Using participants’ own mobile phones for Ecological Momentary Assessment – insights from a study with young adult smokers

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Center for Tobacco Control Research and Education

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Acknowledgements

• Anneke Bühler, PhD
• Stuart G. Ferguson, PhD
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• Dr. Ferguson was supported through a fellowship from Cancer Council Tasmania (Australia)
Overview

- What is EMA?
- How do mobile phones come in?
- Feasibility data
  - Discussion of results – lessons learned
- Application of EMA data
  - Analysis of situational antecedents of smoking in light and heavy smokers
- General discussion, Q&A
Ecological momentary assessment (EMA)

- **Aim:** Assessments of behavior in natural environment, high ecological validity
- **Multiple assessments with short questionnaires**
- **Default gold standard:** Electronic diaries
- **Procedure:**
  - **Time sampling:** Participants are prompted at random time-points and complete assessment
  - **Event sampling:** Participants report events, e.g. smoking
    (Shiffman et al., 2008, Annu Rev Clin Psychol; Ferguson & Shiffman, 2011, Subst Use Misuse)
Electronic diaries

- **Advantages**
  - Can be pre-programmed
  - Random prompts and event sampling
  - Time- and date-stamp observation (time-series analyses)

- **Disadvantages**
  - Costs
  - Long-term monitoring of large groups of people difficult
Mobile Internet
Almost two-thirds of cell owners go online using their phones

Among cell phone owners, the % who use the internet or email on their phone

<table>
<thead>
<tr>
<th>Year</th>
<th>Email</th>
<th>Internet</th>
<th>Total Cell Internet Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr-09</td>
<td>25%</td>
<td>25%</td>
<td>-</td>
</tr>
<tr>
<td>May-10</td>
<td>34%</td>
<td>38%</td>
<td>43%</td>
</tr>
<tr>
<td>May-11</td>
<td>38%</td>
<td>44%</td>
<td>47%</td>
</tr>
<tr>
<td>Apr-12</td>
<td>44%</td>
<td>53%</td>
<td>55%</td>
</tr>
<tr>
<td>May-13</td>
<td>52%</td>
<td>60%</td>
<td>63%</td>
</tr>
</tbody>
</table>

Source: Pew Internet & American Life Project Spring Tracking Survey, April 17-May 19, 2013. N=2,076 cell phone owners ages 18+. Interviews were conducted in English and Spanish and on landline and cell phones. The margin of error for results based on cell phone owners is +/- 2.4 percentage points.
Recent developments

Distinct coping strategies differentially predict urge levels and lapses in a smoking cessation attempt

Jeannette Brodbeck *, Monica S. Bachmann, Hansjörg Znoj
University of Berne, Department of Clinical Psychology and Psychotherapy, Gesellschaftstrasse 49, CH-3012 Berne, Switzerland

ICAT: Development of an Internet-Based Data Collection Method for Ecological Momentary Assessment Using Personal Cell Phones

Emmanuel Kuntsche¹,² and Florian Labhart¹

DOI: 10.1027/1015-5759/a000137
Key questions: Feasibility

- Can time- and event-based sampling schemes be replicated in Internet-based EMA studies?

- Can compliance with study protocols be maintained?

- How do we issue random prompts?
The Smokebook study
Sampling

N = 150 smokers
(100 LITS, 50 HS)

6-week-interval 1

6-week-interval 2

6-week-interval 3

6-week-interval 4

Thursday

Friday

Saturday

5 random prompts

5 self-initiated assessments

...
Technology

- Browser-based questionnaires
  - Usable with every Internet-enabled phone
  - Advantage: no app, independent of particular platform/device (e.g., iOS, Android, Windows)
- Centrally accessible system
  - Highly flexible
- Automatic online SMS system for random prompting
Inclusion criteria

- 18 to 25 year
- Men and women
- Own a smartphone
- Intention to quit or reduce smoking
  - Sampling of smoking cessation events
  - Generalizability of results: Smokers looking for professional support are motivated to quit
- > 100 cigarettes/lifetime
  - LITS: <=5 cig/day, min. 21 day smoked (out of last 30)
  - HS: >=10 cig/day, daily smoking
Sample

