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Original Research Article

The Efficacy of a Home-Based Functional Skills Training Program for Older Adults With and Without a Cognitive Impairment

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Abstract

Background and Objectives: The performance of everyday technology-based tasks, such as online banking or shopping, can be challenging for older adults, especially those with a cognitive impairment. Technology-based tasks are cognitively demanding and require learning new skills. This study explored the efficacy of a technology-based functional skills assessment and training program (FUNSAT) among aging adults with and without mild cognitive impairment (MCI) in home settings.

Research Design and Methods: One hundred and eighty-four racially/ethnically diverse male and female adults aged 65+ participated in the study. The sample included 75 noncognitively impaired (NC) older adults and 109 older adults with MCI. The FUNSAT program includes medication and money management, transportation, and shopping tasks. The MCI participants were randomized to the FUNSAT training or FUNSAT training combined with computer-based cognitive training (FUNSAT/CCT). The nonimpaired adults received the FUNSAT training only. Using alternative forms of the assessment component of the FUNSAT program, assessments occurred at baseline, post-training, and 1- and 3-month post-training. This paper reports the post-training results.

Results: The findings indicated that the performance of both the nonimpaired and MCI participants improved significantly for all 6 tasks post-training. Specifically, training resulted in improvements in task completion time and task errors. Participants also reported greater confidence when performing the tasks in the real world.

Discussion and Implications: Nonimpaired aging adults and those with MCI can learn to perform technology-based everyday tasks. Further, home-based technology training protocols are feasible for aging adults with and without a cognitive impairment.

Clinical Trial Registration: NCT04679441

Translational Significance: Aging adults with and without cognitive impairments often experience challenges with daily living activities, especially those involving new technology. This study demonstrated that a technology-based functional skills assessment and training program enhanced the ability of noncognitively impaired aging adults and those with mild cognitive impairment to perform novel technology-based tasks. The findings also demonstrated that home-based training programs are feasible for older adults.

Keywords: Functional performance, Mild cognitive impairment, Technology training

The ability to perform everyday activities is essential to independent living. The performance of these tasks can be challenging for aging adults given the cognitive demands associated with these activities and age-related cognitive changes, such as declines in working memory, processing speed, and reasoning. Studies have shown, for example, that older adults often encounter difficulties with tasks such as medication management (e.g., Feger et al., 2020) and money management (e.g., Gamble et al., 2015). The performance of everyday activities can be even more challenging for aging adults with a cognitive impairment such as mild cognitive impairment (MCI), typically thought of as a stage of cognitive functioning between normal cognitive aging and dementia. Several investigators (e.g., Aretouli & Brandt, 2010; Burton et al., 2009; Farias et al., 2006; Gomar et al., 2011; Hughes et al., 2012) have shown that individuals with MCI have difficulty performing a wide range of functional everyday activities. Prevalence estimates indicate that, in 2020, the number of people with MCI in the United States was 12.23 million and will increase to 21.55 million by 2060 (Rajan et al., 2021). Thus, many people are at risk for deficits in everyday functional skills (FS), declining quality of life, and the ability to live independently.

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Living independently also requires flexibility and adapting to a dynamic and continually changing environment. For example, in today's technology-driven world, the need to use technology to perform everyday activities is almost ubiquitous. Further technology systems change rapidly and, in many cases, are becoming more complex. The functionality of many technology devices or applications, such as smartphones or ride-sharing apps such as Uber, is also constantly increasing. Thus, interacting with technology requires new learning and continually adapting to changes in technology systems and applications. Our group has shown that although older adults, including those with cognitive impairments, are willing and able to learn to use new technology, they often encounter challenges using technology (e.g., Czaja et al., 2018; Dowell-Esquivell et al., 2024; Harvey et al., 2022; Kalantari et al., 2023). Further, despite the current increase in technology uptake, the digital divide still exists for many older adults, such as those in the older cohorts, lower socioeconomic strata, and those who live in rural locations or have a disability (Faverio, 2022).

Models of successful aging (e.g., Rowe & Kahn, 1997) and adaptation for growth models (e.g., Wu & Strickland-Hughes, 2019) stress the importance of providing aging adults with opportunities for new learning to facilitate adaptation to a changing environment and enhance independent living. Cognitive Enrichment Theory (Hertzog et al., 2008) also posits that engaging in a cognitive activity, such as new learning, can positively affect cognitive functioning in older age. Engaging in new learning can also affect well-being and quality of life. For example, Narushima and colleagues (2018) found that older adults' participation in a public continuing education program was positively associated with psychological well-being and self-perceived health. Pihlainen et al. (2021) found that older adults who participated in nonformal digital training sessions had an increase in digital literacy and also reported an increase in well-being.

Several studies have examined interventions to enhance older adults' cognitive abilities or FS. For example, the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) intervention, which provided training on memory, reasoning, and speed of processing, resulted in improvements in cognitive abilities (Ball et al., 2002), self-reported 10-year stability of Instrumental Activities of Daily Living (Rebok et al., 2014), some improvements on driving performance (Ball et al., 2010), as well as reduced longitudinal declines in quality of life (Wolinsky et al., 2006). Other investigators have also shown that training older adults on FS results in performance gains in the trained skills and increases in cognitive abilities required by those skills. Park et al. (2014) found that providing older adults with training on quilting or photography resulted in performance improvements in the trained activities and increased episodic memory performance. Leanos and colleagues (2020) simultaneously trained older adults on three novel skills: Spanish, iPad use, and painting. They found that this training approach resulted in training gains for the trained tasks and improved cognitive abilities. Gómez & Rodríguez (2021) evaluated the effectiveness of the "Training Programme in Everyday Cognition," attempting to improve everyday cognition and global cognitive performance in older adults. The focus of the training was on medication management. The program was compared to a conventional cognitive training program. The results showed that the "Training Programme in Everyday Cognition" resulted in greater gains in everyday cognition and global cognitive performance than the conventional cognitive training program. Our group also found that providing older adults with training on computer-based everyday tasks resulted in significant improvements in the tasks trained and in a measure of global cognition (Czaja et al., 2020). In our study examining the benefits of a software system for community-dwelling older adults at risk for social isolation (Czaja et al., 2018), we found we were able to successfully train older adults with no prior computer experience, including those in the older cohorts and the lower socioeconomic strata, on the software application and that the use of the application also resulted in gains in technology proficiency and well-being. Other studies have also shown that engagement in cognitive activities may protect against cognitive decline (e.g., Edwards et al., 2017; Fratiglioni et al., 2004) and may lead to increases in learning self-efficacy (Nguyen et al., 2020).

