create and capture data

* situated: right now, right here

Ecological Momentary Assessment (EMA)

- *R*s signaled ("pinged," "beeped") by device multiple times a day (usually) to report about current circumstances (*in situ*)
  - originally signaled by pager ("beeper") and responded in paper diary but smartphones are now typically used to signal participants and administer the brief questionnaires
- Researchers typically ask about current context,
  - In the moment: "now" or "when you heard the beep"
  - Social: "Who is with you?"
- Depending on topic of study, *R* may be asked about
  - Objective situation: e.g., "What are you doing?" "Who is present?"
  - Subjective state: e.g., "How anxious are you right now?"
- Direct descendant of diary studies but reporting is prompted by signal
  - Measurement is fine grained: prompting is scheduled and automatic

EMA (2)

- *Ecological:* Data collected in real-world environments, as participants go about their lives
- *Momentary:* current, often subjective, state, e.g., stressed
  - no recall or summary over long periods required
  - Aim is to avoid measement error inherent in retrospection
- *Assessment*: Moments are strategically selected for assessment
  - Repeated self-reports are typically collected on the device that signals – "pings" – participant in the moment and then administers questionnaire
  - Ideally, measurement frequency adequately represents states or events of interest
- Participants complete multiple assessments during study, providing picture of how their experiences and behavior vary over time and situations

EMA Sampling Approaches

- Time-based
  - Resolution depends on frequency and duration of target behavior
    - e.g., blood pressure every 30-40 mins; migraines 1-2 times daily
  - Fixed versus variable times/intervals
- Event-based
  - Typically, participants determine when event has occurred and initiate assessment, i.e., they are not signaled
  - Occurrence of some events can be automatically detected by devices such as changes in heart rate, location (geofencing), mobility (e.g., travel in vehicle)
  - Can be hard to objectively define some events, e.g., an acute pain episode, or intense cigarette craving, so left to participants' judgment
  - Concern about poor compliance and falsification

EMA Example

- Smoking cessation study (Shiffman et al. 1997)
  - Do smokers trying to quit relapse because initial lapse causes negative feelings
  - Administered EMA and retrospective surveys
- Lapses did increase negative affect but did not predict relapse – in contrast to participants' later recall
  - Smokers recalled their mood after lapse as worse than their EMA reports indicated
- Interpreted as evidence that real time assessments of behavior and experiences, as both antecedents and consequences of events, enable more valid and detailed understanding of phenomenon

Quality of EMA Data

- Is in-the-moment assessment actually more accurate than recall?
- There is usually a discrepancy between the two
  - e.g., EMA and retrospective measures of coping with stress correlate *r*=.51 (Stone et al., 1998)
- While forgetting mostly eliminated by EMA, reports can be inaccurate if
  - event still underway when participant signaled
  - participant changes how they classify events during EMA period
  - Non-compliance (e.g., do not respond when pinged)

EMA Reports vs. Subsequent Recall

- EMA shown to predict theoretically related outcome better than global recall measure:
  - EMA measures of job stress better predict carotid blockage than global measure (Kamarck, et al., 2007)
- In some cases, recall is better predictor of subsequent behavior than EMA
  - Redelmeier & Kahneman (1998) colonoscopy patients' retrospective evaluation pain during procedure when they provided frequent in-the-moment reports of pain
  - Participants retrospective reports of pain were better predicted by two moments during the procedure, *peak* and *end* pain than by average in-the moment pain
  - Peak-end approach better predicted return for subsequent procedure than real time assessments
  - But recall reflects how event is *encoded* rather than how *experienced*

Quality of EMA Data (2)
Do EMA Rs Report About "the Moment?"

- Rs may provide typical or average assessment over an interval rather than at the moment they were pinged
- Wen et al. (2021) conducted cognitive interview right after EMA to explore what interval participants reported about
  - EMA concerned anxiety, happiness, hunger, and pain
  - Manipulated extent to which participants trained how to respond to EMA
- With minimal training
  - 68% of participants reported in cognitive interview that they focused on the moment, not longer period or their typical feelings
- With more extensive training
  - 98% reported that they focused on the moment

Reactivity and EMA

- *Reactivity* refers to change in behavior as a result of its being measured
  - e.g., monitoring caloric intake and expenditure can lead weight watchers to take in fewer or burn more calories
  - Behavior change actually is the goal of fitness or health apps
- Possible that in response to being repeatedly signaled, EMA participants' experiences change
  - Describing state in response to signal might affect how participant experiences a state, e.g., being pinged when trying to relax might affect reports of relaxation
- No evidence, so far, that number of signals affects self-report
  - Stone et al. (2003) signaled groups to report pain on 5-point scale either 0, 3, 6, or 12 times per day for 12 days
  - No systematic differences between frequency groups
  - No effect on recalled pain after the 12 days

Passive (Sensed) Measurement

- Measurement error (ME) inherent to self-reports; EMAs introduce additional (ME)
- Alternative is to passively collect physical and physiological data via sensors, typically wristband/smartwatch (e.g., Fitbits) or smartphones
- Measurement occurs without any initiating action by participant
  - e.g., accelerometer on smartphone detects bodily movements including steps – always on
  - No recall, no self-report involved
- Sensor data are *primitive* in sense that low level building blocks
  - Raw sensor data processed by apps to produce more complex measures (e.g., steps)
- Researchers must often infer behavior from pattern of sensor data; increasingly EMAs administered to help interpret sensor data

Native Smartphone Sensors

Proximity sensor

Bluetooth NFC

Compass

Barometer

Air humidity sensor

Camera*

GPS

Cellular network

Wi-Fi

Light sensor

Microphone

Fingerprint sensor

Thermometer

Accelerometer Pedometer

Gyroscope

*can be used to measure heart rate (Android/Samsung), linear distance (iPhone Measure app), as well as for photography

Passive (Sensed) Measurement (2)

- This is new!
  - much less known about sensor measurement than self-reports; “best practices” still evolving
  - Most studies using sensors for social measurement are, so far, primarily demonstrations of feasibility
- Used to measure behaviors, i.e., actions – objective phenomena
- No direct way to “sense” most subjective phenomena
  - Psychological stress can be pretty accurately measured via electrodermal activity or heartrate but opinions, e.g., presidential approval, not measurable with sensors

Passive (Sensed) Measurement (3)

- Even the measurement of objective phenomena requires *inference*
  - e.g., the GPS location to which a phone is carried each weekday morning is assumed to be the owner's workplace – but may be coffee shop, etc.
  - e.g., steps are measured by acceleration of phone (accelerometer output) and change in location (GPS); thus, what is counted as a "step" is really inferred from two sensors that are not designed to measure steps

Coverage Error

- Those who do not own the sensor devices (smartphone or smartwatch) are likely to differ significantly from owners
- possibly on the very behaviors that sensors measure
  - e.g., in a study of physical activity based on accelerometer data, older people are less likely own a device (so cannot participate) and are also likely to be less physically active, biasing findings
  - To overcome coverage problems and allow generalization to population, researchers can provide devices to participants:
- Even if device ownership were universal, participation rates likely to be low
  - Reasons for non-participation: intrusiveness, privacy, ability to use only limited features (Wenz et al., 2017; Keusch et al., 2019)
  - In studies that collect both self-report and sensor data from the same smartphone/smartwatch users, the researcher is in effect asking users to make two participation decisions

Measurement Error

- Passive measurement is not perfectly accurate

1. Sensors might be inaccurate
   - Two different devices (e.g., smartphone vs. GPS watch), two brands of smartphones (e.g., iPhone vs. Samsung), two generations of the same smartphone (e.g., iPhone 6 vs. iPhone 16), or even two versions of the same operating system (e.g., Android 10 vs. Android 14) can produce different measures (e.g., Bähr et al. 2020; Goodspeed et al. 2018; Höchsmann et al. 2018)
2. Inference from raw sensor data to target behavior (e.g., from phone's movement to "steps" to "walking") may lead to misclassification (invalidity)
   - e.g., sleep may be defined by darkness, silence and lack of movement detected by sensors (Wang et al., 2014) could be due to phone left in bag at home
3. Non-compliance
   - Unintentional (e.g., forget to turn phone back on after movie; leave phone at home) -- probably increases variance (noise) but not systematic error (bias)
   - Deliberate (e.g., app turned off to hide undesirable behaviors or locations) -- producing bias
   - Evidence, so far, is that compliance is high (Bähr, et al. 2020; Sugie, 2018)

Cost

1. Passive data collection requires little effort for either the participant or the researcher and is in some ways inexpensive, i.e., few variable costs
2. But costs for…
   - App development, potentially for different operating systems
   - IT infrastructure (i.e., storage capacity and skilled support staff) for big datasets
   - Data preparation, analysis, and reporting capability (e.g., data wrangling, machine learning, data linkage, visualization, etc.)
   - Providing device to participants
3. Taken together, these factors can lead to a more expensive project than might be initially evident

Implications for Privacy*

1. Continuous (always-on) or high frequency measurement, likely to seem intrusive to prospective participant, potentially reducing consent or completion of study
   - Privacy regulations for this kind of data really do not exist, at least in US
2. Several steps have been used to reduce potential concerns
   - Explain why passively collected data are required to meet project's scientific goals and how participants' data and identities will be protected
   - Allow participants to turn off tracking temporarily; "privacy nudging"
   - Limit sensors' abilities, e.g., Wang et al. (2014) designed speech detection process that could determine if participants were "around conversation" but not what was said or who said it

*from Keusch & Conrad, 2021

2. Examples of Studies Combining Situated (EMA) & Passive Data Collection

How does self-reported (subjective) versus measured (objective) physical activity vary across countries?