- Recruitment through Facebook ads and postings
- Sample characteristics
  - n = 92
  - Age: 21.2
  - 39 women (42.4%)
  - 71 students (77.2%)
  - 45 LITS (48.9%): 3.5 cigarettes/day
  - 47 HS (51.1%): 16.1 cigarettes/day
Baseline (20 min)

- Sociodemographics
- Past smoking behavior
- Nicotine dependence
- Self-efficacy
- Quit motivation
- Personality
  - Trait self-control
  - Trait affect

EMA (20 questions - 2 min)

- Smoking or non-smoking
- Internal
  - Affect & arousal
  - Craving
- External
  - (Smoking) people
  - Activity, place (smok. ban)
  - Food, drink, alcohol
… to improve retention and compliance

- Reminder-SMS and questionnaire on Wednesday
- Incentives: Smokebookpoints for completed EMA questionnaires (50 Cent per questionnaire - max. 5€ per day, 60€ total)
- Enter lottery for an iPad at the end of study
- Additional adjustments during the study
  - SMS reminders with instructions Wednesday
  - Reminder calls with instructions Wednesday
# Results

<table>
<thead>
<tr>
<th></th>
<th>Total sample (n = 92)</th>
<th>LITS (n = 45)</th>
<th>HS (n = 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total reports completed</td>
<td>885</td>
<td>456</td>
<td>429</td>
</tr>
<tr>
<td>Reports/participant/day</td>
<td>4.17 (2.77)</td>
<td>4.47 (2.56)</td>
<td>4.44 (3.13)</td>
</tr>
<tr>
<td>Total random prompts</td>
<td>708 (50.2%)</td>
<td>386 (54.8%)</td>
<td>322 (45.7%)</td>
</tr>
<tr>
<td>Random prompts/participant/day</td>
<td>3.56 (1.98)</td>
<td>3.75 (1.92)</td>
<td>3.35 (2.03)</td>
</tr>
<tr>
<td>Total self-initiated reports</td>
<td>177</td>
<td>70</td>
<td>107</td>
</tr>
<tr>
<td>Self-initiated reports/participant/day</td>
<td>1.90 (1.22)</td>
<td>1.71 (1.21)</td>
<td>2.06 (1.23)</td>
</tr>
</tbody>
</table>
Results

- Total days of with observations = 276

Days with any EMA data

Days with any random prompt assessments

Days with any self-initiated assessments

Participation
Results – random prompts

- Total SMS sent 1410

Total completed

Completed within 10 minutes
Results – random prompts

- Participants responding

To over 50% of RPs

To over 80% of RPs
Results – predicting compliance

- Age, gender, and baseline smoking status were used to predict number of assessments
- Age was related to more assessments
- Female gender associated with fewer assessments
- Smoking status did not predict number of assessments
Discussion - reasons

- 20 interviews with participants after end of study
  - Too many assessments, too frequent
  - Repetitiveness (same questions over and over)
  - Time interval during the day (morning, evening, and weekend)
  - Problems with incentives (display)
  - No overview over personal statistics
  - Problems with reception/Internet on the go
  - Not able to react promptly because too busy, or other reasons (work, school, etc.)
Discussion – replenishment sample (N=15)

- Participants initially contacted before the first wave of EMA assessment
- Reminded of importance of completing prompted assessments (within 10 min) and instructed to self-initiate prompts
- Reminded of incentives
- Improved compliance
  - EMA data on 95.6% of days
  - Completed 72.0% of random prompts (54.9% <10 min)
  - Completed self-initiated reports on 35.6% of days
Discussion - lessons learned

- Involvement of participants
  - Increase personal contact with study staff
- Communicate importance of compliance!!!
- Tailored questionnaires (skip rules)
- Different incentive scheme
- Display of personal statistics after every assessment
- More options to customize time-interval
- Different approach for event-based sampling
  (Shiffman et al., 2002, J Abnorm Psychol)
Discussion

- Comparison with other EMA studies (Shiffman, 2009, Psychol Assess)
  
  - From ED studies: compliance with prompts varied widely across studies from 90% to as low as 52% (college students)
  
  - Unclear what causes this variation (sample, incentives, training, feedback)
  
  - Possibly more difficult to engage young adult participants in compliant behavior
  
  - Compliance with recording of events more difficult to assess
Discussion

- Median response time 25 minutes
  (Kuntsche & Labhart, 2012, Drug Alcohol Depen)

(compared to 10 minutes in our study)
Conclusion

- Internet based EMA procedures relying on participants’ phones are technically feasible
- Especially interesting for studying young populations in countries with good availability of mobile Internet
- Potentially useful for long-term and large-scale monitoring
- Problems with participant compliance have to be overcome
Using EMA data for an applied research question...

