Creating Salient Summaries for People with Episodic Memory Impairment

Matthew L. Lee
Anind K. Dey
episodic memories
caregiver burden
MemExerciser

Sensors
Wearable camera
Audio Recorder
GPS Logger

Lifelog Data

CueChooser

Selected Memory Cues

MemExerciser

Caregiver Input

Review

"Lots of food at Mary's house"
too much data!

Only the “good” cues should be reviewed!
FIELD STUDY
IN SEARCH OF GOOD MEMORY CUES
(Lee & Dey, ASSETS 2007)
field study: identifying good memory cues

Research Question

**What are the characteristics of a good memory cue?**

Organization of Autobiographical Memory

Activity information dominant in narratives
(Reiser 1985; Taylor 1997; Dijkstra 2006)

Who, What, Where can tell you When (Wagenaar 1986)
**method**

1. **WEAR** the Microsoft SenseCam during a personally-significant experience.

(Hodges *et al.*, 2006)
method

2. **SORT** the photos using a card-sorting approach.
types of cues

**People:** daughter, waitress

**Places:** facade of a store, the dining room

**Actions:** playing piano, driving home

**Objects:** birthday cake, stained-glass window
Every experience had a majority of one type of cue and thus can be characterized by its **dominant cue type**.

<table>
<thead>
<tr>
<th>Experience</th>
<th>Photo #1</th>
<th>Photo #2</th>
<th>Photo #3</th>
<th>Photo #4</th>
<th>Photo #5</th>
<th>Photo #6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Reunion</td>
<td>Person <em>(widow &amp; daughter)</em></td>
<td>Object <em>(birthday cake)</em></td>
<td>Person <em>(an old friend)</em></td>
<td>Person <em>(nephew)</em></td>
<td>Person <em>(old friends)</em></td>
<td>Person <em>(relative)</em></td>
</tr>
<tr>
<td>Church performance</td>
<td>Action <em>(hands clapping)</em></td>
<td>Action <em>(audience getting into the spirit)</em></td>
<td>Person <em>(pastor)</em></td>
<td>Action/Person <em>(unexpected speech)</em></td>
<td>Action <em>(presentation of family)</em></td>
<td>Object <em>(stained glass windows)</em></td>
</tr>
<tr>
<td>Trip to Philadelphia</td>
<td>Place <em>(tall ceilings in house)</em></td>
<td>Place/Action <em>(walking through town)</em></td>
<td>Place/Action <em>(BBQ in backyard)</em></td>
<td>Place <em>(walking into town)</em></td>
<td>Place / Object <em>(backyard; treehouse)</em></td>
<td>Action <em>(ice cream on drive back)</em></td>
</tr>
<tr>
<td>Visit to History Museum</td>
<td>Object <em>(furniture exhibit)</em></td>
<td>Object <em>(photography exhibit)</em></td>
<td>Object <em>(kitchen exhibit)</em></td>
<td>Object <em>(photograph of slave trade)</em></td>
<td>Object <em>(artifact exhibit)</em></td>
<td>Object <em>(letters exhibit)</em></td>
</tr>
</tbody>
</table>
good cues are *memorable*

Cues are anchors into the original experience

Participants often discarded photos that they did not remember or recognize from their experience

“I don’t know who this is.”
good cues are **distinctive**

Different forms

*unusual* details of an experience (e.g., spilled water glass)

*prototypical* details of an unusual experience (e.g., snow at ski lodge)

<table>
<thead>
<tr>
<th>Unusual</th>
<th>Prototypical</th>
</tr>
</thead>
<tbody>
<tr>
<td>spilled water glass</td>
<td>snow at ski lodge</td>
</tr>
<tr>
<td>too much food</td>
<td>wife at luncheon</td>
</tr>
<tr>
<td>unusual windows</td>
<td>widow at memorial service</td>
</tr>
</tbody>
</table>
good cues are *personally significant*

Personally significant details hold more meaning

Kept photos of people they know, not strangers

Greater personal significance results in a more deeply encoded memory trace

1950’s kitchen exhibit  Dad’s old pal  friend at garden center
design recommendations

What are the characteristics of good memory cues?

Good cues *match the dominant cue type of the experience*.  
=> automate it!

Good cues are *memorable, distinctive, and personally significant*.  
=> difficult, so rely on human expert.
MemExerciser
(Lee & Dey, Ubicomp 2008)
system overview

Automatic CAPTURE ➔ Hybrid SELECTION ➔ Active REVIEW

Sensors
Wearable camera
Audio Recorder
GPS Logger

Lifelog Data ➔ CueChooser

Caregiver Input ➔ Selected Memory Cues

CueViewer

Review
automatic capture

“set it and forget it”
Content: Visual (photos) + Audio (voices)
Context: location, movement, light

SenseCam  Voice recorder  GPS Logger
hybrid cue selection

Automated Content/Context Analysis
+
Human Caregiver Expertise
**good memory cues (1)**

Good cues *match the dominant cue type of the experience.*  
(Lee & Dey, ASSETS 2007)

<table>
<thead>
<tr>
<th>Experience Type</th>
<th>Automated Analysis Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>People-based</td>
<td>Face and voice detection</td>
</tr>
<tr>
<td>Location-based</td>
<td>GPS location stay points</td>
</tr>
<tr>
<td>Object-based</td>
<td>Accelerometer movements</td>
</tr>
<tr>
<td>Action-based</td>
<td>Scene Segmentation</td>
</tr>
</tbody>
</table>
good memory cues (2)

Good cues are **memorable, distinctive, and personally significant** (Lee & Dey, ASSETS 2007)

Leverage caregiver’s expertise to:
- **select meaningful**, personally-significant cues
- optionally **annotate** the pictures with voice and drawings to create slideshow
active cue review

Self-guided interaction

Tablet-based viewer appliance

Reveals cues progressively to encourage user to think deeply about each cue and encounter “Aha!” moments
Bill, Alice, and Carol at the Zoo
4/11/2008

It was a gorgeous Spring day, perfect for walking through the zoo. We saw lions, tigers, bears, and enjoyed watching them in their natural habitats.