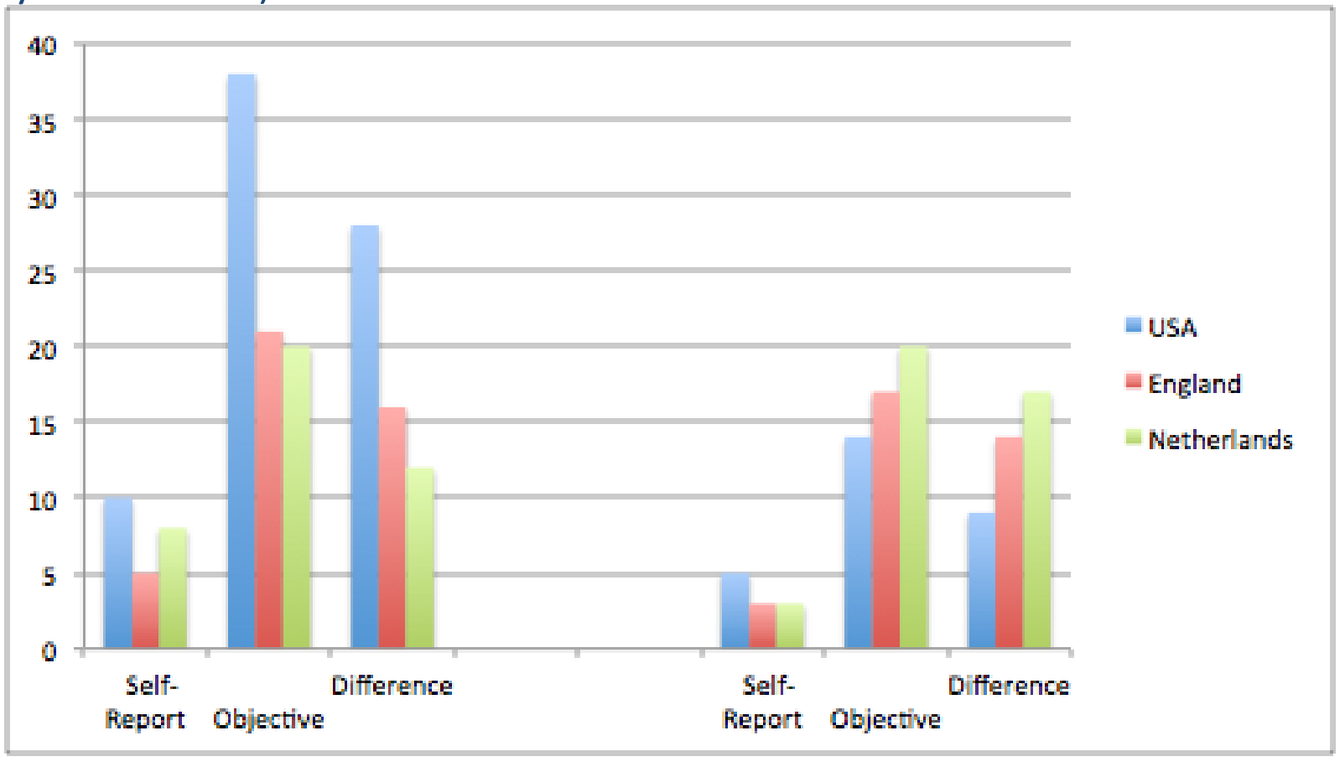
- Participants from 3 existing longitudinal studies in the U.S., England and the Netherlands were invited to participate in a study of physical activity
- Self-reported physical activity was collected via a web-survey (U.S., Netherlands) or in person interview (England)
- All participants were provided with an actigraph watch (Geneactiv) and asked to wear the watch for a full week
- Comparisons were made between the subjective and objective measures, and by country

Kapteyn A, Banks J, Hamer M, Smith JP, Steptoe A, van Soest A, Koster A, Htay Wah S. What they say and what they do: comparing physical activity across the USA, England and the Netherlands. J Epidemiol Community Health. 2018 Jun;72(6):471-476. doi: 10.1136/jech-2017-209703. Epub 2018 Apr 11. PMID: 29643112; PMCID: PMC5969391.

How does self-reported versus objective physical activity vary across countries?

(Kapteyn et al. 2018)

- Physical activity declines with age
- Significant differences exist between subjective and objective measures of physical activity, with subjective measures over-estimating physical activity
- U.S. participants much more likely to be inactive than their European counterparts and less likely to be very active
- Greatest differences observed among U.S. participants compared to European participants



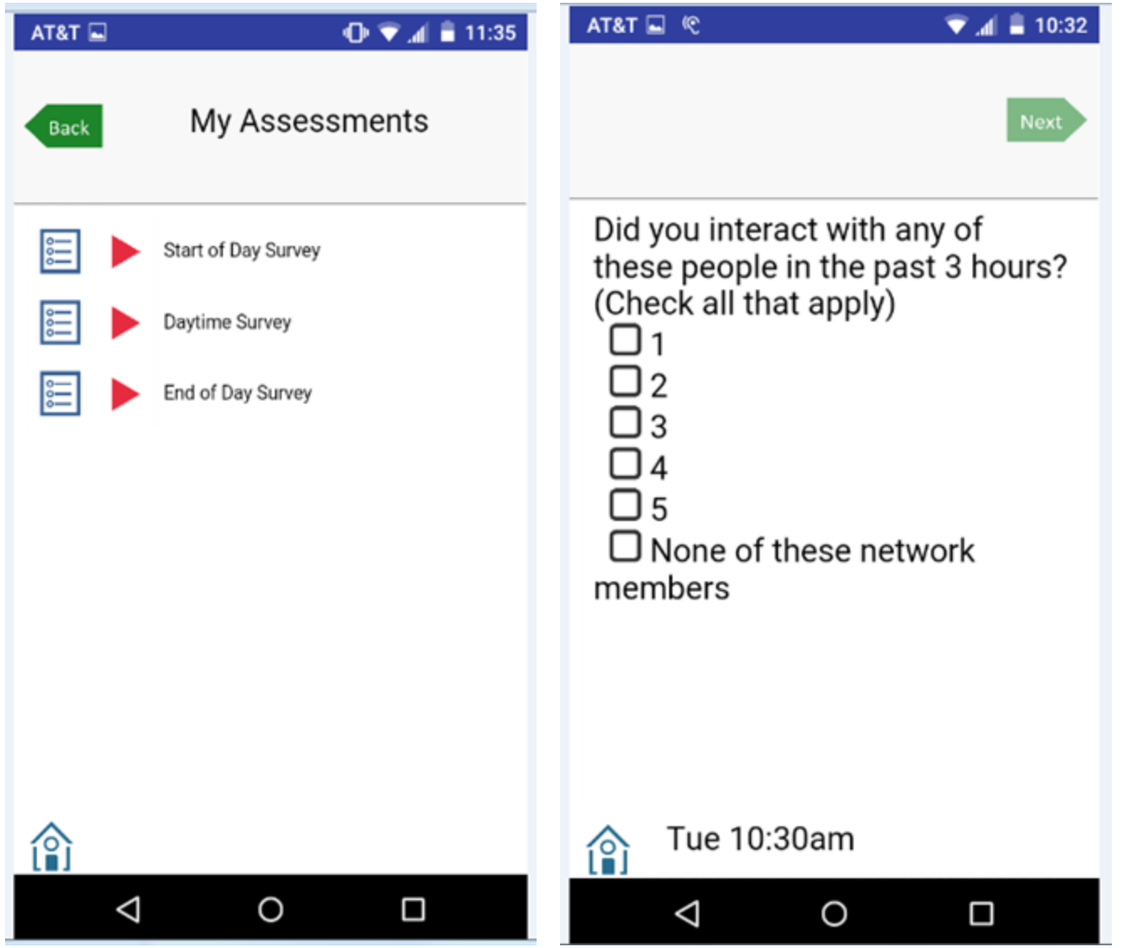
Do social connections influence health and well being?

(Fingerman et al. 2019)

- Participants over 65 years of age completed in-home interview to collect demographics, health status and physical measurements

- Participants were given actigraph watch to wear for 5 days and mobile device with Ecological Momentary Assessments (EMA) to complete every 3 hours throughout the day for 5 days

- EMA included questions on social interactions with people in their core support network- including the frequency, type and duration of activities



Do social connections influence health and well being?

