HHS Public Access
Author manuscript
J Assoc Nurses AIDS Care. Author manuscript; available in PMC 2018 November 01.

Published in final edited form as:
J Assoc Nurses AIDS Care. 2017 ; 28(6): 971–976. doi:10.1016/j.jana.2017.06.011.

The potential of computerized cognitive training on HIV-associated neurocognitive disorder: A case comparison study

Shyla Hossain, MA(Hons)[*],
Research Assistant, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

Pariya L. Fazeli, PhD,
Assistant Professor, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

Frida Tende, MPA, MPH,
Research Assistant, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

Brittany Bradley, BA,
Research Assistant, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

Peggy McKie, MPH, and
Program Manager, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

David E. Vance, PhD, MGS
Professor & Director of Research and Scholarly Development, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

Keywords

brain fitness; HIV-Associated Neurocognitive Disorder; speed of processing; speed of processing training; Useful Field of View

---

As people age with HIV, they often confront medical and behavioral issues. One pressing issue is HIV-Associated Neurocognitive Disorder (HAND), which occurs in nearly 50% of adults with HIV (Heaton et al., 2010). The severity and prevalence of HAND may also increase with the onset of age-related neurological insults (e.g., transient ischemic attack), thus compromising everyday function such as medication adherence and driving safety

---

[*]Corresponding Author: Shyla Hossain: shossain@uab.edu.

Disclosures
The authors report no real or perceived vested interests that relate to this article that could be construed as a conflict of interest.

(Vance, Fazeli, & Gakumo, 2013). The mechanisms leading to HAND are varied and complex, and may include neuroinflammation, depression, substance abuse, and poor mental stimulation. Over time, these mechanisms may decrease cognitive reserve and brain health, resulting in cognitive deficits, as observed with HAND (Vance, Fazeli, Moneyham, Keltner, & Raper, 2013).

Nurses have struggled to find effective treatment strategies to improve cognition in this vulnerable population, and currently, few strategies exist that may be effective in reducing HAND (Vance, Fazeli, Moneyham et al., 2013). Non-pharmacological, behavioral strategies are preferred when treating HAND, given the complexity of multiple system impairments (e.g., hepatic and renal insufficiency) and frequent polypharmacy. One behavioral strategy to address HAND is computerized cognitive training, which has markedly improved cognition and everyday function in some clinical populations (Ross et al., 2016; Vance, Humphrey, Nicholson, & Jablonski-Jaudon, 2014; Wolinsky et al., 2006). In the NIH-funded ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly) Study, 2,802 normal community-dwelling older adults were randomized into one of four treatment arms: (a) 10 hours of speed of processing (SOP) training, (b) 10 hours of memory training, (c) 10 hours of reasoning training, and (d) a no-contact control group. Although there were some training benefits in targeted proximal cognitive domains, SOP training also produced unique transfer benefits to participants, including safer driving (Ross et al., 2016). In fact, the director of the National Institute of Nursing Research remarked that SOP training, as used in the ACTIVE Study, helps people as they age to retain their cognitive function (Cire, 2014), even 10 years after training. Furthermore, SOP training protected against depression and improved internal locus of control, self-rated health, and health-related quality of life. These quality of life outcomes are essential aspects of living with HIV that likewise require intervention (Vance et al., 2014; Wolinsky et al., 2006).

Given the efficacy of SOP training found in the literature, such training may be of use in adults with HIV. In a pre-post experimental design, 46 middle-aged and older (40+) adults with HIV were randomized to one of two treatment arms: (a) 10 hours of SOP training or (b) a no-contact control group (Vance, Fazeli, Ross, Wadley, & Ball, 2012). Compared to the control group, those in the training group improved significantly on a measure of visual SOP called the Useful Field of View (UFOV®). Furthermore, this cognitive improvement translated into significant improvement on a laboratory measure of everyday function called the Timed Instrumental Activities of Daily Living Test.

Building on these findings, an on-going R01 study (The Think Fast Study) is examining the effectiveness of SOP training in older (40+) adults diagnosed with HAND. Participants were randomized to one of three treatment arms: (a) 10 hours of Internet training (control), (b) 10 hours of SOP training, or (c) 20 hours of SOP training. This descriptive study compared cases in each of these treatment arms to provide insight on the potential value of this approach.

Methods

Overview

The first three participants with HAND to complete training in each of the treatment arms of the parent study were analyzed for the case comparison study reported here by examining pretest-posttest changes in their HAND diagnoses and their UFOV® scores. As this was a descriptive study of a treatment protocol, causal inferences are limited. The parent study was approved by the University of Alabama at Birmingham Institutional Review Board.

