The use of smartphones for wayfinding by people with mild dementia

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Abstract: The aim of this study was to explore the acceptability, feasibility and usability of older people with mild dementia to use smartphone for wayfinding. Thirty cognitively normal older people and 16 people with mild dementia were recruited to participate in a wayfinding trial in the free-living environment. Five feasibility and three acceptability markers were compared between the groups. Content analysis on the video-recorded trial processes and individual interviews was employed to identify the usability issues. The results found that there were no significant between-group differences on the feasibility markers, except that the people with mild dementia needed significantly more time to complete the wayfinding trial and workshop; or on the acceptability items. Sensory/cognitive impairment and GPS signal reliability affected their usability. Mild dementia does not limit the older people to use smartphones for wayfinding in the free-living environment. Future studies should examine the efficacy and safety of smartphone to promote outdoor independence of the people with mild dementia.

Keywords: dementia, smartphone, technology, cognitive impairment, wayfinding

Introduction

Dementia is a clinical syndrome characterized by a progressive decline in cognitive function leading to impairment in independent functioning (American Psychiatric Association, 2013). Spatial disorientation is an early symptom of dementia, particularly the Alzheimer's type (Pai & Jacobs, 2004; Pengas et al., 2010; Yew, Alladi, Shailaja, Hodges, & Hornberger, 2013). Because of spatial disorientation, people with dementia perform worse in outdoor wayfinding, even in familiar areas (Sheehan, Burton, & Mitchell, 2006). Wayfinding prob lems or getting lost are among the earliest symptoms of people with Alzheimer's disease (AD) (deIpolyi, Rankin, Mucke, Miller, & Gorno-Tempini, 2007). It affects people with mild dementia more profoundly, as they still retain a certain capacity to engage in outdoor activities (Tsai & Chen, 2017). Disorientation or wayfinding difficulties are associated with outdoor injuries. Therefore, caregivers usually decrease the frequency of outdoor activities and limit the areas of activity to those with which the people with dementia are most familiar (Duggan, Blackman, Martyr, & Van Schaik, 2008). Consequently, people with dementia experience a reduction in their outdoor activities, leading to a more sedentary lifestyle and social isolation, which has a further negative impact on their cognitive functioning and psychosocial health (e.g., depression) (Teipel et al., 2016).

There are many intervention strategies, including both compensatory and restorative approaches, to effectively enhance correct wayfinding behaviors. These interventions include providing cues and active orientation (Caffo` et al., 2014). However, these interventions were primarily conducted in controlled settings (e.g., day care centers or indoors). They cannot help people with dementia to find their

way in a natural setting (e.g., finding their way back home after shopping in a market).

Tracking technologies, including radio frequencies and global positioning systems (GPS), have been successfully used to track the positions of people with dementia to prevent incidents of people going missing (Tatjana et al., 2016). However, they can only help to find the people with dementia when they have gone missing. They do not help people with dementia who have wayfinding difficulties to navigate in outdoor settings. Also, tracking the locations of the people with dementia raises many ethical issues, such as the tension between the peace of mind of caregivers and the privacy or dignity of the people with dementia (Yang & Kels, 2016). Nonetheless, a recent study showed that the acceptance of GPS for helping people with dementia is high and that both the people with dementia and their caregivers are likely to continue using GPS (Liu, Cruz, Ruptash, Barnard, & Juzwishin, 2017).

Recently, GPS was applied to drivers with mild dementia, and was shown to have improved their driving ability in a simulated environment (Yi, Lee, Parsons, & Falkmer, 2015). This suggests that people with mild dementia can benefit from GPS not only in a passive way (i.e., being found when they are lost), but can potentially promote their independence in an outdoor setting.

GPS is a common navigational tool to assist people with wayfinding not only when driving but also when walking. It can be launched on most smartphone platforms. Smartphone penetration rate in older people is high (60.7% in people 60 years) with progressive increase (92.9% in people at 50–59 years) (The Government of the Hong Kong Special Administrative Region, 2016). Using a smartphone to assist with wayfinding is becoming increasingly feasible. However, older people

with mild dementia experience a decline in their ability to divide their attention (or to multitask) and in their ability to learn to operate the sophisticated tools (e.g., maps or electronic devices) required for wayfinding (Bryden, Charlton, Oxley, & Lowndes, 2013). Studies have shown that specially designed GPS settings, such as using auditory navigational control, are the most beneficial for older people to carry out wayfinding because it reduces the demands on the users' attention (Liu, 2001). The feasibility and acceptability of using smartphones for various health purposes (e.g., cognitive assessment, promoting balance and medication adherence) has been found to be satisfactory (Kwan & Lai, 2013; Park, Goering, Head, & Ellis, 2017; Reyes, Qin, & Brown, 2018). However, there is a dearth of studies on whether cognitive impairment affects the feasibility and acceptability of the use of smartphones by older people to help them find their way by walking in a free-living environment. There are also uncertainties regarding the usability of the smartphones in relation to people with mild dementia.

