SleepTight: Low-burden, Self-monitoring Technology for Capturing and Reflecting on Sleep Behaviors

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Self-monitoring

An activity of recording one’s own behaviors, thoughts, or feelings

Self-monitoring is important

**Therapeutic Purpose**

Being aware of how you are doing can result in **reactivity** and enable you to change behavior or maintain appropriate behavior.

* Reactivity: The change in the frequency of a target behavior

*Nelson & Hayes. (1981)*
Data Capture Mechanisms

Manual Capture

Automated Capture
Manual Capture

+ Increased self-awareness
+ Engagement with data
+ Flexibility of choosing target behaviors
+ Some data can only be tracked manually
- High capture burden
- Forgetting -> compromised data accuracy
Automated Capture

- Reduced mental load
- Better accuracy (depending on the data)
- Cumbersome to wear (wearable sensing)
- Reduce engagement with data
Data Capture Mechanisms

Manual Capture

Somnometer
(Shirazi et al., 2013)

Sleepful app
(Lawson et al., 2013)

Automated Capture

Lullaby
(Kay et al., 2012)

Toss ‘N’ Turn
(Min et al., 2014)

SWP
(Chen et al., 2013)
## Sleep Tracking

<table>
<thead>
<tr>
<th>NAME:</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer the following in the morning</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What time did you get into bed last night?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>What time did you try to fall asleep?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>How long did it take you to fall asleep after that?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>What did you do between getting into bed and falling asleep?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>Did you wake up during the night? How often? How long were you awake total?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>What time was your final awakening this morning?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>What time did you get out of bed?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>Did anything unusual happen yesterday that might have affected your sleep? (Illness, disturbances, emotional stress, etc)</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>What is the total amount of time you slept last night in hours and minutes? (Best estimate)</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>Did you take any medication that might have affected your sleep? What? When?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td><strong>Answer the following in the evening</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you have any caffeinated or alcoholic beverages today? What? How much? When?</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>Please rate your average sleepiness today on a scale of 1-10. 1=wake up, 10=very sleepy</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>

http://www.swedish.org

Sleep Center Patient Resource.
Goal

To support easy & flexible manual capture of multiple behavior factors
SleepTight Design Goals

1. Capture both target behaviors and contributing factors
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2. Reduce the capture burden
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1. Capture both target behaviors and contributing factors
2. Reduce the capture burden
3. Provide feedback to promote self-reflection
SleepTight Design

Capturing Multiple Behaviors
Leveraging App Widget
Feedback
Capturing Multiple Behaviors

Target behaviors: Sleep

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last night, I went to bed</td>
<td>11:55 PM</td>
</tr>
<tr>
<td>Minutes to fall asleep</td>
<td>10 mins</td>
</tr>
<tr>
<td>This morning, I woke up</td>
<td>7:08 AM</td>
</tr>
<tr>
<td>I finally got out of bed</td>
<td>7:22 AM</td>
</tr>
<tr>
<td>Last night, I woke up</td>
<td>1</td>
</tr>
<tr>
<td>How long have you stayed awake in total?</td>
<td>1 min</td>
</tr>
</tbody>
</table>

The overall sleep quality was Good

About 1 hour before going to bed, I did the following activities:
- Email, Web surfing
- My sleep was disturbed by No reason

Contributing factors

Custom Behaviors
Capturing Multiple Behaviors

Target behaviors: Sleep

- Last night, I went to bed at 11:55 PM
- Minutes to fall asleep: 10 mins
- This morning, I woke up at 7:08 AM
- I finally got out of bed at 7:22 AM
- Last night, I woke up 1 time
- How long have you stayed awake in total? 1 min

The overall sleep quality was:

- Very Poor
- Poor
- Neutral
- Good
- Very Good

About 1 hour before going to bed, I did the following activities:

- Check: Email, Web surfing

My sleep was disturbed by:

- Check: No reason

Contributing factors

- Meal
- Exercise
- Caffeine
- Alcohol
- Medication
- Tobacco
- Meeting
- Problem

Delete Events
Leveraging App Widget
Leveraging App Widget

# of unlocking event / day
4.8-105.3 times

Truong et al., (2014)
Leveraging App Widget

- Lower Capture Burden
- Lower Access Burden
Feedback for Self-reflection

Daily View

4-week View

Comparison View
Study Design

App-only System Condition

Regular app
Study Design

- Regular app
- Lock screen widget
- Home screen widget

Full System Condition
Study Design

A three-phased study

- Interview
- Questionnaire
- Instruction

4-week deployment

- Weekly survey

- Debriefing interview
- Questionnaire

22 participants (9 Males, 13 Females)
Average age—29.7 years old (range: 20-49)
Random assignment
Findings

Data Capture Behaviors
Information Access
Self-reflection
Data Capture Behavior [Diary adherence]

88% of the sleep diaries were captured from the widgets

92% (M = 25.89, SD = 2.71) vs. 73% (M = 20.42, SD = 7.18)

p = .03
Data Capture Behavior
[# of total contributing factors]

Full system: 151.11 (SD = 68.82)

App-only system: 141.5 (SD = 78), p = N/S

9% of the contributing factors were captured from the widgets
Time Difference b/w Event Time and Logging Time

Full System: 7.1 hours (SD = 3.33) < App-only System: 11.7 hours (SD = 5.00)  
p = .02

Number of ‘Add Activity’ Events by Hour of Day
Self-reflection

Self-reflection during *opportune moments*:

What did you learn?

“...my time to go to bed is a little inconsistent”

“...I don’t drink as much alcohol as I thought I did”

“...drinking alcohol seems to lead to poor sleep.”

**Finding-Sleep pattern** (neutral statement)

**Finding-Other activity** (disproof)

**Hypothesis-Relationship between sleep and other factors**
Designing Successful Manual Tracking Tools
Lower the User Burden

Lower the Capture Burden
Lower the Access Burden
Leverage Visual Reminders
Leverage Manual Tracking in Self-reflection

- Configuration
- Data capture
- Feedback
  - Reflection during data capture
  - Reflection when receiving feedback
Thank you!

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