The goals of this study were to evaluate the efficacy of a computer-based FS assessment and training program (FUNSAT) among older adults with MCI and those without a cognitive impairment. In our previous studies (e.g., Czaja et al., 2020; Harvey et al., 2022), we demonstrated that older adults with and without a cognitive impairment can experience significant improvements in the performance of simulations of everyday computer-based tasks such as using an Automatic Teller Machine (ATM) and online banking following computer-based training on these tasks. This study used an updated version of the FUNSTAT training software, which included improved graphics and improved graduated feedback messages. The language options for the FUNSAT program were also expanded. The program was available in English and Spanish. Also, the study was conducted at two sites in diverse geographical locations—the southeast (Miami, FL) and the northeast (New York City). Importantly, unlike our previous study, where training was guided by a trainer and occurred in groups in senior settings, in this study, the training was self-administered and delivered remotely in the participants' homes.

The FUNSAT training program was evaluated on a sample of noncognitively impaired older adults (NC) and older adults with MCI. Following a baseline assessment, the NC sample received the FUNSAT training program. To examine if computerized cognitive training (CCT) provided a booster to skills training for those with MCI, following a baseline assessment, MCI participants were randomized to the FUNSAT alone training condition or FUNSAT training combined with Computerized Cognitive Training (FUNSAT/CCT) training condition. As discussed, computer-based cognitive training can result in an improvement in cognitive abilities, such as processing speed, important to everyday activities (e.g., Ball et al., 2002). We hypothesized that the FUNSAT alone training would result in task performance improvements for the trained tasks for both the impaired and nonimpaired older adults and generalize to an alternate form of the tasks. We also hypothesized that the combined FUNSAT/CCT training would result in greater training gains for the MCI participants. We also examined if training resulted in improvements in task self-efficacy or confidence in performing the tasks in the real world.

Study Design and Methods

Study Design

The study design was a randomized trial conducted in two geographical regions with diverse populations. Participants were recruited from Senior Centers in South Florida ($N = 4$) and New York City (all five boroughs, $N = 10$). Following the initial screening, orientation to the study, and an in-person baseline assessment, MCI participants were randomized into the FUNSAT training-only condition or the FUNSAT/CCT training condition, stratified by site. The noncognitively impaired participants received the FUNSAT training only to help develop normative standards for training gains. The WCG IRB approved the study and all participants provided written informed consent. Participants who were unable to comprehend the written consent form were not enrolled.

Participants

The sample consisted of English- or Spanish-speaking adults aged 60 or older who live independently. Participants had to have at least 20/60 vision with or without correction, be able to read a computer screen, and use a computer keyboard or mouse (e.g., did not have a severe motor impairment). Males and females were recruited without restrictions on racial or ethnic status. Exclusion criteria included not meeting the cognitive status and literacy criteria (described subsequently), the inability to undergo assessments in either English or Spanish, a diagnosis of a serious psychiatric condition apart from major depression, a previous medical history of brain disease such as, seizures, tumor, or significant traumatic brain injury with extended loss of consciousness.

Participants were compensated \$30.00 per assessment, \$5.00 for each training session, \$15.00 for each task upon mastery (see later), and \$2.00 for each EMA survey answered. Recruitment strategies included presentations at the Senior Centers and word of mouth.

Procedures

Description of the FUNSAT training and assessment program

The FUNSAT training and assessment software program was delivered on a touchscreen device (Chrome Book) in a cloud-based format. Participants were provided with a Chrome book and had the option of accessing the internet via a provided hotspot or through their own Wi-Fi connection. The program is accessed via a web browser such as Google Chrome, which is available on the Chrome Book screen. The FUNSAT assessment and training program was developed using a user-centered design approach. Initially, a heuristic analysis was performed by the investigators to ensure that the updated version (cloud-based third generation) of the program conformed to usability guidelines for older adults (e.g., Czaja et al., 2019). Usability testing of the program was then conducted at both sites with NC older adults and MCI older adults. Feedback from the heuristic analysis and usability testing was used to refine the program.

