Neuropsychological Functioning and Driving Simulator Performance in Middle-aged and Older Adults with HIV: A Pilot Study

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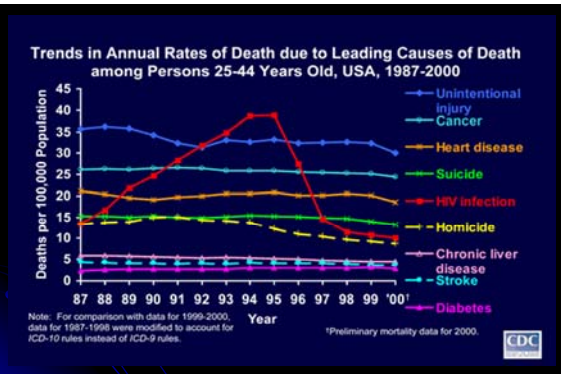
As today's speaker, I have no financial arrangement or affiliation with (a) corporate organization(s) offering financial support or grant monies for, or related to, the content of this continuing medical education program.

Demographics of Aging and HIV

- Of the 1.1 million adolescents and adults living with HIV those 50 years and older represent:
  - 15% of all new cases
  - 24% of those with HIV
  - 29% of those with AIDS
  - 35% of all AIDS-related deaths
  - (CDC, 2008)
- By 2015, nearly half of those with HIV in the United States will be 50 years and older (Kirk & Goetz, 2009).



With the advent of protease inhibitors, HIV-related deaths have decreased substantially (Vance et al., 2011).

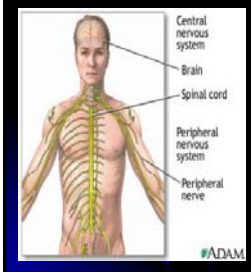
Is Successful Aging with HIV Possible?

SUCCESFUL AGING	HIV
Length of Life	Compromised (?)
Biological Health	Compromised (?)
Mental Health	Depression, Anxiety
Cognitive Efficiency	Cognitive Decline (?)
Social Competence	Social Withdrawal
Productivity	Abandoned Goals
Personal Control	Loss of Control (?)
Life Satisfaction	Individual Differences

Vance, D. E., Bayless, H., Kempf, M. C., Keltner, N. L., & Fazeli, P. L. (2011). Aging, HIV, and wellness: Augmenting the components of successful aging. Aging Health, 7(3), 435-446.

HIV Impacts the Nervous System

Primary HIV-Neurological Problems



- **HIV-associated dementia and cognitive motor disorders**
- Myelopathy (inflammation of the spinal cord)
- Peripheral neuropathy (damage to the nerves of the peripheral nervous system)
- Myopathy (muscular weakness)

Neuropsychological Study of Aging with HIV

Research Questions

1. Are older adults with HIV more vulnerable to cognitive impairment than younger adults with HIV and older adults without HIV?
2. If so, do these cognitive impairments correspond to everyday functioning?
3. Are there differences in performance in everyday functioning between these groups?

Vance, D. E., Fazeli, P. L., & Gakumo, C. A. (2013). 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, 24(2), 112-125.

Methods: Participants

- Entry criteria
  - For HIV+, diagnosed 1 year or more
  - Not homeless
  - At least 19 years old
  - Able to speak/understand English
  - Not mentally impaired
  - Not currently undergoing radiation or chemotherapy
  - Not pregnant
  - No history of brain trauma with loss of consciousness greater than 30 minutes
  - No severe neurological problems (e.g., schizophrenia, bipolar disorder)

Methods: Participants (cont).

- Participants recruited from 1917 Clinic, UAB Reporter, brochures, and word-of-mouth
- Participants were compensated $50 for their time.