(Fingerman et al. 2019)

- Increased engagement with more social connections (people close to you) is associated with increased physical activity, decreased sedentary time and improved mood

- Engaging with people who are not as close to you increased diversity of activities participant engaged in

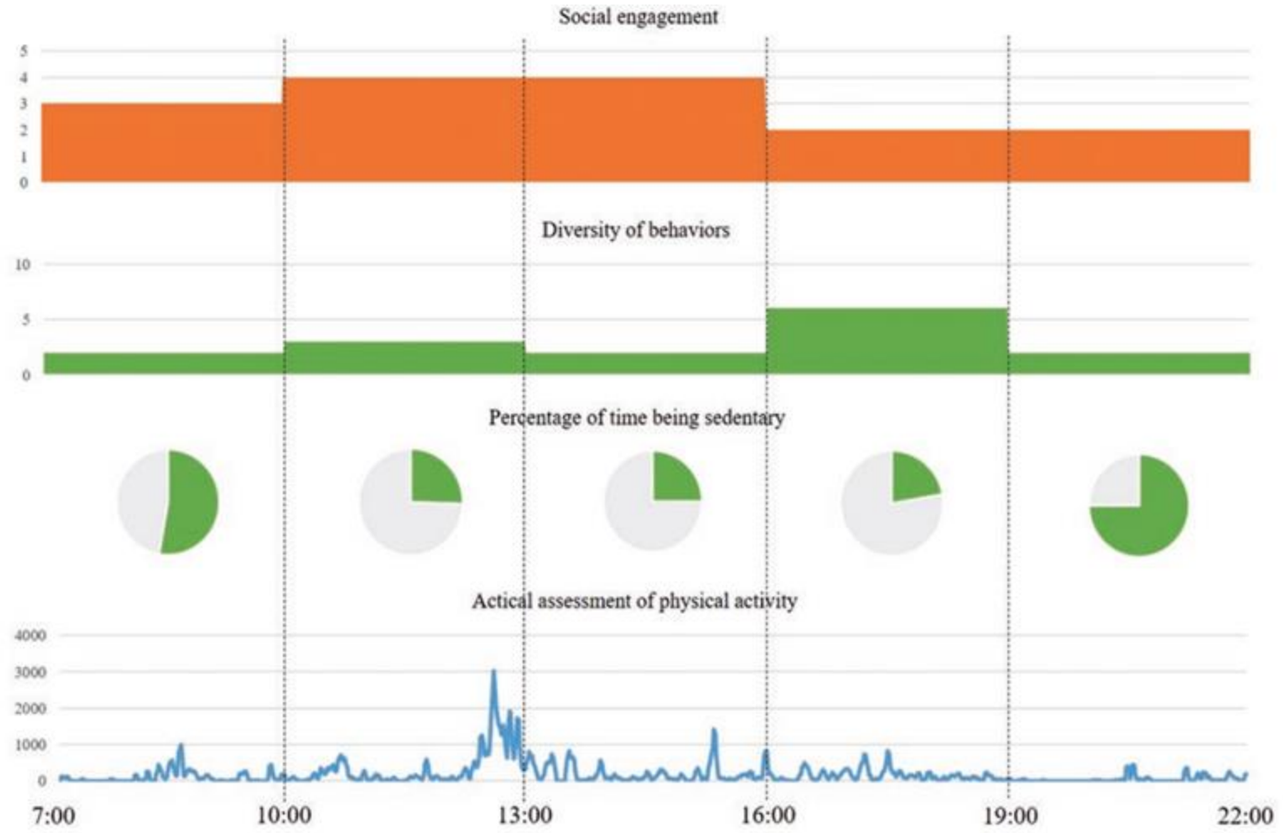
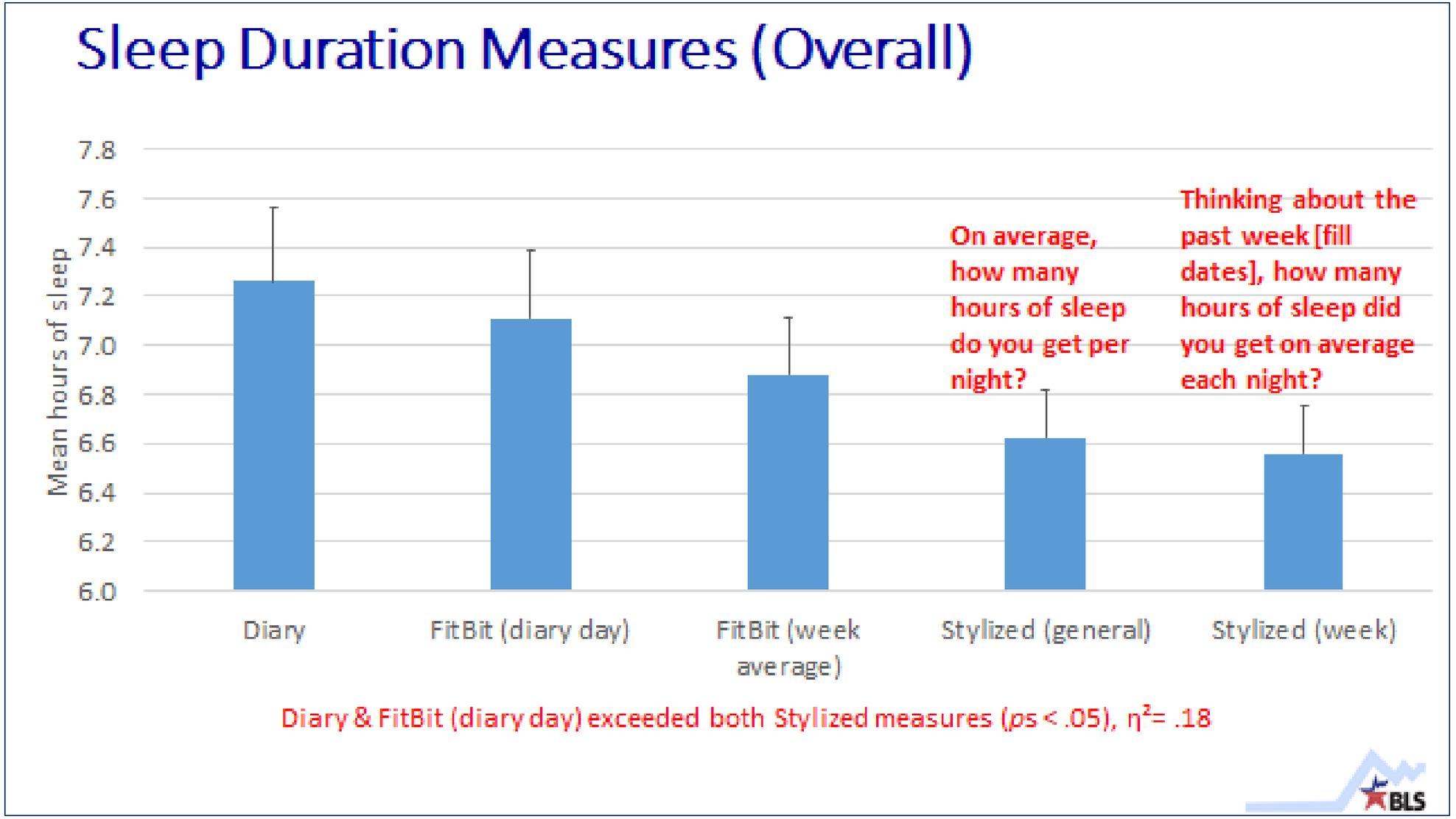


Figure 1. Illustration of daily activities in a participant with mean social integration score from 7 a.m. to 10 p.m. Orange blocks represent the number of encounters with different types of ties and green blocks represent the number of sets of behaviors this participant engaged in every 3 hr. The pies represent the percentage of time participant spent sedentary in each 3-hr block. Blue lines represent continuous activity counts assessed by the Actical.

Pilot Study comparing 3 measures of sleep



Agreement Across Sleep Duration Measures

Excellent (.76)

Fair (overall = .36)
Good (weekdays = .62)
Poor (weekends = .28)

Fair (.49)

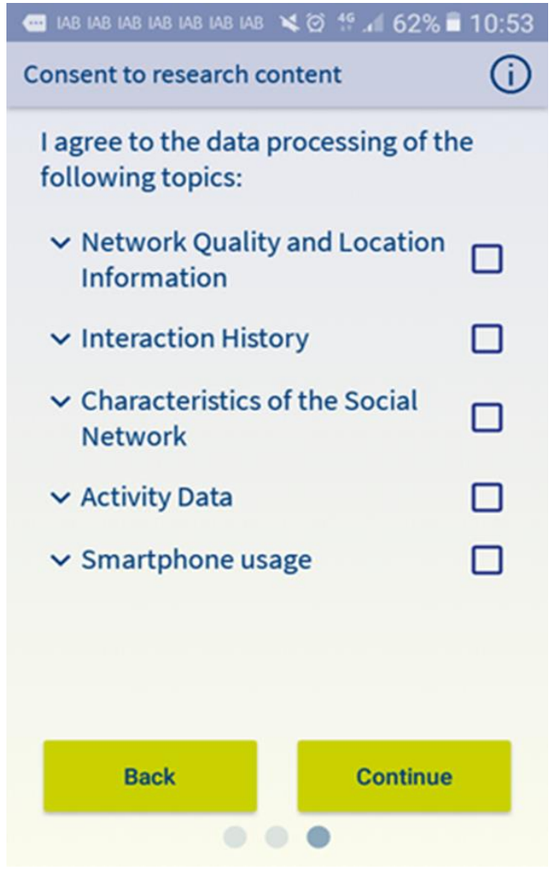
IAB-SMART (Kreuter et al. 2018)