The FUNSAT assessment and training program includes simulations of operating an ATM and a ticket kiosk, internet banking, utilizing a pharmacy website for online shopping and prescription refills, navigating a telephone voice menu for prescription refills, and managing medication (comprehending medication labels and organizing medication; Figure 1). As shown in Figure 1, the task simulations were representations of actual real-world systems. The six tasks were presented in a multimedia format that included graphic representations, text, and voice and had multiple subtasks with sequential demands. For example, for the telephone refill task, participants called the pharmacy (using a simulated mobile phone keypad), refilled different prescriptions (pill bottles appeared on the screen), chose a delivery preference, and requested a pickup time and date. Data on completion time and errors were collected in real time. Task completion time is an important performance indicator for many activities. For example, people rarely have unlimited time to use an ATM or a ticket kiosk. Task completion time only captured the time the participant was actively engaging in a task. The six tasks had different numbers of subtasks, ranging from 3 to 6. The FUNSAT training software automatically progressed to the next question if more than four errors were made on any item in a subtask (e.g., repeatedly choosing the wrong account in the ATM task). Immediate error feedback was delivered by initial repetition of the original instructions in a pop-up window and graduated instruction, with increases in the level of corrective information. For example, if the participant entered the wrong pin in the ATM task in their first attempt, they would receive the following feedback, repeating the original instruction, "Try Again! ATM PIN is 1234." If they repeated the error for a second time, the feedback was, "Try Again! Remember, your PIN is 1234. Please enter 1234." Feedback for a third error was "Try Again! Press 1, then press 2, then press 3, and then press 4. Then press ENTER." If they made a fourth error, the four keys lit up in sequence and the participant was instructed to touch them. Successful mastery of a subtask (e.g., Entering a PIN) was performing that subtask with no errors once or twice consecutively with a maximum of a single error. Mastering all individual subtasks was considered complete mastery of a task. When a participant returned to training before mastering a subtask, only the nonmastered items were re-trained.

Computerized cognitive training

As described, the MCI participants were randomized to FUNSAT training alone or combined FUNSAT/CCT training. The primary computer-based cognitive training procedure was Brain HQ "Double Decision" task. This task was chosen due to the significant benefits achieved from multitasking processing speed training reported in the ACTIVE trial (e.g., Ball et al., 2002) and in our previous study (Czaja et al., 2020). The multitasking program consisted of two concurrent tasks: identifying one of two centrally presented items (Car vs Truck) and the location of a concurrently presented stimulus that differs from seven others in a semicircular array. In line with previous studies with Brain HQ, participants were also allowed to train up to 20% of their sessions on an additional task, "Hawkeye," to provide variety. The "Hawkeye" task involves locating a target bird amongst a flock of birds that appear in the periphery. The birds only appear on the screen for a short time (Figure 1).

General procedure

The same protocol was followed at both sites. Interested participants provided consent and were screened for cognitive status (described later) and the other eligibility criteria (e.g., able to read at the sixth-grade level). Eligible participants were provided with an overview of the protocol completed the baseline cognitive assessment using the computer tablet version (BAC App; Atkins et al., 2017) of the Brief Assessment of Cognition (BAC; Keefe et al., 2004) and the Wechsler Memory Scale—revised, Logical Memory I and II (Anna Thompson Story) (Wechsler, 1997) and a Demographics Questionnaire.

