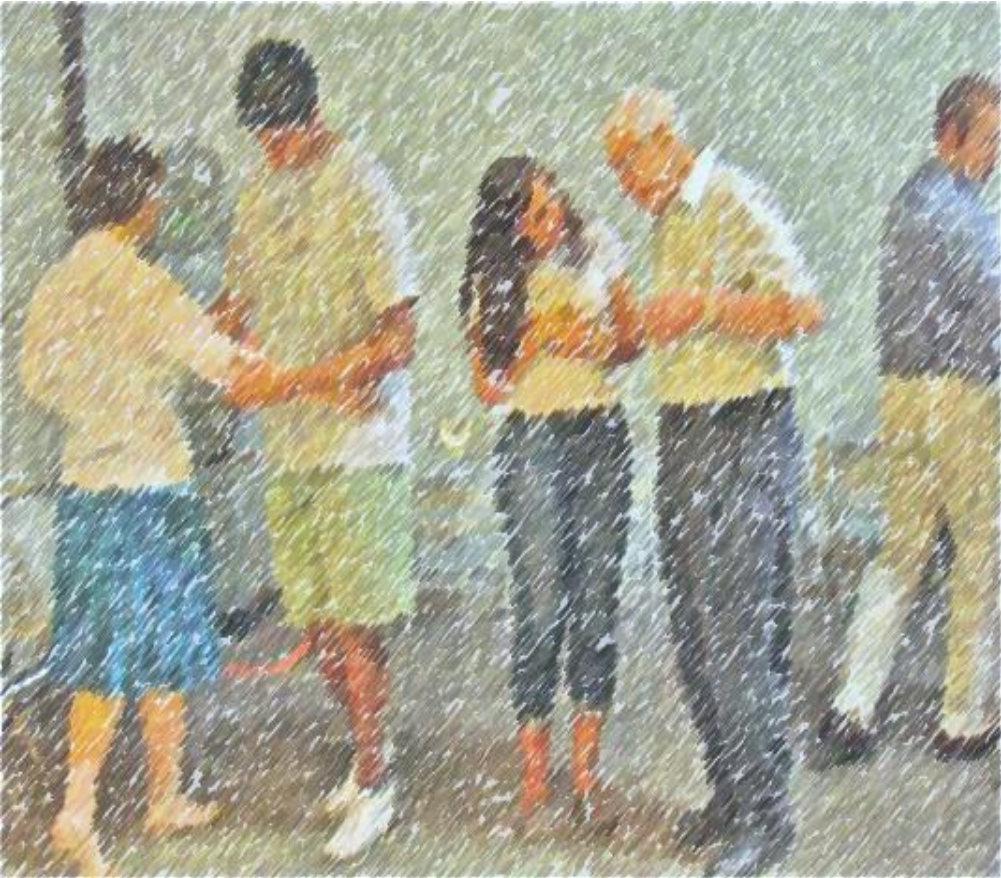
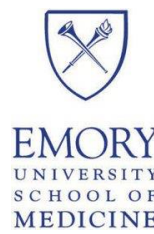


Movement, Mobility and Cognition



Dr. Madeleine E. Hackney

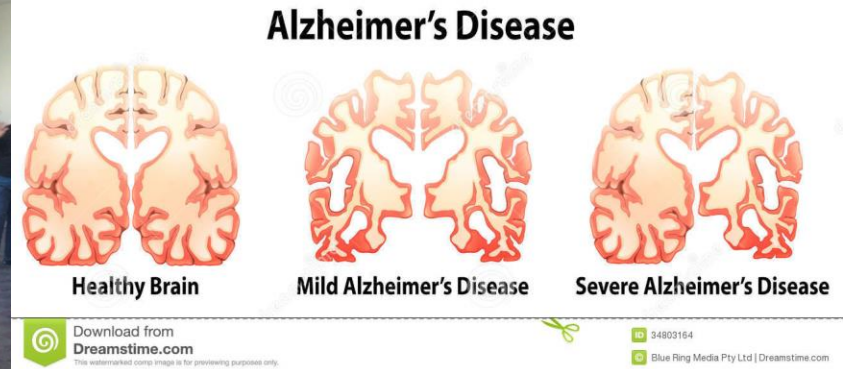
Brain Talk Live: July 29, 2025

Associate Professor, Emory University
School of Medicine, Department of
Medicine, Division of Geriatrics and
Gerontology

