

Capturing and Measuring Experiences in Everyday Life: An Overview of Ecological Momentary Assessment

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Preliminaries

Thank you!

Thanks to Marilyn Uy (NTU), Angela Lee, Kallie Yearick, & Dan Newman (UIUC), Catharine Fairbairn (UIUC), Allison Gabriel (Arizona)!

All slides will be sent to participants

ExpiWell (www.expiwell.com) is free for survey creation; let me know if you want a trial 14 day Plus license (or longer) for your ESM/EMA trial

Learning Objectives

- 1) Summarize Experience Sampling Method (ESM), Ecological Momentary Assessment (EMA) (Ambulatory Assessment) and its key components
- 2) Summarize potential uses of ESM for research and practice
- 3) Explain key issues for consideration in ESM research question and design
- 4) Describe different techniques for analyzing ESM data
- 5) Implement ESM/EMA project in the ExpiWell software

Workshop components

- 1) History and purposes of Experience Sampling Method (ESM), Ecological Momentary Assessment (EMA) (Ambulatory Assessment) (20 mins)
- 2) Current trends and practices (30 mins)
- 3) Design, costs, and implementation (40 mins)
- 4) Describe different techniques for analyzing ESM data (20 mins)
- 5) Implementing ESM/EMA in ExpiWell (40 mins)

Workshop components

- 1) **History and purposes of Experience Sampling Method (ESM), Ecological Momentary Assessment (EMA), and Ambulatory Assessment (20 mins)**
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ESM: History, Purposes, and Definition

How did the Experience Sampling Methodology begin?

- Fundamentally *person-centered* ... (cf. Woo, Jebb, Tay, & Parrigon, 2018)
- Gordon Allport (1937): Goal of psychology -- or psychology of personality -- is the complete understanding of an individual
 - “Wundt, James, and Titchener serve as examples. The first wrote: ***“It [psychology] investigates the total content of experience in its relations to the subject.”*** The second: *“Psychology is the science of finite individual minds;”* and the third: [p. 142] ***“Psychology is the study of experience considered as dependent on some person.”***”

ESM: History, Purposes, and Definition

How did the Experience Sampling Methodology begin?

- Donald Fiske (1971): “to measure ... the ways a person usually behaves, the regularities in perceptions, feelings and actions”



ESM: History, Purposes, and Definition

- Earliest applications were in the study of adolescents (Csikzentmihalyi et al., 1977)
- “What do adolescents do all day long?” (Activities, Motivation, Reactions)



ESM: History, Purposes, and Definition

Known limitations of past methods

- Qualitative interviews - removed from natural contexts
- Direct observation - intrusiveness, limited contexts
- Time-budgeting methods - retrospective biases

Current Method

- Twenty-five adolescents reported their daily activities and the quality of their experiences for a total of 753 times during a normal week, in response to random beeps transmitted by an electronic paging device.



ESM: History, Purposes, and Definition

Results

- “In this sample adolescents were found to spend **most of their time either in conversation with peers or in watching television**. Negative affects were prevalent in most activities involving socialization into adult roles. **Television viewing appears to be an affectless state associated with deviant behavior and antisocial personality traits.**” (Csikzentmihalyi et al., 1977)

ESM: History, Purposes, and Definition

Results

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ESM: History, Purposes, and Definition

Essence of ESM historically

- **Signaling Device:** Multiple signals and randomization (or intense fixed schedule signals) in order to capture representative activities and experiences



- **Experience Sampling Form:** Activities, Persons, Thoughts, Emotions (Hektner, Schmidt, & Csikszentmihalyi, 2007)

Date ____ Time you were beeped ____ a.m./p.m. Time you responded ____ a.m./p.m.

As you were beeped . . .

Where were you? _____
Please _____

What was the **main thing** you were doing? _____
be _____

What **else** were you doing at the same time? _____
specific _____

What was on your mind? _____

Were you alone . . . Yes _____ No _____ . . . or were you with . . .
(please check all that apply)

Your Spouse ____ Your Boss ____ Co-workers ____ Friend(s) ____ Girl/Boyfriend ____

Your Mother ____ Your Father ____ Teacher ____ Classmates/peers ____ Other(s) ____

Your child(ren) _____ (please indicate who) _____

Your sibling(s) _____ (please indicate who) _____

Think back on how you got into this activity . . .

Were you doing this **main activity** because you . . . (check all that apply)

(1) wanted to _____ (2) had to _____ (3) had nothing else to do _____

Indicate how you felt about the main activity. (please circle one number for each question)

	Not at all	A little	Somewhat	Very much
Did you enjoy what you were doing?	0	1	2	3
Was this activity interesting ?	0	1	2	3
How well were you concentrating ?	0	1	2	3
Were you living up to your own expectations ?	0	1	2	3
Did you feel in control of the situation?	0	1	2	3
Did the situation allow you to be involved or to act ?	0	1	2	3
Did you have the abilities to deal with the situation?	0	1	2	3
Was the activity important to you?	0	1	2	3
Were others expecting a lot from you?	0	1	2	3
Were you succeeding at what you were doing?	0	1	2	3

ESM: History, Purposes, and Definition

What about Ecological Momentary Assessment (EMA)? What are the similarities and differences with ESM?

EMA: More recent development (Stone et al., 2007; Stone & Schiffman, 1994)

Driven by Clinical and Health psychology

- Concerned about biases in retrospective global reports
- Interested in how behaviors unfold dynamically in the real-world

ESM: History, Purposes, and Definition

Methodological Foundation of EMA

- ESM
- Behavioral therapy and self-monitoring (e.g., marital conflict)
- Ambulatory monitoring in health (e.g., blood pressure)



Essence of EMA

- Using repeated collection of real-time data on subject's behaviors and experience in their natural environments

ESM: History, Purposes, and Definition

Overview of ESM vs. EMA

	ESM	EMA
Aspects of Ecological Validity	<p><i>Focus on Representativeness</i></p> <p>Representative Activities</p> <p>Representative Subjective Experience</p>	<p><i>Focus on Momentariness</i></p> <p>Momentary Activities</p> <p>Momentary Experiences</p>
Analytic Focus	<p>Frequencies of activities</p> <p>General psychological levels across and within activities (e.g., motivation, mood)</p>	<p>Trajectories of psychological phenomena</p> <p>Dispersion of psychological phenomena over time (e.g., positivity spirals)</p> <p>Dynamics of psychological phenomena (i.e., how one dimension relates to another over time)</p>

ESM: History, Purposes, and Definition

Overview of ESM vs. EMA

	ESM	EMA
When are surveys taken?	<p><i>Representativeness-focus; general activities and experiences over the day and days</i></p> <p>Time-contingent (i.e., regular timed surveys)</p> <p>Signal-contingent (i.e., whenever a notification is sent)</p>	<p><i>Phenomenon-focus; measuring appropriate intervals to assess changes in psychological phenomena</i></p> <p>Time-contingent (i.e., regular timed surveys)</p> <p>Signal-contingent (i.e., whenever a notification is sent)</p> <p>Event-contingent (i.e., whenever an event occurs)</p>
Mode of Data/Reporting	Self-reported experience-related surveys	Generally any type of self-reported surveys; also includes health data, physical data, etc.

ESM: History, Purposes, and Definition

We use the term ESM for the historical reference

- Our definition encompasses aspects of **both ESM as historically defined and EMA as more broadly generalized**
 - *ESM/EMA: Real-time data collection of momentary experiences (thoughts, behaviors, emotions, contexts, events) that are typically expected to change in natural environments*
- Many researchers use these terms synonymously these days (e.g., Trull & Ebner-Priemer, 2009) but it is helpful to know their historical distinctions and purposes

ESM: History, Purposes, and Definition

What about Ambulatory Assessments?

