The Use of Smartphone in Older people with Early Dementia for Outdoor Way-finding: Pilot study

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Dementia is a clinical syndrome
  • Progressive cognitive function decline
  • Impairment in independent functioning

Spatial disorientation and wayfinding problems
  • A form of cognitive impairment
  • An early symptom in dementia, particularly AD type
  • People with mild dementia still engage in outdoor activities
  • Spatial disorientation results in
    • Way finding difficulties, or being lost
    • Reduction in outdoor activities (limited by themselves/caregivers)

Consequence of reduced outdoor activities
  • ↑ sedentary lifestyle, social isolation
  • ↓ cognitive function, psychosocial health
Background – conventional solutions

• Providing cues and active orientation
  • Effective to enhance correct wayfinding behaviors
  • Limitations:
    • In controlled settings (e.g., day care centers, nursing homes)
    • Cannot help in natural settings (e.g., shopping malls, markets)

• Using tracking technology (e.g., RFID, GPS)
  • Successfully used to track the positions of people with dementia
  • Limitations:
    • Helps caregivers to find their missing family members
    • Does not assist the people with dementia to navigate
    • Raises ethical issues, e.g., dignity and privacy
Background – an innovative solution

- Using a smartphone platform, with
  - GPS technology – minimal spatial functioning
  - Voice commanding – minimal learning
  - Auditory navigation control – minimal learning

- Good feasibility using smartphone for health, e.g.,
  - Cognitive assessment, promoting balance, medication adherence

- Research gap:
  - The wayfinding problem is known and the technology is available
  - A dearth of studies reporting its feasibility, acceptability, and usability
Objectives

1. Compare the **acceptability** to older people with and with mild dementia of using smartphones for wayfinding

2. Compare the **feasibility** for older people with and without mild dementia of using smartphones for wayfinding, and

3. Explore the issues of **usability** faced by people with mild dementia in using smartphones to conduct wayfinding
Methods

- **Design**
  - Quantitative (objectives #1 and #2)
    - Cross-sectional and observational design
  - Qualitative (objective #3)
    - Field observation and interview

- **Sampling**
  - Convenience sampling
    - Cognitively normal (n=30)
    - People with mild dementia (n=30)

- **Settings**
  - Cognitively normal: 2 community elderly centers
  - People with dementia: 2 dementia day care centers
Methods

• Eligibility criteria
  • Cognitively normal group
    • Age ≥ 65
    • Mobility at “outdoor walker” level (i.e., MFAC cat VII)
    • Normal walking speed (i.e., walking speed ≥ 0.8m/s in a 4-meter walk)
    • No cardiac pacemaker
    • Normal cognitive function (i.e., MMSE ≥ 26)
  • People with mild dementia group
    • Ditto, except the following
    • Having a confirmed diagnosis of dementia (i.e., as documented on the medical record)
    • Mild stage of dementia (i.e., as defined by an MMSE score = 20-25)
The wayfinding trial setup

• By using iphone 7 plus, with
  • Map application (i.e., Maps, Chinese version)
  • Voice commanding application (i.e., Siri, Chinese version)

• The wayfinding trial
  • Close to the participant recruitment centers
  • Three pre-planned trips with standardization on
  • Distance: 300m (estimated by the Maps)
  • Number of turns for the shortest walking distance: 3 turns
  • Day time, non-rainy day
  • Start the trial by speaking a standard sentence: “I want to go to XXX”
  • Accompanied by 1 center staff member and 1 research assistant
  • Put on earphone on one side
  • Time allowed: 15 minutes
The training workshop

• The training workshop
  • Instruct all the needed skills, e.g.,
    • Initiating Maps by Siri
    • Understanding a set of audio-visual instructions in the Maps
  • Time allowed to complete: 30 minutes
  • The participants pass the training if they can
    • Read a Chinese sentence which could be recognized by Siri
    • Initiate Maps by Siri
    • Verbalize the meaning of a set of audio-visual instruction given by the Maps
Measurements

• Acceptability (i.e., objective #1)
  • Senior Technology Acceptance Model (STA) questionnaire
    • 28 items with two domains
      • Acceptance of technology (item number=7)
      • Factors affecting acceptance of technology (item number=21)

• Feasibility (i.e., objective #2)
  • Number of attempts to initiate Siri by voice
  • Number of participants who could successfully arrive at the destination without hints within 15 minutes
  • Number of successful turns made following the advice of Maps
  • Time needed to complete the wayfinding trial
  • Time needed to complete the training workshop