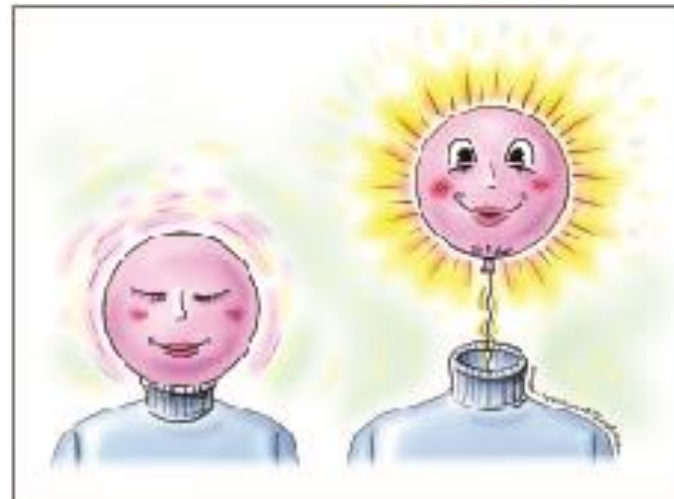
Research Scientist, Atlanta VA Medical
Center

21st century has critical neurological problems to solve-

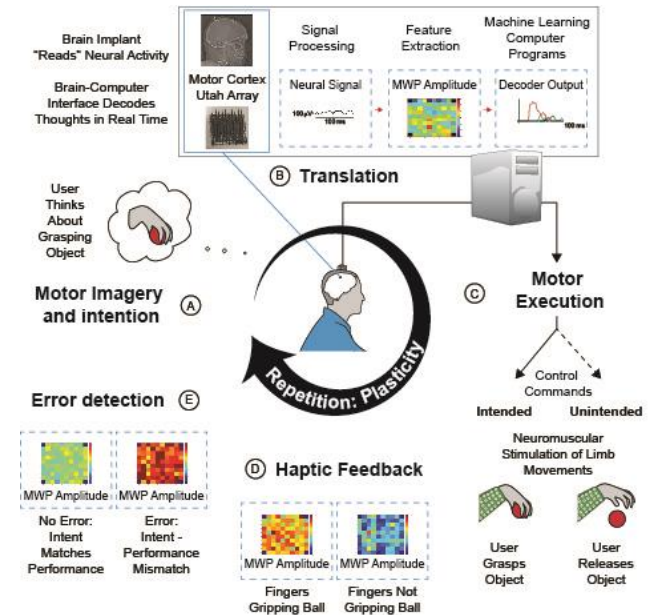
Parkinson's
Alzheimer's



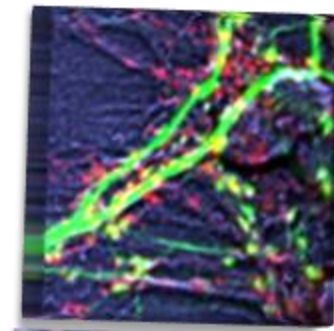
Solutions



Drawn By: Eric Franklin



Neural plasticity may underlie potential movement and mobility effects on cognition in PD and AD



- **Brain's ability to modulate connections between brain cells, based on experiences**

- Anatomical, molecular, genetic, structural, functional levels
- Increased synthesis, release of neurotrophins and neurotransmitters
- Reorganization of cortical representations, synaptogenesis, and synaptic potentiation

- **Challenge brain with new activities & experiences**

- New synaptic connections form between neurons
- Better communication between neurons
- Benefits increase when challenges are “on-going”, ie. Regular exercise, dance and art!