- Broader than EMA and ESM
- **Bio-physio-psycho-social-environmental monitoring in naturalistic settings over time**

Society for Ambulatory Assessment

Ambulatory Assessment comprises the use of field methods to assess the ongoing behavior, physiology, experience and environmental aspects of people in naturalistic or unconstrained settings. Ambulatory Assessment uses ecologically-valid tools to understand biopsychosocial processes as they unfold naturally in time and in context.

- Experience sampling and ecological momentary assessment
- Repeated-entry diary techniques
- Monitoring of physiological function, in combination with or without physical behaviour
- Acquisition of ambient environmental parameters

ESM: History, Purposes, and Definition

QUESTIONS?

Workshop components

- 1) History and purposes of Experience Sampling Method (ESM), Ecological Momentary Assessment (EMA), and Ambulatory Assessment (20 mins)
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Trends and uses of ESM

Tremendous Growth.

Not surprisingly then, there has been a surge of Experience Sampling methodology and design in the social sciences. A quick search on Google Scholar on this topic (“experience sampling”) reveals an exponential increase in the numbers of papers referencing ESM. There has been roughly a five-to-six fold increase in the numbers of academic papers using ESM every decade.

1980-1990: 280 papers

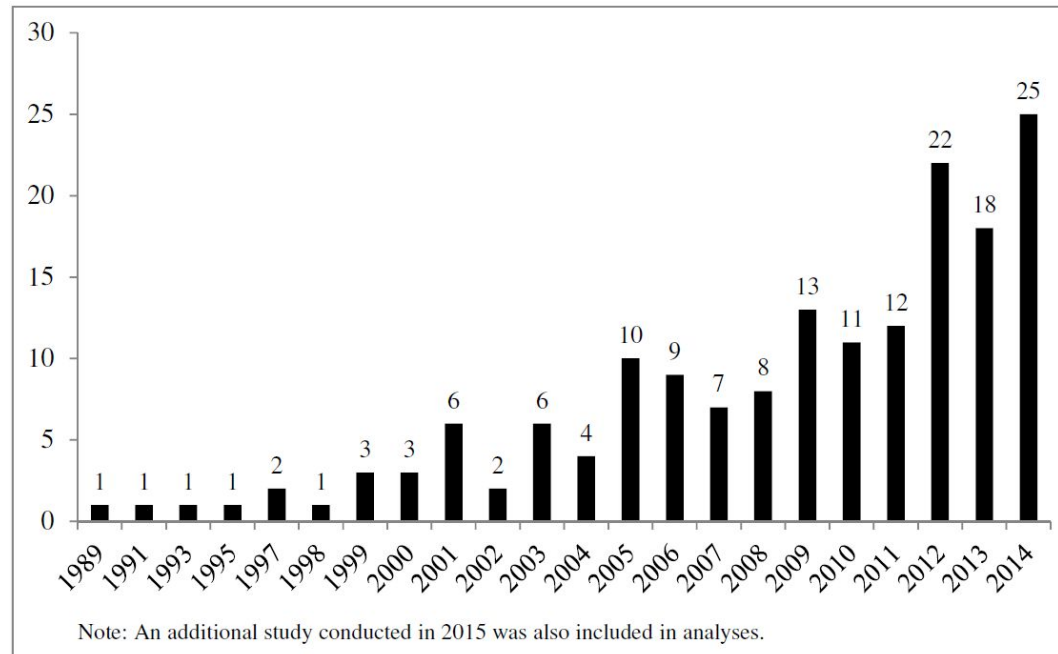
1991-2000: 1,190 papers

2001-2010: 7,810 papers

2010-2016: 16,000 papers

Trends and uses of ESM

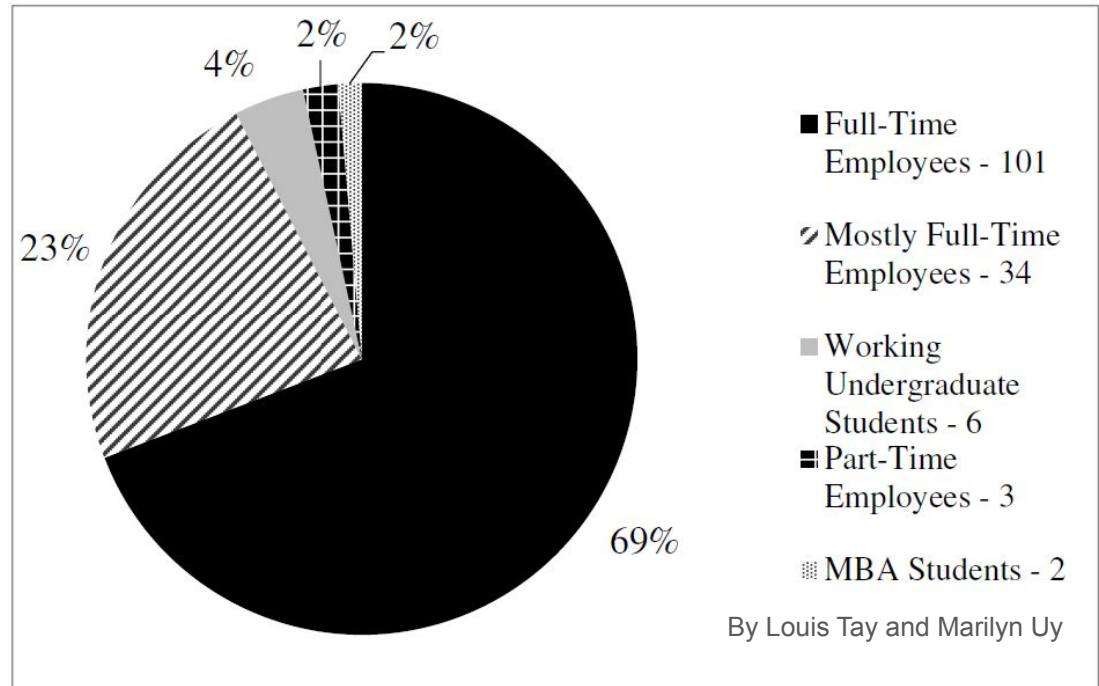
Trends in ESM for *Organizational/Applied Psychology Research* (Yearick, Lee, & Newman, 2017) based on 167 samples



Trends and uses of ESM

Trends in ESM for *Organizational/Applied Psychology Research* (Yearick, Lee, & Newman, 2017) based on 167 samples

- Mean sample size = 93



Trends and uses of ESM

Trends in ESM for *Organizational/Applied Psychology Research* (Yearick, Lee, & Newman, 2017) based on 167 samples