TABLE 1

Sample Characteristics (N = 172)

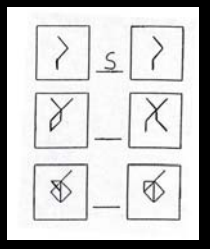
	HIV-POSITIVE (n = 88)		HIV-NEGATIVE (n = 84)	
	M (SD)	*n (%)*	*M (SD)*	*n (%)*
Age (years)	46.25 (10.18)		47.93 (13.06)	
Education (years)	12.72 (2.42)		12.79 (1.68)	
Gender				
Female		23 (26.1%)		51 (60.7%)
Male		65 (73.9%)		33 (39.3%)
Race				
African American		33 (37.5%)		29 (34.5%)
Caucasian		54 (61.4%)		55 (65.5%)
Other		1 (1.1%)		0 (0%)
Income ($K)	17.4 (1.32)		19.8 (1.53)	
Number of Medical Conditions	2.88 (1.79)		2.13 (2.01)	
Number of Medications	4.84 (0.33)		2.18 (0.33)	
Years Diagnosed with HIV	13.22 (7.53)		Not applicable	
CD4+ Lymphocyte Count	526.88 (289.26)		Not applicable	
Viral Load (ml)	16,839 (118,796)		Not applicable	

Methods: Procedure

- Cross-sectional Design
- Interviews conducted at UAB Roybal Center for Translational Research in Aging and Mobility
- Psychosocial, Neuropsychological, and Everyday Functioning Battery (2½ hour interview)

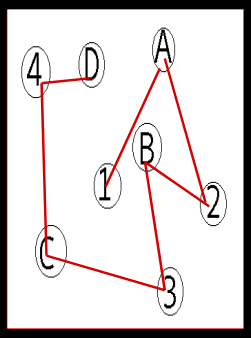
Methods: Measures

- Neuropsychological Component
  - **Speed of Processing (Fluid)**
    - Useful Field of View Test (UFOV®)
    - Pattern Comparison
    - Letter Comparison
    - Complex Reaction Time Test (CRT)
  - **Executive Functioning (Fluid)**
    - Trails B
    - CLOX
  - **Memory/Attention (Fluid)**
    - WMS-III Spatial Span
    - WMS-III Digit Span
  - **Psychomotor Ability (Fluid)**
    - Finger Tapping Test
    - Trails A
    - WAIS Digit Symbol Copy and Substitution
  - **General Intelligence (Crystalized)**
    - WRAT



Trails B

"On this page are both numbers and letters. Begin at number 1 (**point to 1**) and draw a line from 1 to A (**point to A**) A to 2 (**point to 2**) 2 to B (**point to B**) and so on until you reach the circle marked 'End'."



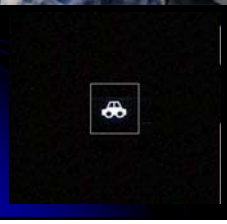
Useful Field of View®

- The Useful Field of View® is defined as the area from which one can extract visual information in a single glance without eye or head movement. While it is a test of visual attention, it is also sensitive to visual impairment.
- The limits of this area are affected by:
  - Visual sensory function
  - Slower processing ability
  - Difficulty dividing attention
  - Difficulty ignoring distraction

Welcome to UFOV Test 1

This exercise will measure how fast you can identify a single object.

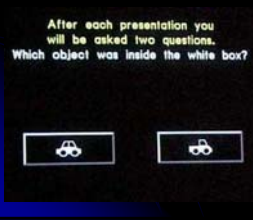
Touch continue for a demonstration

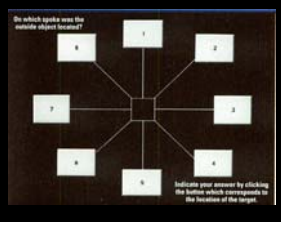


Welcome to UFOV Test 2

This exercise will measure how fast you can divide your attention between two objects.

Touch continue for a demonstration

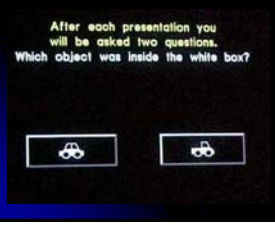


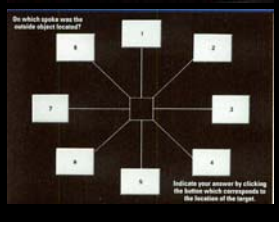


Welcome to UFOV Test 3

This exercise will measure how fast you can divide your attention between two objects when the outside object is surrounded by clutter.