Our capacity for movement changes over the lifespan

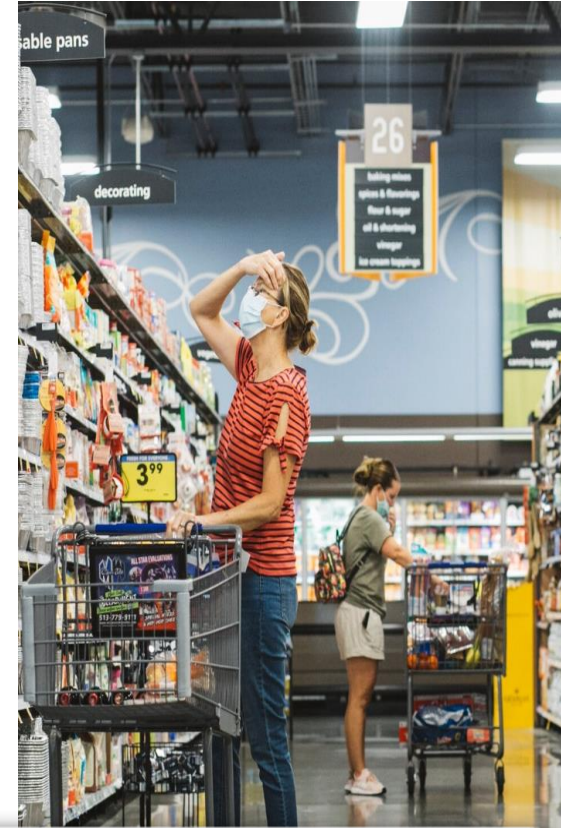
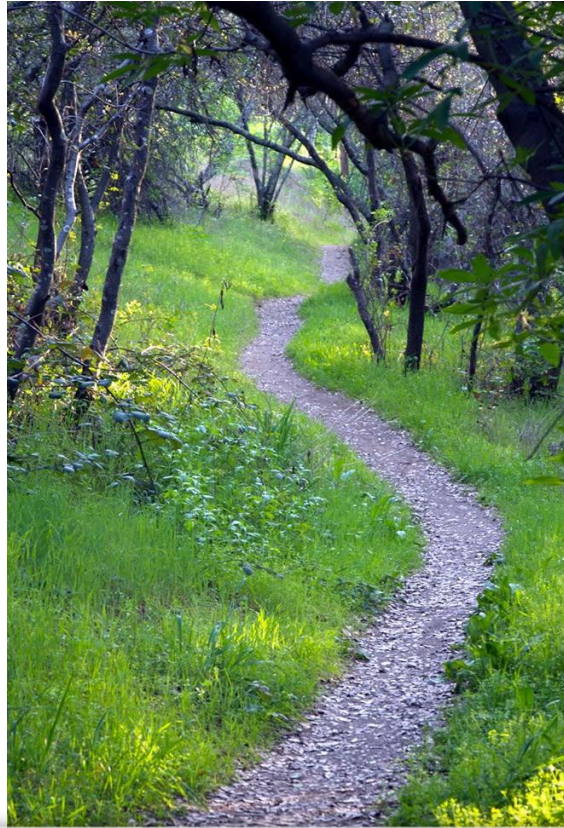




Movement and thought are intertwined in everything we do

- Motor-cognitive integration:
 - cognition is embodied in action, and the motor system actively engages in mental processing

Real-world walking and mobility are complicated!