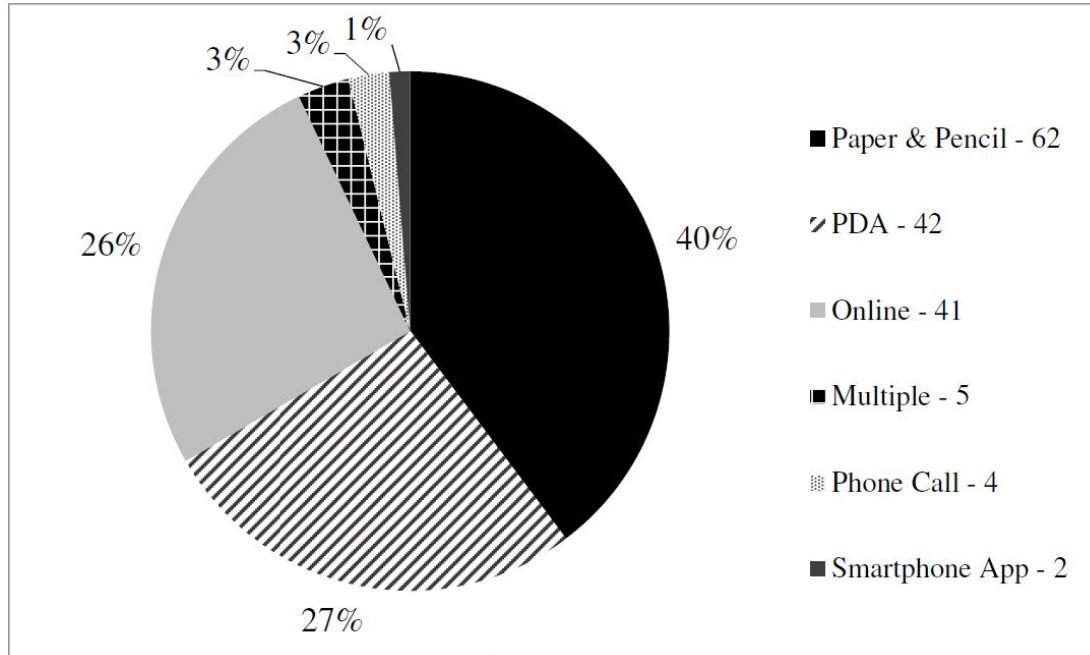
- Mean sample size = 93
- Average study duration = 10 days
- 50% of studies used multiple signals per day (about 4)
- Types of signaling
 - Interval contingent (time-based/fixed times; 59%)
 - Signal contingent (random times; 19%)
 - No signaling (diary; 10%)
 - Event-contingent (event-based; 4%)
 - Multiple (7%)

Trends and uses of ESM

Construct Category	Frequency	%
Affect/Emotion/Mood	100	60
Stress	75	45
Work Behaviors	61	37
Health	58	35
Situational Factors	53	32
Job Attitudes	49	29
Individual differences	33	20
Motivation	27	16
Non-work attitudes	19	11

Trends and uses of ESM

Trends in ESM for *Organizational/Applied Psychology Research* (Yearick, Lee, & Newman, 2017) based on 167 samples



Trends and uses of ESM

Interview with scholar doing cutting-edge ESM research

- Catharine Fairbairn (Clinical Psychology, University of Illinois Urbana-Champaign)
- *What are the advantages of ESM?*
 - Direct assessment of objective alcohol consumption
 - Connecting both breath and transdermal assessment devices
 - Breathalyzer
 - SCRAM (ankle monitor) / Wrist Sensors
 - Understand contexts of alcohol consumption
- *Where is research going with this?*
 - Validation with self-reports



Trends and uses of ESM



Interviews with scholars doing cutting-edge ESM research

- Allison Gabriel (Management & Organizations, University of Arizona)
- *What are the advantages of ESM?*
 - Unpack and address practical real-world issues (e.g., breastfeeding in workplace; experiences of sexual harassment)
 - Better understand within-person experiences
 - Contribute to work-family theory
- *Where is research going?*
 - Methodological bar is increasing for ESM
 - Need to consider physiological indicators

Trends and uses of ESM

Practice: Possible uses of ESM in industry / practice?

- Received NSF Innovation Corps initiative to extend research and technology to entrepreneurship



National Science Foundation
WHERE DISCOVERIES BEGIN

- Interviewed about 30 Human Resource professionals in 2016
 - Academics in the area of HR
 - HR managers and professionals
 - HR consultants

Trends and uses of ESM

Potential Applications

Accident Prevention and Analysis: Monitoring fatigue, attention, and workplace safety

- Healthcare industry
- Airline industry
- Transportation industry (more broadly)



May be difficult for real-time assessments but could have regular (end-of-day) assessments

Trends and uses of ESM

Potential Applications

Tracking and Feedback of Well-being, Attitudes, Turnover Intentions

- High turnover industries (healthcare, hotel, restaurants)
- Remote workers (in place of costly *in-person* check-ins)
- Conference attendees / sponsors

Trends and uses of ESM

Potential Applications

Real-time performance feedback

- Tech-companies (meeting-based signaling and feedback)
- Team-based projects



Trends and uses of ESM

Ecological Momentary Interventions to enhance well-being

- Triggered based on experiences, events, or locations
- Provide lessons that individuals can take on a daily basis
- Micro-assessments for individuals over time
- Personalized timings
- Integrated with social network functionality

Application: ENHANCE (<https://eddiener.com/enhance>)

Trends and uses of ESM

Potential Issues in Applying Experience Capture in HR / Organizations

- Anonymity
- Feedback - Automated or Manual
- Syncing with HR systems / Calendars
- Benchmarking / Standardized tools
- Dashboarding

Trends and uses of ESM

QUESTIONS?

Workshop components

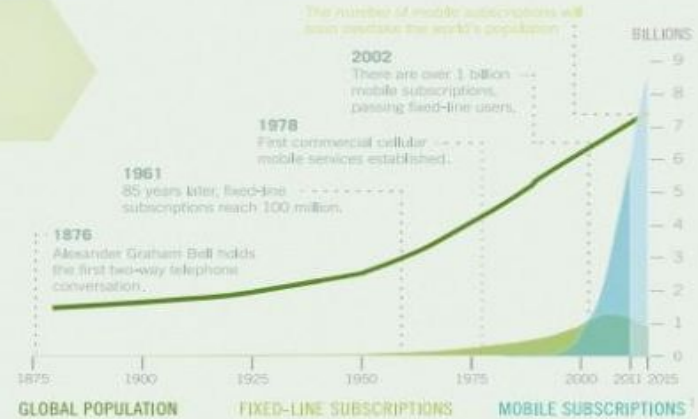
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Take advantage of mobile technology trend & reach!

THE PACE AT WHICH
MOBILE PHONES
SPREAD GLOBALLY IS
UNMATCHED
IN THE
HISTORY OF TECHNOLOGY



PERCENT OF THE WORLD'S POPULATION WITH MOBILE CELL SIGNAL²



OVER
6 BILLION
MOBILE SUBSCRIPTIONS
WORLDWIDE

75% of the
WORLD
NOW HAS ACCESS
to a MOBILE PHONE

By Louis Tay and Marilyn Uy



Checklist for ESM Implementation

1. Decide whether ESM is what you need.
2. Determine your resources.
3. Set study parameters.
4. Implement the study.
5. Manage the data.



Source: Conner Christensen et al., (2003). A practical guide to experience-sampling procedures. *Journal of Happiness Studies*, 4, 53-78.

