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Association of Racial Status and Training Language with Baseline Performance and Training Gains During Computerized Training of Technology-related Everyday Functional Skills In Older Adults

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ABSTRACT

Objectives: *Research consistently finds that lower baseline performance predicts greater gains with computerized training. Lower baseline performance can originate from many factors, including educational and environmental disadvantages, leading to reduced exposure to functional tasks. Across six computerized technology-related functional skills, baseline performance and training gains were compared across race and training language.* ***Design:*** *Randomized clinical trial.* ***Setting:*** *About 14 community centers in New York City and Miami.* ***Participants:*** *Participants aged 60−90 with diverse ethnic (52% Latinx) and racial (27% Black) status, trained in in English (60%) or Spanish (40%).* ***Intervention:*** *Remotely delivered computerized cognitive and skills training (FUNSAT^{TM}) for an hour twice a week for up to 12 weeks.* ***Measurements:*** *Completion time across all 6 tests pre and post training.* ***Results:*** *The total sample included 42 Black English Speakers, 52 White English speakers, and 61 Spanish speakers. Spanish speakers had the poorest baseline performance on all tasks, underperforming English-speaking Latinx participants. However, Spanish speaking participants had the largest training gains. Lower MOCA scores predicted lower baseline performance and greater training*

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gains across samples. Educational attainment predicted training gains only in the Spanish speakers. Despite education effects in this group, all improvements were statistically significant with large effect sizes. ***Implications:*** *Lower baseline performance of functional skills was a positive predictor of training gains and was efficiently reversed through training. Even participants who initially appeared more impaired achieved substantial gains, congruent with the results reported in psychiatric populations. Critically, low baseline competence should not be interpreted as reflecting negatively on potential training gains.* (The American Journal of Geriatric Psychiatry: Open Science, Education, and Practice 2024; 2:32−42)

Highlights

- **What is the primary question addressed by this study?**
  The study addressed the question of whether racial and ethnic status, as well as assessment language, of community- dwelling older people predicted poorer baseline performance on a computerized functional skills program assessing technology-based everyday functional tasks and whether any baseline disadvantages were overcome with skills training.
- **What is the main finding of this study?**
  Monolingual Spanish speakers and Black English speakers had the poorest baseline performance. This baseline disadvantage was overcome with training and these two subsamples had the largest overall training gains over a 12-week period.
- **What is the meaning of the finding?**
  These findings suggest that baseline performance disadvantages in technology-related everyday living do not reflect the inability to learn complex technology related skills. Baseline disadvantages are likely due to lack of opportunities and experience which can be reversed with targeted training

INTRODUCTION

As the global population ages, the number of individuals affected by both Alzheimer's Disease Related Dementias (AD/ADRD) and mild cognitive impairment (MCI) is expected to rise. AD/ADRD is a leading cause of disability in elderly populations, even at mild phases[1] and MCI is associated with deficits in everyday functioning, particularly with performance-based assessments.[2] With no current effective medications for these conditions, development of nonpharmaceutical interventions and treatments is extremely important. One promising intervention is computerized training of cognitive and functional skills. Computerized cognitive training (CCT) has a developing base of evidence supporting its efficacy in bettering cognitive functioning. In older populations with both normal cognition (NC;[3]) and MCI,[4] meta-analyses of studies delivering CCT have concluded that these strategies show promise in enhancing cognitive performance. However, there are potential limitations in the generalizability of training due to the narrow focus on cognition in most computerized training interventions, which commonly does not transfer to functional gains without additional training.[5]

Many risk factors have been identified for AD/ADRD, each of which may have a unique impact on cognitive training outcomes. In the U.S., women make up about two-thirds of all AD/ADRD cases,[6] yet research remains limited regarding the influence of sex on cognitive training outcomes. In the research available, some studies found no connection between sex and cognitive training outcomes[7] while others suggest women may have better training outcomes.[8] Our own research in samples with substantial representation of women has suggested that female participants with both normal cognition and MCI attain significant benefits from training.[9,10]