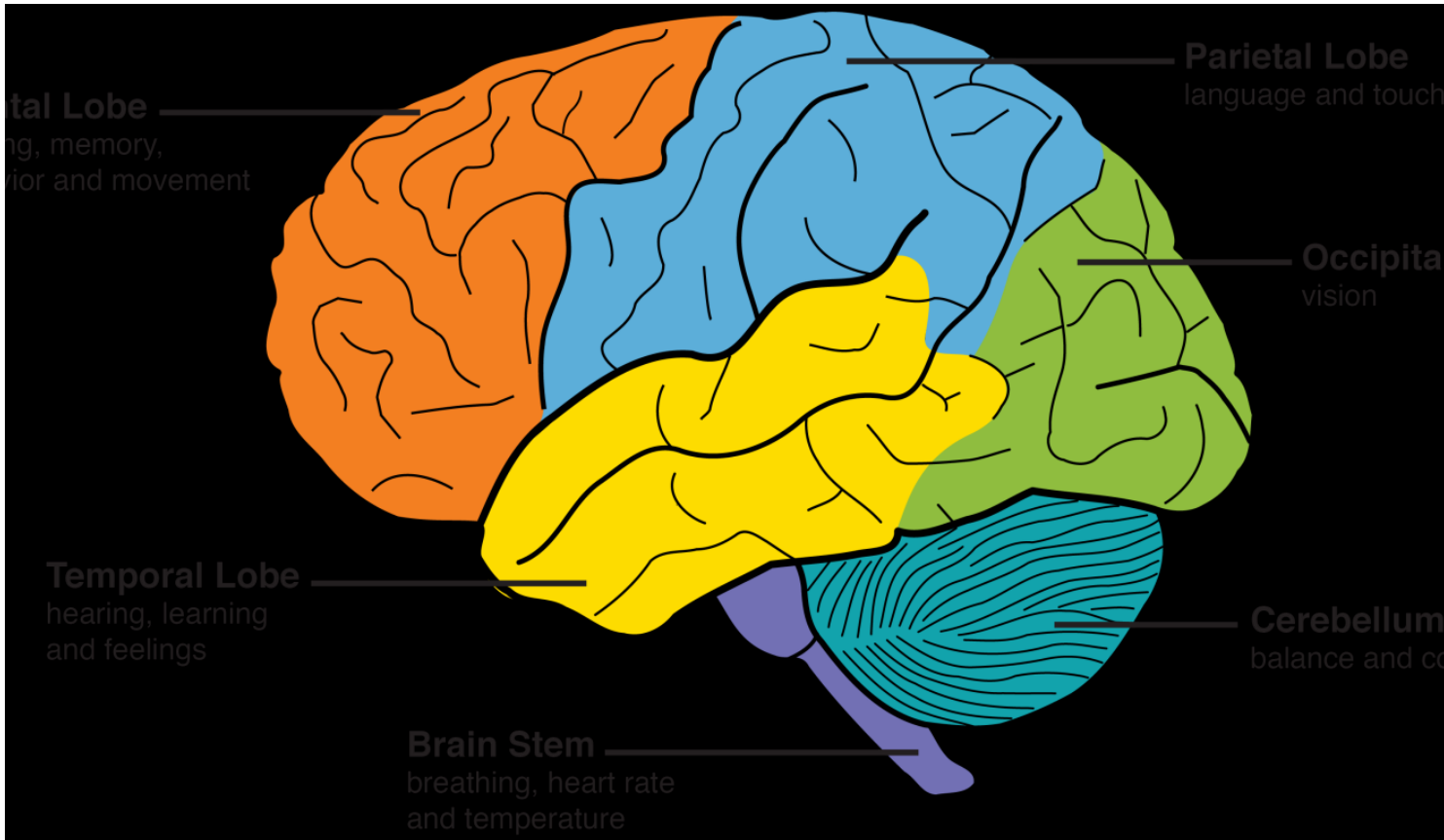


We must often, and readily change and adapt our gait patterns to be able to move about in our ever-changing environment!

Mild Cognitive Impairment (MCI) hinders the ability to make walking stride changes needed for daily mobility

- **Cognition needed for walking adaptation:**
 - **Attention/ working memory**
 - **Executive function**
 - **Visuospatial function**
- **MCI associated w/cognitive deficits across these domains**
- **Results in walking impairments and falls**
- **Rigorous early rehabilitation approaches needed**



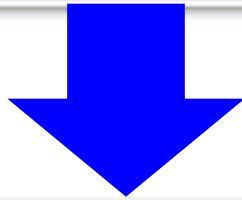


- Dance engages cognitive processes through imagery and creative movement
- Dance may improve spatial function and other aspects of cognition
 - Increased cardiovascular fitness modulates brain activations associated with spatial learning

Dance and Creative Movement:
cogent vehicle for delivering
cognitive rehabilitation

Creative movement, music and dance therapies may help walking adaptation in MCI

- **Steps with spatial & temporal structure**
- **Induce highly unusual walking patterns**



Assay and Therapy Tools:

- **Systematic administration**
- **Clear performance goals in terms of posture and timing**



We have introduced Spatiotemporal Activity Modification (STEAM) to people with cognitive impairments

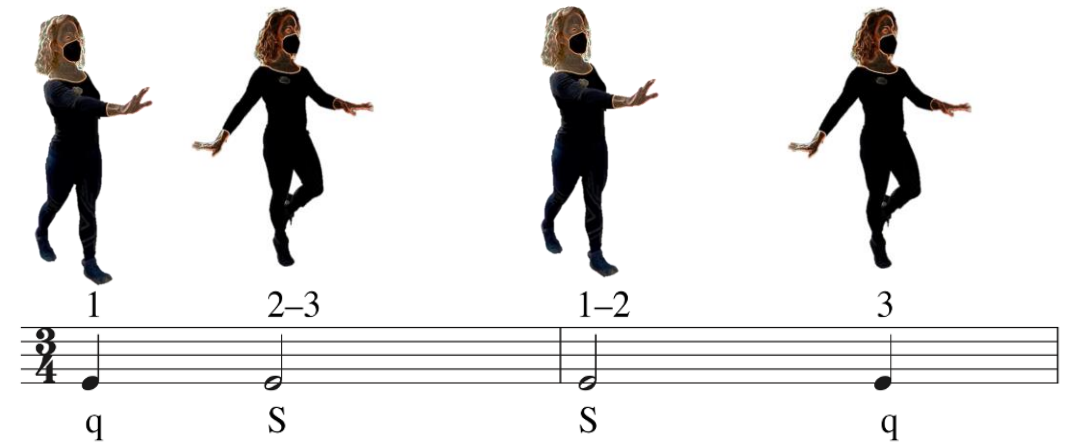
Spatial

The coordination of movement



Temporal

The rhythm of movement



Spatiotemporal Activity Modification (STEAM)

target spatial and temporal domains of gait adaptation

ISOLATED:

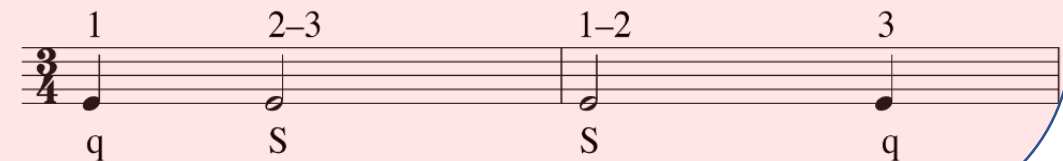
Spatial

Coordination w/in ballet framework



Temporal

Timing w/in prescribed rhythm & meter

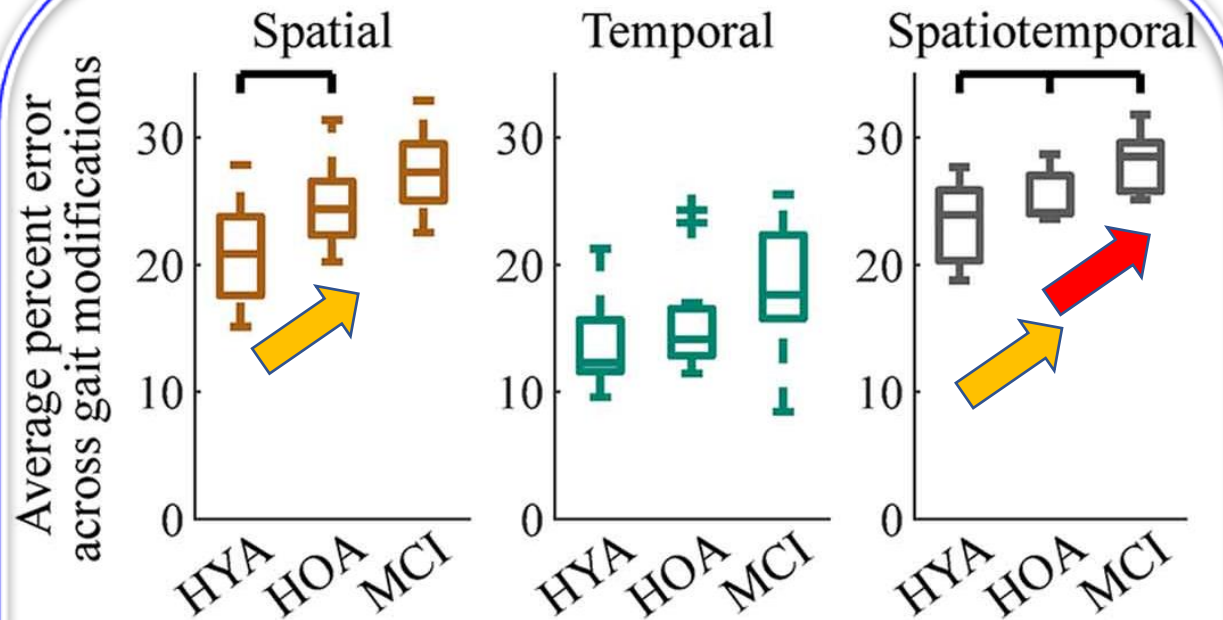


STEAM targets spatial and temporal domains of walking adaptation

COUPLED:

Spatial & Temporal

Ballet coordination patterns + prescribed rhythm & meter



STEAM assays differential effects of **aging** and **cognition** on gait modulation accuracy (*Rosenberg et al., Front. Age. Neur., 2023*)

