The Gerontologist
cite as: *Gerontologist*, 2019, Vol. 59, No. 1, 147–157
doi:10.1093/geront/gny069
Advance Access publication June 29, 2018

Special Issue: Technology and Aging: Intervention Research

Things Are Changing so Fast: Integrative Technology for Preserving Cognitive Health and Community History

Raina L. Croff, PhD,[1,*] Phelps Witter IV, BS,[2] Miya L. Walker, BS,[3] Edline Francois, BA,[1] Charlie Quinn, BS,[2] Thomas C. Riley, BS,[2] Nicole F. Sharma, BA,[2] and Jeffrey A. Kaye, MD[1]

[1]NIA-Layton Aging and Alzheimer's Disease Center, Oregon Health & Science University, Portland. [2]Oregon Center for Aging and Technology, Oregon Health & Science University, Portland. [3]Department of Health Studies, OHSU-PSU School of Public Health, College of Urban and Public Affairs, Portland, Oregon.

*Address correspondence to: Raina Croff, PhD, NIA-Layton Aging and Alzheimer's Disease Center, Oregon Health & Science University, Mail Code CR131, 3181 SW Sam Jackson Park Road, Portland, OR 97239-3098. E-mail: croff@ohsu.edu

Received: January 10, 2018; Editorial Decision Date: May 9, 2018

Decision Editor: Suzanne Meeks, PhD

Abstract

Background and Objectives: Multimodal interventions are increasingly targeting multiple cognitive decline risk factors. However, technology remains mostly adjunctive, largely prioritizes age relevancy over cultural relevancy, and often targets individual health without lasting, community-wide deliverables. Meanwhile, African Americans remain overburdened by cognitive risk factors yet underrepresented in cognitive health and technology studies. The Sharing History through Active Reminiscence and Photo-imagery (SHARP) program increases physical, social, and cognitive activity within a culturally meaningful context that produces community deliverables—an oral history archive and cognitive health education.
Design and Methods: The SHARP application was tested with 19 African Americans ≥55 years, aiming for an easy, integrative, and culturally meaningful experience. The application guided triads in walks 3 times weekly for 6 months in Portland, Oregon's historically Black neighborhoods; local historical images prompted recorded conversational reminiscence. Focus groups evaluated factors influencing technology acceptance—attitudes about technology, usefulness, usability, and relevance to integrating program goals. Thematic analysis guided qualitative interpretation.
Results: Technology acceptance was influenced by group learning, paper-copy replicas for reluctant users, ease of navigation, usefulness for integrating and engaging in health behaviors, relevance to integrating individual benefit and the community priority of preserving history amidst gentrification, and flexibility in how the community uses deliverables. Perceived community benefits sustained acceptance despite intermittent technology failure.
Discussion and Implications: We offer applicable considerations for brain health technology design, implementation, and deliverables that integrate modalities, age, and cultural relevance, and individual and community benefit for more meaningful, and thus more motivated community engagement.

Keywords: Exercise/physical activity, Memory, African American, Gentrification, Social engagement

Background

Recent studies cite the greater need for nonpharmacological preventive cognitive health trials aimed at mitigating multiple modifiable risk factors, with attention on high-risk, presymptomatic populations (Tariq & Barber, 2018). African Americans are particularly vulnerable to cognitive decline including Alzheimer's disease and vascular dementia because combined but modifiable cardiovascular (diabetes, hypertension, obesity; Dore, Waldstein, Evans, & Zonderman, 2015; Gottesman, Fornage, Knopman, & Mosley, 2015;

Wessels et al., 2011), lifestyle (diet, physical, and cognitive inactivity; Solfrizzi et al., 2008; Wright et al., 2017), and socioeconomic risk factors (lower education, diminished access to quality health information, lower health literacy, lower-walkability environments, increased vulnerability to gentrification and its financial and mental health effects; Dore et al., 2015; Gordon & Hornbrook, 2016; Gupta et al., 2016; Keene, Sarnak, & Coyle, 2017; R. Smith, Lehning, & Kim, 2017; Tsang et al., 2017; Yen, Michael, & Perdue, 2009). Modifiable factors like physical activity (Buchman et al., 2012; National Center of Biotechnology Information, 2017; Winchester et al., 2013), social engagement (Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004; Savica & Petersen, 2011), and cognitive stimulation such as reminiscence may sustain/improve brain health (Huang et al., 2015). Technology can motivate older adults to engage in and sustain physical activity (e.g., smartphone app; Lyons, Swartz, Lewis, Martinez, & Jennings, 2017), social engagement (e.g., online chat; Dodge et al., 2015), and reminiscence (e.g., Web-based digital life storytelling (Elfrink, Zuidema, Kunz, & Westerhof, 2017; Lazar, Thompson, & Demiris, 2014). Integrating technology with neighborhood walking is a useful, relevant way to involve older adults in these preventive health behaviors simultaneously, potentially modifying multiple risk factors. However, most brain health interventions focus on a single activity mitigating just one risk factor, using adjunctive technology (auxiliary, facilitating the primary intervention, but not essential) rather than integrative (essential to the primary intervention as the platform allowing multiple modalities to work in unison). Whether adjunctive or integrative, usability studies typically focus on designing age-relevant technologies (Wildenbos, Peute, & Jaspers, 2015), though increasingly, cultural relevance has become a focus (Joseph, Keller, Adams, & Ainsworth, 2015; Maglalang et al., 2017; S. A. Smith et al., 2016). This is not surprising given that older minorities, and African Americans are underrepresented in brain health intervention research and technology usability studies (Lang et al., 2013; Tzuang, Owusu, Spira, Albert, & Rebok, 2017). Finally, where brain health programs targeting older African Americans place dual priority on multimodality and cultural relevance for improved *individual* health benefits (Rovner, Casten, Hegel, & Leiby, 2012), few programs integrate a greater *community* benefit into their design, technology, or program deliverables.

Aligned with recommendations that older African American brain health research should, in the eyes of its participants, be valuable on an individual *and* community level (Barnes & Bennett, 2014), we demonstrate how the Sharing History through Active Reminiscence and Photo-imagery (SHARP) program uses culturally relevant, integrative technology to blend multiple modalities with potential to deliver individual health benefits alongside community benefits.

SHARP program technology engaged participants in the neighborhood walking with historical image prompt for recorded conversational reminiscence. Simultaneously, technology has potential to provide community benefits: a digital oral history archive of Portland's historically Black neighborhoods in the face of gentrification, and archival excerpts will be integrated into a healthy aging webtool and community learning sessions for older African Americans and their families.