Other significant risk factors in receiving a diagnosis of AD/ADRD are racial and ethnic status and their experiential correlates. Black individuals face a two-fold increased likelihood for an AD/ADRD diagnosis and Latinx individuals, particularly recent or less acculturated immigrants, have a 1.5-fold increase in the likelihood of a diagnosis of AD/ADRD compared to the non-Latinx population.[11] Existing data on cognitive training and MCI are limited concerning the influence of race on outcomes. One report[12] showed that older Black participants with normal cognition had the same cognitive gains with computerized speed training in the ACTIVE Trial[13] as White participants, but that they had reduced gains in the human-delivered training interventions for memory and problem solving. A more recent study[14] comparing CCT versus paper and pencil training in participants with MCI yielded similar results across racial status, consistent with CCT studies in serious mental illness.[15]

Life experiences and opportunities, such as quality of and access to education,[16] also influence chances of diagnoses of AD/ADRD, with most studies reporting a significant connection between lower education levels and an increased risk for diagnosis.[17] The concept of cognitive reserve[18] helps explain individual differences in resilience to age-related brain changes, suggesting that higher education, occupational attainment, and positive leisure activities[19] can delay the onset of dementia symptoms. The theory of Cognitive Reserve suggests that individuals with higher reserve use their brains more efficiently or employ alternative networks to compensate for changes in brain functioning. Epidemiological and neuroimaging studies support the notion that those with higher reserve can tolerate more pathology before manifesting clinical decline,[20] with functional MRI studies revealing that reserve is linked to more efficient use of neural networks, including reallocating activity when task demands become more challenging.[21] These findings underscore the importance of widely accessible high-quality educational opportunities as a public health strategy, not only for personal development but also as a potential means to mitigate the risk of later-life cognitive decline and dementia.

Education and its correlates may also play a role in the efficacy of cognitive training. In an analysis of the ACTIVE trial, Clark et al.[22] reported that computerized speed training benefits were greater in participants with 12 or fewer years of education compared to 16 or more. Similarly, there seems to be support for the suggestion that lower baseline performance is associated with greater training gains in NC and MCI[23,24] as well as in other conditions such as schizophrenia.[25,26] These findings suggest that those with disadvantages in baseline performance, arising from multiple can overcome this disadvantage and have a superior benefit from cognitive training.

The socioeconomic digital divide is closely related to education disadvantages and has been evolving in recent years. Historically, this divide has been along access to technology, as those with lower socioeconomic status (SES) could not afford technology in the same way as their higher SES peers could. However, as technology becomes increasingly more accessible, this divide is transitioning toward how the technology is designed and used. For example, there has been a lack of adjusting access to online health interfaces for those with poorer computer literacy; given that lower SES and educational opportunities correlate with poorer computer literacy, these interfaces discourage usage among those with lower SES.[16] This difference, not in accessibility, but in usability and usage, closely tracks SES and educational opportunities, ultimately reinforcing existing social inequalities.

Overall, each of the risk factors for diagnoses of AD/ADRD could pose a barrier to cognitive training outcomes. Given the early stage of research into how these disadvantages influence computerized training outcomes, the goal of this study is to determine whether individuals facing multiply-determined baseline disadvantages can still achieve training gains using a program focused on technology-based activities of daily living (Functional Skills Assessment and Training: FUNSAT™). Specifically, we examined baseline global cognitive performance, educational attainment, and racial and ethnic status, and the language used for training (English or Spanish), analyzing their association with both baseline performance and training-related gains. Being a monolingual Spanish speaker is likely associated linguistic isolation and challenges in technology access, because not all applications have readily accessible multilingual access. Given the evidence that lower baseline scores and cognitive impairments may be associated with greater training gains across various origins, we propose the following hypotheses: 1) Monolingual

Spanish speakers and Black English speakers will manifest lower baseline performance on technology-related functional assessments, likely because of challenges in access to technology. 2) Participants with lower baseline scores on indices of global cognitive performance will make significant training gains across racial and language status, 3) Reduced educational attainment will predict lower baseline scores but not reduced training gains, similarly to global cognitive status.

METHODS

Overall Study Design

This study was a randomized controlled trial carried out at a total of fourteen community centers in South Florida and New York City. These are nonmedical community facilities attended by community residents for a variety of social and personal activities. All recruitment was done in person, through town-hall meetings and word of mouth. After initial screening, participants underwent an in-person baseline evaluation on a fixed-difficulty assessment of six functional tasks and then engaged in up to 12 weeks of self-administered computer-based training at home. The study received approval from the Western-Copernicus Group IRB, and every participant gave their signed informed consent to participate.