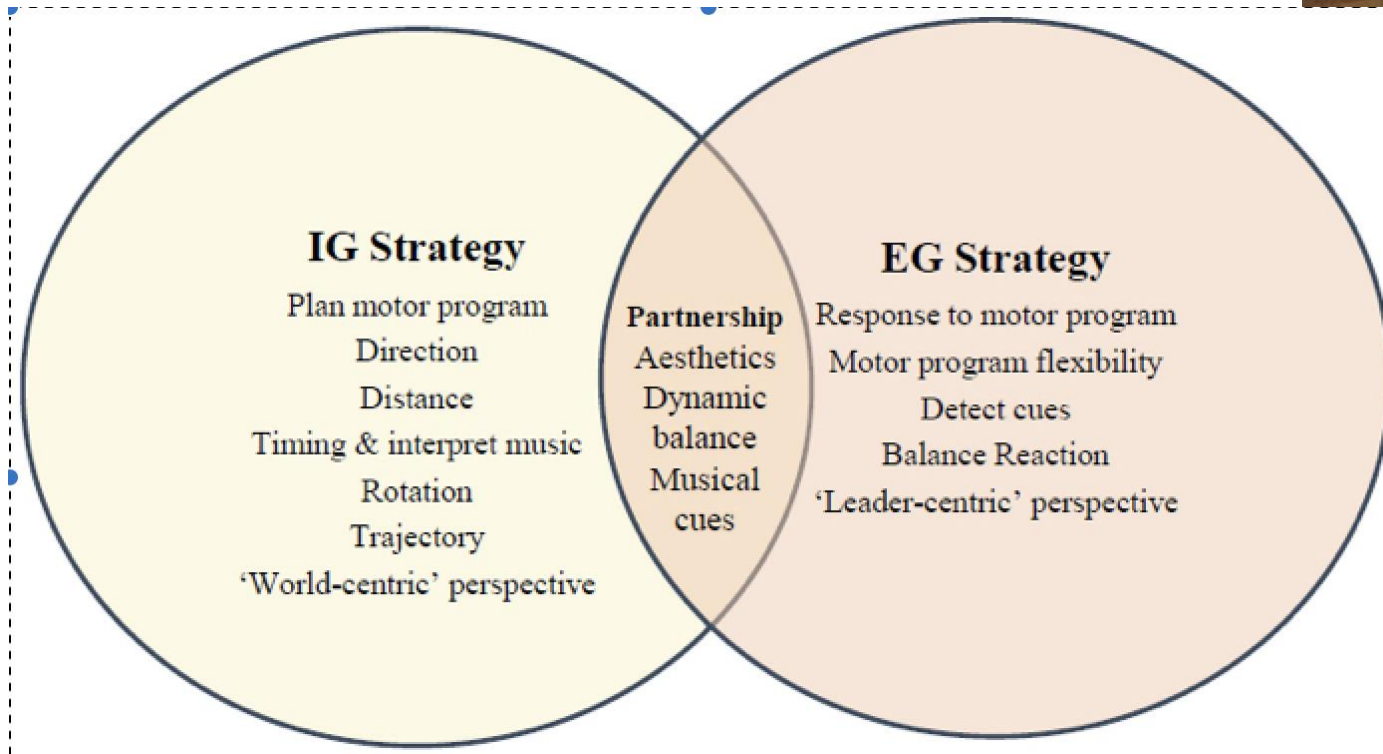
Partnered DANCE IS A
MOVEMENT
CONVERSATION?



HOW IS THIS
ACCOMPLISHED?

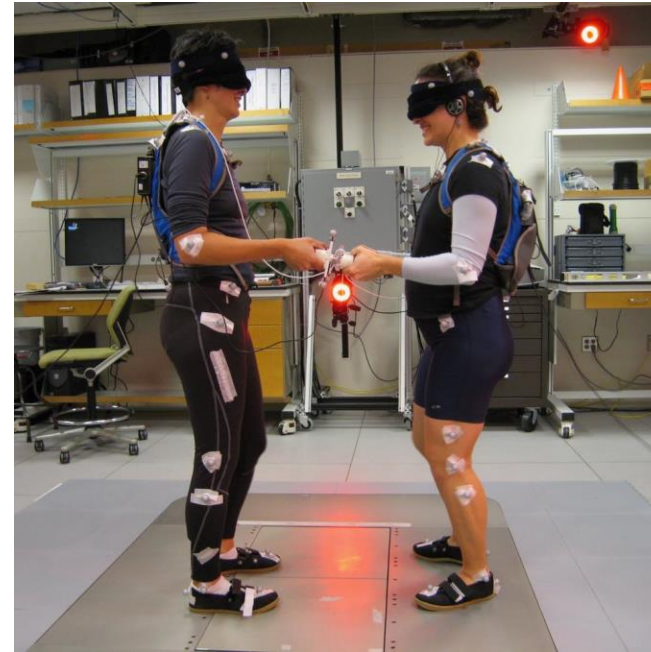
Leading- plan & select movement= internally guided movement (IG)