Participants

Participants were recruited from the larger parent study. All potential participants were recruited with flyers and brochures posted at a university HIV clinic, and were telephone screened to determine eligibility. To qualify for the study, participants had to: (a) be 40+ years of age, (b) be diagnosed with HIV at least 1 year, (c) have no severe neuromedical comorbidity (e.g., schizophrenia), (d) be able to drive, (e) reside within 60 miles of the research center, (f) not be blind or deaf, (g) be able to understand/speak English, and (h) be stably housed. Eligible participants were consented during a baseline (pretest) visit and were then administered a neurocognitive battery to determine if they had HAND. Only those who had HAND continued with the study; for the qualifications of HAND, please see the Frascati Criteria below.

Instruments

Demographics and health—Basic demographic information (e.g., age, gender, education, and ethnicity) and health information (e.g., self-reported CD4+ T lymphocyte count) were gathered at baseline (pretest). An obvious limitation of self-reported health information is that these data are subject to recall bias, coupled with poor health literacy and numeracy (Gakumo, Vance, Moneyham, Deupree, & Estrada, 2013). In the larger parent study, electronic medical chart extraction will be performed to verify self-reports in the entire sample. Nevertheless, the values reported by these participants were within typical expected ranges.

Frascati criteria—Using a comprehensive neurocognitive battery at baseline (pretest) and posttest, a diagnosis of HAND was determined using the Frascati criteria and a clinical rating algorithm developed by the HIV Neurobehavioral Research Center (Blackstone et al., 2012; Woods et al., 2004). Using a cognitive battery that assessed seven domains of cognitive functioning (i.e., verbal memory, verbal fluency, executive functions, speed of information processing, visual and verbal learning, working memory, and motor skills), participants were ranked for each test according to norms based on their age, gender, education, and race. Those performing at least one standard deviation below the normed mean for any two of the cognitive domains were diagnosed with HAND. A clinical rating algorithm used these data to calculate an overall score ranging from 1 (*above average*) to 9 (*severe impairment*); a score of 5 or higher is indicative of HAND (Woods et al., 2004). Although other factors can be considered in determining HAND (i.e., Instrumental Activities of Daily Living performance), the HAND diagnoses in this study were based strictly on cognitive performance.

Useful Field of View (UFOV®) test—The UFOV® is a measure of visual SOP and attention administered on a computer monitor with touch-screen technology. The UFOV® consists of four increasingly complex visual subtests in which one must identify target objects presented several times from 17 – 500 milliseconds (ms). Lower scores (fewer ms) reflect faster SOP, whereas higher scores may indicate a SOP deficit. Test-retest reliability is quite high and ranges from 0.74 to 0.81 (Edwards et al., 2005).

Procedure/Treatment

Participants diagnosed with HAND were randomized to receive either 10 hours of Internet training (control), 10 hours of SOP training, or 20 hours of SOP training. Block stratified randomization was used to ensure participants were evenly distributed by race and SOP (UFOV®) deficit. The first three participants to complete training (one in each treatment arm) were used to avoid any selection bias. Internet training consisted of reviewing websites to learn about nutrition, health and fitness, animals, state capitals, etc. These Internet activities were chosen to be interesting but were not considered to have any therapeutic cognitive benefit. The SOP training consisted of five games specifically designed to increase visual SOP, namely: (a) Double Decision (UFOV®), (b) Eye for Detail (eye movement), (c) Hawk Eye (visual accuracy), (d) Target Tracker (multiple object tracker), and (e) Visual Sweeps (fundamental SOP). All participants completed the maximum amount of assigned training and then completed a posttest assessment. On average, the posttest was completed 27 days after the last day of training, contributing to an average of 73 days between baseline (pretest) and posttest.

Data Analysis

A simple pre-post qualitative comparison of these cases was constructed (Table 1) to observe changes in HAND diagnosis and UFOV® scores.

Results

All three cases were African Americans 50 to 59 years of age with similar education and income levels. Participants did not have AIDS (self-reported CD4+ T lymphocyte count > 200 cells/mm^3). Only the participant who received 20 hours of SOP training no longer met the criteria of HAND at posttest, as indicated by a 1-point improvement in his clinical rating. Participants in the SOP arms improved noticeably more on UFOV® by 450 ms to 783 ms compared to the Internet (control) participant (187 ms).

Discussion

Our case comparison study reflects an explicit hypothesis of the parent R01 study: that dosage (amount of training) represents an important consideration in improving cognitive function. The participant who received 20 hours of SOP training (Case C) had larger SOP gains than the participant who received 10 hours of SOP training (Case B), and both had larger gains than the control group (Case A). In addition, both cases B and C improved remarkably on the UFOV® test (450 ms improvement for 10 hours of SOP training and 783 ms improvement for 20 hours of SOP training). In the gerontology literature, improvement on this test is the hallmark of this cognitive training, which also reflects better driving ability in older adults (Ross et al., 2016). The larger parent study is currently gathering self-rated driving data, driving simulator data, and driving records from the division of motor vehicles to examine the effects of SOP training over a 5-year period. As observed in previous studies with older adults who completed this training, it is expected that older adults with HIV who engage in SOP training will likewise improve their driving behavior over time by being able to process information more quickly and efficiently as they drive.