The methods and primary outcomes of the current study have been published previously. Those papers reported on gains on the training simulations across cognitive status: Normal Cognition versus Well-diagnosed MCI,[10] on transfer of training gains to real-world outcomes,[27] and improvements in cognitive and functional capacity performance following training.[28] Those previous papers also examined the effects of combined CCT and functional skills training, finding greater gains per training session for combined treatment, but no overall differences in performance differences at the time of training completion. The current paper reports on language and racial factors correlating with performance, including differences in baseline performance on the training simulations and training gain. As a result, rather than dividing by MCI subtype diagnosis, we use baseline scores on the Montreal Cognitive Assessment (MOCA,[29]) as an indicator of global cognitive performance. As we previously reported, participants across MCI subtypes consistently had lower MOCA scores than healthy individuals[10] and lower baseline performance on cognitive and functional capacity measures.[28]

Participants

The study included male and female community residents over 60 years of age. Participants were required to be proficient in either English or Spanish, have at least 20/60 vision, be able to read from a computer screen, and operate a touch-screen device. All races and ethnicities were eligible to participate in the study. Individuals were not eligible for the study if they had a MOCA score below 18, had a reading proficiency below a 6th grade reading level in the language in which they had selected to be assessed and trained, or could not complete assessments in English or Spanish. Participants were not included if they had undergone a similar intervention in the previous year. Medical reasons for exclusion included a previous history of a serious psychiatric condition, except for depression, or histories of past neurological incidents such as seizures, brain tumors, cerebral vascular accidents (CVA), or severe traumatic brain injuries resulting in extended periods of unconsciousness.

Cognitive Assessments

Montreal Cognitive Assessment (MOCA,[29]). The MOCA evaluates cognitive abilities with scores ranging from 0 to 30 and all assessments were conducted by certified bilingual raters.

Reading Performance: English-speaking participants' literacy levels were assessed with the Wide Range Achievement Test 3rd edition (WRAT-3[30]). Spanish speakers were assessed with the Woodcock-Munoz Language Survey, 3rd edition (WMLS-III;[31]).

General Procedures

The third generation of the FUNSAT program trains the same skills as previous generations, including ATM usage, operating a ticket kiosk, internet banking, online shopping, refilling a prescription using a telephone voice menu, and managing medication by both comprehending medication labels and organizing medications (Supplemental Fig. 1). Each task was presented in a multi-media format including text, voice, and graphic representations. All participants were provided a Google Chromebook by the investigators and allowed to retain it after the study. Baseline assessments included a fixed difficulty (Form A) version with 6 tasks and all subtasks were administered without training or any corrective feedback. The six tasks had 3−6 subtasks with sequentially increasing difficulty demands. With each error made, the original instructions would reappear in a pop-up window. If a participant made more than four errors on any one item, the software automatically moved on to the next item. Completion time and errors were collected in real time while participants completed each task, with time measured while the participant was actively engaged in the task.

After the baseline assessments, home-based training started. In each training session, targeted for 1 hour, participants aimed to make as much progress as possible in mastering the items on individual subtasks. The program delivered training only on subtasks that had not yet been mastered (completed with no errors or twice consecutively with one error). NC participants only trained with FUNSAT to develop normative standards for training gains. MCI participants were randomized into two groups: FUNSAT only or FUNSAT + CCT. Randomization was stratified by overall geographic area (NY versus Miami) and sex. After the 12-week period, or upon mastering all tasks, participants were re-evaluated using a different version of the fixed difficulty simulations administered at baseline.

Those in the combined FUNSAT + CCT group underwent a 3-week CCT training (up to two 1-hour sessions weekly) before transitioning to FUNSAT for up to 9 weeks. Participants were compensated $30.00 for baseline in-person assessments and remote follow-up assessments, $5.00 for each training session and received a bonus of $15.00 for each of the 6 tasks mastered.