Objectives

The objectives of this study are to:

(i) Compare the acceptability to older people with and without mild dementia of using smartphones for wayfinding,

(ii) Compare the feasibility for older people with and without mild dementia of using smartphones for wayfinding, and

(iii) Explore the issues of usability faced by people with mild dementia in using smartphones to conduct wayfinding.

Methods

Design

A cross-sectional and observational approach was employed in this study to achieve the first and second objectives, while a qualitative approach was used to achieve the third objective.

Sampling, settings, and participants

Convenience sampling was employed in this study. The cognitively normal participants were recruited from two community elderly centers. People with mild dementia participants were recruited from two day care centers that provide services (e.g., cognitively based and rehabilitative activities) for people at various stages of dementia.

People who fulfilled the following criteria for eligibility were recruited: (1) age: 65 years, (2) mobility level: able to walk independently in an outdoor setting, according to the Modified Functional Ambulation Classification (MFAC)'s (Tsang et al., 2014) definition of an outdoor walker (i.e., category VII), (3) normal walking speed, as defined by a walking speed test result of 0.8 m/s in a 4-meter walk (Yano, Inokuchi, & Kario, 2013), and (4) no cardiac pacemaker.

Participants in the cognitively normal group fulfilled two additional criteria: (1) no known diagnosis of dementia, and (2) normal cognitive function as defined by a Mini Mental State Exam (MMSE) score of 26 (Chiu et al., 1998; Folstein, Folstein, & McHugh, 1975). Participants in the people with mild dementia group fulfilled the following two additional criteria: (1) a confirmed diagnosis of dementia as documented in their medical record, and (2) mild stage of dementia as defined by an MMSE score of 20–25 (Folstein et al., 1975).

Implementation

All of the participants attempted a standardized wayfinding trial. The participants were instructed to find a way to arrive at the destination by walking as guided by the smartphone. All of the participants had to attend and pass a training workshop before the trial.

The smartphone setup. Apple iPhone 7 plus with a map application (namely Maps) and a voice command application (namely Siri) was employed. Maps is an application that can identify the position of the users by a GPS and give instructions (including both visual and verbal) to assist users to find their way according to a map. Siri is an application that can transform the voice commands of users to operate the smartphone and give instructions to the users. Cantonese was set to be the language used in Siri. Siri was used as the application for communicating between the users and the smartphone. Therefore, the users did not need to learn new commands (e.g., typing location names) or new skills (e.g., reading maps).

The wayfinding trial. The wayfinding trial was launched in urban areas in Hong Kong. The locations of the wayfinding trial were close to the center where we had recruited the participants. Three trips were designed and standardized. The shortest walking distance of all of the trips was set at 300 meters according to the Maps. The number of turns needed for the shortest walking distance was set at three according to the Maps. Participants recruited from the same center started at the same location. One of the three trips was randomly assigned to participants who did not know the destination in advance. All of the trials took place during daytime, on a day when it was not raining. To start the trial, the participants pressed the Home

button of the iPhone 7 plus to initiate Siri, and spoke a standard sentence (i.e., I want to go to “the name of the destination”).

During the trial, one staff member of the center walked with each participant to ensure the participant’s safety, while another research assistant collected data along the process. After the commencement of the trial, the participants completed the trial using only the smartphone. To facilitate the voice navigational control on the smartphone, the participants put on earphones and microphones. The earphones were applied on only one side of ear to ensure that the participant could listen to signals from the environment. The people who accompanied the participant were not allowed to give any hints to the participant, unless the participant was unable to complete the trial within 15 minutes.

The training workshop. The training workshop for each participant took no longer than 30 minutes. In the workshop, the participants were instructed individually to use the smart phone to conduct wayfinding, including initiating Maps by Siri, understanding a set of audio-visual instructions given by the Maps (e.g., turning signage, distance to turning points). The training workshop was conducted in an outdoor setting located close to the center but not part of any of the trips in the wayfinding trial. At the end of the workshop, the participants were instructed to read a sentence that included nine common syllables of Cantonese to test whether Siri could recognize their pronunciation. The participants were also asked to initiate Maps by Siri. If Siri could recognize the participants’ Cantonese pronunciation and verbalize the meaning of the set of audio-visual instructions given by the Maps, and if the participants could initiate Maps by Siri, they passed the training workshop.