Checklist for ESM Implementation

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Decide whether ESM is what you need:

- For episodic (experiential) as opposed to semantic (conceptual)
 - Retrospective reporting may be more useful for predicting intentions than aggregated online experiences

“compared students' predicted, on-line, and remembered spring-break experiences, as well as the influence of these factors on students' desire to take a similar vacation in the future. Predicted and remembered experiences were both more positive—and, paradoxically, more negative—than on-line experiences. Of key importance, path analyses revealed that remembered experience, but neither on-line nor anticipated experience, directly predicted the desire to repeat the experience. **These results suggest that although on-line measures may be superior to retrospective measures for approximating objective experience, retrospective measures may be superior for predicting choice.**” (Wirtz, Scollon, Kruger, & Diener, 2013, Psych Science)

Decide whether ESM is what you need:

- Target participants *willing* and *able* to provide momentary reports
- Control over the situation (more control = lab)

Checklist for ESM Implementation

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Determine your resources:

- Strong research team
 - Proper training
 - Patience
 - Positive attitude
- Incentives for participants (~ \$40-\$200 depending on sample/design)
 - Pro-rating of incentives depending on completion rate
 - Mixed incentives: cash plus lucky draws
 - Non-monetary: feedback report, etc.
- ESM platforms
 - Ease of use, budget, support
 - Some platforms are free but more technical and limited
 - Option to hire a programmer to customize your platform

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Set study parameters:

- Protocol type
- Sampling periods
- Survey length

Set study parameters: **protocol type**

- **Interval contingent:** (e.g., every 10am and 6pm; at the end of every day; etc.); least burdensome to participants
- **Signal contingent:** (e.g., when signaled by a beep/SMS--scheduling can be pure random or stratified within a block); most burdensome to participants
- **Event contingent:** (e.g., after every interaction with your direct supervisor lasting for more than 10 minutes) reporting only when the event happens; crucial to define inclusion criteria (what counts as *event* for a participant?)
- **Context contingent:** (e.g., based on location or specific event) reporting only context triggers experience capture (e.g., <http://web.mit.edu/caesproject/>)
 - Can also be person-contingent (e.g., dyadically triggered)

Set study parameters: **protocol type**

- Decision will be based on--
 - Prevalence of target behavior or focal event/experience
 - Susceptibility of phenomenon to retrospective bias
 - Participant response burden



Set study parameters: **protocol type**

- Signal and Time Contingent: Consider as well temporal framing of experiences and the time frame of questions
- ***Immediate / Online (e.g., what are you doing right now)***
 - Concern about recall biases
 - May not capture specific behaviors when signal occurs
- ***Short-term retrospective (e.g., what were you doing in the last two hours)***
 - Concern about capture of behaviors when signal occurs
 - Less concern about recall bias
- ***Prospective (e.g., what do you intend to do in the next two hours)***

Set study parameters: **sampling periods**

- Number of observations needed for a stable estimate of a phenomenon within each person
 - Run a multilevel power analysis (Maas & Hox; 2005; Snijders & Bosker, 1999); depends on level of analysis (within- vs between-) and effect size
 - Statistical power for cross-level interaction:
<http://www.hermanaguinis.com/crosslevel.html>
 - Guideline for testing cross-level interaction (level 2 moderator): at least 30 people with 30 observations; 60 people with 25 observations; 150 people with 5 observations (Kreft & DeLeeuw, 1998); ~ 50 (level 2) most ESM-based organizational studies
 - If you want to increase power, better to add people than observations (Bolger, Stadler, & Laurenceau, 2012)

Set study parameters: **sampling periods**

- Number of observations needed for a stable estimate of a phenomenon within each person
 - Lane, S. P., & Hennes, E. P. (2018). Power struggles: Estimating sample size for multilevel relationships research. *Journal of Social and Personal Relationships*, 35, 7-31.
 - Lane, S. P., & Hennes, E. P. (2019). Conducting sensitivity analyses to identify and buffer power vulnerabilities in studies examining substance use over time. *Addictive Behaviors*, 94, 117-123.
 - <https://osf.io/ez2rm/>

Set study parameters: **survey length**

- Ideally brief (shortened scales typically used) less than 2 minutes; daily response burden ~15-20 minutes per day (or even less)
- Naturalistic incidence of events/states
 - Enough to capture fluctuations; ideally no more than 6 times per day and no more than 3 weeks (Delespaul, 1992)
 - Although “breaks” can be given between intensive longitudinal assessment
 - Also, there are studies that go on for months!
 - Living Deliberately Class
- Participant burden and anticipated compliance
 - Response rates range from 50%-95%
 - Could be higher in some fields, like clinical psychology

Checklist for ESM Implementation

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5. Manage the data.



Implement the study:

- Run pilot test
- Create a manual with FAQs for ESM study (IRB approval)
- Participant Issues
 - Recruitment (strategies depend on your sample--***what's in it for them*** and/or ***the company/institution?***)
 - Maintaining participant motivation (research alliance / feedback)
 - Increasing compliance (conduct systematic **participant orientation**)
 - Regular follow-up!
 - Low response rate respondents
 - Reminder of incentives
 - ***Loss aversion framing*** + Threshold for Payment

Implement the study:

- Things to consider putting in for Handout to Participants:
 - Title
 - Contact information (phone, email)
 - Short study rationale (why, how are they helping?)
 - How can a study be completed and time length
 - Is there a baseline survey?
 - Is there a follow-up survey?
 - Instructions for doing the ESM survey
 - Getting started
 - Expected frequencies
 - Incentive/Payment schedule
 - Frequently asked questions: clarifying survey terms like “in the moment”, “episode”

Trends and uses of ESM

Interviews with scholars doing cutting-edge ESM research

- Catharine Fairbairn (Clinical Psychology, University of Illinois Urbana-Champaign)
- *What should researchers know?*
 - Be prepared to be frustrated!
 - Talk with early participants to hear what is happening (recommends first 20 participants)
 - Obtain survey information about experiences



Trends and uses of ESM



Interviews with scholars doing cutting-edge ESM research

- Allison Gabriel (Management & Organizations, University of Arizona)
- *What should researchers know?*
 - Start with how one would analyze the data
 - Think about the timings of when things happen
 - Especially in terms of phenomenon capture and timings of mediation
 - Carefully consider how one provides instructions and adapts items
 - Conduct small scale qualitative studies

Gabriel, A. S., Podsakoff, N. P., Beal, D. J., Scott, B. A., Sonnentag, S., Trougakos, J. P., & Butts, M. M. (2018). Experience Sampling Methods. *Organizational Research Methods*.

doi:10.1177/1094428118802626

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Manage the data:

- Data cleaning takes time:
 - Double replies (depending on the platform's level of sophistication in handling ESM data or mobile service provider's network issues)
 - Checking 'back fill': Do participants provide responses way after the desired time? Does your software prevent backfill?
 - Connecting respondent surveys...
 - Connecting sensor data with survey data

Manage the data:

- Missing data:
 - Three types of missing:
 - **Missing Completely at Random (MCAR)**
 - Nothing systematic about missing responses and will not bias estimates
 - **Missing at Random (MAR)**
 - Missingness related to observed variable rather than missing variable
 - E.g., If women (observed) will less likely reveal weight (missing)
 - **Missing Not at Random (MNAR)**
 - Missingness related to values of missing variable
 - E.g., If overweight (missing values) individuals will less likely reveal weight (missing)

Manage the data:

- Missing data:
 - Multilevel mixed modeling techniques can handle missing data and unbalanced data (different # of observations per participant) **without listwise deletion, as long as data are missing at random (MAR)** (Schafer & Graham, 2002, Psych Methods)
 - Maximum likelihood estimation from incomplete data via the expectation maximization or EM algorithm (Dempster et al., 1977) already in most mixed model softwares (e.g., Mplus)
 - See also Newman (2003; Organizational Research Methods)
 - Generally recommends **Maximum Likelihood** and **Multiple Imputation** (e.g., SAS, R, SPSS) approaches for longitudinal data