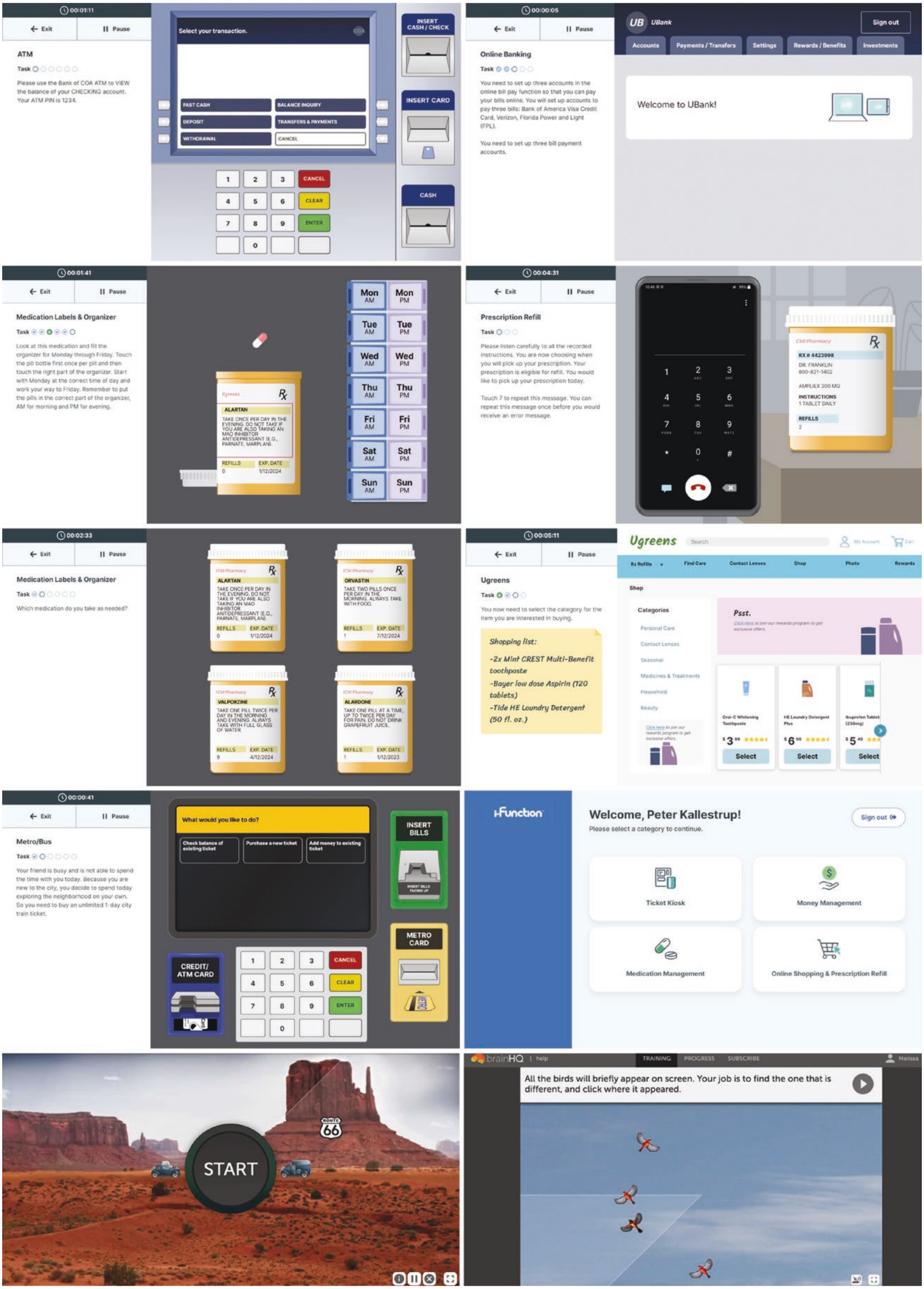

Figure 1. Screen shots of the FUNSAT task simulations and Brain HQ training screens. FUNSAT = functional skills assessment and training.

They were then scheduled to complete the assessment component of the FUNSAT program.

Participants performed the assessment component of the FUNSAT program in person with a trained research assistant. Participants completed the assessment tasks at their own pace in the following order: ticket kiosk, ATM, medication management, telephone refill, internet banking, and Ugreens website. The MCI participants were then randomized into the FUNSAT training alone condition or the combined FUNSAT/CCT training condition.

All participants were then provided with basic technology training (Czaja et al., 2018), training on the FUNSAT training program, and provided instructions on the training protocol. They completed the FUNSAT training or FUNSAT/CCT training in their home. The FUNSAT training program targeted all six tasks. Training dosage was set at a maximum of 24 training sessions or mastery of all six tasks. The recommended training protocol was two 60-min sessions per week over a period of up to 12 weeks. In each session, participants trained for up to 60 min and were instructed to practice as many tasks as possible, completing each task twice consecutively. As participants progressed in training, they re-trained only on tasks not previously mastered. Task training completion was tracked so that at the next session the participant would begin with the next uncompleted task in sequence. Those in the combined FUNSAT/CCT training group received a 3-week, twice weekly 1-hr burst of computer-based cognitive training, after which they trained for up to 9 weeks on the FUNSAT training program.

At the end of the 12-week training period or mastery of all six training tasks, a follow-up assessment occurred with Form B of the FUNSAT assessment program. Follow-up assessments also occurred at one (Form C of the FUNSAT assessment) and 3 months post-training (Form B of the FUNSAT assessment). At the 1-month assessment, participants who performed at a level of 20% worse than their post-training assessment on any of the tasks received booster training on those tasks for 60 min twice per week for of 3 weeks unless they achieved task mastery sooner.

Supplementary Figure 1 presents the study flow with the timing of assessments and training.

Measures

All measures were available in English and Spanish, and assessments were performed in the participants' preferred language (English or Spanish). Assessments were performed by certified bilingual raters.

Montreal Cognitive Assessment

The Montreal Cognitive Assessment (MOCA; Nasreddine et al., 2005) was used to assess cognitive status. The measure assesses different cognitive domains including attention and concentration, executive functions, memory, language, visuospatial skills, conceptual thinking, calculations, and orientation. Scores range from 0 to 30.

For the NC participants, the MOCA cutoff was ≥25 (adjusted for education to a cutoff of 24 for participants with low education; Sink et al., 2015).

MCI status was ascertained with a neuropsychological assessment using the Jak-Bondi criteria (Jak, et al., 2009), which operationalizes impairment as performance >1 standard deviation (*SD*) below normative expectations on at least two cognitive domains. In addition to the MOCA, participants were administered the Wechsler Memory Scale—revised Logical Memory I and II (Anna Thompson Story) and the BAC (Keefe et al., 2004) computer tablet version (BAC App; Atkins et al., 2017). Normative standards from previous studies were used to evaluate performance. Participants were designated as having normal cognition or one of three different MCI subtypes: Amnestic (impairments on two or more memory tests but no other domains); Non-Amnestic (impairments on two nonmemory cognitive domains, but no more than one memory domain); and Combined (two or more impairments on both memory and other domains). Participants scoring <18 on the MOCA were excluded.

Literacy

The literacy level of English speakers was assessed with the Wide Range Achievement Test (Jastak, 1993) third edition and for the Spanish-speaking participants using the Woodcock-Munoz Language Survey, third edition (Woodcock et al., 2017). Participants were required to have at least a sixth-grade literacy level (in the participant's commonly spoken language).

Wechsler Memory Scale—Revised, Logical Memory I and II (Wechsler, 2009)

Participants were read the Anna Thompson story and asked for immediate recall, followed by a 20-min delayed recall. During the 20-min delay, they complete the other nonverbal assessments using the BAC App.

Brief Assessment of Cognition

The BAC (Keefe et al., 2004) measures domains of cognition known to be related to everyday functioning. The BAC App (Atkins et al., 2017) delivers the same assessments with cloud-connected tablet delivery for ease of administration and standardization. The cognitive domains assessed with the BAC App include Verbal Learning and Memory, Digit Sequencing, Token Motor Task, Symbol Coding, Verbal Fluency Examinations, and Tower of London.

Task performance measures included task completion time and errors for each of the six tasks, which were summed across the task subtasks. Participants were also asked post-training about their confidence in their ability to perform the trained tasks in the real world. We assessed feasibility by examining participant retention, training adherence, and training completion rate.