Touch continue for a demonstration

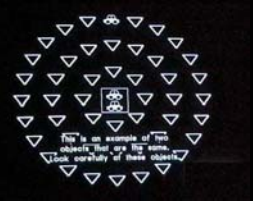


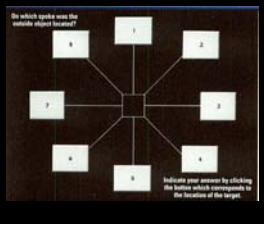


Welcome to UFOV Test 4

This exercise will be like the previous exercise except the center task will be more difficult.

Touch continue for a demonstration





Methods: Measures

- **Everyday Functioning Component**
  - **Speeded IADLs**
    - Timed Instrumental Activities of Daily Living (TIADL)
  - **Non-speeded IADL**
    - Observed Tasks of Daily Living (OTDL)
  - **Self-reported Mobility**
    - Mobility Questionnaire (MQ)
      - Life space
      - Driving space
      - Driving exposure
      - Falls
  - **Performance-based Mobility Assessment**
    - Timed "Get Up and Go" Test (TGUG)
    - Functional Reach Test (FR)

TABLE 2

Adjusted Means of Neurocognitive and Everyday Performance between Groups (N = 172)

	HIV-POSITIVE		HIV-NEGATIVE		
	YOUNGER (n = 55) M (SD)	OLDER (n = 33) M (SD)	YOUNGER (n = 43) M (SD)	OLDER (n = 41) M (SD)	FINDINGS
PSYCHOMOTOR SPEED					
Finger Tapping Test (number of taps)	103.23 (14.92)	98.31 (14.73)	104.35 (14.74)	92.34 (14.50)	A†
SPEED OF PROCESSING					
Useful Field of View (milliseconds)	805.09 (357.39)	881.12 (854.15)	550.01 (254.25)	738.09 (348.45)	A‡, H†
Complex Reaction Time (seconds)	1.76 (1.07)	1.30 (1.06)	1.26 (1.06)	1.55 (1.04)	A†, H†
Letter Comparison (number correct)	47.34 (10.95)	41.99 (10.86)	51.17 (10.83)	44.72 (10.65)	A†
Pattern Comparison (number correct)	33.06 (7.21)	28.77 (7.12)	36.18 (7.13)	32.13 (7.01)	A‡, H†
MEMORY FUNCTIONING					
Hopkins Verbal Learning (number correct)	24.97 (6.00)	22.32 (5.92)	24.67 (5.70)	22.64 (5.83)	A†
EXECUTIVE FUNCTIONING					
Wisconsin Card Sorting (number correct)	62.65 (18.76)	57.92 (18.50)	63.39 (18.49)	64.47 (18.25)	ns
EVERYDAY FUNCTIONING					
Timed Instrumental Activities of Daily Living (z-score composite)	-0.31 (3.05)	2.12 (7.99)	-0.57 (3.00)	0.66 (7.96)	A†, H†, HxA†
Observed Tasks of Daily Living (total score)	68.43 (7.37)	66.64 (7.29)	70.13 (7.39)	69.24 (7.17)	ns

Notes: A = Age main effect detected; H = HIV main effect detected; HxA = HIV x Age interaction detected; M = mean; ns= not significant; SD = standard deviation. † = sig. at < .05; ‡ = sig. at < .01.

Cognitive Functioning in HIV

- Adults with HIV are vulnerable to degrees of speed of processing deficits.
- In a recent study, one third of adults with HIV exhibited severe speed of processing deficits (Vance, Wadley, Crowe, Raper, & Ball, 2009).
- In general, such speed of processing deficits also increase in general as people age (Ball & Vance, 2007).