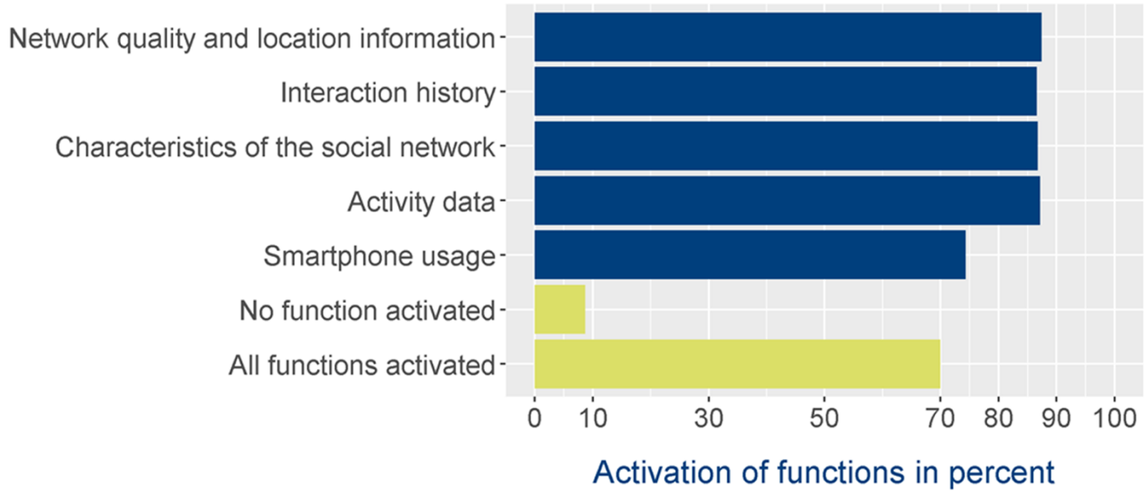
- Sampling from PASS panel participants aged 18-64
- Wave 11 in 2017:
  - Do you own a smartphone?: 84% YES
  - Which operating system do you use?: 70% Android
- Limited to smartphone owners with Android operating system
  - Access to required sensor data only possible through Android OS
- Recruitment in Jan/Feb 2018 via mail with one reminder
- 6 months of data collection

Methodological Questions

- Feasibility of smartphone data collection
- Coverage error
- Nonparticipation error
- Measurement error

IAB-SMART app (Kreuter et al. 2018)





Usage patterns of social network sites

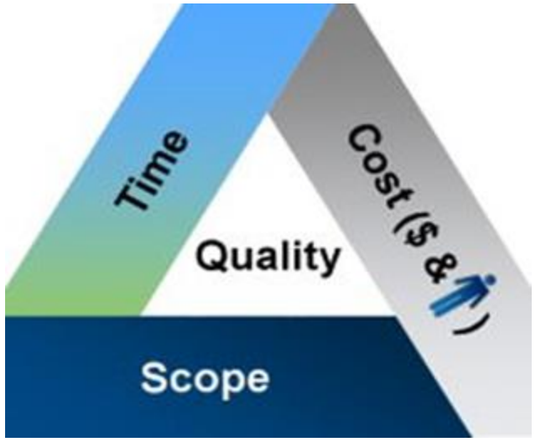
Selected social apps					
App used at least once					
%	96.7	81.2	78.2	28.2	7.0
Std. Err.	1.2	3.8	3.7	3.9	1.6
No. of daily app uses					
Mean	14.8	1.9	5.4	1.1	0.2
Std. Err.	1.1	0.1	1.0	0.2	0.0
% of all app uses					
%	27.9	6.2	9.1	1.9	0.4
Std. Err.	1.5	1.0	1.1	0.4	0.1
% of app use time					
%	24.0	12.9	11.1	2.3	0.6
Std. Err.	1.6	1.8	1.8	0.5	0.3

Daily averages per participant. Only classified, non-system apps. Unweighted n=539.

3. Case Study: Operational Considerations, Data Collection and Measurement

Operational considerations in integrating wearables, apps and sensors in population-based studies

- Ethics board approval
- Method of obtaining consent (and storing consent)
- Linking data from multiple sources (assigning IDs)
- Data security
- Monitoring data: live or upload required?
- Storing data: types of data, frequency, location, versions, etc
- Cleaning data
- Sharing data
- Providing participants with meaningful results
- Equipment/materials needed
- Resources needed (programmers, database managers, data analysts)



Case Study: Daily Experiences and Wellbeing Study

- Study to assess the association between the type and frequency of social interactions on cognitive and physical health among adults over the age of 65
- Oversample of Black and Hispanic adults
- Hypothesis: Increased social engagement will lead to increased physical activity, as well as better health & cognitive status.

ADULT FAMILY PROJECT

THE UNIVERSITY OF TEXAS AT AUSTIN

INSTITUTE FOR SOCIAL RESEARCH
SURVEY RESEARCH CENTER
UNIVERSITY OF MICHIGAN

Case Study: Daily Experiences and Wellbeing Study

- Telephone screening to identify home-dwelling adults over 65 years of age who were not working full time
- In-home interview and physical measures (day 0) followed by 5 days of:
  - Actigraphy
  - Mobile device with apps to record sound and prompt for ecological momentary assessment (EMA)
- Daily reminder phone calls
- In-home assistance if needed
- Devices obtained on day 5; phone taken of room where participant spends the most time
- Interviewers responsible for upload and transfer of all data from various devices

Wearable: Actical Watch

- Interviewer responsible for configuring actigraph for each participant

- Entered ID, height, weight, gender, age, start date, start time, epoch length (15 seconds)

- Challenge: removable watch strap given multiple users in Texas heat

- Data lost due to: removal of device, battery, technical glitch

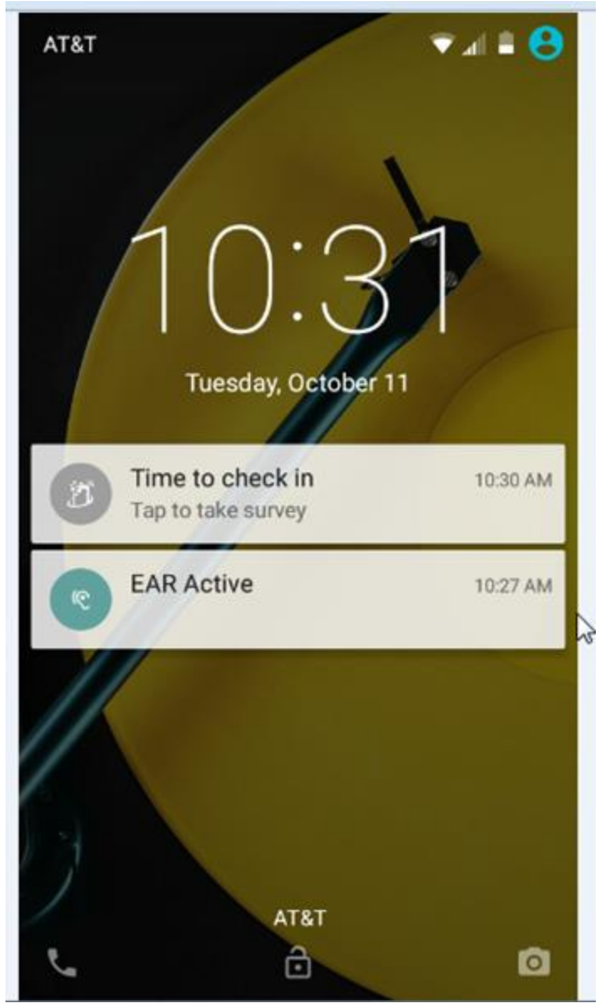
App: mobile Ecological Momentary Assessment (mEMA)

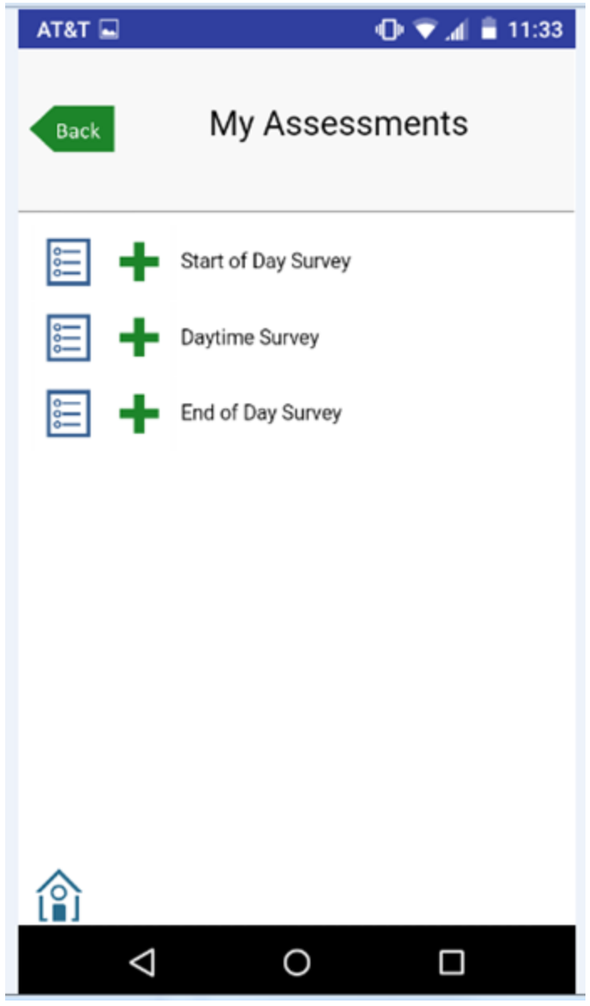
- Settings were entered on a website
- Interviewer entered ID, start date, start time, end date, end time, frequency of triggering each of the surveys
  - Start of day
  - Daytime
  - End of day