- Comparison of situational smoking antecedents among light and heavy smokers
Light and intermittent vs. heavy smoking

- Subtypes of smokers have been characterized by means of surveys, lab studies, and observational studies (Coggins et al., 2009, Psychopharmacology)

- Differences between LITS and HS
  - LITS smoke for positive reinforcement
  - LITS react with less craving to smoking related cues
  - LITS’ smoking more associated with risky drinking

- Another key difference: Age – LITS are younger on average
LITS vs. HS – previous EMA results

- Two studies have compared situational antecedents between LITS and HS
  - Older adults $M_{\text{age}} = 40$ (Shiffman & Paty, 2006, J Abnorm Psychol)
  - College students (Cronk & Piasecki, 2010, NTR)

- Some conflicting results (regarding the roles of craving, type of activity, consumption of food, drinks, and alcohol)

- In general: LITS are more influenced by other persons’ smoking and location type

- Mood not associated with smoking
Research question

- Examine situational predictors of smoking in young adult LITS and HS

- Examine different predictors related to
  - internal situational aspects (e.g., mood, craving)
  - external situational aspects (e.g., location, activity, food, smoking by others)

- Do situational predictors of smoking differ between young adult LITS and HS?
Baseline (20 min)
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- Quit motivation
- Personality
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  - Trait affect

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Sample selection

- 203 participants fulfilled inclusion criteria
- 155 completed the baseline assessment
- 138 reported any EMA assessment
  - 68 excluded because they did not provide retrospective data on their smoking behavior for more than 1 wave
  - 29 excluded because they transitioned between groups during course of the study

Analytical sample:
n = 41 participants (23 LITS, 18 HS)
## Sample characteristics

<table>
<thead>
<tr>
<th></th>
<th>LITS (n=23)</th>
<th>HS (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>21.3 (2.2)</td>
<td>22.6 (2.6)</td>
</tr>
<tr>
<td>Gender female</td>
<td>47.3%</td>
<td>61.1%</td>
</tr>
<tr>
<td>Currently students</td>
<td>100%</td>
<td>77.8%*</td>
</tr>
<tr>
<td>Smoking rate (cig per day)</td>
<td>3.6 (1.1)</td>
<td>16.2 (3.1)***</td>
</tr>
<tr>
<td>Smoking pattern for 12 months or more</td>
<td>43.5%</td>
<td>77.8%*</td>
</tr>
<tr>
<td>Nicotine dependence (HONC)</td>
<td>5.0 (2.1)</td>
<td>7.1 (2.4)**</td>
</tr>
</tbody>
</table>
Available data

- Only assessments within 60 min after issuing of the prompt were considered.
- 1543 EMA assessments analyzed (37.6 per participant)(602 smoking situations)
- 65.6% of random prompts responded to in the first 10 minutes after issuing.
- Average response time 12.5 min.
Data analysis

- Generalized estimating equations (GEE)
- Characteristics of the situation (e.g., mood, activity, ...) were used to predict smoking (vs. non-smoking) as categorical dependent variable (like logistic regression)
- Adjusted for potential covariates (e.g., location was adjusted for smoking bans and smoking by others)
- Interaction effects (smoking status x predictor) to test if relationships between predictors and smoking differ between LITS and HS
Results