Measurements

Demographic data including age, gender, level of education, marital status, cognitive function, and living conditions were collected prior to the training workshop. Cognitive function was measured using the Chinese version of the MMSE (Folstein et al., 1975).

To examine feasibility, five feasibility markers were measured by the research assistants who accompanied the participants during the wayfinding trial, namely: (1) number of attempts to initiate Siri by voice, (2) number of participants who could successfully arrive at the destination without hints within 15 minutes, (3) the number of successful turns made following the advice of Maps, and (4) the time needed to complete the wayfinding trial. The time needed to complete the training workshop was also measured.

To examine acceptability, the Chinese version of the Senior Technology Acceptance Model (STAM) questionnaire (Chen & Chan, 2014) was used to determine the participants' level of acceptance of the use of a smartphone to conduct wayfinding. STAM is a 28-item questionnaire. Each item was rated by the participants on a 10-point Likert scale, with scores of 1–5 to indicate disagreement and 6–10 to indicate agreement (1 ¼ strongly disagree, 10 ¼ strongly agree). STAM assesses older people's acceptance of technology in three domains, namely: (1) attitude towards using technology, (2) perceived usefulness, and (3) perceived ease of use. STAM also assesses factors affecting the ability of older people to accept technology in six domains, namely: (1) facilitating condition to use technology, (2) technology self-efficacy, (3) technology anxiety, (4) social relationships, (5) life satisfaction, and (6) physical function.

To explore usability issues relating to people with mild dementia using smartphones to conduct wayfinding, qualitative methods were used. During the

wayfinding trial, only the people with mild dementia group were video-recorded by the accompanying research assistant. Immediately after the completion of the wayfinding trial, individual interviews were conducted to explore the participants' experience. The interviews were audio-recorded.

Data analysis

IBM SPSS version 23 software was used to analyze the quantitative data. Given the small sample size, non-parametric statistics were employed. Demographic and clinical data were presented by median with the interquartile range (IQR) or by frequency with percentages. Variables were compared between groups (i.e., dementia vs. normal) by using Mann– Whitney U and Pearson's Chi-square tests. The level of significance was set at 0.05.

For the qualitative data, two trained research assistants, who also had participated in video-recording the wayfinding trials, watched the videos repeatedly and transcribed visual information related to factors affecting the participants' use of smartphones to conduct wayfinding. They did the transcriptions following the method devised by Derry et al. (2010). The audio data of the individual interviews were also transcribed. Content analysis was employed to analyze the transcribed visual and audio data, in order to form categories about the factors that were observed to influence people with mild dementia to use smartphones to conduct wayfinding (Elo & Kyng€as, 2008).

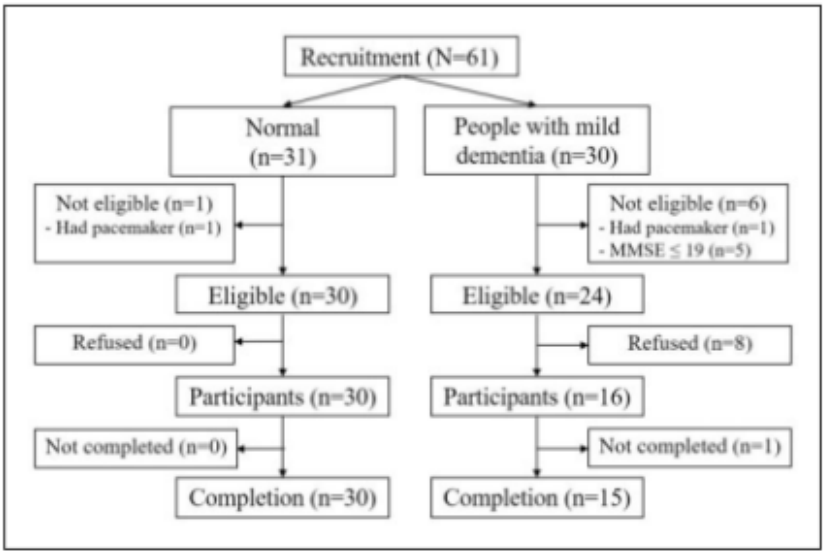

Figure 1. Participant flow chart.