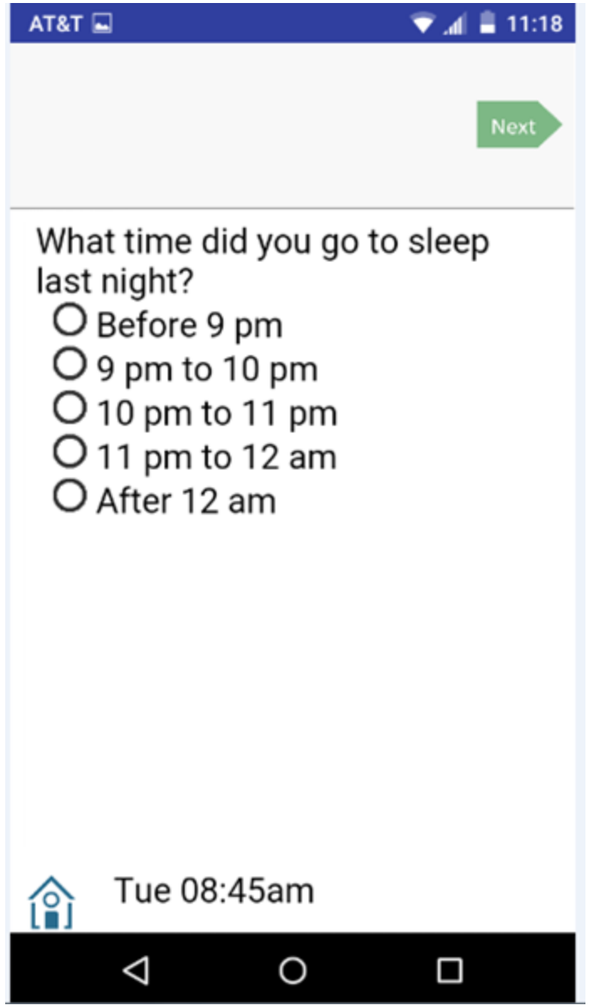
- Data transferred from laptop to phone to be used in mEMA app (names)

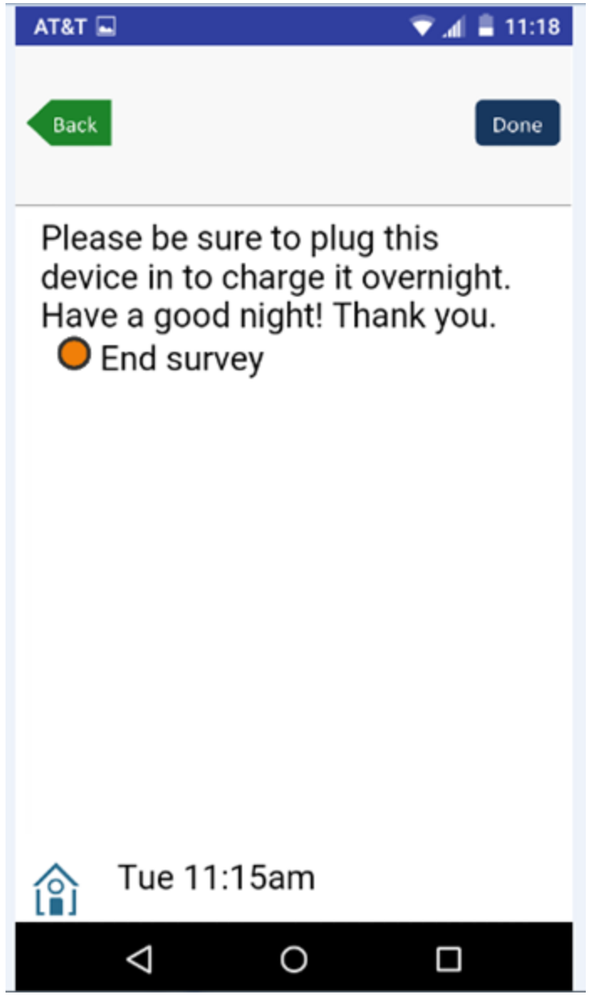
- Challenges:
  - Respondent compliance and privacy
  - App under development; updates deployed throughout field period
  - Offline surveys - led to significant data loss at time of sync and was not possible to monitor completion rates in real time

mEMA App


AT&T
10:31
Tuesday, October 11
Time to check in
Tap to take survey
10:30 AM
EAR Active
10:27 AM
AT&T


AT&T
11:33
Back
My Assessments
Start of Day Survey
Daytime Survey
End of Day Survey

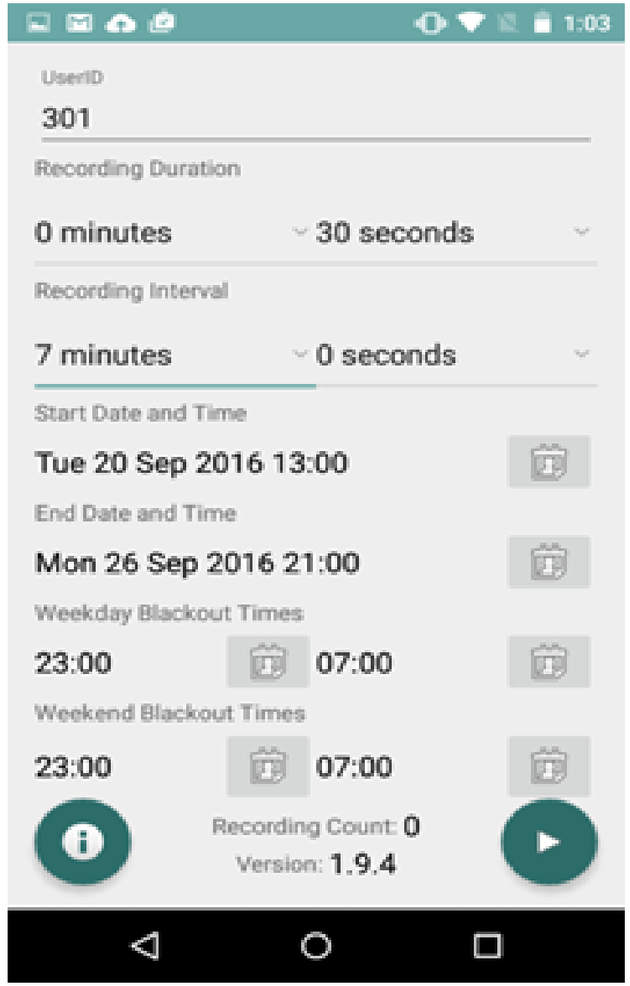

AT&T
11:18
Next
What time did you go to sleep last night?
Before 9 pm
9 pm to 10 pm
10 pm to 11 pm
11 pm to 12 am
After 12 am
Tue 08:45am


AT&T
11:18
Back
Done
Please be sure to plug this device in to charge it overnight. Have a good night! Thank you.
End survey
Tue 11:15am

App: Electronically Activated Recorder (EAR)

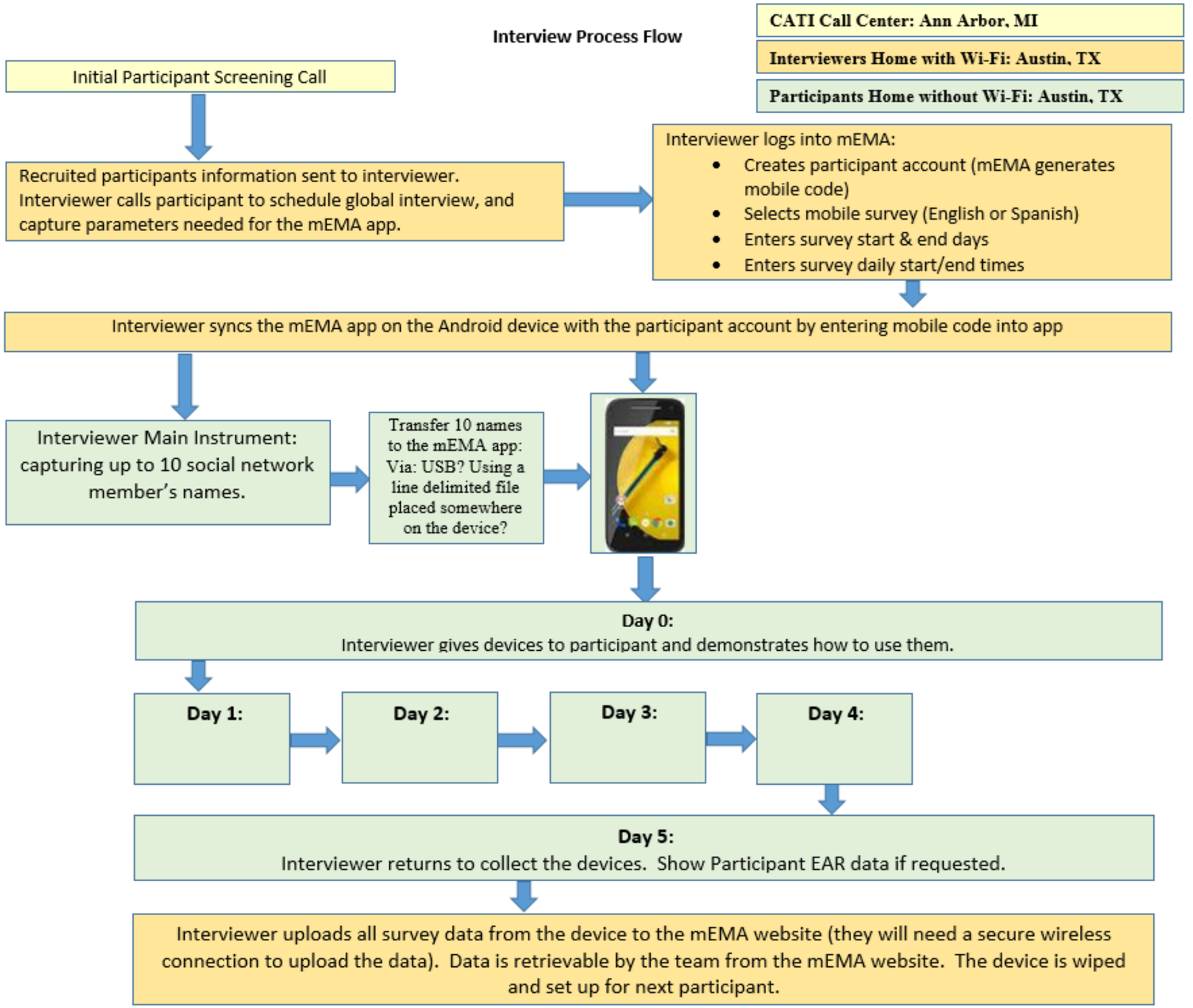
- Interviewer entered settings in EAR app on phone including ID, recording duration, recording interval, start date, start time, end date, end time, weekend blackout times, weekday blackout times