SHARP was piloted in Portland, OR in 2016, with the aim to test technology usability and cultural relevance. SHARP targeted cognitively intact and independently ambulatory African Americans aged ≥55 and took place in historically black neighborhoods. The technology was developed to play an integrative role in blending walking, reminiscence, and social engagement, modalities shown to individually sustain brain function (Buchman et al., 2012; Hertzog, Kramer, Wilson, & Lindenberger, 2008; Savica & Petersen, 2011; Winchester et al., 2013). Combined behavioral modalities may have a greater impact on brain health (Han et al., 2017; Ward et al., 2017).

The SHARP technology was developed by the Oregon Center for Aging and Technology at Oregon Health & Science University, whose focus is the study of healthy, independent aging and the use of technology to support positive outcomes. SHARP is a program of the Oregon Collaborative Center of the Centers for Disease Control and Prevention's Healthy Brain Research Network.

Theoretical Model

The technology acceptance model (TAM) framed our approach to usability testing (Davis, Bogozzi, & Warshaw, 1989). The model asserts that potential users' perceptions of how easy a technology is to use and whether it is useful will influence their attitudes about using the technology, which in turn influence behavioral intention to use the technology, and eventually actual use. TAM extensions cite job relevance, technology experience, and age as influencing technology acceptance (Venkatesh & Davis, 2000; Venkatesh, Morris, Davis & Davis, 2003). For SHARP, the "jobs" are engaging in walking and conversational reminiscence within a culturally engaging structure—how is program technology essential to this? Age and technology experience can have considerable influence on perceived technology usefulness, usability, and relevance (Lee & Coughlin, 2014). Multimodal intervention technology for older adults needs to be essential to the intervention so that engaging in the expected behaviors is easier with the technology than without it.

Our goal was to create an application that older adults perceived as useful, easy, and relevant to intervention tasks and to fulfilling the community priority of history preservation. If participants perceive technology to be useful, easy, and relevant, then protechnology attitudes and strong intentions to use it will ensue. Fortunately, participants come into usability studies expecting that the technology in question is imperfect, thus the request for testing. This buys the researcher space (a forgiving attitude about initial imperfect design and features) and time (duration of user testing) to revise and retest technology until it meets participant standards to influence their attitude and intent to use.

TAM offers a theory on why people may accept technology; how to make technology useful, easy, relevant and ultimately integrative could only be answered through user testing. Here, we describe the SHARP program's integrative technology, share participant perceptions of technology that reflect its degree of usefulness, usability, and relevancy, and report on revisions in response to user testing, including initial shortcomings we hope will be instructive. Finally, we offer considerations for successful integrative (rather than adjunctive) technology and how to make technology adoption successful and more culturally meaningful in older adult brain health interventions.

Design and Methods

Recruitment and Participant Characteristics

Following other walking application usability studies (Paul et al., 2016; Shalan, Abdulrahman, Habli, Tew, & Thompson 2018), 21 participants were recruited through word-of-mouth, fliers, Portland's community-based PreSERVE Coalition for African American Memory and Brain Health and its partnered organizations, and speaking engagements at churches, cultural events, and service organizations in which we provided sign-up sheets and followed up with e-mail and phone calls. Participants were African American, aged ≥55 years, able to walk 45 min without mobility aids, scored ≥24 on the Mini-Mental State Examination, and had ≥10 years residence in Portland's historically black neighborhoods for more engaged reminiscence. Older African Americans were our focus because disproportionate risks for cognitive decline compared with white Americans, community urgency to record neighborhood stories in the face of gentrification, and because this was the lead investigator's hometown population, which helped establish participant trust. The Oregon Health & Science University's Internal Review Board approved the study (approval number IRB00011936).

Design

The technology was evaluated during three concurrent stages over the 6-month trial: (a) *Implementation*. Triads walked three times weekly, using the application on an Android tablet that provided walking routes, historical neighborhood images to prompt conversational reminiscence, and that recorded conversations and tracked time, pace, and attendance. Three walks a week is consistent with studies showing cognitive function may be maintained or improved by walking two or more hours weekly (Lautenschlager et al., 2008; Winchester et al., 2013) and by frequent social engagement (Dodge et al., 2015; Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000). The research team intermittently walked with groups, noting any frustration or confusion as participants used technology. (2) *Program evaluation*. In focus groups at Months 1, 3, and 6, participants discussed experiences with and opinions of technology and its cultural relevancy. (c) *Revisions*. Technology improvements were tested during the 6-month pilot, gleaned from evaluations and researcher observations.

Implementation of the SHARP Application and the Walking Program

Triads ($n = 7$) were largely formed by friends inviting friends and availability. Social relationships were prioritized over physical compatibility. Triads remained fixed, though withdrawal initiated merges to form new triads. Triads (vs pairs or quartets) were selected because sidewalks accommodated up to three people side-by-side, and eliminated side conversations, improving sound quality and data capture.

Materials

Triads were given a 5″ × 7″ Android tablet with an external microphone to enhance sound quality. The tablet was carried cross-body or around the neck in a pouch with a clear, touch-sensitive cover. Triads received a backup digital recorder in a lanyard-style pouch, and a binder of weather-protected 5″ × 7″ paper-copy routes to mimic tablet use. Group training prepared participants to use the application.

Routes and Memory Markers

Typically, one person acted as "lead," selecting routes, communicating where to meet, and charging the tablet. Roles were not predefined; participants willingly designated responsibilities. Offering limited technical assistance, research team members accompanied triads on their first three walks and intermittently thereafter. Routes were approximately 1-mile loops, designed to be completed in 30–45 min at a moderate pace (Figure 1). Routes were themed (businesses, nightlife, school days, leisure, food and markets, fashion, and 17 more). A red line marked routes; a green star marked start/end; three balloons indicated memory markers; a running clock tracked percent completed. For safety and sound quality, routes mostly followed residential streets, using marked crosswalks on main streets.