Analyses

We used paired *t*-tests for the analyses as we had an unbalanced design in that the NC sample only received the FUNSAT training. These analyses were computed in the SPSS (IBM, 2023) v28. Task performance differences were analyzed using a series of six paired *t*-tests to examine pre–post-training differences for each of the six training tasks. Separate analyses were performed for time and errors. The analyses were performed for the total sample and the individual subgroups of nonimpaired participants and participants with MCI. We used the same approach to examine differences in outcomes as a function of training condition (FUNSAT training only vs FUNSAT/CCT) among the participants with MCI. We used independent sample *t*-tests to compare the number of training sessions completed for each task as a function of cognitive status. Chi-square tests were used to compare the portion of individuals who mastered each task as a function of cognitive status. We computed Pearson correlations to examine associations between the MOCA and literacy scores and baseline and change scores for task completion time for all six tasks. This was done separately for the NC and MCI samples.

Results

Recruitment and Participant Characteristics

Two hundred and eighty-seven individuals provided consent and were screened for inclusion (Figure 2). Of these, 10 were excluded due to cognitive impairment severity and 93 did not complete the baseline assessment. A total of 184 participants were enrolled in the trial including 109 older adults with MCI and 75 NC older adults. Of those with MCI, 6 individuals never trained, 10 withdrew before training completion, 1 had not completed training prior to the study end, and an additional 2 finished training but did not complete the post-training assessment prior to the study end. Of the NC participants, three withdrew before training completion and one participant completed training but withdrew prior to the post-training assessment. Thus, attrition was low, especially for a home-based self-administered protocol, as only 10% of those randomized withdrew from the study (n = 10 MCI and 3 NC) or never trained (n = 6 MCI).

The sample of those who began the training component of the program was primarily female (76%) and ranged in age from 60 to 88 years. There was no significant difference in age among the MCI and NC participants. The average age of those with MCI was ~72 years (M = 71.68; SD = 6.40), and of the NC participants was ~71 years (M = 71.17; SD = 6.36). The sample was racially and ethnically diverse 47% of the sample identified as Latinx, 23% as Black/African American, and 34% as White (Table 1). Slightly over 20% of the participants in both cognitive status groups declined to select a racial status classification, with all these participants endorsing Latinx ethnicity. There were no differences in baseline characteristics among MCI participants according to treatment condition or between sites (all p values >.05). The MCI participants had lower cognitive status (MOCA scores; $t(162) = 11.50$, $p < .001$) and lower levels of educational attainment ($t(162) = 4.18$, $p < .001$ than the NC participants. As shown, there were slightly more male and Latinx participants in the MCI group as compared to the NC group.

Participants who did not complete training had MOCA scores that were lower than those who completed the training (22.52 [SD = 3.40] vs 24.59 [SD = 3.40], t = 3.05, p = .004). However, there were no significant differences between the completers and noncompleters in age (t = 1.24, p = .214), education (t = 1.89, p = .06) or in sex, race, training language, or ethnic status (all $X^2 < 3.78$, all p values >.06). The reasons for drop-out included personal problems (35%), in sufficient time to devote to training (30%), illness (22%), vacation, or other time away (13%).

Training Adherence

Overall, 90% of those enrolled in training mastered the tasks or completed 12 weeks of training. Of those who completed training (n = 164), 79% of the overall sample had early mastery of all six tasks (prior to 12 weeks) including 64% of those with MCI and 96% of the NC participants. In the overall sample, those who had early mastery averaged 6.52 (SD = 5.94) training sessions per task compared to those who did not master all six tasks, who averaged 7.70 (SD = 6.21) training sessions. Thirty-four percent of those with MCI and 4% of the NC participants completed 12 weeks of training but did not achieve mastery on all six tasks. There was also a significant difference in the number of training sessions completed for each of the six tasks, such that the MCI participants completed more training sessions than the NC participants for all six tasks (all p values<.001). Seventy-seven percent of the MCI participants received booster training as compared to 68% of the NC participants.