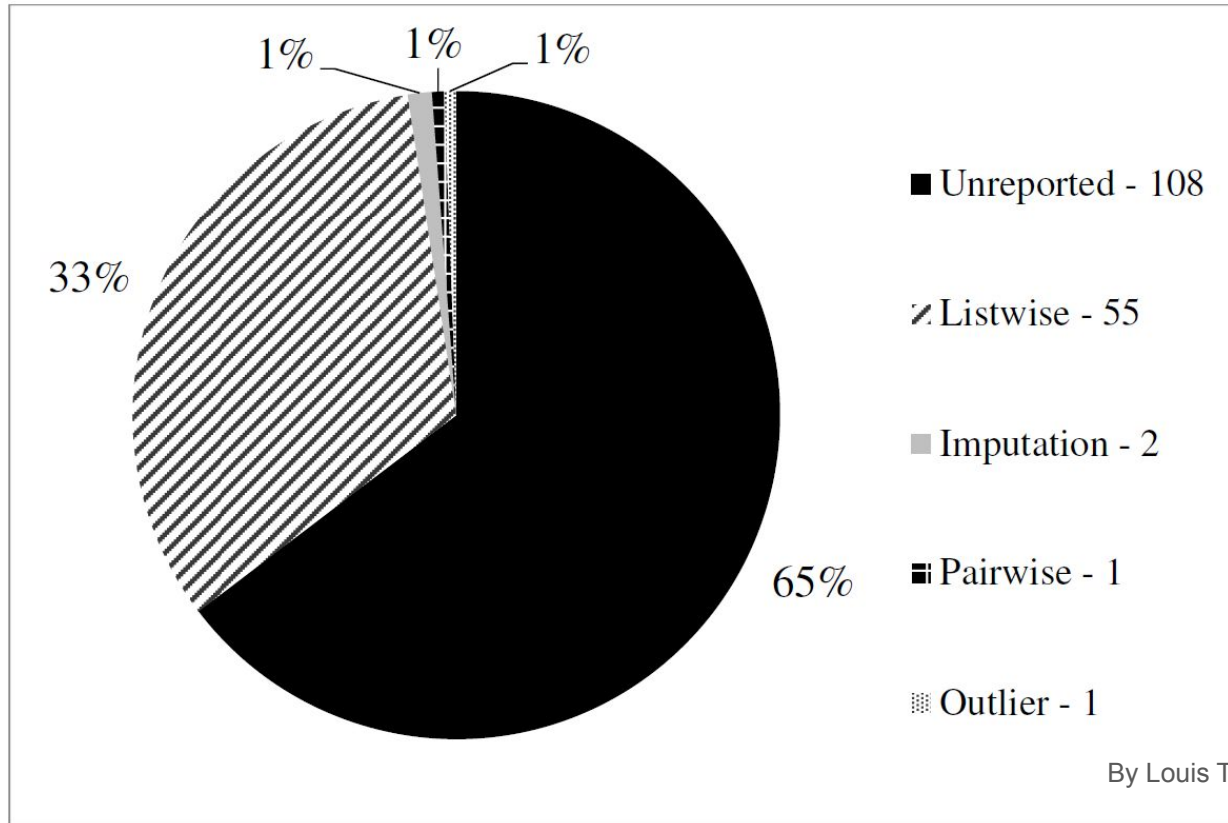
Manage the data:

- Missing data:
 - In general - try to address this issue before it happens!
 - Pilots (too many notifications?)
 - Incentivize (e.g., bonus for > 70%)
 - Need to calculate missing data statistics for respondents
 - Percentage of missing responses
 - Percentage of missing surveys
 - Do some individuals have an inordinate amount of missing data? (e.g., 80% missing)
 - *Report missing data statistics*

Manage the data:

- Missing data:
 - If there is substantial missing for some participants?
 - Ways to address concern and assess if MNAR?
 - Examine demographic differences
 - Calculate correlations (with level of missingness), OR
 - Calculate between group differences (high missing vs. low/no missing)
 - Do post-hoc follow-up (in-person or phone) on key variables.
- Assuming you have full data:
 - Calculate correlations (with level of missingness), OR
 - Calculate between group differences (high missing vs. low/no missing)

Missing data



Manage the data:

- Problematic data:
 - There may also be problematic data apart from missing data that can lead to problems in estimation
 - Calculate careless responding (see Meade & Craig, 2012; Psych Methods)
 - Or include attention checks in ESM surveys (e.g., Keith, Tay, & Harms, 2017)
 - Attention checks to make sure missingness is not due to lack of care on survey responses

Manage the data:

- Learn **multilevel mixed modeling** by taking short courses or using these books as references (ESM is software agnostic!)
 - MPlus Program: Byrne (2013)
 - Stata Program: Rabe-Hesketh & Skrondal (2008)
 - HLM Program; Raudenbush & Bryk (2002)
 - R Program: Finch, Bolin, & Kelley (2014)
 - SPSS Program: Heck, Thomas, & Tabata (2013)
 - SAS Program: Littell, Milliken, Stroup, Woulfingher, & Schabenberger (2006)

Design, Costs and Implementation

QUESTIONS?

Workshop components

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Different techniques/analytics for ESM

Key papers on longitudinal analyses in organizational and psychological research

- Avey, J. B., Luthans, F., & Mhatre, K. H. (2008). A call for longitudinal research in positive organizational behavior. *Journal of Organizational Behavior*, 29(5), 705-711.
- Ballinger, G. A. (2004). Using generalized estimating equations for longitudinal data analysis. *Organizational research methods*, 7(2), 127-150.
- Beal, D. J. (2015). ESM 2.0: State of the art and future potential of experience sampling methods in organizational research. *Annual Review of Organizational Psychology and Organizational Behavior*, 2(1), 383-407.
- Bliese, P. D., Chan, D., & Ployhart, R. E. (2007). Multilevel methods: Future directions in measurement, longitudinal analyses, and nonnormal outcomes. *Organizational Research Methods*, 10, 551-563.
- Bliese, P. D., & Ployhart, R. E. (2002). Growth modeling using random coefficient models: Model building, testing, and illustrations. *Organizational Research Methods*, 5, 362-387.

Different techniques/analytics for ESM

Key papers on longitudinal analyses in organizational and psychological research

- Fisher, C. D., & To, M. L. (2012). Using experience sampling methodology in organizational behavior. *Journal of Organizational Behavior*, 33, 865-877.
- Ohly, S., Sonnentag, S., Niessen, C., & Zapf, D. (2010). Diary studies in organizational research. *Journal of Personnel Psychology*, 9, 79-93.
- Ployhart, R. E., & Vandenberg, R. J. (2010). Longitudinal research: The theory, design, and analysis of change. *Journal of Management*, 36, 94-120.
- Uy, M. A., Foo, M. D., & Aguinis, H. (2010). Using experience sampling methodology to advance entrepreneurship theory and research. *Organizational Research Methods*, 13, 31-54.
- Wang, M., Beal, D. J., Chan, D., Newman, D. A., Vancouver, J. B., & Vandenberg, R. J. (2016). Longitudinal research: A panel discussion on conceptual issues, research design, and statistical techniques. *Work Aging and Retirement*, 3, 1-24.