Memory markers are global positioning system (GPS)-triggered historical neighborhood images to prompt conversational reminiscence. Images spanned 70 years (1940–2010), when Portland's historically black neighborhoods flourished, decayed, and experienced intense gentrification (Hannah-Jones, 2011; Portland (Or.). Bureau of Planning, 2000). Images included people, public and family events, quotidian life, landmarks, businesses, social clubs, street views, hit song lists, and ads. Each memory marker posed two questions. Question 1 solicited memories and

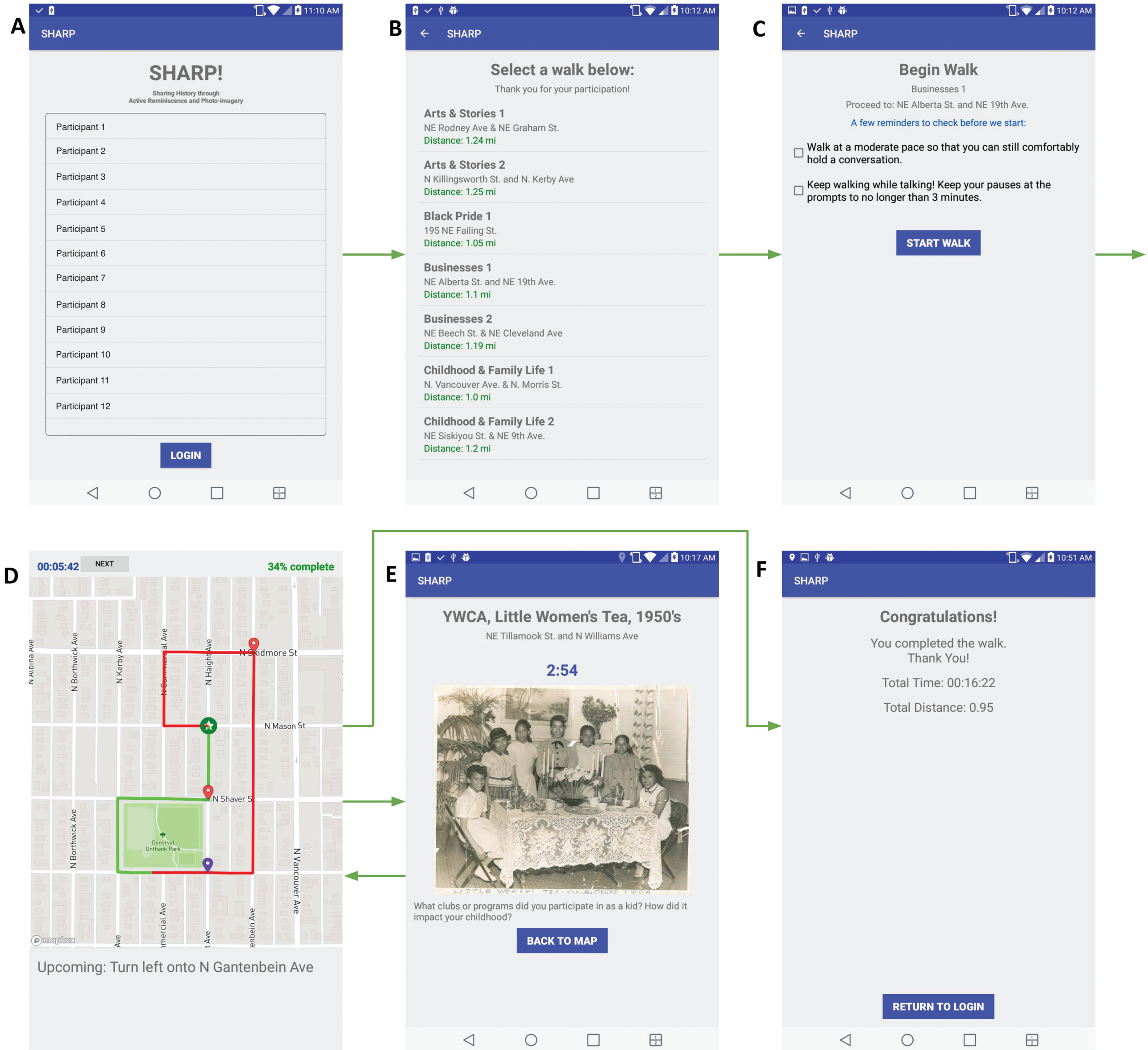

Figure 1. Application flow. (a) Participant log in. (b) Walk selection. (c) Mandatory reminders before beginning walk. (d) Global positioning system-tracked route. Green star for start/end. Balloons signal memory markers. (e) Memory marker: Image and question prompts (Oregon Historical Society Lot 587 ORH95658). 3:00 min countdown clock. (f) End walk congratulatory message, distance, and time.

reflection on the image; question 2 was broader so everyone could add to conversation regardless if they knew the person, place, or event pictured. Images were acquired in 2014–2016 from state, city, university, church, and organization archives, as well as the Internet and community members.

Using the SHARP Walking Application

The SHARP application was designed for minimal participant interaction. The triad leader makes five mandatory selections (clicks): (a) select the application on the home screen, (b) select participants from a drop-down list, (c) select route from a scroll menu, (d) select reminders (walk at a moderate pace, stop when using the tablet or viewing images, keep walking while talking, keep pauses under 3 min), and (e) click start. Maximum brightness and volume were preset. Participants typically did not need to manipulate the tablet once walking began. Simplicity was prioritized over complexity to reduce device manipulation, such as organizing routes into an alphabetical scroll menu (simple) rather than nesting routes by theme (complex) and having GPS-automated appearance and disappearance of navigational prompts and memory markers. Routes could be completed twice before becoming inaccessible. Audio recording began automatically.

Triads set their pace for about one block before reaching Memory Marker 1. A blinking blue circle tracked position. The red-lined route became green with distance covered.

Pop-up alerts and a whistling sound indicated turn-by-turn directions. An alert sounded once participants were 20 ft. from a memory marker. Upon arrival, a second alert sounded, and the image and questions appeared with a countdown clock to remind participants to stop for 3 min or less. Walk time, distance, and a "Walk completed!" message was displayed at walk's end.

Data Capture and Technical Configuration

The application was built on the Android operating system and utilized the Realm Object Database for storing data locally. Most data models used were stored in Realm. For offline functionality, data could be downloaded using a representational state transfer (RESTful) JavaScript object notation (JSON) application program interface (API). During download, the application stored all data for walking paths, participants, groups, memory markers, and completed walks by group. The application downloaded all photo prompts and vector map tiles provided by Mapbox via the Android software development kit (SDK).

During a walk, all participant interaction with the application was recorded, including opening and closing the application. Using the tablet's built-in GPS, the application continuously recorded groups' latitude and longitude. The application used these data to project triads' location on the walking path, allowing path progress to be updated even when triads strayed off path. The application continually checked group location against the upcoming memory marker and directions. Google Maps API was used to generate directions, downloaded as part of the walking path data model, and provided turn-by-turn pop-up navigation.