Ethics

Written informed consent to participate in the study was obtained from all of the participants. For the people with mild dementia, the written proxy consent of their primary family caregiver was also obtained.

Results

Procedures

Sixty-one older people were invited to participate in this study, as shown in Figure 1. We invited 31 older people to join the cognitively normal group, but one person was not eligible after the screening because that person had an implanted cardiac pacemaker. Thus, 30 cognitively normal participants completed the study.

We invited 30 older people with documented dementia and who had an MMSE score of 20–25 within the past one year. After screening, six of them were found to be not eligible because they had either an MMSE score <20 (n ¼ 5) or a cardiac pacemaker (n ¼ 1). Of those who were eligible (n ¼ 24), eight refused to

participate (recruitment rate ¼ 66.6%). One of the participants could not complete the training and dropped out (completion rate ¼ 93.8%). In the end, 15 older people with mild dementia completed the study.

Demographics

Table 1. Demographic data of the participants.

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

IQR: inter-quartile range; MMSE: Mini-Mental State Exam; MWU: Mann–Whitney U test.
*p value < 0.05,

As shown in Table 1, the people with mild dementia group (median age ¼ 79 years) was significantly ($p < 0.001$) older than the normal group (mean age ¼ 66.5 years). The cognitive functioning of the people with mild dementia group (median MMSE ¼ 24) was significantly ($p < 0.001$) poorer than that of the normal group (median MMSE ¼ 29). The level of education of the people with mild dementia group was lower than that of the normal group (p ¼ 0.017). There were no significant differences between two groups in gender, living conditions, and marital status.

Feasibility

Table 2. Feasibility markers of the participants.

Feasibility markers	People with mild dementia ($n = 16$)	Normal ($n = 30$)	p value
	Median (IQR)		MWU
Successful no. of turns following Maps' advice	3 (0)	3 (0)	0.567
Time needed to complete the wayfinding trial (minutes)	9.5 (4.2)	7.1 (3.4)	0.002*
Time needed to complete the workshop (minutes)	4.0 (0.8)	5 (0)	0.011*
	Frequency (%)		Pearson X^2
Successful initiation of Siri by voice in the 1st attempt	16 (100)	30 (100)	1.000
Successful arrival to destination without hints			0.859
Yes	13 (18.8)	25 (83.3)	
No	3 (81.2)	5 (16.7)	

IQR: inter-quartile range; MWU: Mann–Whitney U test.
*p value < 0.05,

As shown in Table 2, all of the participants in both groups were able to successfully initiate Siri by voice in their first attempt. The majority of the participants in both groups were able to complete the wayfinding trial by making three successful turns following the advice of Maps, with no significant difference between the groups. The majority of the participants in the people with mild dementia group (n ¼ 13, 81.2%) and in the normal group (n ¼ 25, 83.3%) were able to arrive at their destination without hints. There was no significant difference between the groups. However, the people with mild dementia needed significantly more time to complete the wayfinding trials (p ¼ 0.002) and the training (p ¼ 0.011).

Acceptability

Table 3. Acceptability to the participants.

Senior Technology Acceptance Model questionnaire		People with mild dementia ($n = 16$)	Normal ($n = 30$)	p value
	PR	Median (IQR)		MWU
Acceptance of technology				
Attitude towards using technology	0–20	18.5 (3.8)	17.5 (5.3)	0.159
Perceived usefulness	0–30	26.5 (5.5)	25.5 (8.3)	0.861
Perceived ease of use	0–20	15 (5.0)	17.5 (5.0)	0.065
Factors affecting acceptance of technology				
Facilitating conditions for using technology	0–50	34.5 (16.5)	40.0 (9.0)	0.066
Technology self-efficacy	0–20	17.0 (4.5)	17.0 (3.0)	0.506
Technology anxiety	0–20	9.0 (5.0)	6.0 (8.3)	0.158
Social relationships	0–30	25.0 (5.0)	25.5 (5.0)	0.502
Life satisfaction	0–10	10.0 (2.0)	9.0 (2.0)	0.547
Physical functioning	0–80	70 (25.5)	79.0 (6.0)	0.016*

IQR: inter-quartile range; MWU: Mann–Whitney U test; PR: possible range.
*p value < 0.05.

As shown in Table 3, the majority of the participants in both groups were positive in their acceptance of using a smartphone for wayfinding, as indicated by a median score of above the mid-point of the possible range in their attitude towards using technology, perceived usefulness, and perceived ease of use. There was no significant difference between the groups.