Table 1. Situational predictors of smoking situations

<table>
<thead>
<tr>
<th>Variable</th>
<th>NS-Sit (M, SD, %)</th>
<th>S-Sit (M, SD, %)</th>
<th>OR S- versus NS-Sit (95% CI)</th>
<th>AOR S- versus NS-Sit (95% CI)</th>
<th>OR S- versus NS-Sit (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affect</td>
<td>6.10 (1.88)</td>
<td>6.05 (1.99)</td>
<td>0.99 (0.83-1.19)</td>
<td>0.98 (0.79-1.21)*</td>
<td>0.98 (0.86-1.10)</td>
</tr>
<tr>
<td>Quadratic</td>
<td>1.02 (0.98-1.07)</td>
<td>1.02 (0.97-1.07)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arousal</td>
<td>4.07 (1.70)</td>
<td>4.35 (1.72)</td>
<td>1.09 (0.92-1.30)</td>
<td>1.05 (0.87-1.28)*</td>
<td>1.10 (0.98-1.23)</td>
</tr>
<tr>
<td>Quadratic</td>
<td>1.00 (0.95-1.06)</td>
<td>0.99 (0.92-1.05)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craving</td>
<td>14.8</td>
<td>74.5</td>
<td>16.47*** (9.48-28.60)</td>
<td>15.87*** (8.99-28.01)*</td>
<td></td>
</tr>
<tr>
<td>External</td>
<td>37.3</td>
<td>13.5</td>
<td>0.26*** (0.15-0.45)</td>
<td>0.25*** (0.13-0.47)*</td>
<td></td>
</tr>
<tr>
<td>Smoking ban</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td>1.7</td>
<td>3.1</td>
<td>2.01 (0.77-5.27)</td>
<td>1.57 (0.43-5.72)*</td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>7.3</td>
<td>4.5</td>
<td>0.58 (0.24-1.41)</td>
<td>0.94 (0.45-1.97)*</td>
<td></td>
</tr>
<tr>
<td>Bar</td>
<td>2.4</td>
<td>4.0</td>
<td>1.65 (0.87-3.13)</td>
<td>0.95 (0.50-1.80)*</td>
<td></td>
</tr>
<tr>
<td>School</td>
<td>10.6</td>
<td>5.3</td>
<td>0.95 (0.57-1.57)</td>
<td>1.03 (0.59-1.82)*</td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>66.0</td>
<td>52.5</td>
<td>0.59*** (0.45-0.76)</td>
<td>0.66 (0.43-1.01)*</td>
<td></td>
</tr>
<tr>
<td>Others’ home</td>
<td>5.5</td>
<td>12.1</td>
<td>2.30*** (1.42-3.73)</td>
<td>1.88* (1.01-3.40)*</td>
<td></td>
</tr>
<tr>
<td>Other place</td>
<td>6.2</td>
<td>12.6</td>
<td>2.10*** (1.20-3.68)</td>
<td>1.22 (0.73-2.06)*</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>19.9</td>
<td>14.8</td>
<td>0.69 (0.42-1.14)</td>
<td>0.87 (0.53-1.45)*</td>
<td>1.09 (0.68-1.77)</td>
</tr>
<tr>
<td>Talking</td>
<td>15.0</td>
<td>26.0</td>
<td>1.96** (1.27-3.04)</td>
<td>1.46 (0.85-2.51)*</td>
<td>1.27 (0.95-1.69)</td>
</tr>
<tr>
<td>Doing nothing</td>
<td>25.2</td>
<td>21.5</td>
<td>0.84 (0.53-1.31)</td>
<td>0.88 (0.55-1.43)*</td>
<td>1.64* (1.05-2.53)</td>
</tr>
<tr>
<td>Relaxing</td>
<td>32.5</td>
<td>27.8</td>
<td>0.80 (0.46-1.38)</td>
<td>0.83 (0.48-1.42)*</td>
<td>0.82 (0.58-1.17)</td>
</tr>
<tr>
<td>Waiting</td>
<td>13.4</td>
<td>12.6</td>
<td>0.89 (0.53-1.49)</td>
<td>1.03 (0.55-1.94)*</td>
<td>1.57* (1.07-2.57)</td>
</tr>
<tr>
<td>Other activity</td>
<td>16.6</td>
<td>13.9</td>
<td>0.83 (0.59-1.17)</td>
<td>0.70 (0.45-1.07)*</td>
<td>0.58 (0.28-1.21)</td>
</tr>
<tr>
<td>Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any food or drink</td>
<td>51.6</td>
<td>63.7</td>
<td>1.66** (1.20-2.30)</td>
<td>1.46* (1.07-1.99)*</td>
<td>1.55* (1.09-2.22)</td>
</tr>
<tr>
<td>Food</td>
<td>29.8</td>
<td>29.2</td>
<td>0.98 (0.69-1.41)</td>
<td>0.95 (0.67-1.34)</td>
<td>1.36 (1.00-1.85)</td>
</tr>
<tr>
<td>Coffee</td>
<td>8.2</td>
<td>9.4</td>
<td>1.20 (0.69-2.10)</td>
<td>1.04 (0.59-1.84)*</td>
<td>1.07 (0.54-2.12)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0.9</td>
<td>11.7</td>
<td>13.63*** (5.51-33.69)</td>
<td>8.69*** (3.08-24.53)*</td>
<td>1.44 (0.66-3.16)</td>
</tr>
<tr>
<td>Smoking by others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anyone</td>
<td>18.1</td>
<td>46.2</td>
<td>3.78*** (2.19-6.53)</td>
<td>3.92* (2.33-6.58)*</td>
<td>1.74** (1.36-2.22)</td>
</tr>
<tr>
<td>Unknown person</td>
<td>4.9</td>
<td>11.2</td>
<td>3.27*** (1.32-2.45)</td>
<td>2.62* (1.45-4.73)*</td>
<td>1.77 (0.96-3.28)</td>
</tr>
<tr>
<td>Family</td>
<td>2.2</td>
<td>6.7</td>
<td>3.11*** (1.69-5.72)</td>
<td>3.24*** (1.61-6.52)*</td>
<td>1.13 (0.65-1.94)</td>
</tr>
<tr>
<td>Friends</td>
<td>7.3</td>
<td>23.8</td>
<td>3.85*** (2.24-6.63)</td>
<td>3.54*** (1.99-6.29)*</td>
<td>1.99*** (1.33-2.96)</td>
</tr>
</tbody>
</table>