Upon reaching memory marker or navigational prompt, the application recorded the event. Events provided a timestamp when memory markers or directions popped up and were dismissed. Completion time was recorded as the final event for a walk, and audio recording automatically stopped.

New content (e.g., new participants and routes) automatically synced to the tablet. Whoever kept the tablet for each triad was only responsible for charging it at home. Data were formatted as a JSON array, sent to the API's appropriate entry point, and stored permanently in a MySQL database with audio stored on a partition allocated on the secure server.

Program Evaluation

Two to three triads at once attended a focus group at Months 1, 3, and 6. Nine focus groups were completed. Each session, participants completed a brief survey with Likert-type scales to evaluate program readiness for dissemination. Surveys focused on the overall program; specific comments about technology could be added to qualify program readiness ratings. Facilitated group discussion focused more on technology, asking questions to understand perceived usefulness, ease of use, and relevance. *Usefulness*. Does the application help or hinder your… (1) Walking experience? (2) Conversation and memories? (3) Ability to follow the route? (4) Motivation to engage in this study? *Ease*. How is the application… (5) Working for you? (6) Not working? (7) Text size? (8) Image and map visibility? (9) GPS-tracking? *Relevance*. How do you feel about the application's… (10) Role in a program designed to celebrate African American culture? (11) Role in bringing together walking, talking, and remembering? (12) How can we improve the application for older adults? Discussions were audio recorded and professionally transcribed.

Analysis

Evaluation Surveys

Program readiness ratings (*ready-good as is* = 4; *almost ready-needs some minor changes* = 3; *not quite ready-needs many minor changes* = 2; *not ready-needs some major changes* = 1; *not ready at all-needs many major changes* = 0) were grouped into a survey scale, a total score was calculated, and a mean score was our measure of program readiness. Write-in suggestions for technology improvements were added to our qualitative data.

Focus Groups

Transcripts were coded for common threads of meaning or patterns in the data, guided by thematic analysis (Boyatzis, 1998) and drawing from constant comparison and grounded theory (Charmaz, 2014; Strauss & Corbin 1990). Using Microsoft Word's comments feature, we assigned codes and added notes to contextualize participant comments. Codes were data-driven; codes that closely reflected researcher-designated topics in the surveys and moderator guide were revisited to ensure responses, not researcher questions, indeed guided code designations.

Three coders (R. Croff, M. Walker, E. Francois) independently coded focus group transcripts 1 and 2. Through an iterative process of constantly comparing coded sections and discussing our thought processes for code and subcode designations, a common code scheme was refined, and each code was defined. In this phase, we began grouping codes that shared larger patterns of meaning into themes. Next, coders R. Croff and M. Walker recoded transcripts 1–2 using the refined code scheme to ensure code designations matched code definitions. Coder number 3 (E. Francois) reviewed coding accuracy and consistency, bringing discrepancies (i.e., code definition restriction/expansion, code convergence/splitting, confirming or changing code-theme designations) to the group for final consensus. Coders R. Croff and M. Walker then independently coded transcripts 3–4, and coder E. Francois reviewed for inter-rater reliability. Once the group felt inter-rater reliability was reached, the first two coders equally divided remaining transcripts 5–9. Any new coding decisions were added to the code scheme and applied to prior coded transcripts for consistency.

Technology-related data were organized into three overarching themes reflecting TAM tenets: (a) Participant readiness for and attitudes about technology, (b) Usefulness and usability, and (c) Relevance: Potential to integrate individual and community benefit (Table 1). Within themes, data were coded "barriers," "facilitators," and "cultural significance." Within codes, data were subcoded "aging," "suggested improvements," programmatic components ("tablet," "display," "navigation"), "motivation," "deliverables," "history," and "gentrification." We interpreted data-coded "cultural significance" as speaking beyond the technology's cultural *relevance* (how it related to/reflected aspects of African American culture), but to its *significance* (how it facilitated making meaning and purpose from African American culture, for African Americans).

Results

Demographics and Participant Characteristics

Twenty-one African Americans (17 female; 4 male) were consented of 27 women and 15 men contacted. Two participants (1 female; 1 male) withdrew after orientation and were not replaced, rendering one triad a pair (6 triads, 1 pair) so that overall 19 participants engaged in walks and completed demographic surveys (16 female; 3 male). Three participants withdrew after Month 1 (n = 16; 3 triads, 3

Table 1. Code Scheme and Feedback Summary

Theme: Readiness for and attitudes about program technology		Feedback informing technology revisions
Code: Barriers *distracting, confusing frustrating, anxious, worried, not feeling comfortable*	**Subcode: Aging** *seniors, older folks, the older we get, at my/our age, we're not used to, new for us, we [older people] need/don't need*	• Better tablet training • Longer introduction period
Code: Facilitators *helped, interesting, it worked, easy, I liked it/it was great when*		• Optimistic about program technology because perceived individual and community benefits outweighed perceived barriers to learning new technology • Group learning preferred • Paper replicas eased anxiety and transition to technology
Theme: Usefulness and usability		**Feedback informing technology revisions**
Code: Barriers *(same terms as prior)*	**Subcodes: Suggested improvements** *we [older people] need/don't need, you/it should, make it more/less, inconsistent, change, add, fix*	• Desired maps with clearer and larger street names (barrier/suggested improvement, display) • Voice command preferred to supplement pop-up commands and navigational directions (barrier/suggested improvement, navigation)
Code Facilitators *(same terms as prior)*	**Aging** *(see prior terms)* **Tablet Display Navigation**	• Group leader preferred, facilitated group organization (facilitator) • Minimal required manipulation of technology preferred, should be intuitive and integrative to program experience (facilitator/suggested improvement, aging, tablet) • Simple navigation preferred over nested menus (facilitator/age, navigation) • Retaining back up, low-tech tools relieved anxiety in case of technology failure (facilitator/aging)
Theme: Relevance: Potential to integrate individual and community benefit		**Feedback informing technology revisions**
Code: Cultural Significance *culture, meaningful, motivating, deliverables, about/for us [African Americans], important, our/the Black/African American community, benefit, gentrification, history*	**Subcodes:** Motivation Deliverables History Gentrification *(all terms are participant-derived)*	• Potential dual benefit (community and individual) a principal motivator to join and stay in study (motivation, deliverables) • Community deliverables should address a community-identified priority (e.g., preserving memories/history of African American culture in the face of gentrification) (deliverable, history, gentrification) • Program technology should result in deliverables that benefit community beyond the study (deliverables) • Open- ended deliverables allow community to apply to community- identified priorities as they see fit (deliverables)

Note. Participant terms and phrases from which codes and subcodes were derived are in italic.

pairs, 1 single); the single participant merged with one a pair (4 triads, 2 pairs). Two participants withdrew after Month 3 (n = 14; 2 triads, 3 pairs, 2 singles). Singles merged with pairs (4 triads, 1 pair), but inconsistently so that sometimes triads became pairs and pairs became triads.