- Challenges:
  - App was under development and all user features had not been integrated
  - Interviewer could not determine when recording started and when data was transferred
  - Each sound file was an individual file (>700 files per respondent)
  - App stopped working for cases collected between end of December and beginning of January
  - Confidentiality



App: Photos (native camera)

- Interviewer used phone app on day 5, when they returned to pick device up
- After completing all other activities, asked participant for consent to take picture of room they spend most time in
- Up to 3 photos stored on phone
- Challenge: Confidentiality (respondent and others)


Interview Process Flow
CATI Call Center: Ann Arbor, MI
Interviewers Home with Wi-Fi: Austin, TX
Participants Home without Wi-Fi: Austin, TX
Initial Participant Screening Call
Recruited participants information sent to interviewer. Interviewer calls participant to schedule global interview, and capture parameters needed for the mEMA app.
Interviewer logs into mEMA:
Creates participant account (mEMA generates mobile code)
Selects mobile survey (English or Spanish)
Enters survey start & end days
Enters survey daily start/end times
Interviewer syncs the mEMA app on the Android device with the participant account by entering mobile code into app
Interviewer Main Instrument: capturing up to 10 social network member's names.
Transfer 10 names to the mEMA app: Via: USB? Using a line delimited file placed somewhere on the device?
Day 0:
Interviewer gives devices to participant and demonstrates how to use them.
Day 1:
Day 2:
Day 3:
Day 4:
Day 5:
Interviewer returns to collect the devices. Show Participant EAR data if requested.
Interviewer uploads all survey data from the device to the mEMA website (they will need a secure wireless connection to upload the data). Data is retrievable by the team from the mEMA website. The device is wiped and set up for next participant.

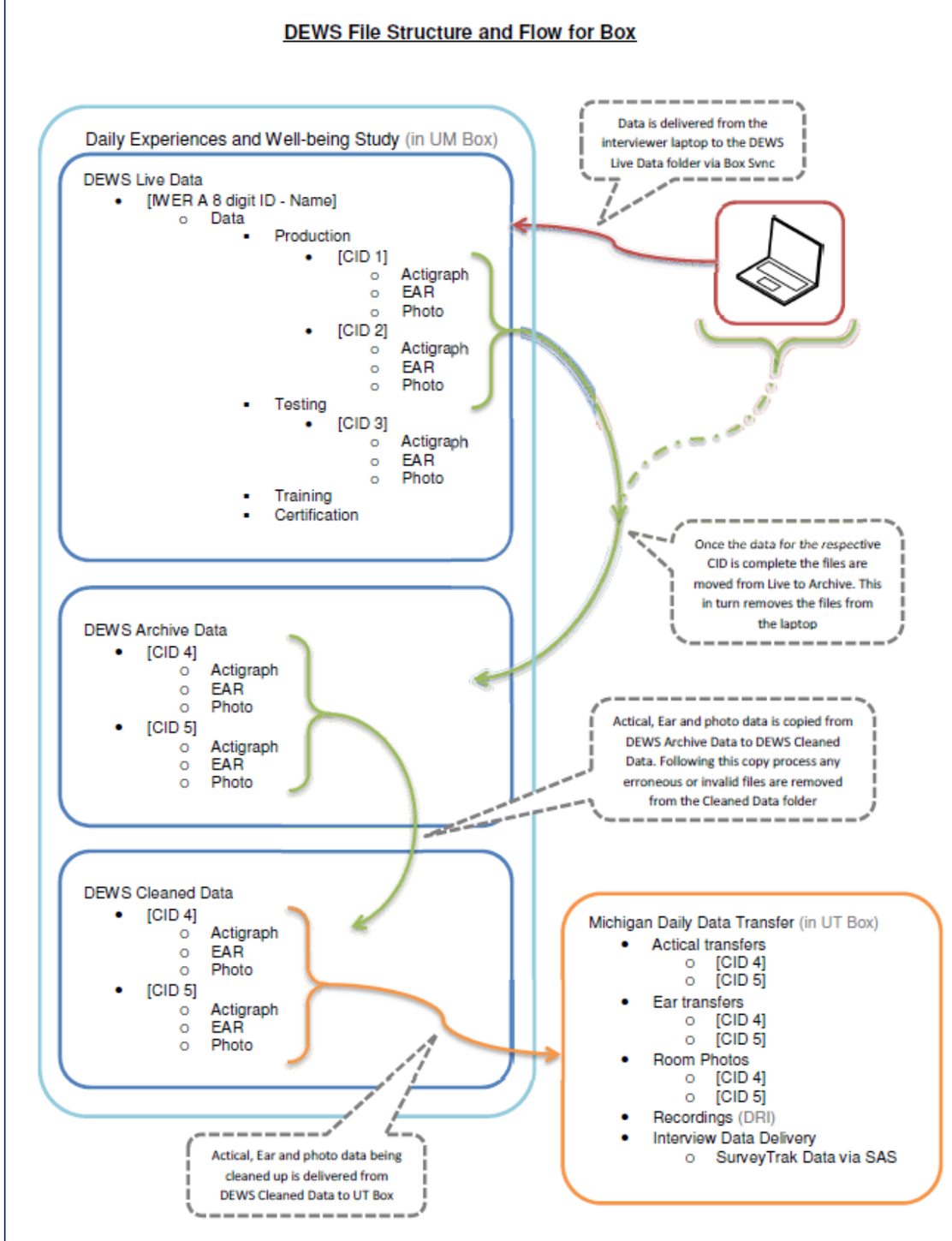
Determining file storage structure and space needs

Application	File Name	File Type	Number of Files	Size	Total Size	Frequency	Total Sample Estimate	File Location on Device	File Location on Laptop (Path)	File Location UM Server	File Transfer Method	Delivery frequency *
Ear		WAV	500 - 700	2.5 MB	1 - 1.5 GB	128 files per day	350 - 525 GB	SD Card\Ear (aka z:\Ear)	C:\blproj\SNWB_2016\Main\Comp\EAR		**Box.com?**	bi-weekly
Ear		CSV	1	20 KB	20 KB	1	7 MB	SD Card\Ear (aka z:\Ear)	C:\blproj\SNWB_2016\Main\Comp\EAR		**Box.com?**	bi-weekly
Actical		AWCF	1	50 KB	50 KB	1	17 MB	Actical Watch	C:\blproj\SNWB_2016\Main\Comp\ActiGraph\		**Box.com?**	bi-weekly
Camera		JPG	05-Apr	1.5 MB	7 MB	0 - 5	525 MB - 2.4 GB	Internal Storage\DCIM\Camera (aka y:\DCIM\Camera)	C:\blproj\SNWB_2016\Main\Comp\Photo		**Box.com?**	bi-weekly
mEMA								n/a (mema application moves files)	n/a (mema application moves files)	n/a (mema application moves files)	mEMA upload	UT will download
mEMA		Txt	1	1 KB	1 KB	1		Storage\Documents\mema (aka y:\Documents\mEMA)	C:\blproj\SNWB_2016\Main\Comp\mEMA?	n/a?		not delivered
						Total	**351 - 528 GB**					
Digitally Recorded Interview		AVI	1	~150 - 250 MB	~150 -250 MB	1	51 - 85 GB				ST send/rec	bi-weekly
Blaise Merged Screener?												bi-weekly
Blaise Merged IW		Blaise or SAS?									ST send/rec	bi-weekly
Blaise Merged Contact Obs (Post-Iw		Blaise or SAS?									ST send/rec	bi-weekly
MQDS Codebook		.doc										production, when data
ST tables data?											ST send/rec	bi-weekly
Consent forms		PDF								L:\projects\Social Networks & Well	Box.com	monthly

	Data collected via 3rd party software/devices, delivered by UM to UT
	Data collected via laptop, delivered by UM to UT
*	Deliver data bi-weekly with the exception of the first two weeks: deliver the first case, weekly on Thursday until November 10, and then every two weeks
Eligible R address fi	Each Monday and Wednesday
Blaise and device da	10/31, 11/14, 11/28, 12/8, 1/4,