Different techniques/analytics for ESM

Key papers on longitudinal analyses in organizational and psychological research

- Wang, M., Zhou, L., & Zhang, Z. (2016). Dynamic modeling. *Annual Review of Organizational Psychology and Organizational Behavior*, 3, 241-266.
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- Zyphur*, M., Voelke, M., Tay, L., Allison, P. D., Preacher, K. J., Zhang, Z., Hamaker, E., Shamsollahi, A., Pierides, D. C., Koval, P., Diener, E. (2019). From Data to Causes II: Comparing Approaches to Panel Data Analysis. *Organizational Research Methods*. Advanced online publication. doi: <https://doi.org/10.1177/1094428119847280>
- Zyphur*, M., Allison, P. D., Tay, L., Voelke, M., Preacher, K. J., Zhang, Z., Hamaker, E., Shamsollahi, A., Pierides, D. C., Koval, P., Diener, E. (2019). From Data to Causes I: Building a general cross-lagged model (GCLM). *Organizational Research Methods*. Advanced online publication. doi: <https://doi.org/10.1177/1094428119847278>

Different techniques/analytics for ESM

- Activities/Experiences
- Trajectories
- Dynamics
- Multilevel
- Others

Different techniques/analytics for ESM

- *Activities/Experiences*
- Trajectories
- Dynamics
- Multilevel
- Others

Different techniques/analytics for ESM

Activities/Experiences

- Time allocated for activity or situation
- Frequencies/levels of behaviors or experiences

Mean-level analyses for each activity/situation

Different techniques/analytics for ESM

More recently, there has been a push for Day Reconstruction Methodology (Kahneman et al., 2004) as a proxy for ESM (~1000 working women)

Mean affect rating

Activities	Positive	Negative	Competent	Impatient	Tired	Mean hrs/day	%Resp.
Intimate relations	5.10	0.36	4.57	0.74	3.09	0.2	0.11
Socializing	4.59	0.57	4.32	1.20	2.33	2.3	0.65
Relaxing	4.42	0.51	4.05	0.84	3.44	2.2	0.77
Pray/worship/meditate	4.35	0.59	4.45	1.04	2.95	0.4	0.23
Eating	4.34	0.59	4.12	0.95	2.55	2.2	0.94
Exercising	4.31	0.50	4.26	1.58	2.42	0.2	0.16
Watching TV	4.19	0.58	3.95	1.02	3.54	2.2	0.75
Shopping	3.95	0.74	4.26	2.08	2.66	0.4	0.30
Preparing food	3.93	0.69	4.20	1.54	3.11	1.1	0.62
On the phone	3.92	0.85	4.35	1.92	2.92	2.5	0.61
Care of my children	3.86	0.91	4.19	1.95	3.56	1.1	0.36
Computer/e-mail/Internet	3.81	0.80	4.57	1.93	2.62	1.9	0.47
Housework	3.73	0.77	4.23	2.11	3.40	1.1	0.49
Working	3.62	0.97	4.45	2.70	2.42	6.9	1.00
Commuting	3.45	0.89	4.09	2.60	2.75	1.6	0.87

Different techniques/analytics for ESM

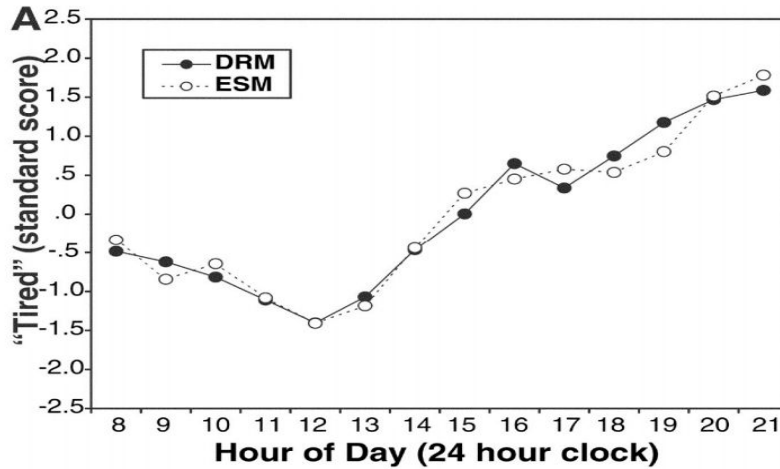
- Activities/Experiences
- ***Trajectories***
- Dynamics
- Multilevel
- Others

Different techniques/analytics for ESM

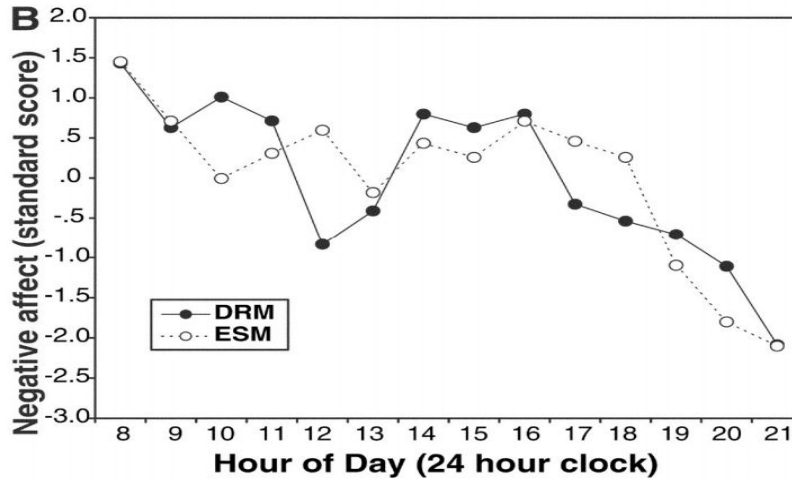
Trajectories - examining pattern of a variable over time

Possible interests

- Daily or weekly rhythms (e.g., Kahneman et al., 2004)
 - *Time-series analysis* (Jebb et al., 2015)



Tiredness



Negative affect

Different techniques/analytics for ESM

Trajectories - examining pattern of a variable over time

Possible interests

- Daily or weekly rhythms (e.g., Kahneman et al., 2004)
 - *Time-series analysis* (Jebb et al., 2015)
- Level differences as a function of intervention or organizational change
 - *Discontinuous growth models* (Bliese et al., 2007; Bliese et al., 2006)
 - *Interrupted time series analysis* (Bernal et al., 2016)

Different techniques/analytics for ESM

- Activities/Experiences
- Trajectories
- ***Dynamics***
- Multilevel
- Others

Different techniques/analytics for ESM

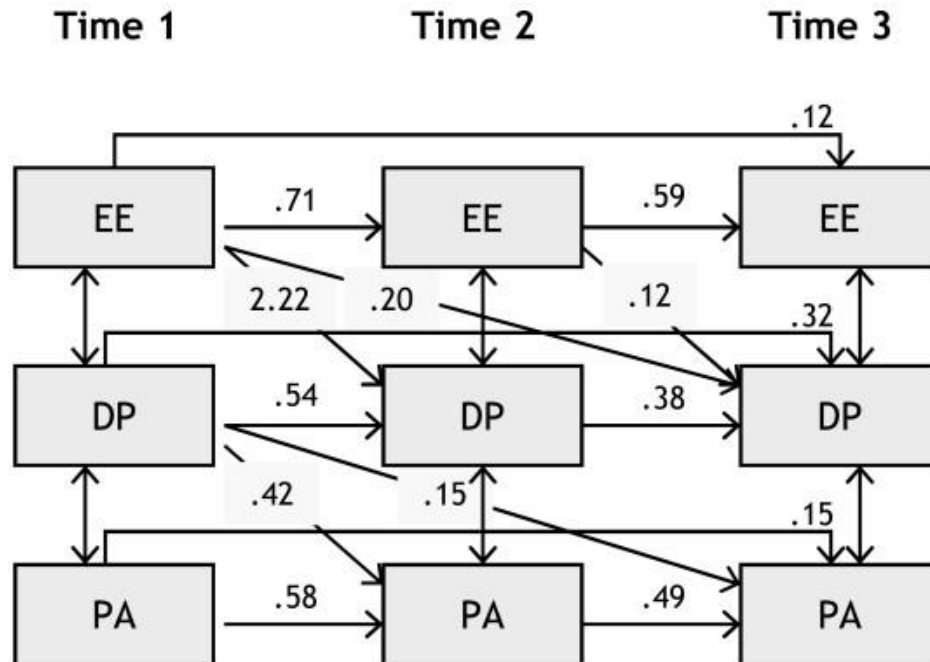
Dynamics - how variables are related to each other over time

Possible interests

- Mediation over time
 - General SEM for multilevel mediation (Preacher, Zyphur, & Zhang, 2010)
- Causal direction (e.g., Houkas et al., 2011)
 - Cross-lagged panel model / Random Intercept CLPM (Hamaker, Kuiper, & Grasman, 2015)
- Panel Modeling (e.g., Zyphur et al., 2018)
 - Michael J Zyphur, Manuel C Voelkle, Louis Tay, Paul D Allison, Kristopher J Preacher, Zhen Zhang, Ellen L Hamaker, Ali Shamsollahi, Dean C Pierides, Peter Koval, Ed Diener
 - <https://youtu.be/tHnnaRNPbXs>

Different techniques/analytics for ESM

Houkas et al (2011) Development of burnout over time and the causal order of the three dimensions of burnout among male and female GPs. A three-wave panel study. BMC Public Health, 11, 240.