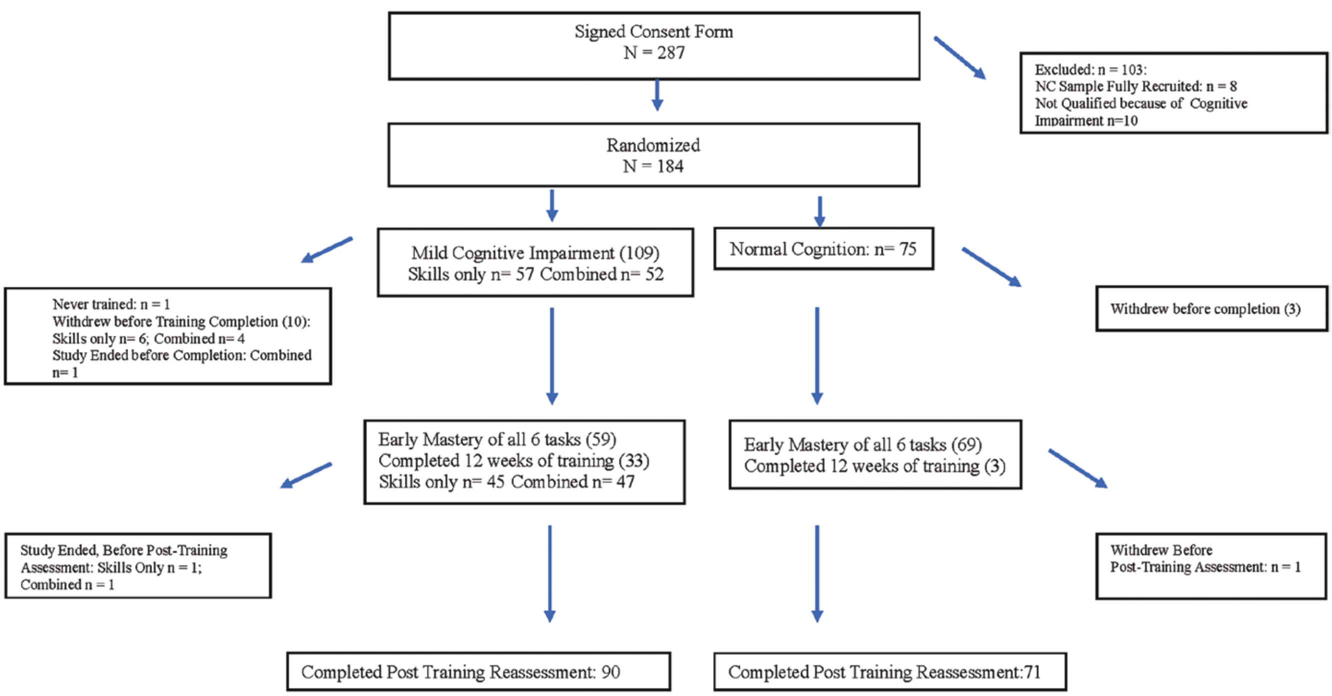

Figure 2. Consort diagram of participant flow. NC = noncognitively impaired older adults.

Change in Task Performance From Baseline to Post-Training

Tables 2 and 3 present the means and *SD*s for task completion time and errors for the six tasks at baseline, and the post-training assessment (with an alternative form) for the two groups of participants. The NC sample performed significantly better at baseline on all six tasks than the MCI participants for both task completion time and errors (all p values <.002; Figure 3). We also found that cognitive status (MOCA scores) was significantly correlated with baseline performance (all p values <.001) and for changes in task completion time from baseline to the post-training assessment (p values ranged from .04 to <.001). We did not apply a Bonferroni correction to the correlations because every correlation was nominally significant.

Table 1. Participant Demographic Information at Baseline for Those That Completed Training

Variable	MCI Participants (N = 92)			NC Participants (N = 72)			*t* or X^2	*p*
	M	*SD*	*N* (%)	*M*	*SD*	*N* (%)		
Age	71.68	6.40		71.17	6.36		−0.50	.65
MOCA score	22.45	3.21		27.15	1.37		11.50	<.001
Years of education	13.29	3.94		15.56	2.52		4.18	<.001
Site								
South Florida			38 (41%)			32 (43%)	1.21	.55
New York			54 (59%)			40 (57%)		
Sex								
Male			18 (20%)			7 (8%)	6.00	.05
Female			74 (80%)			65 (92%)		
Race								
White			36 (39%)			34 (37%)		
Black			28 (30%)			14 (19%)		
Asian			1 (1%)			2 (3%)		
Native			8 (9%)			1 (1%)		
More than one			19 (21%)			5 (7%)		
Other/would not specify						16 (22%)		
Ethnicity								
Latinx			52 (57%)			34 (46%)	8.20	.04
Non-Latinx			40 (43%)			38 (54%)		
Training Language								
English			50 (55%)			48 (67%)	2.64	.27
Spanish			42 (35%)			24 (33%)		
MCI classification								
Amnestic			14 (15%)					
Multidomain			38 (41%)					
Non-Amnestic			40 (43%)					

Notes: MCI participants = participants with mild cognitive impairment; MOCA = Montreal Cognitive Assessment; NC participants = participants without cognitive impairment; *SD* = standard deviation.

Table 2. Task Completion Time (in seconds) for All Six Tasks at Baseline and Post-Training

Tasks	NC participants						MCI participants					
	Baseline		Post-training				Baseline		Post-training			
	M	*SD*	*M*	*SD*	*t*	*d*	*M*	*SD*	*M*	*SD*	*t*	*d*
Ticket Kiosk	903.35	329.81	608.89	154.55	10.88	0.85	1,202.19	516.36	764.20	361.74	7.88	0.83
ATM Banking	1,153.30	475.87	889.61	275.47	9.92	0.78	1,885.02	955.00	1,172.71	502.30	8.86	0.91
Medication Management	843.90	270.53	542.15	127.48	10.12	0.80	1,339.24	632.45	793.27	467.63	7.59	0.80
Telephone Refill	695.94	222.63	601.79	313.66	6.71	0.53	1,007.23	419.21	725.01	272.58	6.55	0.69
Internet Banking	1,030.44	395.91	851.43	363.67	10.50	0.83	1,622.40	849.96	972.18	400.86	8.24	0.87
U Greens Website	1,183.18	538.60	834.52	343.33	9.88	0.70	1,946.54	931.59	1,280.13	618.68	6.89	0.73

Notes: MCI participants = participants with mild cognitive impairment; NC participants = participants without cognitive impairment; *SD* = standard deviation. MCI participants had longer task completion times at baseline on all six tasks, all $t > 4.27$, all $p < .001$. All change scores in completion time are significant at $p < .002$ or less.

Table 3. Task Performance Errors for All Six Tasks at Baseline and Post-Training

Tasks	NC Participants						MCI participants					
	Baseline		Post-training				Baseline		Post-training			
	M	*SD*	*M*	*SD*	*t*	*d*	*M*	*SD*	*M*	*SD*	*t*	*d*
Ticket Kiosk	12.31	7.13	6.75	4.58	7.08	0.83	21.53	10.44	12.92	8.43	7.42	0.78
ATM Banking	16.93	12.49	8.76	7.08	6.53	0.77	38.64	23.03	22.07	15.88	7.01	0.74
Medication Management	17.63	15.29	5.08	6.13	7.28	0.86	44.89	31.09	22.12	30.13	5.67	0.60
Telephone Refill	7.56	6.74	4.87	5.00	3.01	0.36	16.63	11.44	9.84	7.89	5.32	0.56
Internet Banking	12.72	8.20	5.83	4.89	7.97	0.95	30.12	22.19	14.35	12.02	7.16	0.76
U Greens Website	13.28	6.62	7.61	7.56	5.54	0.66	32.21	25.59	18.46	15.87	5.44	0.57

Notes: MCI participants = participants with mild cognitive impairment; NC participants = participants without cognitive impairment; *SD* = standard deviation. MCI participants made more errors at baseline on all six tasks, all $t > 5.42$, all $p < .001$. All changes in errors with treatment are significant at $p < .002$ or less.