• Usability (i.e., objective #3)
  • The wayfinding trial process was video recorded
  • Individual interviews after immediately after completion
Data analysis

• Quantitative data
  • IBM SPSS version 23.0
  • Non-parametric statistics
  • Descriptive: Median and IQR
  • Comparison: Mann-Whitney U and Pearson $X^2$

• Qualitative
  • Transcribe visual and audio data
  • Content analysis to identify categories of factors related to participants’ usability
Results: Participant flow chart

Recruitment (N=61)

- Normal (n=31)
  - Not eligible (n=1)
    - Had pacemaker (n=1)
  - Eligible (n=30)
    - Refused (n=0)
    - Participants (n=30)
      - Not completed (n=0)
      - Completion (n=30)

- People with mild dementia (n=30)
  - Not eligible (n=6)
    - Had pacemaker (n=1)
    - MMSE ≤ 19 (n=5)
  - Eligible (n=24)
    - Refused (n=8)
    - Participants (n=16)
      - Not completed (n=1)
      - Completion (n=15)
### Results: Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>People with mild dementia (n=16)</th>
<th>Normal (n=30)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median (IQR)</td>
<td></td>
<td>MWU</td>
</tr>
<tr>
<td>Age, years</td>
<td>79 (11.3)</td>
<td>66.5 (10.3)</td>
<td>p &lt; 0.001*</td>
</tr>
<tr>
<td>MMSE</td>
<td>24 (2.7)</td>
<td>29 (1.25)</td>
<td>p &lt; 0.001*</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5 (31.2)</td>
<td>11 (36.7)</td>
<td>p=0.713</td>
</tr>
<tr>
<td>Female</td>
<td>11 (68.8)</td>
<td>19 (63.3)</td>
<td></td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>7 (43.8)</td>
<td>4 (13.3)</td>
<td>p=0.017*</td>
</tr>
<tr>
<td>Primary</td>
<td>3 (18.8)</td>
<td>2 (6.7)</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>5 (31.3)</td>
<td>11 (36.7)</td>
<td></td>
</tr>
<tr>
<td>Tertiary or above</td>
<td>1 (6.3)</td>
<td>13 (43.3)</td>
<td></td>
</tr>
<tr>
<td>Living conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live alone</td>
<td>3 (18.8)</td>
<td>6 (20.0)</td>
<td>p=0.919</td>
</tr>
<tr>
<td>Live with caregivers</td>
<td>13 (81.3)</td>
<td>24 (80.0)</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>8 (50)</td>
<td>11 (36.7)</td>
<td>p=0.382</td>
</tr>
<tr>
<td>Married</td>
<td>8 (50)</td>
<td>19 (63.3)</td>
<td></td>
</tr>
</tbody>
</table>

*p value < 0.05, IQR = inter-quartile range, MMSE = Mini-Mental State Exam, MWU = Mann-Whitney U test
## Results: Feasibility

<table>
<thead>
<tr>
<th>Feasibility markers</th>
<th>People with mild dementia (n=16)</th>
<th>Normal (n=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median (IQR)</td>
<td></td>
<td>MWU</td>
</tr>
<tr>
<td>Successful no. of turns following Maps’ advice</td>
<td>3 (0)</td>
<td>3 (0)</td>
<td>p=0.567</td>
</tr>
<tr>
<td>Time needed to complete the wayfinding trial, minutes</td>
<td>9.5 (4.2)</td>
<td>7.1 (3.4)</td>
<td>p=0.002*</td>
</tr>
<tr>
<td>Time needed to complete the workshop, minutes</td>
<td>4.0 (0.8)</td>
<td>5 (0)</td>
<td>p=0.011*</td>
</tr>
<tr>
<td></td>
<td>Frequency (%)</td>
<td></td>
<td>Pearson X²</td>
</tr>
<tr>
<td>Successful initiation of Siri by voice in the 1st attempt</td>
<td>16 (100)</td>
<td>30 (100)</td>
<td>p=1.000</td>
</tr>
<tr>
<td>Successful arrival to destination without hints</td>
<td></td>
<td></td>
<td>p=0.859</td>
</tr>
<tr>
<td>Yes</td>
<td>13 (18.8)</td>
<td>25 (83.3)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (81.2)</td>
<td>5 (16.7)</td>
<td></td>
</tr>
</tbody>
</table>

*p value<0.05, IQR=inter-quartile range, MWU=Mann-Whitney U test
Results: Acceptability