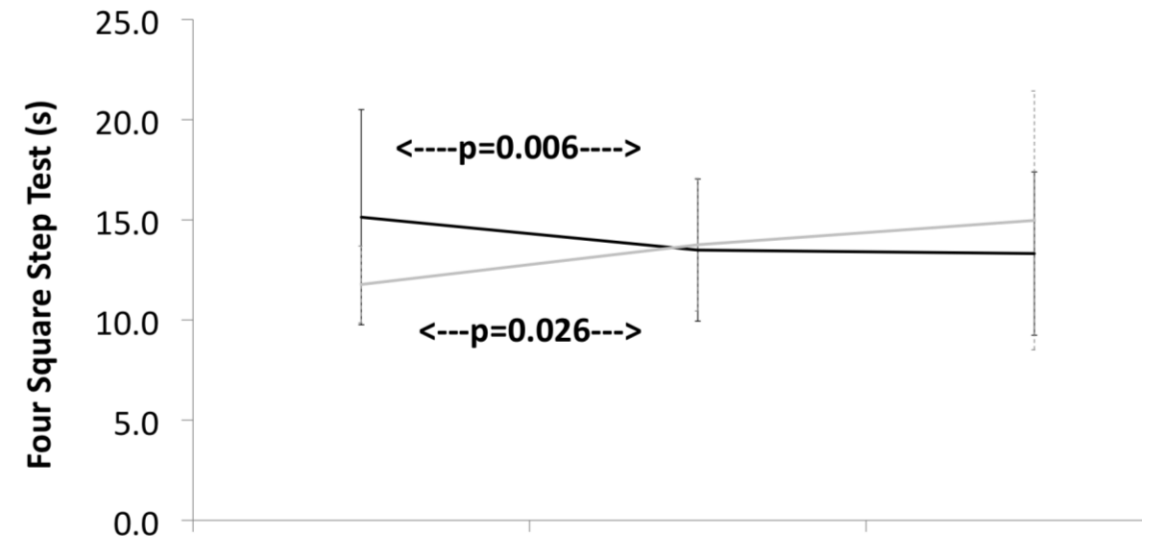
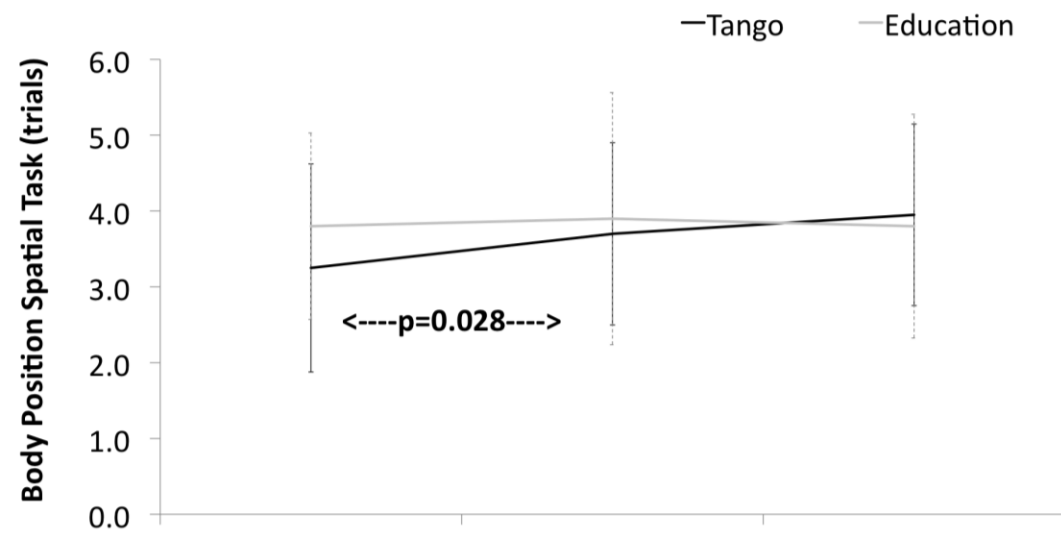
Following- response to external cues= externally guided movement (EG)