Additionally, the participant who received 20 hours of SOP training improved enough on the cognitive battery to no longer meet the Frascati criteria for HAND, while the other two cases remained stable. According to a meta-analysis on cognitive training in older adults, Lampit, Hallock, and Valenzuela (2014) found that a dose of 20 hours or less of SOP training was more effective in improving performance in this cognitive domain (effect size = 0.34), compared to more than 20 hours (effect size = 0.24). In other words, there may be a point of diminishing therapeutic return in the investment of engaging in training. Although preliminary, our case comparison study suggests that 20 hours of SOP training may prove to be the optimal therapeutic dose to improve HAND; however, a larger sample is needed to replicate such initial findings.

Based on prior work with SOP training, it has been hypothesized that these cognitive exercises “are most clearly procedural, operating through sensory-motor elaboration and repetition” and such “[p]rocedural tasks have a broader pattern of regional brain activation” (Wolinsky et al., 2006, p.1325). Electrophysiological studies have already indicated that adults who receive SOP training, compared to controls, experience increased N2pc and P3b amplitudes, which reflect increased attention toward a target stimulus and increased ability to ignore task-irrelevant stimuli (processing capacity), respectively (O’Brien et al., 2013). Both amplitudes decrease with age, which suggests changes in prefrontal lobe function. Furthermore, the lack of attention and inhibition control associated with prefrontal dysregulation, especially in those infected with HIV (Schweinsburg et al., 2012), may be an inefficient way to process information quickly and accurately. Thus, SOP training may reduce dependence on frontal lobe-oriented activity by reallocating such responses to posterior brain regions that can improve SOP and translate to everyday functional improvements (O’Brien et al., 2013).

Conclusion

In conclusion, as cognitive abilities begin to decline with age, concerns emerge about more profound cognitive declines in older adults with HIV (Vance, Fazeli, & Gakumo, 2013). Fortunately, prior work already shows that SOP training can improve this cognitive ability and improve everyday functioning in middle-aged (40+) and older adults with HIV in the short-term (Vance et al., 2012), and in the long-term for normal community-dwelling older adults (Ross et al., 2016). Although more data are needed on a much larger sample to confirm the efficacy of this cognitive training program, this case comparison study highlights the potential impact of SOP training in addressing HAND and the many symptoms caused by poorer cognitive functioning.

Acknowledgments

This study was funded by an NIH/NIMH R01-award (1R01MH106366-01A1; ClinicalTrials.gov [NCT02758093]; Vance, Principal Investigator) titled “An RCT of Speed of Processing Training in Middle-aged and Older Adults with HIV”, and an NIH/NINR R21-award (1R21NR016632-01; Vance, Principal Investigator) titled “Individualized-Targeted Cognitive Training in Older Adults with HAND”. Special thanks to Donald Franklin for his help with scoring assessments.

References

Blackstone K, Moore DJ, Franklin DR, Clifford DB, Collier AC, Marra CM, … Heaton RK. Defining neurocognitive impairment in HIV: Deficit scores versus clinical ratings. Clinical Neuropsychologist. 2012; 26(6):894–908. DOI: 10.1080/13854046.2012.694479 [PubMed: 22708483]

Cire, B. Cognitive training shows staying power. 2014 Jan 13. Retrieved from https://www.nia.nih.gov/newsroom/2014/01/cognitive-training-shows-staying-power

Edwards JD, Vance DE, Wadley VG, Cissell GM, Roenker DL, Ball KK. Reliability and validity of useful field of view test scores as administered by personal computer. Journal of Clinical and Experimental Neuropsychology. 2005; 27(5):529–543. DOI: 10.1080/13803390490515432 [PubMed: 16019630]

Gakumo CA, Vance DE, Moneyham LD, Deupree JP, Estrada CA. Health numeracy and health literacy within the context of HIV disease management. Nursing: Research and Reviews. 2013; 3:23–32. DOI: 10.2147/NRR.S37548

Heaton RK, Clifford DB, Franklin DR Jr, Woods SP, Ake C, Vaida F, … Grant I. HIV-associated neurocognitive disorders persist in the era of potent antiretroviral therapy: CHARTER study. Neurology. 2010; 75(23):2087–2096. DOI: 10.1212/WNL.0b013e318200d727 [PubMed: 21135382]