The majority of the participants in both groups agreed on the factors that favorably affected the participants' acceptance of the technology (median score of above the mid-point of the possible range), including the facilitating condition to use technology, technology self-efficacy, social relationships, life satisfaction, and physical function. There were no significant differences between the groups with the exception of physical function. The people with mild dementia gave a lower rating of their physical function (median ¼ 70, IQR ¼ 25.5) than did the normal group (median ¼ 79.0, IQR ¼ 6.0), and the difference between the groups was significant (p ¼ 0.016).

The majority of the participants in both groups disagreed on the unfavorable factor (i.e., technology anxiety) affecting the participants' acceptance of the technology (median score of below the mid-point of the possible range). There was no significant difference between the groups.

Factors influencing the usability of smartphones by people with mild dementia to conduct wayfinding

In the field observations and interviews, several factors influencing the usability of smartphones by people with mild dementia to conduct wayfinding were identified. They can be categorized as relating to the person and the smartphone.

Factors related to the person. Sensory impairment was observed as having imposed difficulties on the people with mild dementia in operating the smartphone, particularly the audiovisual function of the smartphone.

"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)

The use of smartphones for wayfinding by the people with mild dementia was observed to have been affected by impairment in the cognitive domains, including visuospatial disturbance, divided attention, and memory.

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)

"After few minutes (he needed to reinitiate the routing because of a technical error in the smartphone), the person forgot where he was asked to go." (D27-009-10)

Factors related to the smartphone. The GPS signal was not strong or reliable in some locations. 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)

The iPhone interface was busy, making it difficult for the participants to restart the Maps. When the running of the Maps was disturbed by other applications (e.g., system information or messages), it was not easy for the person to go back to the Maps to continue the wayfinding.

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

Discussion

To our knowledge, this is the first study that has shown that it is feasible for people with mild dementia to use smartphones to conduct wayfinding in outdoor and

free-living settings. There were no significant differences between the groups in the number of turns that were successfully made by following the advice of the smartphone and in the number of successful arrivals at the destination without hints being provided by the people who accompanied the participants. In the workshop, all of the people with mild dementia were able to learn how to use the smartphone for wayfinding within 15 minutes. Therefore, it is feasible and acceptable for smartphones with voice navigation control to be used by people with mild dementia to conduct wayfinding. Further studies should be undertaken to examine the efficacy and safety of smartphones to resolve the wayfinding problems of people with mild dementia, as well as to promote their independence.

The difficulties that people with dementia experience in wayfinding have been attributed to topographical disorientation due to various visuospatial deficits (e.g., landmark agnosia, egocentric disorientation, heading disorientation, and anterograde disorientation) (Serino, Cipresso, Morganti, & Riva, 2014). It is likely that these deficits are related to neuronal deficits in the hippocampus and related areas (Burgess, Trinkler, King, Kennedy, & Cipolotti, 2006). The provision of cues has been successfully used to help people with dementia to conduct wayfinding in a controlled setting (e.g., a nursing home) (Davis & Weisbeck, 2016). With advancements in information and communication technology, wayfinding technology can be extended to providing cues in outdoor settings for the navigation of people with dementia (Teipel et al., 2016). Previous studies showed that people with cognitive impairment have decreased ability to manage everyday technology (Malinowsky, Almkvist, Kottorp, & Nygard, 2010), likely because their cognitive deficits ˚ hinder their learning on interacting with the technological devices. A smartphone with a GPS and voice navigation system compensates for these deficits

by giving advice to people with mild dementia on how to navigate in a free-living environment. The people with mild dementia do not need to know the spatial relationship between landmarks (i.e., alloentric orientation) or the spatial relationship between themselves and the environment. They do not even need to learn new skills communicating with the technological devices. The people with mild dementia in the study did just as well as the normal group did in completing the outdoor navigation trial in which they were not previously told the destination.

Walking is an automatic task in which cognitive functions are used to control the functions of many other systems (e.g., the musculature, proprioceptive, and sensory feedback systems). The decline of the executive functions is most significantly associated with gait speed (Callisaya et al., 2015). Navigating in an outdoor setting involves many challenging cognitive tasks (e.g., identifying paths, landmarks, and traffic). People with dementia exhibit particularly poor dual-task (i.e., walking while performing a challenging cognitive task) gait speed (Montero-Odasso et al., 2017). Furthermore, even without cognitive impairment, gait speed of ambulant older people is slower. Slower gait can be influenced by many factors related to aging, such as frailty, comorbidities, and the use of medications (Kuys, Peel, Klein, Slater, & Hubbard, 2014). In this study, the rates at which the normal group and people with mild dementia group successfully completed the trials were comparable. The people with mild dementia were significantly older and more cognitively impaired than the normal individuals. Yet they were still able to use the smartphone to conduct finding; they just needed a bit more time to complete the task.