*P < 0.05; **P < 0.01; ***P < 0.001. ORs adjusted for smoking by others and drinking alcohol. ORs adjusted for smoking by others. ORs adjusted for smoking ban and smoking by others. Caution: Please note that some of the statistical significances changed in the sensitivity analysis (see Supporting Information Table S1). Particularly the results of the sensitivity analysis suggest that the role of alcohol in smoking among HS may be underestimated. Importantly, however, all reported relationships remained in the same direction. AOR, adjusted odds ratio; CI, confidence interval; HS, heavy smokers; LITS, light and intermittent smokers; NS-Sit, non-smoking situation; OR, odds ratio; S-Sit, smoking situation.
Multivariate result  
(increased odds of smoking)

- Both groups:
  - Craving (LITS: OR=16; HS OR=5)
  - Being in a location where smoking is allowed
  - Any food or drink, smoking by others/unknown persons/friends

- LITS:
  - Home of others, alcohol (!), smoking by family

- HS:
  - Medium range affect, being at work, waiting, food only
Discussion

- Results suggest that cue-associated smoking plays a bigger role for LITS than for HS

- Several situational antecedents (e.g., craving, drinking alcohol, smoking by others) seem to be more important for triggering smoking in LITS

- Consistent with previous research, we found no strong associations between situational mood and smoking

- Evidence for the effectiveness of smoking bans based on event-level data
Limitations

- Reported relationships are correlational
- Participants did not respond to all random prompts, mean delay of 12.5 minutes for response was rather large
- We only collected data on a subset of smoking situations and underreporting was an issue
- Data are not representative (inclusion criteria, small sample size, sampling of specific weekdays)
Conclusions

- Already among young adult smokers at an early stage in their smoking career, differences between LITS and HS emerged

- LITS may smoke to make an already pleasurable situations more enjoyable

- Social smoking may be one of the key explanations to characterize the smoking behavior of young adult LITS

- Smoking behavior of HS may be more habitual and automatic, used to cope with boredom, or to kill time
Next steps: Analysis of Smokebook data

- Compare HS and LITS on baseline characteristics
  - Role of smoking restraint strategies (e.g., count cigarettes, limit daily number of cigarettes)

- Analyze transitions in smoking behavior over time
  - Does amount of stimulus control predict changes in smoking longitudinally?
Next steps: Postdoc

- Develop easy to use and easy to adapt software for EMA assessments

- Use EMA to examine environmental influence factors on smoking behavior
  - Exposure to points of sale
  - Exposure to advertisements
For more information…

- … come talk to me!

- Methods and development paper:
  Thrul et al., 2015, European Addiction Research

- LITS vs. HS paper:
  Thrul et al., 2014, Drug Alcohol Review
Short Communication

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Situational and mood factors associated with smoking in young adult light and heavy smokers

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... Thank you!