The Driving Simulator Study: A Pilot Study

Background

- In a study of 40 HIV+ and 20 HIV- adults,
  - 28% of those with HIV+ were classified as having neuropsychological impairment
  - 0% of those without HIV- were.
- The HIV+ adults, as a group, experienced poorer performance on:
  - UFOV
  - driving simulator (e.g., more crashes)
  - on-road test evaluations.
- Neuropsychological performance + driving simulations explained 48% of on-road test evaluations (Marcotte et al., 2004).

Background

- In a study of 42 HIV+ and 21 HIV- adults, again the HIV+ adults performed significantly worse than the HIV- adults on UFOV.
- Poor UFOV test performance and poorer neuropsychological performance was related to:
  - Higher self-reported accidents in the past year (Marcotte et al., 2006).

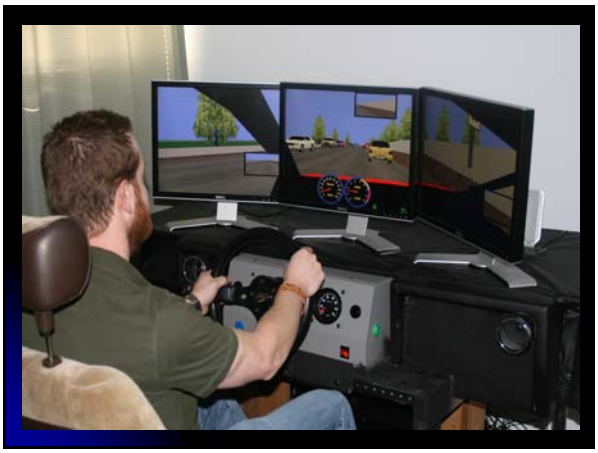


Table 1. Sample Descriptive (*N* = 26)

Variable	*M* (*SD*)	*n* (%)	Range
Demographics			
Age	51.23 (6.17)		41.4 – 67.07
Race (no. Caucasian)*		8 (30.8%)	
Number (%) Heterosexual		14 (53.8%)	
Gender (no. Men)		17 (65.4%)	
Years of Education	13.04 (2.03)		8 - 18
Number (%) working Full or Part-time		5 (19.2%)	
Income**	2.08 (1.16)		1 – 5
Mental and Physical Health Variables			
Total Number of Comorbidities	6 (2.42)		2 – 10
Total Number of Medications	7.19 (3.66)		1 – 14
CESD Score	16.85 (12.89)		1 – 52
Far Visual Acuity***	-0.03 (0.12)		-0.10 – 0.50
Alcohol Use	0.26 (0.61)		0 – 2.77
Drug Use	0.03 (0.05)		0 – 0.23
Years with HIV	15.92 (7.18)		3.27 – 29.47
Number (%) Taking HAART		24 (92.3%)	
HAART Medication Adherence	2.08 (2.41)		0 – 8
Self-report CD4+ Lymphocyte Count	565.00 (291.35)		190 – 1058
Self-report Viral Load	3,171.15 (13,971.17)		13 – 71,000
Cognitive Variables			
Complex Reaction Time	1.75 (0.52)		1.10 – 3.08
UFOV Total	659.65 (384.93)		94 – 1,940
Letter Comparison	48.73 (11.35)		25 – 72
Pattern Comparison	34.42 (5.19)		24 – 45
HVLT Recall	27.77 (4.79)		19 – 35
Finger Tapping Test	46.04 (6.59)		34.10 – 62.30
Trails A	32.98 (7.41)		19.82 – 54.09
Trails B	83.36 (32.89)		37.25 – 161.44

Notes. *All others were African American except 1 who was Hispanic; **For income, 1 = $0 - $10,000 and 8 = above $70,000; ***For far visual acuity, the LogMar score is reported where lower values = better visual acuity, and 0.00 = 20/20 vision.