Physical function is related to muscle mass and cardiopulmonary fitness, which decline as part of the normal process of aging (Chien, Kuo, & Wu, 2016). This

decline in physical function is not necessarily related to cognitive impairment. Even though the perceived physical function of the people with mild dementia was significantly lower than that of the normal group, this did not affect their acceptance of the use of smartphones to help them in wayfinding. With regard to their attitudes towards the technology, and to perception of its usefulness and ease of use, people with mild dementia exhibited a high level of acceptance of smartphones for wayfinding.

Although the quantitative findings are promising with regard to the acceptability and feasibility of using smartphones to help people with mild dementia conduct wayfinding, several findings from the qualitative observations may provide suggestions on how the usability of current smartphones might be improved. In this study, the people with mild dementia were also older people with many normal age-related changes and relatively lower levels of education. To make it easier for people with mild dementia to use a smartphone to solve their wayfinding problems, several modifications are suggested. First, the people with mild dementia in this study faced some problems in using the smartphone that were unrelated to their cognitive impairment but related to some common changes related to aging (e.g., it was not easy to see/press the button) and to poor technological literacy (e.g., the inability to resume the navigation applications after some unrelated application popups). Similar usability issues have also been reported in the literature (Salman, Ahmad, & Sulaiman, 2017). Thus, more elder-friendly features should be incorporated in the smartphone interface for people with mild dementia. Second, the people with mild dementia were provided with both visual and verbal cues in the wayfinding trial. However, some of those cues were not meaningful to them (e.g., remaining distance in meters before turning). Further studies should be conducted on navigational cues

that are meaningful to people with mild dementia (e.g., the names of familiar landmarks). Third, when focusing on the navigational cues given by the smartphone, the people with mild dementia did not pay much attention to traffic lights when crossing roads. This is a potential safety issue, which was also reported in other studies (Dommes et al., 2015). Safety measures, such as providing training on how to safely cross roads (Orlosky, Weber, Gu, Sonntag, & Sosnovsky, 2015) and GPS based navigation aids (Hagethorn, Krose, Greef, & Helmer, 2008) should be implemented € for people with mild dementia. Fourth, like many other metropolises, Hong Kong is densely populated and there are many electronic devices that interfere with radio frequencies, which jeopardizes the accuracy of the positioning. Future smartphone models should come equipped with better interference suppression technologies (e.g., robust algorithms (Hong et al., 2014; Joo, Choi, Chun, & Sin, 2017)) and more accurate positioning technologies (e.g., combining GPS/COMPASS data (Cai, Gao, Pan, & Dai, 2014)) to resolve the occasional problem of unreliability in providing locations.

There are several limitations in this study, including the small sample size, non-random sampling, and group allocation. In addition, the reason why the eight eligible people with mild dementia (recruitment rate ¼ 66.6%) refused to take part in this study is unknown. Yet, it is common in dementia research to encounter problems with recruiting participants. Recruitment rates range from 1% to 80%, and it is also common for people to give “no reason” for refusing to participate in studies (Cohen-Mansfield, 2002). Finally, although participants used smartphones for wayfinding in the free-living environment, they were actually accompanied by research team members during the wayfinding trial. How smartphone-related safety issues, such as smartphone theft, impact on the older people with mild dementia to use smartphones

for wayfinding, and how effective the anti-theft applications (e.g., SmartDog) (Chang, Lu, & Song, 2016) can address this problem is uncertain.

Conclusion

It is feasible and acceptable for people with mild dementia to use smartphones with voice navigation control. However, the people with mild dementia in this study took more time to complete the wayfinding trial and their physical functioning was perceived to be poorer than that of the normal older people. Yet these factors did not influence their successful completion of the wayfinding trial or their attitude, perception of the usefulness and perceived ease of use of smartphones to conduct wayfinding. To further improve the usability of smartphones, further modifications of the smartphone should accommodate the age related changes experienced by people with mild dementia, provide meaningful verbal instructions for navigation, and enhance the accuracy of the GPS signals.

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