Data storage:

Process Diagram

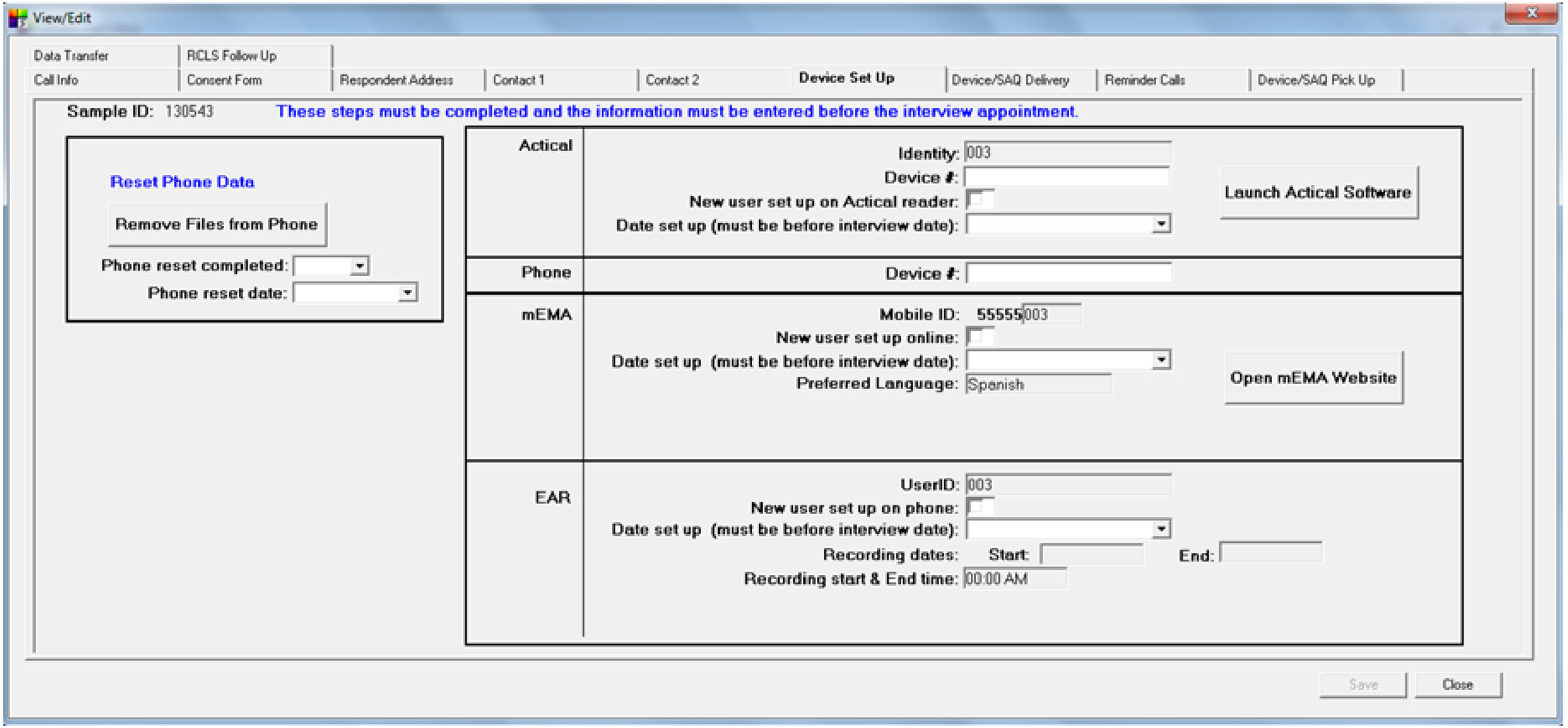


Sample management system

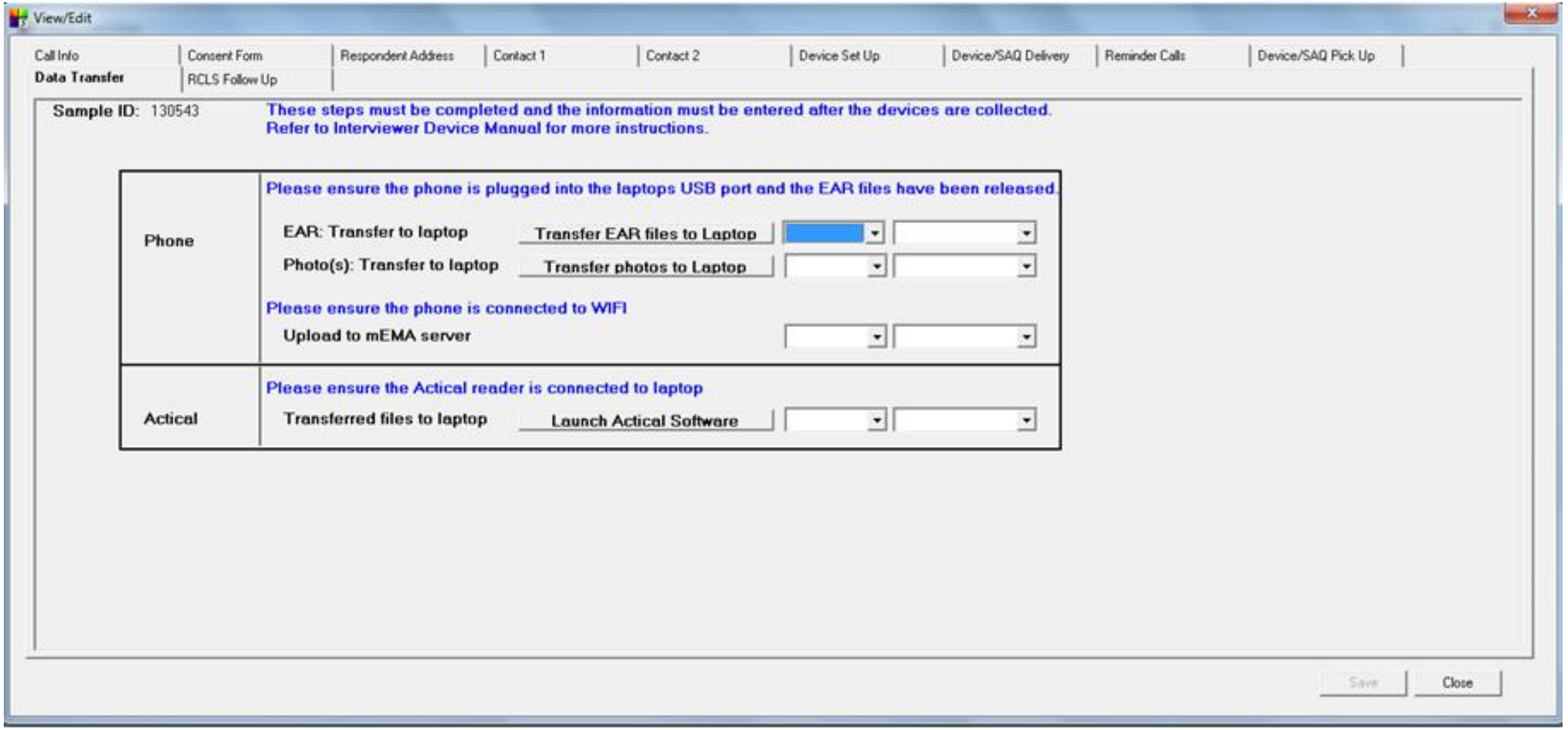
- Customize to match stages of project
  - Set up
  - Delivery
  - Reminders
  - Pick-up
  - Data-transfer

- Include links to software, web sites, Box

Sample management system: Set up



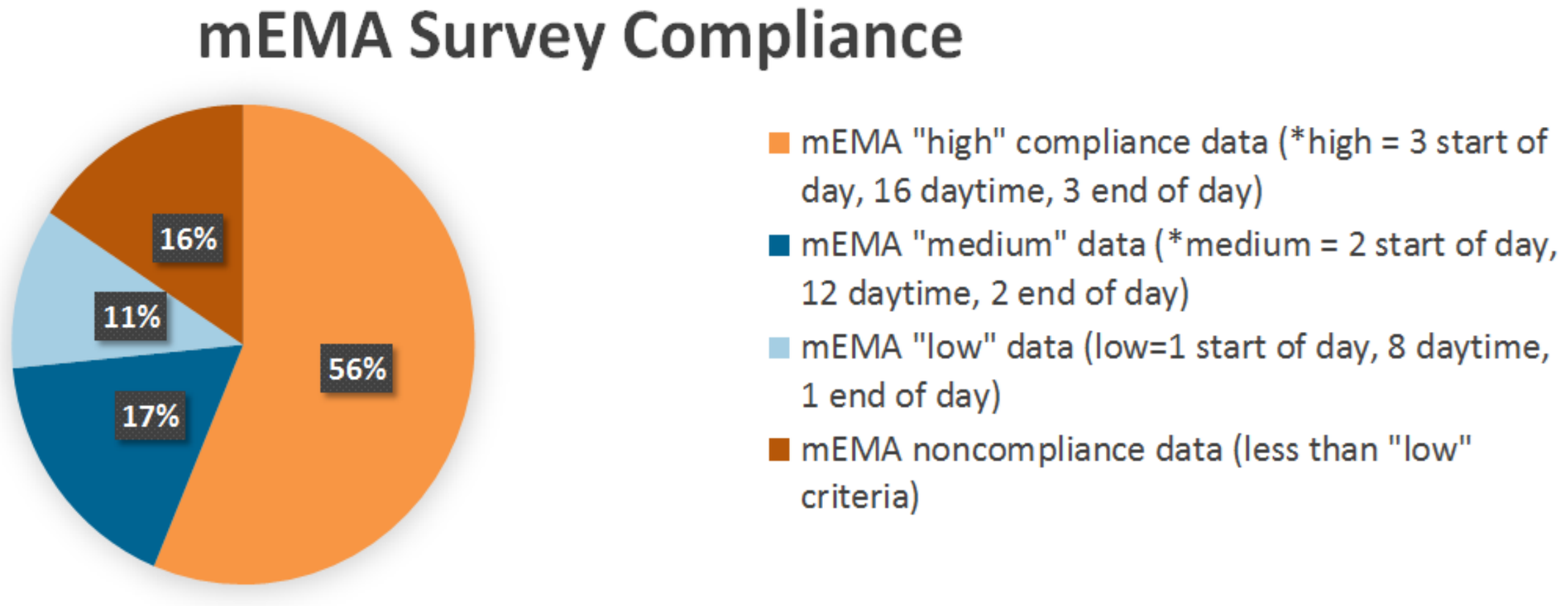
Sample management system: Data download/transfer