Table 2. Driving Simulator Outcomes for the Sample (*N* = 26)

Driving Simulator Outcome Variables	*M* (*SD*)	Range
Lowest Gross Reaction Time	0.90 (0.21)	0.52 – 1.33
Average Gross Reaction Time	1.01 (0.20)	0.63 – 1.41
Total No. of Collisions	2.50 (1.24)	0 – 5.00
Total No. of Pedestrians Hit	0.35 (0.63)	0 – 2.00
Total No. of Correct Divided Attention Responses	12.38 (3.67)	3.00 – 18.00
Total Drive Time (sec)	1491.34 (275.78)	1251.37 – 1877.39
% of Total Drive Time Over the Speed Limit	66.94 (14.48)	7.97 – 79.95
% of Total Drive Time Out of Lane	5.29 (2.47)	2.19 – 10.26
Lowest Divided Attention Reaction Time	1.16 (0.23)	0.80 – 1.73
Average Divided Attention Reaction Time	2.79 (0.67)	0.52 – 1.33
Self-report Driving Habit Variables	***M* (*SD*)**	**Range**
Self-Rated Driving Quality*	1.54 (0.58)	1 – 3
No. of Days out of 7 Driven Per Week	5.35 (2.23)	1 – 7
No. of Miles Driven in Average 7-day Week	123.08 (145.61)	0 – 700
Total No. of Accidents in Past 2 Years	0.46 (0.86)	0 – 3
Total No. of Times Pulled Over in Past 2 Years	0.27 (0.45)	0 – 1

Notes. No. = Number. *For Self-Rated Driving Quality, 1 = Excellent, 5 = Poor

Table 3. Correlations between Demographic, Mental, and Physical Health Variables and Driving Simulator Outcomes (*N* = 26)

Variables	Lowest Gross RT	Avg. Gross RT	Total # Collisions	Total # Pedestrians Hit	Total # Correct DA Responses	Total Drive Time (sec)	% of Drive Time Over Speed Limit	% of Drive Time Out of Lane	Lowest DA RT	Average DA RT
Age	.33	.29	.19	.03	-.35	.18	.03	-.07	.49*	.45*
Education	-.11	-.13	.04	.09	-.09	.10	.08	-.36	.32	.09
Number of Co-morbidites	-.25	-.15	-.03	.16	.21	.11	-.08	-.05	-.17	-.19
Number of Medications	-.27	-.29	-.14	-.32	.05	.05	-.19	-.28	.06	-.04
CESD	-.31	-.22	-.02	.24	.14	.07	.17	.07	-.25	-.07
Visual Acuity	-.36	-.24	-.15	.16	.04	.03	.16	.32	-.15	.09
Alcohol Use	-.19	-.23	-.22	.04	-.17	-.05	.25	-.14	.03	.27
Drug Use	-.37	-.41*	-.25	-.11	-.03	.18	-.08	-.05	-.05	.06
Years with HIV	.23	.30	.13	.13	-.02	-.14	.27	.25	.22	.16
Medication Adherence	.21	.17	-.04	-.26	.24	.17	.09	-.18	-.02	-.22
CD4+ Count (self-reported)	-.04	-.04	.07	-.21	-.07	.17	.02	-.24	-.11	.10
Viral Load	-.18	-.13	-.05	-.08	.09	-.03	.10	-.14	.06	.02

Notes. * p < 0.05; ** p < 0.01. DA = Divided attention; RT = Reaction time.

Table 4. Correlations between Cognitive and Functional Variables and Driving Simulator Outcomes (*N* = 26)