Tap the screen with the pen to begin!
an afternoon at the zoo
an afternoon at the zoo

Bill, Alice, and Carol at the Zoo
4/11/2008
an afternoon at the zoo
an afternoon at the zoo

Bill, Alice, and Carol at the Zoo
4/11/2008
an afternoon at the zoo
EVALUATION
participants

3 couples: husband w/ episodic memory impairment, wife as caregiver (CG)

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1/CG1</td>
<td>81/72</td>
<td>Mild Alzheimer’s disease</td>
</tr>
<tr>
<td>P2/CG2</td>
<td>79/76</td>
<td>Mild Cognitive Impairment</td>
</tr>
<tr>
<td>P3/CG3</td>
<td>82/75</td>
<td>Mild Cognitive Impairment</td>
</tr>
</tbody>
</table>
study design

3 experimental conditions:
Control (no intervention)
Self-Guided (MemExerciser)
Caregiver-Guided (Traditional SenseCam)

Within-subjects design
## Study Design

### Control Condition

<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="brain.png" alt="Brain" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Experience**

- Week 1
- Week 2
- Week 3
- Week 4

**Recall Test**
- Sun
- Mon
- Tues
- Wed
- Thurs
- Fri
- Sat
### Study Design: Self-Guided Condition

<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Brain_icon]</td>
<td>![Person_icon]</td>
<td>![Person_icon]</td>
<td>![Person_icon]</td>
<td>![Person_icon]</td>
<td>![Person_icon]</td>
<td>![Person_icon]</td>
</tr>
</tbody>
</table>

Person with EMI reviews slideshow *on their own*

Experience

Recall test

Recall test

Recall test

Week 1

Week 2

Week 3

Week 4
**study design** caregiver-guided condition

<table>
<thead>
<tr>
<th></th>
<th>Sun</th>
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<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week 1</strong></td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
</tr>
<tr>
<td><strong>Week 2</strong></td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
</tr>
<tr>
<td><strong>Week 3</strong></td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
</tr>
<tr>
<td><strong>Week 4</strong></td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
<td>☺️😊</td>
</tr>
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</table>

- **Experience**: Caregiver selects photos
- **Recall test**: Caregiver guides person with EMI through the pictures

- **Recall test**: Day of the week where the recall test occurs.
measures

“A Return to Normalcy”

Hypotheses

1. Improved recall ability
   - # of details recalled after 4 weeks
   - Vividness of recalled details
   - Memory Confidence Ratings

2. Less additional caregiver burden
   - Amount of time spent
   - Interviews with caregivers

Warren G. Harding
Former U.S. President (1921-1923)

“Warren G. Harding” Former U.S. President (1921-1923)
memory recall

Percentage of details recalled four weeks after the original experience.

F[1,5]=6.16, p=0.04
Percentage change in number of details judged as vividly remembered after four weeks. (Remember-Know-Guess scale†)

Control  Caregiver-Guided (SenseCam Viewer)  Self-Guided (MemExerciser)

F[2,4]=8.44, p=0.04

†(Gardiner et al, 1993)
Deeper processing of memories make them easier to remember.†

CG2 said: "It helps [P2] focus his thoughts, plus [the ambient] voices for the slides makes it easier for him to recall each picture."

Person with EMI controls the pace of review. P2 said: "[I] would be more inclined to take more time and look for more details...and get more out of it...because you’re looking for things you don’t normally see."

†(Craik & Tulving, 1975)
### Caregiver Burden

#### Table: Minutes spent using system

<table>
<thead>
<tr>
<th>Caregiver</th>
<th>Self-Guided</th>
<th>Caregiver-Guided filter + review = total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG1</td>
<td>67 mins</td>
<td>n/a</td>
</tr>
<tr>
<td>CG2</td>
<td>64 mins</td>
<td>19 + 52 = 71 mins</td>
</tr>
<tr>
<td>CG3</td>
<td>55 mins</td>
<td>12 + 54 = 66 mins</td>
</tr>
</tbody>
</table>

#### Graph: Minutes caregiver spent using system

- **Caregiver-Guided / SenseCam Viewer**
- **Self-Guided / MemExerciser**

**Weeks:** 1, 2, 3, 4, 5, 6, 7, 8

**Minutes caregiver spent using system:** 0, 50, 100, 150, 200, 250
normalcy for caregivers

All caregivers said the main bulk of the “work” was going through the cues together with the person with EMI. CG2 said “I had to go through it with [P2] every time instead of him just doing it himself.”

CG1, caregiver-guided review method gives an opportunity to engage her husband in a conversation about a shared experience.
Designed lifelogging system
Automated Capture, Hybrid Cue Selection, Active Cue Review

Evaluation: looking for normalcy
Self-Guided
   Better recollection: Ambient Audio + Progressive Revealing of Cues
   Lower Caregiver Burden: Computer-assisted filtering + one-time authoring

Caregiver-Guided
   Shared review => opportunities for conversations
   => active role in preventing further decline
future work

Clinical evaluation with psychometric testing

Fun interactions: scrapbooking, storytelling, photosharing

Salient summaries with machine learning
embedded assessment
acknowledgements

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The End

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