TRAINING PROCEDURES

FUNSAT

Training was delivered with cloud-based software at home; participants had the option to use a provided hotspot or their own Wi-Fi connection. Training was adaptive, with participants receiving immediate error feedback for each question incorrectly answered, with increasing corrective feedback being given after the first error message (the first message just restated the task). For example, if a participant attempting the ATM task entered the wrong pin, a pop-up window would appear stating "Try Again! Your ATM PIN is 1234." Following a second error, a new pop-up window would appear stating "Try Again! Remember, your PIN is 1234. Please enter 1234." A third error would prompt the participant "Try Again! Press 1, then press 2, then press 3, and then press 4. Then press ENTER." And finally, after a fourth error, each key would light up in sequence with a statement telling participants to click the corresponding key as they light up, with this item repeated later at the next training session. Each of the 6 tasks was considered mastered after all subtasks were mastered. After any break from training, only the non-mastered items and subtasks were retrained.

Computerized Cognitive Training

The BrainHQ™ "Double Decision" training exercise was selected as the CCT for the FUNSAT+ CCT group. ACTIVE and other trials[9,23,32] have shown significant benefits from similar speed of processing training exercises. The exercise included two concurrent tasks where participants had to identify an item that appeared in the middle of the screen while simultaneously locating a specific stimulus among seven others in the periphery. Participants also had the option to train up to 20% of their sessions on another BrainHQ task named "Hawk Eye" to increase variety in training. Screenshots for these tasks are also in Supplemental Figure 1.

Data Analyses

We had previously reported that participants with MCI had poorer baseline scores on all six tasks, but relatively greater training gains on all six. Dividing the participants by MCI status would lead to small subgroups and reduce statistical power. Thus, we focused our analyses on race and training language for the entire group, followed by additional analyses to explore performance differences among Latinx participants who trained in English versus Spanish and correlations with MOCA scores and years of education. We examined completion time on six training tasks as our primary dependent measure, examining baseline and change scores. We did not divide the MCI group based on training condition, as we previously reported that the participants did not differ in their overall training gains in time to completion on the simulations, despite a reduced number of skills training sessions in the combined group.

We examined racial (Black versus White) and training language differences in baseline MOCA scores with one-way ANOVAS and Tukey Follow-up Tests, creating three overall participant groups: Black English Speakers, White English Speakers, and Spanish Speakers. We used the same strategy to compare baseline scores and training gains on all six tasks. We also compared Latinx participants who trained in Spanish with those who trained in English with independent sample t-tests, as a follow-up analysis, to distinguish ethnicity from training language. Finally, we correlated MOCA scores and educational attainment with baseline performance and training gains on the six simulations within each the three participant groups. Analyses were performed with SPSS, version 28.[33]

RESULTS

Table 1 presents the demographic information as a function of race and training language. As can be seen in the table, there were no significant group differences in age, but there were significant differences in MOCA scores and years of education, as well as in WRAT scores in English speakers. Post hoc tests found that MOCA scores were higher in White than Black participants, although the Spanish speakers did not differ from either of these groups. Educational attainment was higher in the White participants than the other two groups and WRAT reading scores were higher in the White English speakers than the Black participants.

When all individuals who identified as Latinx (n=82) were compared across testing language (Spanish=61; English=21), it was found that there were no significant differences in age, educational attainment, and MOCA scores, all t<1.60, all p >0.11. In terms of SES, the median annual income for all three groups was $31,000 or less, with Spanish speakers having the lowest median income. Receipt of Medicaid benefits was also common in all three groups and over 50% in the Spanish speakers. English speaking Latinx participants had a rate of receipt of Medicaid of 10%, a Median Income of $67,000, and 24% reported an annual income of over $100,000. There were no significant differences across groups in number of total training sessions completed or the proportion of participants who mastered all six tasks.

Table 2 presents the results of the baseline and change score analyses for the six training tasks across the three groups. There were statistically significant overall differences across the groups for all six baseline training task scores. For all six tasks, Spanish-speaking participants had the lowest scores and for all six tasks performance was significantly ($p < 0.05$) worse for Spanish speakers than for the White English speakers. White participants also performed significantly better ($p < 0.05$) at baseline than the Black participants on the Ticket task and the Pharmacy website.