Variables	Lowest Gross RT	Avg. Gross RT	Total # Collisions	Total # Pedestrians Hit	Total # Correct DA Responses	Total Drive Time (sec)	% of Drive Time Over Speed Limit	% of Drive Time Out of Lane	Lowest DA RT	Average DA RT
Complex Reaction Time	.22	.31	.24	.09	.19	.12	.25	.42*	-.04	-.05
UFOV Subtest 1	.39*	.34	.17	.47*	-.11	-.17	.21	.39*	.22	.24
UFOV Subtest 2	.50**	.47*	.18	.31	-.07	-.05	.27	.11	.11	.19
UFOV Subtest 3	.38*	.38	.12	.30	-.04	-.05	.16	.36	-.02	.13
UFOV Subtest 4	.26	.25	-.09	.10	-.28	.13	.11	.27	-.05	.35
UFOV Total	.44*	.41*	.09	.31	-.16	-.02	.21	.32	.06	.28
Letter Comparison	-.18	-.13	-.09	.02	-.02	-.23	-.40*	.02	-.13	-.22
Pattern Comparison	-.22	-.14	-.01	.06	.11	-.12	-.19	-.23	-.21	-.28
HVLT Recall	-.15	-.29	-.31	-.25	-.02	.24	-.24	-.40*	.00	-.08
Finger Tapping Test	.01	-.01	.12	.21	.16	-.06	.17	-.10	.08	-.12
Trails A	-.12	-.10	.03	-.01	-.20	-.11	.24	-.27	-.06	.21
Trails B	.15	.20	.01	.01	-.42*	-.12	.21	.30	.08	.56**
Self-rated Driving Quality	.20	.17	.37	.14	-.03	.12	.15	.05	.15	.09
Days Driven Out of 7	.22	.25	.14	.15	.03	-.07	-.10	.21	.07	-.10
Miles Driven in 7-day Week	.39*	.35	.05	.42*	-.20	-.17	.11	.27	.17	.24
Accidents in Past 2 Years	.43*	.36	.39*	.00	.13	.08	.02	.17	.10	-.08
Pulled Over in Past 2 Years	-.03	-.04	.08	-.05	.01	.15	.05	-.12	-.17	.02

Notes. * p < 0.05; ** p < 0.01. DA = Divided attention; RT = Reaction time.

Table 5. Correlations between Cognitive Variables and Self-reported Driving Outcomes (*N* = 26)

Variables	Self-rated Driving Quality	Days Driven Out of 7	Miles Driven in 7-day Week	Accidents in Past 2 Years	Pulled Over in Past 2 Years
Complex Reaction Time	.25	.02	.01	.37	-.05
UFOV Subtest 1	.14	.00	.68**	.31	-.07
UFOV Subtest 2	.14	-.08	.52**	.46*	.13
UFOV Subtest 3	.37	-.12	.40*	.40*	.20
UFOV Subtest 4	.15	-.27	.15	.18	.06
UFOV Total	.23	-.16	.47*	.38	.10
Letter Comparison	-.18	.34	.03	-.01	.20
Pattern Comparison	-.18	.16	-.05	-.29	.34
HVLT Recall	-.20	-.25	-.01	.03	.11
Finger Tapping Test	-.01	.10	.27	-.10	.27
Trails A	.25	-.51**	-.33	-.10	.21
Trails B	-.01	-.13	.00	.02	-.09

Notes. * $p < 0.05$; ** $p < 0.01$.

Results

- Increasing age was associated with lower divided attention reaction time in the simulator.
- Poor UFOV performance was predictive of slower Reaction Time, number of pedestrian hits, and driving outside of the lane.
- Poor UFOV test performance was related to higher self-reported accidents in the past year.
- Lower gross reaction time was associated with less driving and fewer self-reported accidents; however, those who drove more experienced more pedestrian hits in the driving simulator (*why?*).
- Poor UFOV performance was predictive of more driving in general (*why?*) and more reported accidents in the past 2 years.

The Speed of Processing Training Study

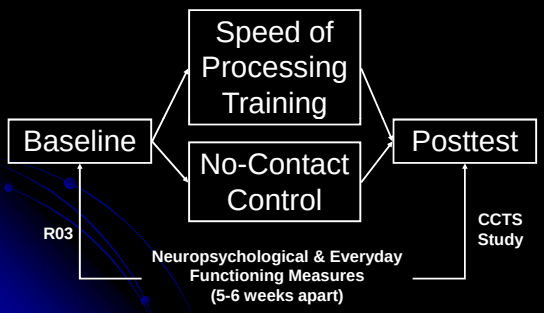
Speed of Processing Training

- This speed of processing training protocol has been used to improve the rate at which normal, community-dwelling older adults process information (Vance, Dawson, Wadley, Edwards, Roenker, Rizzo, & Ball, 2007).
- It has been shown to improve driving performance and measures of everyday functioning.
- Because of its efficacy in older adults, speed of processing training may ameliorate speed of processing in adults with HIV.