Different techniques/analytics for ESM

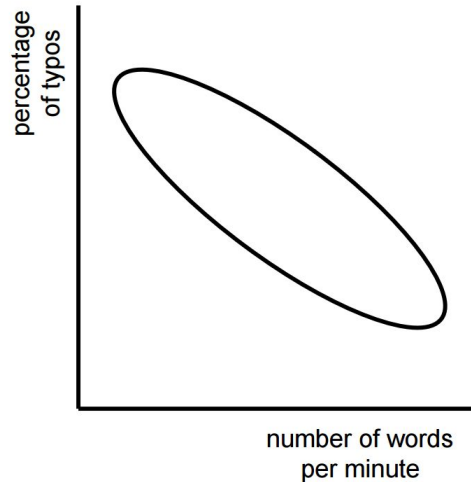
- Activities/Experiences
- Trajectories
- Dynamics
- ***Multilevel***
- Others

Different techniques/analytics for ESM

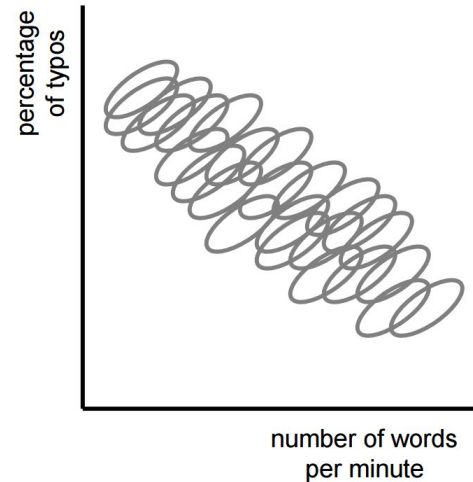
Multilevel - within-individual and between-individual processes

Hamaker (2012)

Cross-sectionally



In general



Different techniques/analytics for ESM

Multilevel - within-individual and between-individual processes

- Understanding within vs. between individual variability of phenomenon
 - Variance partitioning (Bliese, 2000)

- Disentangling within-individual processes over time from between-individual
 - Multilevel growth models (Bliese & Ployhart, 2002)

- Dynamic multilevel modeling (Cramer et al., 2012)

Different techniques/analytics for ESM

Multilevel - within-individual and between-individual processes (Courvoiser et al., 2012)

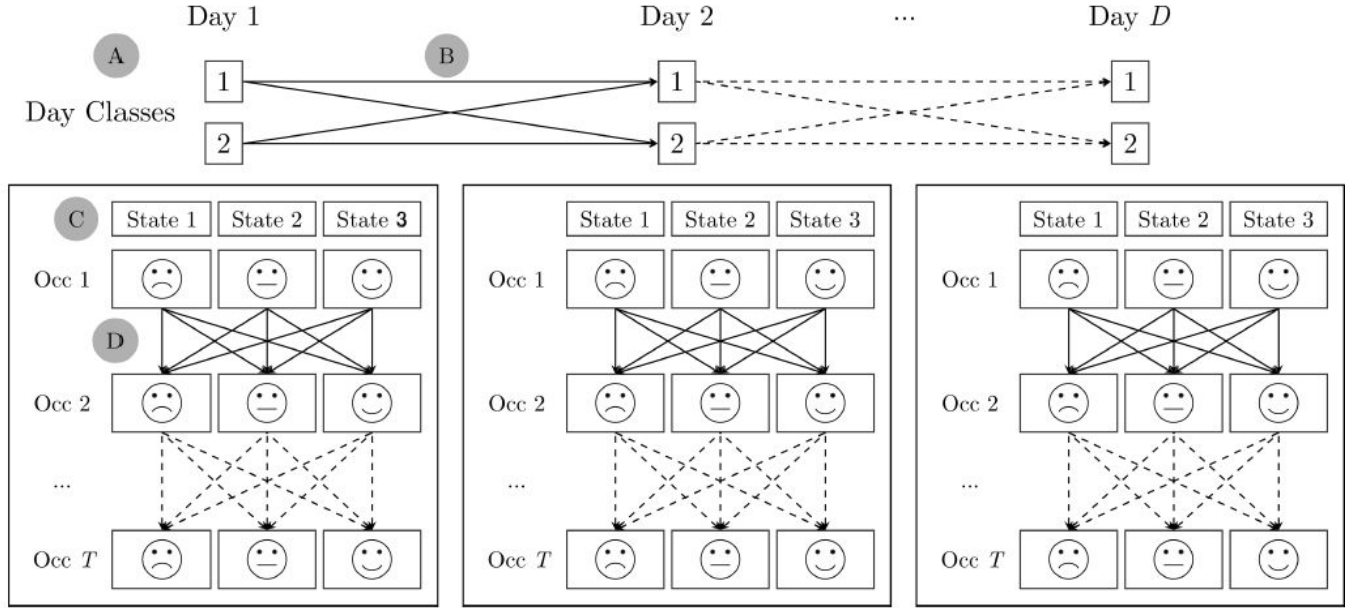


Figure 2. A hierarchical mixture latent Markov model with three latent states and two latent day classes. The measurement part of the model has been omitted. Occ = occasion within a day; D = number of days; T = number of occasions. Parameters denoted by gray-shaded letters are referred to in the text: A = initial day class probabilities; B = day class transition probabilities; C = initial state probabilities; D = state transition probabilities.