In each case, extenuating circumstances prompted withdrawal (personal schedule changes, increased caregiving responsibilities, unrelated injury), and two withdrawals remained connected to the program through donating personal images from which we created walking routes.

Age range was 59–80; M = 69.21, SD = 5.06. Seven participants had <4 years of higher education, and 12 had ≥4 years. Ten participants were retired, and 9 were employed. Ten participants had an annual household income of $0–49,000, and seven had one between $50,000–89,000 (two did not respond). Seven participants were married, and 12 were not married. One participant was receiving care from a household member, and three participants were providing care for a household member.

Finally, all 19 participants used smartphones, defined here as a cell phone capable of running applications, texting, and storing contacts (Cassavoy, 2017), though few utilized smartphone applications extensively.

Program Readiness

Mean readiness scores were 3.0, 3.3, and 2.7 (out of 4.0) for Month 1, 3, and 6 respectively. Across timepoints, there were 27 "3 = *almost ready-needs some minor changes*" compared with 12 "4 = *ready-good as is*." Three "2 = *not quite ready-needs many minor changes*" were only in Month 1. No one rated the program "1 = *not ready*" or "0 = *not ready at all*." All write-in responses were technology-based (poor internet connection and map visibility, inadequate technology training) and pointed to the problem of inconsistent functioning.

Participant Readiness for and Attitudes About Technology

Despite researcher testing, technology failed on the first participant walk. As a result, the first two triads completed their first six walks using paper-copy routes. The first two triads appreciated starting with the familiar (paper-copy routes) and transitioning to the unfamiliar (smartphone application) once revisions were made because it allowed practice with a fail-safe replica, keeping the priority on developing the health behavior rather than on the technology supporting it: "Because the walk truly was about the sharing … the history and talking about the neighborhood changes and what these things are looking like now. But if we had to fool with this device…"

Participants were only vaguely familiar with smartphone technology: "I only know how to use a flip-top cell phone," seeing it as primarily for younger generations: "The tablets you're talking about, just a mini … like a little laptop. We bought them for our kids." Nonetheless, participants, including self-described "luddites" and "antitechnology" saw the pending transition to the application as an opportunity rather than a burden: "I'm just looking forward to the challenges, doing something new and different."

Learning new technology as a group curbed hesitation and bolstered confidence to engage curiosity: "I'm looking forward to [using the application] partly because I really would like to know how [a tablet] works. And I would feel more comfortable in a group of people that were doing this thing than just trying to figure it all out and do it all by myself." Participants had positive attitudes about learning the application to increase walking and conversational reminiscence, but contrary to TAM, this did not necessarily influence everyone's intent to use the technology: "I probably will still never buy [a tablet]. But at least, I'd like to know how these things work."

Participants were open to learning new technology, not only because it was relevant to carry out their "jobs" in the program, but to mitigate other modifiable risk factors for cognitive decline, such as isolation. Trying new technology was framed as one of many changes to which seniors must adapt:

> The older we get, the more we isolate ourselves. We don't make new friends. So that when the older ones die, we're feeling more isolated and lonely. We become controlling and irritating … because we're not happy … our children and relatives, younger relatives, don't want to be around us. Or we refuse to embrace technology … new technology. "No. I don't text. I don't have a computer. No, I don't need that." Ways that … can be good … things that can be good. So, I'm just thinking of how to … stay healthy, because it's going to keep changing. And things are changing so fast.

Usefulness and Usability

After the first two triads, subsequent triads started the program using the application. Despite everyone having been trained, triads preferred designating a leader already familiar with smartphone technology and/or who showed interest in learning and handling it: "Have a group leader…. Ask folks who's willing, explain what the duties might be…. We were lucky that we had a leader that stepped up because it just kept things tied together. And all I knew was, on each of those three days I was going to get a text to meet on this corner at this time. And that worked so well." Some triads preferred the leader be responsible for all equipments—tablet, microphone, and backup binder, others preferred splitting responsibility. For the most technology-reticent participants, this flexibility allowed participants to perceive technology as useful, develop a positive attitude about it, and derive potential benefit from it without developing an intent to use it themselves.

Groups retained backup paper-copy routes in case of technology failure, which despite revisions described later, continued intermittently: "four out of the six months [the application] worked fine." Still, feedback was largely positive: "When [the application] worked, [it] was great." Images effectively prompted stimulating conversational reminiscence, and GPS-tracking alleviated worry about straying off course: "It's great when it's working, because it guides you through the walk." Frustrations were largely due to malfunction, not to application content or concept, and belief in the application's potential to sustain motivation to walk remained high:

> …when I first got involved, I didn't understand the concept. We're going to do what? ...You got the tablet out and you'd start looking at these maps. And you'd go, hey, this is interesting … it's an interesting concept, in terms of the way it's organized … you weren't always walking along the same street in the same area.

Safety was our primary concern in combining smartphone technology and walking, thus instructions to stop viewing or manipulating the application while walking. Yet distracted walking was inevitable, creating anxiety that impeded full immersion in the social and physical experience: "I was distracted by the tablet. So, I wasn't fully engaged with the conversation that was taking place. And I wasn't engaged with … the visual surroundings…. I was more focused on the tablet and where I was walking, to make sure I wasn't going to fall flat on my face…." Technology failure contributed to distracted walking and undermined confidence: "…not feeling comfortable or confident with this piece of machinery in my hand … so my curiosity was 'is it working? Is it working? Is it doing what it's supposed to do?'… that level of anxiety was always there…."

Not surprisingly, participants emphasized that paper-copy routes were imperative: "The [application] worked. But when it didn't … we were lucky to have the book to fall back on."

In developing technology to support older adult health, participants emphasized that researchers must "keep in mind you're dealing with people who are not technology savvy because technology came in after us." One participant cautioned that rapid adoption of new technology was "why [older adults] fall by the wayside." Participants felt introducing technology to older adults should be gradual, with in-person assistance in initial phases, and an uncomplicated interface free of unnecessary layers: "in the age where you're trying to attract people, an extra click on a device is not friendly." Another stated, "when you're talking about scrolling and pressing buttons, the more simple the better. We won't be frustrated." Participants were clear that for older adults less technology was more: "keep it as simple as possible for the seniors."