Lampit A, Hallock H, Valenzuela M. Computerized cognitive training in cognitively healthy older adults: A systematic review and meta-analysis of effect modifiers. PLoS Medicine. 2014; 11(11):e1001756.doi: 10.1371/journal/pmed.1001756 [PubMed: 25405755]

O’Brien JL, Edwards JD, Maxfield ND, Peronto CL, Williams VA, Lister JJ. Cognitive training and selective attention in the aging brain: An electrophysiological study. Clinical Neurophysiology. 2013; 124(11):2198–2208. DOI: 10.1016/j.clinph.2013.5.012 [PubMed: 23770088]

Ross LA, Edwards JD, O’Connor ML, Ball KK, Wadley VG, Vance DE. The transfer of cognitive speed of processing training in older adults’ driving mobility across 5 years. Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2016; 71(1):87–97. DOI: 10.1093/geronb/gbv022

Schweinsburg BC, Scott JC, Schweinsburg AD, Jacobus J, Theilmann RJ, Frank LR, … Woods SP. Altered prefronto-striato-parietal network response to mental rotation in HIV. Journal of Neurovirology. 2012; 18(1):74–79. DOI: 10.1007/s13365-011-0072-z [PubMed: 22271019]

Vance DE, Fazeli PL, Gakumo CA. The impact of neuropsychological performance on everyday functioning between older and younger adults with and without HIV. Journal of the Association of Nurses in AIDS Care. 2013; 24(2):112–125. DOI: 10.1016/j.jana.2012.05.002 [PubMed: 22943982]

Vance DE, Fazeli PL, Moneyham L, Keltner NL, Raper JL. Assessing and treating forgetfulness and cognitive problems in adults with HIV. Journal of the Association of Nurses in AIDS Care. 2013; 24(1S):S40–S60. DOI: 10.1016/j.jana.2012.03.006 [PubMed: 23290376]

Vance DE, Fazeli PL, Ross LA, Wadley VG, Ball KK. Speed of processing training with middle-age and older adults with HIV: A pilot study. Journal of the Association of Nurses in AIDS Care. 2012; 23(6):500–510. DOI: 10.1016/j.jana.2012.01.005 [PubMed: 22579081]

Vance DE, Humphrey SC, Nicholson WC, Jablonski-Jaudon RA. Can speed of processing training ameliorate depressive symptomatology in adults with HIV? Annals of Depression and Anxiety. 2014; 1(3):1013. [PubMed: 26280022]

Wolinsky FD, Unverzagt FW, Smith DM, Jones R, Stoddard A, Tennstedt SL. The ACTIVE cognitive training trial and health-related quality of life: Protection that lasts 5 years. Journals of

Gerontology Series A: Biological Sciences and Medical Sciences. 2006; 61(12):1324–1329. DOI: 10.1093/gerona/61.12.1324

Woods SP, Rippeth JD, Frol AB, Levy JK, Ryan E, Soukup VM, … Heaton RK. Interrater reliability of clinical ratings and neurocognitive diagnoses in HIV. Journal of Clinical and Experimental Neuropsychology. 2004; 26(6):759–778. DOI: 10.1080/13803390490509565 [PubMed: 15370374]

Table 1

Baseline and Posttest Case Comparisons Between Treatment Conditions

	Case A 10 hours of Internet Training	Case B 10 hours of SOP Training	Case C 20 hours of SOP Training	Comparisons/Observations
Race/Gender	African American/Female	African American/Male	African American/Male	Similar
Age (years)	50	55	59	Similar
Education (years)	13	11	14	Similar
Income	$0 – $10,000 USD	$0 – $10,000 USD	$0 – $10,000 USD	Similar
Reported CD4+ T Lymphocyte Count	625 cells/mm^3	370 cells/mm^3	758 cells/mm^3	Not AIDS
Reported HIV Viral Load	Undetectable	Don't Know	Undetectable	Controlled
Comorbidities/Lifestyle	Smokes Non-Drinker	Hypertension Smokes Non-Drinker	Migraines Anxiety	
Days Between Baseline and Posttest	70	86	62	Similar
Days Between Last Training Date and Posttest	23	30	28	Similar
Frascati Criteria CR				
CR Baseline	5	5	5	
CR Posttest	5	5	4	Case C no longer has HAND
CR Improvement	0	0	−1	
UFOV® Baseline	667	1,084	1,031	
UFOV® Posttest	480	634	248	Cases B & C improved the most
UFOV® Improvement	−187	−450	−783	

Note. CR = Clinical Rating; HAND = HIV-Associated Neurocognitive Disorder; SOP = Speed of Processing; UFOV® = Useful Field of View; USD = U.S. dollars.