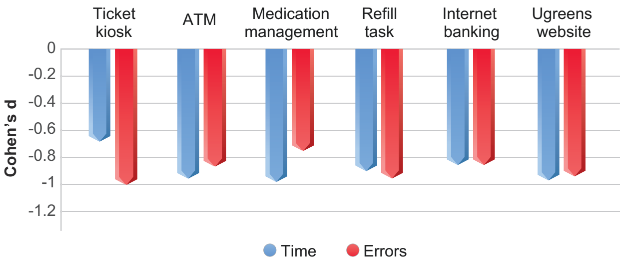

Figure 3. Effect sizes for differences in baseline task performance as a function of cognitive status.

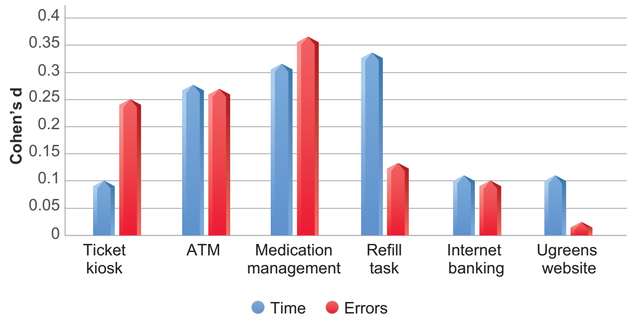

Figure 4. Effect sizes for Training gains for the MCI participants as a function of training condition. MCI participants = participants with mild cognitive impairment.

As hypothesized, examination of performance changes from the baseline assessment to the post-training assessments revealed that for the overall sample, performance on all six tasks improved significantly for both task completion time (all p values <.001 and Cohen's $d > 0.53$ and errors (all p values <.001 and Cohen's $d > 0.47$). Examination of changes in task performance as a function of cognitive status indicated that for both the NC sample (all p values <.001 except for Medication Refill; p <.005) and MCI samples (all p values <.001), there was a significant improvement in task performance times and errors for all six tasks (Table 3). Contrary to our hypotheses, there was no significant difference in improvements in task performance time or errors for any of the six tasks among the MCI conditions as a function of training condition (all p values >.05; Figure 4).

Although all participants demonstrated improvements in performance with training, MCI participants made significantly greater training gains compared to the NC participants for both task completion time and errors across all six tasks (all p values <.03). This is likely because they performed the tasks at a lower level at baseline.

Task-by-Task Training Mastery

For the MCI participants, mastery of the tasks ranged from a low of 69% (ATM task) to a high of 73% (Medication Management task). For the NC participants, mastery of tasks was 97% or 98% across tasks. A greater percentage of the NC participants mastered each task than the MCI participants across all six tasks (all $X^2(1)$ values > 19.52, all p values <.001). Consistent with the lack of training-group differences in improvements in errors or completion time, there were no significant differences among the MCI participants in the rate of mastery of the tasks as a function of training condition, (all $X^2(1)$ values < 0.22, all p values >.64).

Importantly, participants who mastered a task were asked post-training if they were confident in being able to perform the trained tasks in the real world. Among the NC participants, the percentage of participants indicating that they were confident performing the tasks in the real world ranged from 92% to 96% across the six tasks. Among the MCI participants, the percentage of participants indicating that they were confident performing the tasks beyond training ranged from 95% to 99% across the six tasks.

Discussion

This study evaluated the efficacy of an upgraded and cloud-based version of a computer-based FUNSAT program that included everyday activities such as money and medication management in samples of noncognitively impaired and MCI older adults. The assessment and training tasks were veridical representations of systems that are currently used to perform everyday task activities (Figure 1). Differing from our prior work (e.g., Czaja et al., 2020), the FUNSAT program was self-administered at home; participants trained on their own following a recommended training protocol. The sample was racially and ethnically diverse and recruited from two geographic locations in the United States.

The FUNSAT program focuses on technology-based tasks, given the ubiquitous deployment of technology in most domains of daily living. Although the age-related digital divide is narrowing, it still exists for some older adults including those of lower socioeconomic status, the older cohorts, and those with a disability such as MCI, placing these individuals (Faverio, 2022) at a disadvantage with respect to negotiating everyday tasks. Also, the use of mobile devices, such as smartphones and tablets, is lower among aging adults, and these devices are commonly used to perform everyday activities. Further, technology is dynamic and requires continual learning of new skills or modifying previously learned performance patterns (Charness & Boot, 2009). As posited by the recent Adaptation for Growth models of aging (Wu & Strickland-Hughes, 2019) an individual's ability to learn and adapt to new ways of doing things is important to independence, well-being, and quality of life (e.g., Narushima et al., 2018; Pihlainen et al., 2021). For example, during the coronavirus disease 2019 (COVID-19) pandemic, medical appointments, which were typically face-to-face reverted to a videoconferencing format.

At the baseline assessment, performance on all six tasks was lower for those individuals with MCI which is consistent with the literature that indicates that everyday tasks can be particularly challenging for those who are cognitively impaired (e.g., Burton et al., 2009; Farias et al., 2006; Gomar et al., 2011). Cognitive status (MOCA score) was related to task performance at the baseline assessment. The noncognitively impaired sample did not have mastery of the tasks at baseline and also benefitted from the FUNSAT program. These findings point to the need to present opportunities for aging adults, including those with a cognitive impairment, to engage in new learning. As noted by Wu and Strickland-Hughes (2019), the need for adaptation to a changing environment is continual throughout the lifespan. The findings also dispute common myths that aging adults are technophobic and unable or unwilling to learn to use technology for everyday activities.