Relevance: Potential to Integrate Individual and Community Benefit

Participants frequently noted that the technology's potential to integrate individual and community benefit was a principal driver to participation. Participants spoke passionately about community benefits technology could facilitate, particularly in the face of gentrification. Potential community benefit carried greater motivational weight than potential individual benefit: "It was something different … to blend the Afrocentric and historical fact-driven, and of a community that's almost lost. That is the pull. I mean, it really is."

Participants commonly saw potential individual benefit as secondary to the program's community interest: "I think [the program] is unique and interesting, as well as personally redeeming in terms of the health aspects." Program deliverables that technology-enabled were paramount:

> Anybody can get out and walk. But why are you walking? And what do you have when you get home is something different … more importantly, have something to document as a result of that walk.

Technology created an oral history digital archive to inform yet two more deliverables—a cognitive health web-tool and community learning sessions; the archive can be used in any capacity the community sees fit: "…a very good use for [the archive] is to gather information about what a force [the area] was for the Black community, and to get it in the schools. Let the Black kids hear and know about it."

Further, the oral history archive is amenable to serving other community-identified needs:

> … people who are part of the walk can go to the schools and talk to the kids. And that way, it will set up a relationship. It gets them out of their comfort zone … you're talking about the isolation that these older people have. That will help. Maybe … kids show the older people how to do technology. So … it's reciprocal.

Revisions

Participants suggested minor revisions to themes and language, such as "Black Pride" replacing "Afrocentrism" because Afrocentrism was "academic" and uncommon in the 1960s and 1970s. Most suggestions related to navigation. Pop-up directions were too frequent and ambiguous (i.e., "Continue North"). This diverted focus to device manipulation, figuring out where it wanted them to go rather than focusing on the health behaviors the technology was designed to integrate. Participants could not always hear alerts signaling directions due to traffic, conversation, age-related hearing loss, and volume limitations. Participants suggested louder alerts and directional voice commands. Revisions minimized pop-up directions and added voice command.

Internally, revisions greatly reduced the original code-base, making code cleaner and easier to understand. The streamlined code makes maintenance and improvements easier and new features can be built faster. Externally, revisions improved functioning and participant experience with program technology.

Discussion and Implications

Overall, participants perceived technology as useful for engaging in program activities, easy to use, and relevant to integrating modalities and to delivering potential individual and community benefits in ways that reflected African American culture and produced meaning from it. Participants had little smartphone technology experience but still had positive attitudes about using the SHARP application. Being a largely retired group having lived most of their lives in Portland's historically black neighborhoods facilitated engagement. A collective urgency to record community memories amidst gentrification leveraged attitudes about using technology when it failed. Participants saw technology as proactively mitigating cognitive decline *and* the devastation of gentrification on Portland's small black community. Potential long-term individual and community benefits of technology trumped short-term usability barriers, including intermittent technology failure. In short, participants felt the *idea* of program technology merited their extra effort and patience as shortcomings were continually revised.

Ten main factors influenced technology acceptance, relating to design, implementation, and deliverables. Factors do not seem to be culturally driven and are thus widely applicable.

Design. The application should (a) be integrative to participant experience of multiple modalities rather than adjunctive, (b) be integrative to individual and community benefit, (c) have minimal navigational choices (fewer clicks), and (d) use participant-tested rather than researcher-assumed culturally relevant language, images, and themes. *Implementation*. Participant application training should (e) begin with paper replicas and transition to the application to focus on behavioral goals without technology diminishing motivation for reluctant users, (f) be in a group setting, with frequent assistance during initial phases, and (g) be supplemented with paper-copy instructions, maps, and prompts so activity continues despite technology failure. *Deliverables*. Program technology should (h) provide end-products that benefit the community and reflect community-identified priorities (e.g., SHARP's oral history digital archive), (i) be amenable to diverse applications as the community sees fit (*how* the digital archive is used is open to community interpretation and reinvention—i.e., youth education, policy change, intercultural understanding), and (j) have wide dissemination capacity (e.g., SHARP's recorded stories will be integrated into a cognitive health web-tool and community learning sessions).

People born into the age of routine smartphone application use and rapid advances in health-promoting gadgets may be drawn to brain health interventions precisely because of the opportunity to engage with new technology. For older adults, participation in technology-based brain health interventions may well be because the technology is *integrative to the reason* they chose to engage, rather than *being the reason* they engage. In the SHARP pilot, using new technology was secondary, if not tertiary, to other components like preserving memories for the greater community benefit while simultaneously enjoying potential individual health benefits.

SHARP technology plays an integrative rather than adjunctive role in increasing physical activity, social engagement, and reminiscence to decrease cognitive decline in a high-risk population, and in a culturally engaging and meaningful way. SHARP technology design, implementation, and deliverables are adaptable to anyone who has community memories to share and is scalable anywhere people perceive their connection to place and to each other as important for the health of their community and for themselves.

Limitations

A controlled trial is needed to confirm technology usefulness, usability, and relevance to integrating individual health and community benefits. Control groups may show which modalities are most/least effective independently. Our sample was highly educated, majority female, did not use mobility aids, and had smartphone technology experience. Program adjustments must be made for people of varying mobility and with limited or no smartphone technology experience, particularly to increase participation of people over 75. Our 10 listed considerations inform theory development for older African American preferences in integrative, technology-based brain health programming; however, it only draws from one small community. Preferences should be tested with older African Americans in other parts of the country.

Future Research

The 2016 pilot focused on technology usability with cognitively intact individuals. With funding from the Alzheimer's Association and the National Institute on Aging, the subsequent pilot tests usability and health outcomes with both cognitively intact individuals and those experiencing mild cognitive impairment.

Funding

This work was supported by the Centers for Disease Control and Prevention (cooperative agreement number U48DP005006); National Institute on Aging (P30AG008017); and Roybal Centers for Translational Research on Aging (P30AG024978). Contents in this article are solely the responsibility of the authors and do not necessarily represent the official views of the funding institutions.