Consent and participation rates by device

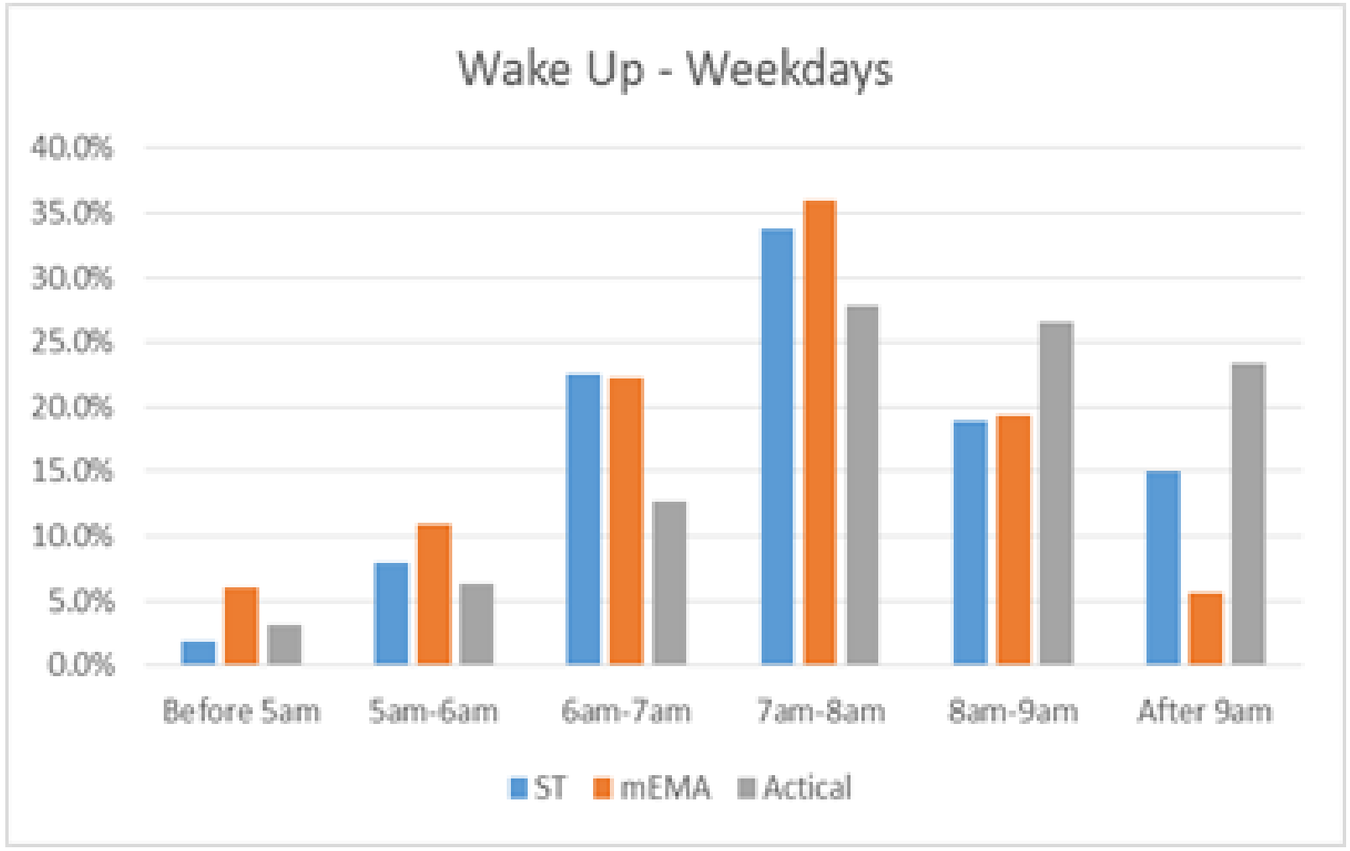
	Actical	EAR	mEMA	Photos
Interviews	333	333	333	333
Agreed	326	321	321	321
Agreement Rate	97.9%	96.4%	96.4%	96.4%
Refused	6	12	12	12
Deceased during	1	1	1	1
Phone lost		2	2	2
Other technical/compliance problems		6	45	31
Data complete	312	304	288	287
Completion rate among agreed	95.7%	94.7%	89.7%	89.4%
Completion rate among all interviewed	93.7%	91.3%	86.5%	86.2%

mEMA compliance



Measurement error: Subjective vs. objective

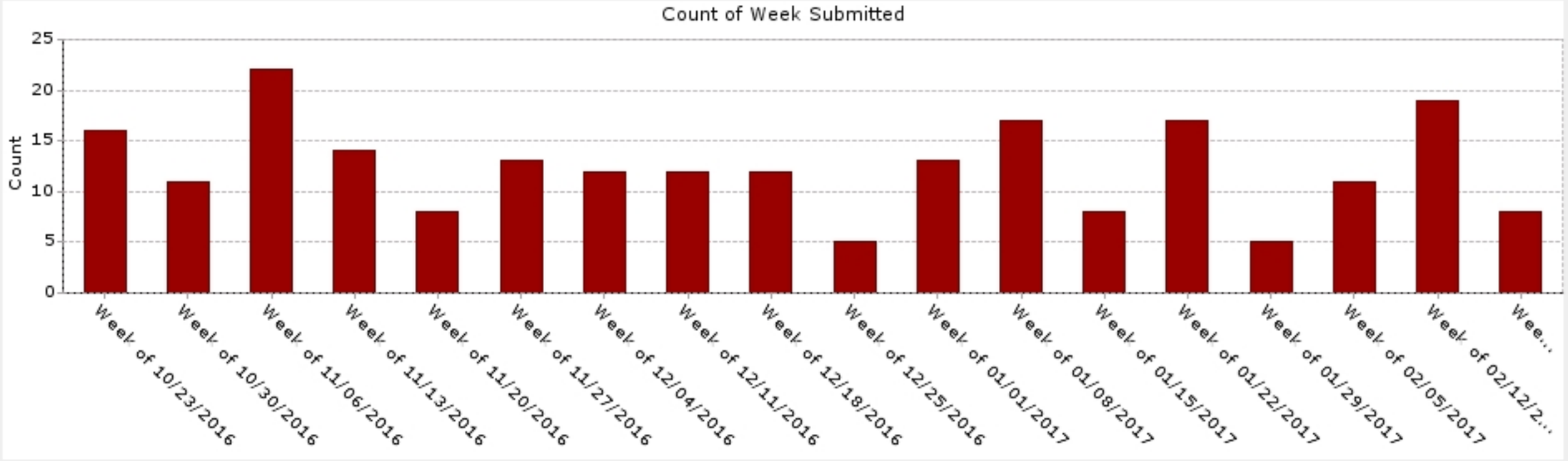
Example: Daily Experiences and Wellbeing Study



Technical support

DEWS Help Desk Calls

This report contains data from 223 Incidents.



Plan for on-going Tech Support!

Lessons Learned

- Many of the apps were still under development; pilot testing should always be conducted if the apps have not been used in population-based surveys
- Special skills required of the interviewers: tech savvy, very patient, very organized
- Should determine up front who will communicate with the app developers if using 3rd party software
- Do not underestimate the on-going technical needs
- Offline data entry does not allow for on-going monitoring of wearables and apps

Additional Considerations

- Consider study population and sample source
- Device ownership & experience
- User-centered design

Questions & Discussion

4. Exercise & Discussion

Q&A

- Readings
- Topics covered today

Exercise

- 20 minutes
- Review one study website
  - All of Us: All of Us Research Program | National Institutes of Health (NIH)
    - Get involved→ Opportunities for Researchers → Data Browser
  - NHANES: NHANES - National Health and Nutrition Examination Survey Homepage (cdc.gov)
    - 2011-2012 data– limited
  - UK Biobank: UK Biobank - UK Biobank
    - Enable your research → About our data
- Questions to answer:
  - Who is the study population?
  - How is/was the wearable data obtained?
  - How is consent obtained?
  - What are some potential sources of error?
  - What data are released?
  - What role might there be for EMA?
  - What is a research question that can be answered using the wearable data that cannot be answered using only self-reported data?