Overall, the results suggest that the FUNSAT program is efficacious. Post-training both NC and MCI participants experienced training gains across all six tasks on task completion time and error measures. In addition, a large percentage of both the NC and MCI participants completed mastery of all six tasks in advance of the mandated 12-week training protocol. These findings are consistent with our prior work (Czaja et al., 2020) showing that aging adults can benefit from training on technology-based FS. They also support findings (e.g., Leanos et al., 2020) that aging adults, including those with a cognitive impairment, can learn new skills simultaneously. In the FUNSAT program, individuals are trained on six unique tasks. Further, the findings indicate cognitive plasticity for aging adults without and without a cognitive impairment.

Importantly, all participants reported an increased confidence in the ability to perform these tasks in the real world. Momentary ecological assessment data collected during the study (Dowell-Esquivel et al., 2024) from baseline to the completion of the trial indicated that both NC and MCI participants reported a significant increase in their frequency of performance of both trained (e.g., ATM banking) and untrained skills (e.g., searching the internet for information). These data suggest environmental transfer of training beyond the trained tasks in concert with increases in confidence.

An important finding of this study was that most of the participants (90%), including those with MCI, after receiving training on the use of the FUNSAT program were able to complete the training at home without the assistance of a trainer. There was also little attrition during training. These findings underscore that the FUNSAT program is feasible. It also points to the importance of a user-centered design approach when designing online training protocols. The FUNSAT program was designed according to design guidelines for older adults (e.g., Czaja et al., 2019), and older adults were included in the usability testing of the program. Most functional assessment and training programs require administration by trained clinicians or research personnel.

Our findings also showed that although on average, the MCI participants performed at lower levels than the NC participants with respect to task performance measures (time and errors) and task mastery, these participants also demonstrated improvements in performance and made significant training gains for all six tasks. In fact, the training gains for the MCI participants were significantly greater than those for the NC participants. These findings are consistent with our recent findings (Falzarano et al., 2024) that demonstrated that aging adults with cognitive impairment were able to learn to use a computer software program designed to foster cognitive and social engagement. In that study, due to the COVID pandemic restrictions, the participants were trained via Zoom. The findings are also consistent with other investigators who have found that aging adults with MCI can benefit from cognitive training (e.g., Brum et al., 2009; Giuli et al., 2016). For example, findings from the *My Mind Project* (Giuli et al., 2016), which investigated the effects of comprehensive cognitive training in older adults with nonimpaired cognition, mild-to-moderate Alzheimer's disease, and MCI found that the training was beneficial for all three groups and resulted in improvements in cognitive outcomes as well in improvements in functional status as measured by the Instrumental Activities of Daily Living Scale. Overall, the study results indicate that a self-administered technology-based training is feasible and beneficial for aging adults with a cognitive impairment. The findings also demonstrate that nonpharmacological interventions can help compensate for cognitive declines in these populations.

There were limitations to our study. The same training protocol was applied to all participants, and it is likely that there are individual differences with respect to activities that need to be trained. The tasks in the program may not be relevant for all aging adults and additional tasks should be added to the program. The optimal training dose and schedule also need to be examined as a function of individual characteristics. Further, including text-to-speech instruction may be advantageous for some individuals given that visual impairments are common in older adults. We also restricted the impaired population to those with MCI and the benefit of the program for individuals with other types of cognitive impairments (e.g., traumatic brain injury) or greater severity of impairment needs to be examined. Finally, given the developments in Artificial Intelligence, building greater adaptability into the program to accommodate the heterogeneous and time-varying cognitive changes of individuals would enhance the program. It would also enhance program reach as it would further reduce the need for in-person support resources. Despite these limitations, our findings clearly point to the benefits of the FUNSAT program and directions for future research.

Implications

Technology-based functional skills training can be beneficial for aging adults with and without MCI and may enhance their ability to negotiate everyday activities. Deploying these programs in a self-administered format in home settings is also feasible and greatly enhances the potential reach of these programs. In both groups of participants, training adherence was high and attrition was low. Providing access to these types of programs helps to foster digital equity and reduces the still-existing age-related digital divide. The findings also replicate those of others and underscore that nonpharmacological behavioral treatment approaches are warranted for aging adults with a cognitive impairment. An important next step is examining the efficacy of the FUNSAT program needs to be examined among more impaired populations. The use of home-based technology-based training platforms also needs further exploration in other contexts such as assisted living facilities or rural locations.

Supplementary Material

Supplementary data are available at *Innovation in Aging* online.

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Conflict of Interest

P. Kallestrup is co-founder and CEO of i-Function, Inc. S.J. Czaja is co-founder and Co-Chief Scientific Officer of i-Function, Inc. P.D. Harvey is co-founder and Co-Chief Scientific Officer of i-Function, Inc, and has other interests unrelated to the content of this paper, including consulting fees or travel reimbursements from Alkermes, Boehringer Ingelheim, Karuna Therapeutics, Merck Pharma, Minerva Neurosciences, and Sunovion (DSP) Pharma in the past year. He receives royalties from the Brief Assessment of Cognition in Schizophrenia (Owned by WCG Endpoint Solutions, Inc. and contained in the MCCB). He is a Scientific Consultant to EMA Wellness, Inc.

Data Availability

The trial was preregistered. Deidentified data are available upon request to the corresponding author. Software codes, stimuli, and data management algorithms are proprietary and are not available. This exemption to open data access is endorsed by the National Institute of Aging.

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