TABLE 1. Demographic Characteristics Across Participant groups

	Black English		White English		Spanish Speakers		F	*P*
	N=42		N=52		n=61			
	M	SD	M	SD	M	SD		
Age	70.63	6.36	72.62	6.99	71.06	5.97	1.32	0.27
MOCA	22.84	3.21	24.83	3.41	23.89	3.50	4.06	0.019
Years of education	13.00	1.89	16.04	3.22	12.94	4.02	12.68	<0.001
WRAT Reading	45.84	5.50	51.96	4.52	- -	- -	5.90	<0.001
Total Training Sessions	7.28	6.08	6.36	6.21	7.98	5.92	1.00	0.372
							X^2	P
% Female	84%		90%		85%		.23	0.87
Mastered all 6 Tasks	79%		83%		76%		.81	0.67
Median Household Income	$23,000		$31,000		$22,000			
% Medicaid Recipients	43%		37%		56%			

Association of Racial Status and Training Language with Baseline Performance

TABLE 2. Baseline Completion Times and Training Gains Across Simulations: Presented in Seconds

	Black English		White English		Spanish Speakers			
Ticket Kiosk	**M**	**SD**	**M**	**SD**	**M**	**SD**	**F**	**p**
Baseline	1,071.84	340.84	852.38	291.57	1,259.32	582.11	12.07	<0.001
Change	339.26	270.95	233.44	281.00	521.50	589.22	5.96	0.003
ATM banking								
Baseline	1,483.63	633.44	1,276.54	583.49	1,872.19	1,089.53	7.38	<0.001
Change	477.49	546.71	313.46	320.03	728.06	856.68	6.61	0.002
Medication Management								
Baseline	1,096.12	553.96	943.72	420.44	1,293.77	628.67	5.70	0.004
Change	456.65	453.50	351.20	307.74	510.05	729.22	1.17	0.31
Telephone Voice Menu								
Baseline	798.74	311.11	722.82	233.30	1,039.42	458.77	12.09	<0.001
Change	191.16	300.27	112.96	199.69	269.18	511.04	2.41	0.09
Pharmacy Website								
Baseline	1,594.35	843.35	1,210.80	550.41	1,987.42	964.40	12.73	<0.001
Change	590.09	733.01	280.43	377.75	713.15	943.40	4.92	0.008
On-Line Banking								
Baseline	1,252.95	463.16	1,073.72	406.06	1,691.77	982.84	11.40	<0.001
Change	409.45	408.79	318.17	263.92	757.77	831.94	8.27	<0.001

For all six tasks, there was statistically significant improvements in time to completion from baseline to the end of training for the entire sample of participants, as determined by paired t-tests. All change scores were significant at t>6.71, all p <0.001. Effect sizes for changes from baseline to post training assessments ranged from a low of d=.53 (telephone voice menu) to a high of d=.86 (ticket purchase).

In notable contrast to their baseline performance, Spanish speakers had the largest improvements on four of the six tasks. Their training gains were significantly (p <0.05) greater than for the White participants on Ticket Task, ATM, Pharmacy website, and on-line banking, with gains in performance significantly (p <0.05) larger than the Black participants for the on-line banking task.

When the participants who identified as Latinx (n=82) were compared across training language with t-tests, it was found that the English speaking Latinx participants (n= 21) performed better on all six six tests at baseline than Spanish speakers (N=61; all t>2.18, all p <0.036). The Spanish speakers had larger changes in time to completion from baseline to end of training on all six tasks, all t>2.09, all p <0.039.

Table 3 presents the results of correlations between MOCA, scores, years of education, baseline FUNSAT scores and training change scores, separated by training language and racial status. MOCA scores were correlated with baseline performance for all six tasks in all three participant groups, reflecting the impairments on these tasks previously reported in participants diagnosed with MCI. Educational attainment was consistently uncorrelated with baseline performance and training change scores for both Black and White English speakers. In contrast, slower baseline performance was correlated with lower educational attainment in the Spanish speakers and lower levels of education were correlated with reduced training gains for four of the six training tasks.