Vance, D. E., Fazeli, P. L., Ross, L. A., Wadley, V., & Ball, K. (2012). The effects of speed of processing training on middle-aged and older adults with HIV. Journal of the Association of Nurses in AIDS Care, 23(6), 500-510.

	No-Contact Control Group (n = 24)		Speed of Processing Group (n – 22)	
Variable	n (%)	Mean (SD)	n (%)	Mean (SD)
Age		52.88 (7.71)		50.11 (6.88)
Gender				
Male	17 (70.8%)		17 (77.3%)	
Female	7 (29.2%)		5 (22.7%)	
Race/Ethnicity				
Caucasian	12 (50.0%)		15 (68.2%)	
African American	12 (50.0%)		7 (31.8%)	
Education (years)		13.13 (2.88)		13.32 (2.10)
Household Income ($10K)		2.04 (1.63)		1.77 (1.51)
Years Diagnosed with HIV		16.30 (6.83)		13.01 (8.12)
HIV Viral Load (copies/mL)		1,936.78 (6,544.28)		8,357.86 (18,911.48)
Current CD4+ T Lymphocyte Count/mm^3		433.75 (220.09)		471.27 (291.73)

Methods



Measures

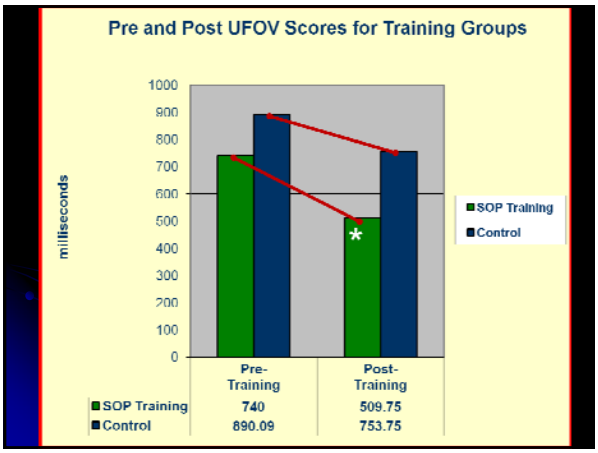
- Useful Field of View Test (UFOV®) – A neuropsychological measure of visual speed of processing and attention.
- Wisconsin Card Sorting Test
- Finger Tapping Test
- Timed Instrumental Activities of Daily Living Test

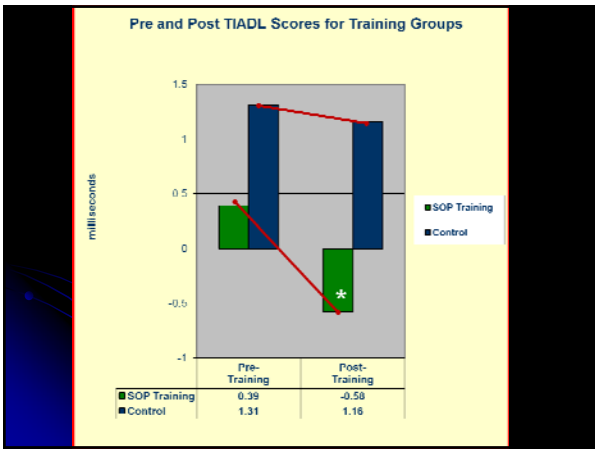
Methods

- Speed of Processing Training

Methods

- Speed of Processing Training (continued)





Overall Conclusion

- Neuropsychological deficits occur with aging and HIV; thus, there are concerns that those aging with HIV will be more at risk of such cognitive problems.
- UFOV is generally more compromised with aging and HIV and those aging with HIV.
- UFOV is associated with poorer driving performance.
- Poorer driving performance has been observed in older adults and adults with HIV.
- Fortunately, UFOV can be improved in older adults and adults with HIV with speed of processing training.
- Such training has been shown to improve driving in older adults; such training may also be effective in those with HIV to improve driving.