Different techniques/analytics for ESM

Multilevel - modeling 'inertia' using multilevel modeling (Kuppens, Allen, & Sheebar, 2010)

- Level 1:
 - $\text{Happy}(t+1)_{ij} = b_{0j} + b_{1j}(\text{Happy}[t])_{ij} + r_{ij}$
- Level 2:
 - $b_{0j} = g_{00} + u_{0j}$
 - $b_{1j} = g_{10} + u_{1j}$

Note: $(\text{Happy}[t])_{ij}$ is group-mean centered

Different techniques/analytics for ESM

- Activities/Experiences
- Trajectories
- Dynamics
- Multilevel
- ***Others***

Different techniques/analytics for ESM

Others

- Qualitative data (text and audio)
- Multimedia data -- photos and videos
 - <https://github.com/IBM/watson-calorie-counter>
- Location data

Different techniques/analytics for ESM

Others

- Reactivity to ESM (Dewey et al., 2015)
 - Do people change behaviors when they are monitored closely?
 - McCarthy, D. E., Minami, H., Yeh, V. M., & Bold, K. W. (2015). An experimental investigation of reactivity to ecological momentary assessment frequency among adults trying to quit smoking. *Addiction*, 110(10), 1549-1560.
 - van Ballegooijen, W., Ruwaard, J., Karyotaki, E., Ebert, D. D., Smit, J. H., & Riper, H. (2016). Reactivity to smartphone-based ecological momentary assessment of depressive symptoms (MoodMonitor): protocol of a randomised controlled trial. *BMC Psychiatry*, 16(1), 359

Different techniques/analytics for ESM

Note ... on the issue of computing reliability (use generalizability study)

The reliability of the average of m item scores across k days is excellent, as can be seen from the following calculation that uses Equation 4 of Cranford et al. (2006) with results in our Table 15.1:

$$R_{KF} = \frac{\sigma_{PERSON}^2 + \left(\frac{\sigma_{PERSON*ITEM}^2}{m} \right)}{\left[\sigma_{PERSON}^2 + \left(\frac{\sigma_{PERSON*ITEM}^2}{m} \right) + \left(\frac{\sigma_{ERROR}^2}{km} \right) \right]}$$

$$= \frac{0.69 + (0.02/2)}{0.69 + (0.02/2) + [0.17 / (44 * 2)]} = 0.99. \quad (1)$$

The reliability of daily change is estimated using Equation 5 of Cranford et al. (2006) along with the numerical values in our Table 15.1:

$$R_{Change} = \frac{\sigma_{PERSON*DAY}^2}{\left[\sigma_{PERSON*DAY}^2 + \left(\frac{\sigma_{ERROR}^2}{m} \right) \right]}$$

$$= \frac{0.28}{0.28 + (0.17/2)} = 0.77. \quad (2)$$

Results of G-Study—Examinee's Relationship Satisfaction From Bar Exam Data Set

Sources of variance	Symbol	Variance estimates	Percentage
Person	σ	0.689	58.7
Day	σ	0.007	0.6
Item	σ	0.013	1.1
Person X Day	σ	0.281	23.9
Person X Item	σ	0.020	1.7
Day X Item	σ	0.000	0.1
Error	σ	0.166	14.1
TOTAL		1.176	100.0

Different techniques/analytics for ESM

Another Note ... report between-individual and pooled-within individual correlations where possible - it helps with accumulating evidence with meta-analyses

- For example:
 - Above diagonal (between individuals)
 - Below diagonal (pooled within individuals)
 - Sample sizes (# individuals; # occasions)
- Use R functions
 - statsBy in *psych* package
 - <http://personality-project.org/r/psych/help/statsBy.html>

Workshop components

- 1) History and purposes of Experience Sampling Method (ESM), Ecological Momentary Assessment (EMA), and Ambulatory Assessment (20 mins)
- 2) Current trends and practices (30 mins)
- 3) Design, costs, and implementation (40 mins)
- 4) Describe different techniques for analyzing ESM data (20 mins)
- 5) **Implementing ESM/EMA in ExpiWell (40 mins)**

Various ESM Platforms

Comprehensive List Compiled by
Dr. Tamlin Conner (U of Otago, NZ)

<http://www.otago.ac.nz/psychology/otago047475.pdf>

- 2 non-app based platforms; 20 app based platforms
- Price range: Zero to > US\$5,000/year



“Free”:

PACO: <https://www.pacoapp.com/>

- Uneven apps (Android vs. iOS); no online participant tracking

ExperienceSampler: <http://www.experiencesampler.com/>

- Programming knowledge, computer to set up a server, and a \$299 per year developer fee for putting up an iOS app; no online participant tracking

MobileQ: Android



ExpiWell www.expiwell.com

Signaling/Scheduling

1. Unlimited Notifications

Notifications that can be randomized within time slots (e.g., 10-11am)

Set up reminder notifications for participants

Track and send additional notification messages to participants

Snooze notifications

2. Unlimited Surveys: Open/Close surveys

Prevent participants from starting a survey until they are notified or close survey after a certain time (e.g., 20 minutes past notification) -- no need to check 'back fill'



ExpiWell www.expiwell.com

Signaling/Scheduling

1. **Mixed Schedules**

Enable for static/event-based surveys throughout the entire project (e.g., baseline survey; demographics; event-based surveys)

2. **Notifications/schedules occur on participant's timezone**

For example: 8am time is 8am EST and 8am CDT and 8am Pacific

Accounts for Daylight Savings changes in participants

3. Can enable **Automated Rolling Start Dates** for participants with “Rolling Schedule”



ExpiWell www.expiwell.com

Real-time tracking

1. **Participant Response Rates**

Can track participant response rates (overall and current) directly and immediately without downloading data and manually linking data

2. **Notification Message System**

Reach out to participants to do ongoing follow-ups

3. **COMING SOON: Repoll Participants from Previous Study; Participant Payments**



ExpiWell www.expiwell.com

Bridging Qualtrics/Survey Monkey/Web Tasks

1. **Text/Instruction Web Links**

Can identify web links in mobile app

2. **Email Projects**

Create a calendar or rolling schedule for Emails and associated surveys to be sent to participants based on their time zone



ExpiWell www.expiwell.com

<https://expimetrics.freshdesk.com/support/home>

Data collection through free iOS and Android apps

1. Survey Questions: Different types of survey questions, Randomization, Skip Logic
2. Photos
3. Videos
4. Voice
5. Web links
6. (Location)
7. Response times



ExpiWell www.expiwell.com

Need Features?

Develop new features close to cost

- Accelerometer data (# steps, distance walked)
- Screen time
- Link to other Apps
- New schedule types
- Piping multimedia



ExpiWell www.expiwell.com

Sample of Customers; GDPR compliant

- University of Pennsylvania, University of Illinois, University of Minnesota, Notre Dame, Bowling Green State University, Stanford University, Wash U St Louis, Boston Museum of Fine Arts
- Royal Melbourne Institute of Technology in Australia, Monash University, UQ in Australia
- Erasmus School of Social and Behavioural Sciences in Netherlands



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Sample of Customers; GDPR compliant

- University of Regina, Brock University in Canada
- Ruhr-Universität Bochum in Germany
- University of Leuven
- University of Neuchâtel in Switzerland
- Singapore Management University, Nanyang Technological University, Hong Kong University of Science and Technology



ExpiWell www.expiwell.com

Grants

- We work closely with researchers in other labs on grants etc.
- Our lab has more than \$4m in grant monies in collaboration with other researchers



ExpiWell www.expiwell.com

Expimetrics Data Security and Privacy

- Expimetrics uses industry best standards to protect customer data and data collected for research.
- Our servers are protected by high-end firewall systems, and scans are performed regularly to ensure that any vulnerabilities are quickly found and patched.
- Expimetrics uses Transport Layer Security (TLS) encryption, or HTTPS, for all transmitted data.
- Our services are hosted by Amazon Web Services (AWS) which is a well-known and trusted data center that meets the requirements of security-sensitive organizations while providing data privacy. As further discussed in the web link: <https://aws.amazon.com/compliance/data-privacy-faq/> “AWS’s alignment with ISO 27018 has been validated by an independent third party assessor. ISO 27018 is the first International code of practice that focuses on protection of personal data in the cloud. It is based on ISO information security standard 27002 and provides implementation guidance on ISO 27002 controls applicable to Personally Identifiable Information (PII) processed by public cloud service providers. This demonstrates to customers that AWS has a system of controls in place that specifically address the privacy protection of their content.”
- Expimetrics subscribers control their users and their data, it is important for the users to practice sound security practices themselves by using strong account passwords, not storing passwords in easily accessible places, and restricting access to their accounts to authorized persons