DISCUSSION

As anticipated, people with a history of disadvantage manifested lower baseline performance as compared to other participants but still achieved significant training gains. Across all groups, Spanish-speaking participants had the lowest scores at baseline, with language (mono-lingual Spanish speaker) appearing to be a more important predictor than Latinx ethnicity. English-speaking Latinx participants performed significantly better on all six tasks at baseline as compared to monolingual Spanish speakers. Thus, not having mastered English appears to lead to an initial performance disadvantage. Despite the lower baseline scores, Spanish speakers had training gains that were significantly larger than other groups for four of the six tasks. Similarly, Black participants performed modestly worse than White participants at baseline and these differences were also offset by

TABLE 3. Pearson Correlations Between MOCA Scores and Years of Education and Baseline and Change Scores for All 6 Training Tasks, separated by Racial and Language Status

	Black English		White English		Spanish Speaker	
	MOCA	Education	MOCA	Education	MOCA	Education
			Ticket Kiosk			
(Baseline)	−.47**	.11	−.44**	.01	−.28*	−.32**
Change	−.23	−.03	−.37*	.21	−.21	−.36**
			ATM banking			
(Baseline)	−.51**	−.04	−.54**	-.19	−.32**	−.28*
Change	−.48**	−.08	−.43**	-.03	−.23	−.28*
			Medication Management			
(Baseline)	−.40**	−.24	−.47**	.01	−.38**	−.34**
Change	−.37**	.12	−.33*	-.20	−.20	−.30*
			Telephone Voice Menu			
(Baseline)	−.56**	−.09	−.35**	-.04	−.41**	−.33**
Change	−.47**	−.07	−.17	.06	−.21	−.11
			Pharmacy Website			
(Baseline)	−.57**	−.17	−.47**	−.11	−.34**	−.34**
Change	−.51**	−.10	−.11	−.05	−.05	−.07
			On-Line Banking			
(Baseline)	−.53**	−.13	−.42**	−.13	−.34*	−.37**
Change	−.36*	−.06	−.21	−.12	−.21	−.29

* p<.05.
** p<.01.

training. These findings parallel those of a recent study that compared computerized, cognitively-focused, training in White and Black participants with MCI.[14] Similar results regarding language related baseline scores and training were previously reported[34] wherein Spanish speaking medical students underperformed English speakers at baseline on an Electronic Medical Record training task and then manifested training gains that led to fully catching up. The lower baseline scores seen in both disadvantaged groups likely reflect the challenges associated with technology exposure and access, as well as educational attainment, particularly for Spanish speakers. Older adult monolingual Spanish speakers were recently reported to have lower Mini-Mental State Examination scores than bilingual speakers, although speaking only Spanish did not predict subsequent decline.[35] Despite these challenges, disadvantaged individuals not only achieved significant training gains from baseline, but also surpassed the gains seen in White English speaking participants.

Lower global cognitive status, as measured by the MOCA, was associated with lower FUNSAT baseline performance, across all samples. Consistent with previous studies across conditions participants with lower cognitive status were still able to make significant training gains despite lower baseline performance. For Spanish-speaking and White English-speaking participants, MOCA scores were uncorrelated with training gains. For Black participants, there was a significant correlation between lower MOCA scores and reduced training gains; however, training gains were still significant for all six tasks.

Education was uncorrelated with either baseline scores or training gains among both Black and White participants, including English-speaking Latinx individuals. Interestingly, for Spanish-speaking participants, lower educational attainment was correlated with both lower baseline scores and reduced training gains in four of six tasks. Finding reduced training gains in Spanish-speaking participants with lower educational attainment were not consistent with our initial hypotheses; however, these gains from baseline performance were still statistically significant and relatively substantial (d>0.5 across all six tasks). Previous research has suggested advantages in both education attainment and cognitive performance for bilingual speakers.[36] Thus, lower educational attainment and language isolation were found to combine to lead to reduced rates of training gains.

We were interested in whether the presence of risk factors for developing AD/ADRD would affect computerized training outcomes. For example, Black and

Latinx individuals are at higher risk of an AD/ADRD diagnosis . Similarly, lower educational attainment is associated with earlier onset of aging related cognitive deficits and is also a risk factor for diagnoses of AD/ADRD . This study shows that individuals with disadvantages, including individuals with reduced levels of educational attainment and reduced cognitive performance, typically viewed as risk factors for AD/ADRD, can achieve significant gains with functional skills training despite starting with lower baseline scores. In fact, those with lower baseline performance were generally able to overcome these disadvantages and see training gains equal to, or greater, than nondisadvantaged individuals. This suggests that risk factors for developing AD/ADRD could possibly be associated with disadvantage up to the time of the index assessment and then overcome with targeted training, although longer-term follow-up is clearly needed to examine potential preventative benefits.