<table>
<thead>
<tr>
<th>Senior Technology Acceptance Model questionnaire</th>
<th>People with mild dementia (n=16)</th>
<th>Normal (n=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PR</td>
<td>Median (IQR)</td>
<td></td>
</tr>
<tr>
<td>Acceptance of technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude towards using technology</td>
<td>0-20</td>
<td>18.5 (3.8)</td>
<td>17.5 (5.3)</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>0-30</td>
<td>26.5 (5.5)</td>
<td>25.5 (8.3)</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>0-20</td>
<td>15 (5.0)</td>
<td>17.5 (5.0)</td>
</tr>
</tbody>
</table>

Factors affecting acceptance of technology

| Facilitating conditions for using technology  | 0-50 | 34.5 (16.5) | 40.0 (9.0) | p=0.066 |
| Technology self-efficacy                     | 0-20 | 17.0 (4.5)  | 17.0 (3.0) | p=0.506 |
| Technology anxiety                           | 0-20 | 9.0 (5.0)   | 6.0 (8.3)  | p=0.158 |
| Social relationships                         | 0-30 | 25.0 (5.0)  | 25.5 (5.0) | p=0.502 |
| Life satisfaction                            | 0-10 | 10.0 (2.0)  | 9.0 (2.0)  | p=0.547 |
| Physical functioning                         | 0-80 | 70 (25.5)   | 79.0 (6.0) | p=0.016* |

*p value<0.05, IQR=inter-quartile range, MWU=Mann-Whitney U test, PR=possible range
Results: Usability

• Related to the person’s impaired sensory function
  “He always presses the area surrounding the Home button of the iPhone and could not hit the button in one attempt.” ---- D26-0004-5
  “She reported that she could not clearly hear the verbal instructions from the iPhone.” ---- D11-019-20

• Related to the person’s impaired cognitive function
  She needed time to figure out the directions of left and right. ---- D04-010-10
  After listening to verbal instruction to “turn left after 90m,” she reported that she did have a clear idea how far 90m is and when she should turn.... One said that the location of the turning point was more meaningful than the number of meters to go to turn left. ---- D19-010-11/D28-014-15
  “She focused on the screen, but also stayed alert to the surrounding environment. She stopped walking many times. She did not pay much attention to the traffic light when reading/listening to the instructions given by the smartphone.” ---- D01-009-10
Results: Usability

• Related to the smartphone

Fluttering of the signal was noted during the test. ---- D19-014-14

The Maps could not identify her location and needed to re-route a few times.
----D11-008-9

She accidentally touched the screen and turned on another application, but she could not re-open the Maps again. ---- D13-009-10
Discussion

• Using smartphone for wayfinding in a free-living environment by older people with mild dementia is feasible and acceptable. But its effect on wayfinding has to be evaluated in future research.

• People with mild dementia takes longer time to complete, it can be
  • related to cognitive impairment, or
  • confounded by ageing effect (e.g., physical function).

• Topographical disorientation due to visuospatial deficit does not hinder people with mild dementia to navigate with the help of smartphone.

• Some modifications may make smartphone more usable
  • Include more elderly friendly features in the smartphone (e.g., color contrast on the buttons, less concurrently running apps)
  • Provide verbal/visual cues meaningful to them (e.g., turn when seeing a familiar landmarks, instead of how many meters left)
  • Install safety measures (e.g., navigation aids to alarm when crossing roads)
  • Install interference suppression devices to provide more accurate positioning cues (e.g., robust algorithm, combining GPS/COMPASS data)
Limitations

• Small sample size
• Non-random sampling and group allocation
• 33.3% of people with mild dementia declined to participate
• Although no safety issue (e.g., smartphone theft) was observed, safety is not guaranteed because the participants were accompanied by the research team during the trial
Conclusion

• It is feasible and acceptable for people with mild dementia to use smartphone for wayfinding; but its effectiveness has to be further researched

• People with mild dementia takes more time to complete the wayfinding, it can be caused by
  • Cognitive impairment or
  • Age-related changes (e.g., poorer physical function)

• Cognitive impairment, poorer perceived physical function, and age did not hinder older people’s
  • Attitude,
  • Perception of usefulness, and
  • Perceived ease of using smartphones for way finding

• Further modifications of the smartphone should
  • Accommodate age-related changes experienced by people with mild dementia,
  • Provide meaningful verbal instructions for navigation, and enhance the accuracy of the GPS signals
Interest to decline

• Nil
Thank you

Questions?