Acknowledgments

For SHARP images, we thank participants and their families, Oregon Historical Society, Cristine Paschild of Portland State University's Rutherford Family Collection and the Senator Avel Gordly Papers, City of Portland Archives, Bonneville Power Administration, and OHSU. We are grateful to Hiroko Dodge, PhD, Linda Boise, PhD, and Thomas McKenna for mentorship, to Marie Smith Health & Social Center, The Urban League of Portland, PreSERVE Coalition, the Alzheimer's Association Oregon Chapter, The Portland Chapter of the Links, Inc., and Portland Alumnae Chapter of The Delta Sigma Theta Sorority, Inc. for community support. For Internship support, we thank OHSU Center for Diversity and Inclusion and the Portland State University NIH-BUILD EXITO Scholars Program. We thank the Oregon Prevention Research Center and the CDC Healthy Brain Research Network for their support. For assistance creating routes, we thank Nathalie Jedynak, Shoshana Maxwell, DO, and Juell Towns.

Conflict of Interest

None declared.

References

Barnes, L. L., & Bennett, D. A. (2014). Alzheimer's disease in African Americans: Risk factors and challenges for the future. *Health Affairs (Project Hope)*, **33**, 580–586. doi:10.1377/hlthaff.2013.1353

Barnes, L. L., Mendes de Leon, C. F., Wilson, R. S., Bienias, J. L., & Evans, D. A. (2004). Social resources and cognitive decline in a population of older African Americans and whites. *Neurology*, **63**, 2322–2326.

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage.

Buchman, A. S., Boyle, P. A., Yu, L., Shah, R. C., Wilson, R. S., & Bennett, D. A. (2012). Total daily physical activity and the risk of AD and cognitive decline in older adults. *Neurology*, **78**, 1323–1329. doi:10.1212/WNL.0b013e3182535d35

Cassavoy, C. (2017, September 30). What makes smartphones smart? Retrieved from https://www.lifewire.com/what-makes-a-smartphone-smart-579597

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989) User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, **35**, 982–1003. doi:10.1287/mnsc.35.8.982

Dodge, H. H., Zhu, J., Mattek, N., Bowman, M., Ybarra, O., Wild, K.,…Kaye, J. A. (2015). Web-enabled conversational interactions as a means to improve cognitive functions: Results of a 6-week randomized controlled trial. *Alzheimer's & Dementia (New York, N. Y.)*, **1**, 1–12. doi:10.1016/j.trci.2015.01.001

Dore, G. A., Waldstein, S. R., Evans, M. K., & Zonderman, A. B. (2015). Associations between diabetes and cognitive function in socioeconomically diverse African American and white men and women. *Psychosomatic Medicine*, **77**, 643–652. doi:10.1097/PSY.0000000000000196

Elfrink, T. R., Zuidema, S. U., Kunz, M., & Westerhof, G. J. (2017). The effectiveness of creating an online life story book on persons with early dementia and their informal caregivers: A protocol of a randomized controlled trial. *BMC Geriatrics*, **17**, 95. doi:10.1186/s12877-017-0471-y

Fratiglioni, L., Wang, H. X., Ericsson, K., Maytan, M., & Winblad, B. (2000). Influence of social network on occurrence of dementia: A community-based longitudinal study. *Lancet (London, England)*, **355**, 1315–1319. doi:10.1016/S0140-6736(00)02113-9

Gordon, N. P., & Hornbrook, M. C. (2016). Differences in access to and preferences for using patient portals and other ehealth technologies based on race, ethnicity, and age: A database and survey study of seniors in a large health plan. *Journal of Medical Internet Research*, **18**, e50. doi:10.2196/jmir.5105

Gottesman, R. F., Fornage, M., Knopman, D. S., & Mosley, T. H. (2015). Brain aging in African-Americans: The Atherosclerosis Risk in Communities (ARIC) experience. *Current Alzheimer Research*, **12**, 607–613.

Gupta, V. K., Winter, M., Cabral, H., Henault, L., Waite, K., Hanchate, A.,…Paasche-Orlow, M. K. (2016). Disparities in age-associated cognitive decline between African-American and Caucasian populations: The roles of health literacy and education. *Journal of the American Geriatrics Society*, **64**, 1716–1723. doi:10.1111/jgs.14257

Han, J. W., Lee, H., Hong, J. W., Kim, K., Kim, T., Byun, H. J.,…Kim, K. W. (2017). Multimodal cognitive enhancement therapy for patients with mild cognitive impairment and mild dementia: A multi-center, randomized, controlled, double-blind, crossover trial. *Journal of Alzheimer's Disease*, **55**, 787–796. doi:10.3233/JAD-160619

Hannah-Jones, N. (2011). In Portland's heart, 2010 census shows diversity dwindling. *The Oregonian*. Retrieved from http://www.oregonlive.com/pacific-northwest-news/index.ssf/2011/04/in_portlands_heart_diversity_dwindles.html

Hertzog, C., Kramer, A. F., Wilson, R. S., & Lindenberger, U. (2008). Enrichment effects on adult cognitive development: Can the functional capacity of older adults be preserved and enhanced? *Psychological Science in the Public Interest: A Journal of the American Psychological Society*, **9**, 1–65. doi:10.1111/j.1539-6053.2009.01034.x

Huang, H. C., Chen, Y. T., Chen, P. Y., Huey-Lan Hu, S., Liu, F., Kuo, Y. L., & Chiu, H. Y. (2015). Reminiscence therapy improves cognitive functions and reduces depressive symptoms in elderly people with dementia: A meta-analysis of randomized controlled trials. *Journal of the American Medical Directors Association*, **16**, 1087–1094. doi:10.1016/j.jamda.2015.07.010

Joseph, R. P., Keller, C., Adams, M. A., & Ainsworth, B. E. (2015). Print versus a culturally-relevant Facebook and text message delivered intervention to promote physical activity in African American women: A randomized pilot trial. *BMC Women's Health*, **15**, 30. doi:10.1186/s12905-015-0186-1

Keene, D. E., Sarnak, A., & Coyle, C. (2017). Maximizing home equity or preventing home loss: Reverse mortgage decision making and racial inequality. *The Gerontologist*. doi:10.1093/geront/gnx209

Lang, R., Kelkar, V. A., Byrd, J. R., Edwards, C. L., Pericak-Vance, M., & Byrd, G. S. (2013). African American participation in health-related research studies: Indicators for effective recruitment. *Journal of Public Health Management and Practice*, **19**, 110–118. doi:10.1097/PHH.0b013e31825717ef

Lautenschlager, N. T., Cox, K. L., Flicker, L., Foster, J. K., van Bockxmeer, F. M., Xiao, J.,…Almeida, O. P. (2008). Effect of physical activity on cognitive function in older adults at risk for Alzheimer disease: A randomized trial. *JAMA*, **300**, 1027–1037. doi:10.1001/jama.300.9.1027