Our results of this study suggest that an inexpensive and scalable intervention can potentially partially reverse the challenges of technological related tasks that can impact daily living. This information is particularly useful given that the risk for AD/ADRD diagnosis is higher in populations with more social disadvantage. This group typically has reduced access to technology use and there have been very limited training interventions available to date, particularly focusing on training language.

There are limitations of this study. It should be noted that lower baseline scores offer more potential for improvement, whereas higher baseline scores may be associated with ceiling effects, limiting the room for improvement. The long-term durability of these training gains will be important to examine.[37] Previous studies in unimpaired populations suggest durability of speed focused-computerized cognitive training at 10 year follow-ups.[38] The MOCA scores are also likely affected by disadvantage on the part of our participants. In some studies, MCI participants can have mean MMMSE scores as high as 28.[39] In our sample, with MCI and NC status ascertained with the Jak_Bondi criteria[40], our average MOCA score was 22.45 (SD=3.21) for MCI and 27.15 (SD=)1.37 for normal cognition. Further research is also needed regarding training gains in individuals who are biomarker positive for AD/ADRD related conditions. Previous studies using training interventions suggested that APOe genotype and cortical thickness were not mediators of computerized training gains,[41] but the study of Beta-Amyloid and Tau biomarkers as moderators will be critical in the future.

Overall, as MCI and AD/ADRD become increasingly more prevalent, the lack of success of pharmacological interventions suggests that alternative strategies, such as computerized training interventions, are necessary to mitigate the negative effects of cognitive decline. The findings in this study show that the individuals manifesting the highest degree of apparent demographic risk for MCI and AD/ADRD may have the most potential to gain from functional skills training. Utilizing functional skills training and other cognitively relevant exercises could limit the already large burden of MCI and AD/ADRD. Low cost, self-delivered interventions will be particularly useful for those with history of disadvantage associated with SES who may not be able to afford help in managing day-to-day activities. Given that older adults are showing considerable increases in the likelihood of accessing technology,[42] such self-delivered interventions are likely to be feasible and acceptable to the target populations.

DISCLOSURES

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Peter Kallestrup reports financial support was provided by National Institute on Aging. Philip Harvey reports a relationship with Boehringer Ingelheim GmbH that includes: consulting or advisory. Philip Harvey reports a relationship with Alkermes Inc that includes: consulting or advisory. Philip Harvey reports a relationship with Karuna Therapeutics Inc that includes: consulting or advisory. Philip Harvey reports a relationship with Minerva Neuroscience that includes: consulting or advisory. Philip Harvey reports a relationship with Merck & Co Inc that includes: consulting or advisory. Philip Harvey reports a relationship with Sumitomo Pharma America Inc that includes: consulting or advisory. Philip Harvey reports a relationship with i-Function, Inc that includes: equity or stocks. Peter Kallestrup reports a relationship with i-Function, Inc that includes: equity or stocks. Sara Czaja reports a relationship with i-Function, Inc that includes: equity or stocks. Annalee Mueller reports a relationship with i-

Function that includes: employment. Andrea Rivera-Molina reports a relationship with i-Function that includes: employment. Philip Harvey reports a relationship with WCG Endpoint Solutions that includes: equity or stocks. Peter Kallestrup has patent i-Function Skills Training Softwre pending to i-Function, Inc. I am on the editorial Board of the American Journal of Geriatric Psychiatry (PDH). If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The intellectual property in the FUNSAT training system is licensed by the University of Miami Miller School of Medicine to i-Function, inc.

AUTHOR CONTRIBUTIONS

Justin E. Macchiarelli: Writing – review & editing, Writing – original draft, Formal analysis, Data curation. Courtney Dowell-Esquivel: Writing – review & editing, Writing – original draft, Formal analysis, Data curation. Alejandro Martinez: Writing – review & editing, Writing – original draft, Project administration. Andrea Rivera-Molina: Writing – review & editing, Writing – original draft, Project administration, Investigation, Data curation. Annalee Mueller: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Data curation. Peter Kallestrup: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. Sara J. Czaja: Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Investigation, Funding acquisition. Philip D. Harvey: Writing – review & editing, Writing – original draft, Supervision, Investigation, Funding acquisition, Formal analysis, Conceptualization.

DATA STATEMENT

The data in this paper were presented as an oral presentation at the American Association of Geriatric Society Meeting in March 2024.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.osep.2024.07.004.

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