Lazar, A., Thompson, H., & Demiris, G. (2014). A systematic review of the use of technology for reminiscence therapy. *Health Education & Behavior*, **41**(1 Suppl.), 51S–61S. doi:10.1177/1090198114537067

Lee, C., & Coughlin, J. (2014). PERSPECTIVE: Older adults' adoption of technology: An integrated approach to identifying determinants and barriers. *The Journal of Product Innovation Management*, **32**,747–759. doi:10.1111/jpim.12176

Lyons, E. J., Swartz, M. C., Lewis, Z. H., Martinez, E., & Jennings, K. (2017). Feasibility and acceptability of a wearable technology physical activity intervention with telephone counseling for mid-aged and older adults: A randomized controlled pilot trial. *JMIR mHealth and uHealth*, **5**, e28. doi:10.2196/mhealth.6967

Maglalang, D. D., Yoo, G. J., Ursua, R. A., Villanueva C., Chesla, C. A., & Bender, M. S. (2017). "I don't have to explain, people understand": Acceptability and cultural relevance of a mobile health lifestyle intervention for filipinos with type 2 diabetes. *Ethnicity & Disease*, **27**, 143–154. doi:10.18865/ed.27.2.143

Paul, L., Wyke, S., Brewster, S., Sattar, N., Gill, J. M., Alexander, G.,…Dybus, A. (2016). Increasing physical activity in stroke survivors using STARFISH, an interactive mobile phone application: A pilot study. *Topics in Stroke Rehabilitation*, **23**, 170–177. doi:10.1080/10749357.2015.1122266

Portland (Or.). Bureau of Planning. (2011). *Portland: Albina Community Plan*. Retrieved from https://scholarsbank.uoregon.edu/xmlui/handle/1794/6186

Rovner, B. W., Casten, R. J., Hegel, M. T., & Leiby, B. E. (2012). Preventing cognitive decline in older African Americans with mild cognitive impairment: Design and methods of a randomized clinical trial. *Contemporary Clinical Trials*, **33**, 712–720. doi:10.1016/j.cct.2012.02.016

Savica, R., & Petersen, R. (2011). Prevention of dementia. *The Psychiatric Clinics of North America*, **34**, 127–145. doi:10.1016/j.psc.2010.11.006

Shalan, A., Abdulrahman, A., Habli, I., Tew, G., & Thompson, A. (2018). YORwalK: Designing a smartphone exercise application for people with intermittent claudication. *Studies in Health Technology and Informatics*, **247**, 311–315.

Smith, R., Lehning, A., & Kim, K. (2017). Aging in place in gentrifying neighborhoods: Implications for physical and mental health. *Innovation in Aging*, **1**(suppl_1), 1273. doi:10.1093/geroni/igx004.4642

Smith, S. A., Whitehead, M. S., Sheats, J. Q., Fontenot, B., Alema-Mensah, E., & Ansa, B. (2016). Formative research to develop a lifestyle application (app) for African American breast cancer survivors. *Journal of the Georgia Public Health Association*, **6**, 50–59. doi:10.21633/jgpha.6.103

Solfrizzi, V., Capurso, C., D'Introno, A., Colacicco, A. M., Santamato, A., Ranieri, M.,…Panza, F. (2008). Lifestyle-related factors in predementia and dementia syndromes. *Expert Review of Neurotherapeutics*, **8**, 133–158. doi:10.1586/14737175.8.1.133

Strauss, A. L., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage Publications.

Tariq, S., & Barber, P. A. (2018). Dementia risk and prevention by targeting modifiable vascular risk factors. *Journal of Neurochemistry*, **144**, 565–581. doi:10.1111/jnc.14132

Tsang, S., Sperling, S. A., Park, M. H., Helenius, I. M., Williams, I. C., & Manning, C. (2017). Health variables are informative in screening for mild cognitive impairment among elderly African Americans. *Journal of Applied Gerontology: The Official Journal South Gerontological Society*. doi:10.1177/0733464817711961

Tzuang, M., Owusu, J. T., Spira, A. P., Albert, M. S., & Rebok, G. W. (2017). Cognitive training for ethnic minority older adults in the United States: A review. *The Gerontologist*. doi:10.1093/geront/gnw260

Varma, V. R., Chuang, Y. F., Harris, G. C., Tan, E. J., & Carlson, M. C. (2015). Low-intensity daily walking activity is associated with hippocampal volume in older adults. *Hippocampus*, **25**, 605–615. doi:10.1002/hipo.22397

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, **46**, 186–204. doi:10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, F. D., & Davis, G. B. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, **27**, 425–478. doi:10.2307/30036540

Ward, N., Paul, E., Watson, P., Cooke, G. E., Hillman, C. H., Cohen, N. J.,…Barbey, A. K. (2017). Enhanced learning through multimodal training: Evidence from a comprehensive cognitive, physical fitness, and neuroscience intervention. *Scientific Reports*, **7**, 5808. doi:10.1038/s41598-017-06237-5

Wessels, A. M., Lane, K. A., Gao, S., Hall, K. S., Unverzagt, F. W., & Hendrie, H. C. (2011). Diabetes and cognitive decline in elderly African Americans: A 15-year follow-up study. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*, **7**, 418–424. doi:10.1016/j.jalz.2010.07.003

Wildenbos, G. A., Peute, L. W., & Jaspers, M. W. (2015). A framework for evaluating mHealth tools for older patients on usability. *Studies in Health Technology and Informatics*, **210**, 783–787.

Winchester, J., Dick, M. B., Gillen, D., Reed, B., Miller, B., Tinklenberg, J.,…Cotman, C. W. (2013). Walking stabilizes cognitive functioning in Alzheimer's disease (AD) across one year. *Archives of Gerontology and Geriatrics*, **56**, 96–103. doi:10.1016/j.archger.2012.06.016

Wright, R. S., Waldstein, S. R., Kuczmarski, M. F., Pohlig, R. T., Gerassimakis, C. S., Gaynor, B.,…Zonderman, A. B. (2017). Diet quality and cognitive function in an urban sample: Findings from the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study. *Public Health Nutrition*, **20**, 92–101. doi:10.1017/S1368980016001361

Yen, I. H., Michael, Y. L., & Perdue, L. (2009). Neighborhood environment in studies of health of older adults: A systematic review. *American Journal of Preventive Medicine*, **37**, 455–463. doi:10.1016/j.amepre.2009.06.022