In Partnered dance, Physical and cognitive function must be Integrated in human human interaction involving human touch where goals are communicated through the hands

- Interactions forces from hands, torso or arm form a sensory and touch communication channel about movement goals during cooperative physical interactions between humans
- Follower figures out and puts into action the movement goals of the leader



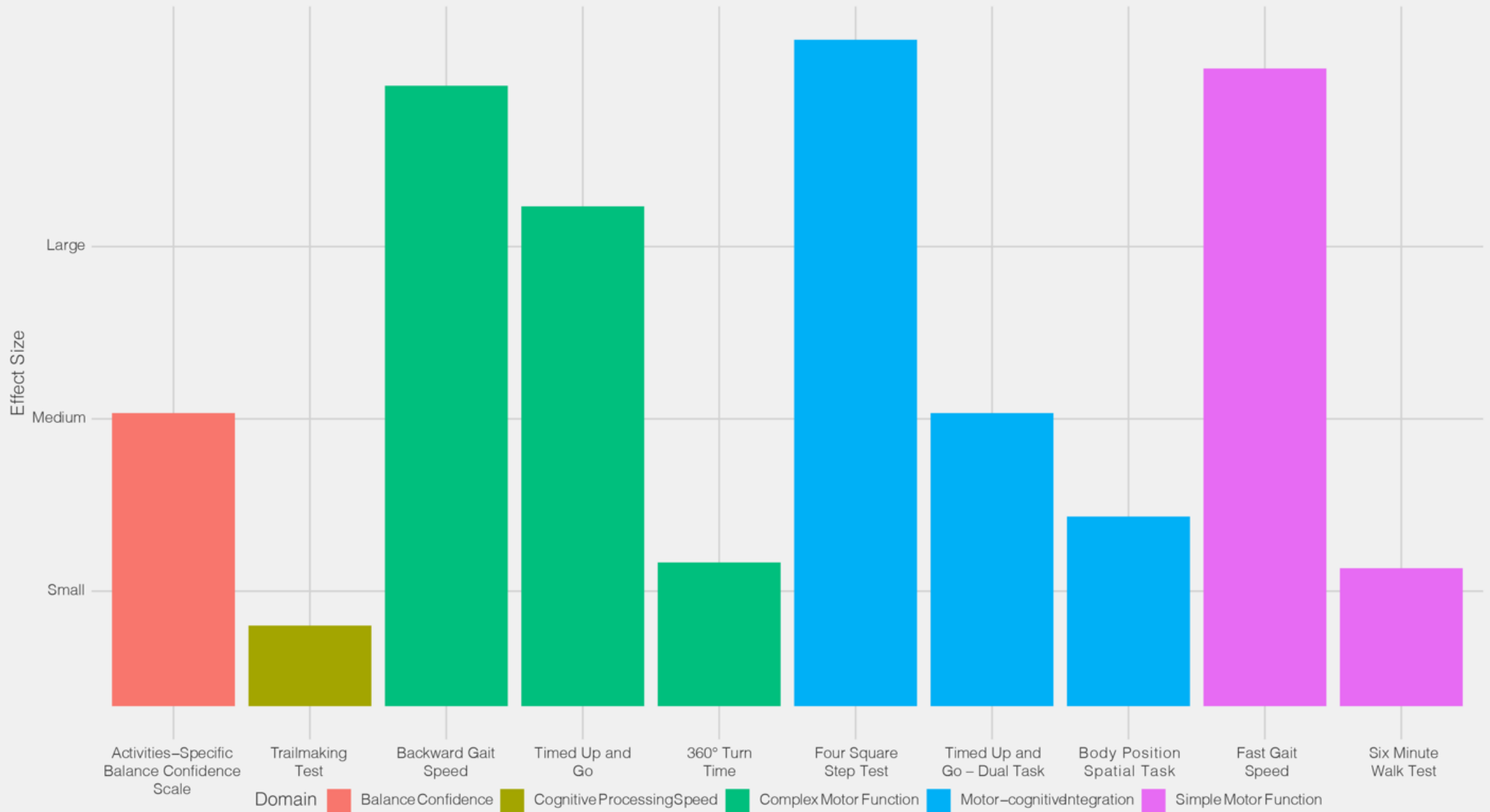


Adapted tango may improve mobility, and motor-cognitive function more than health education in older adults in independent living communities

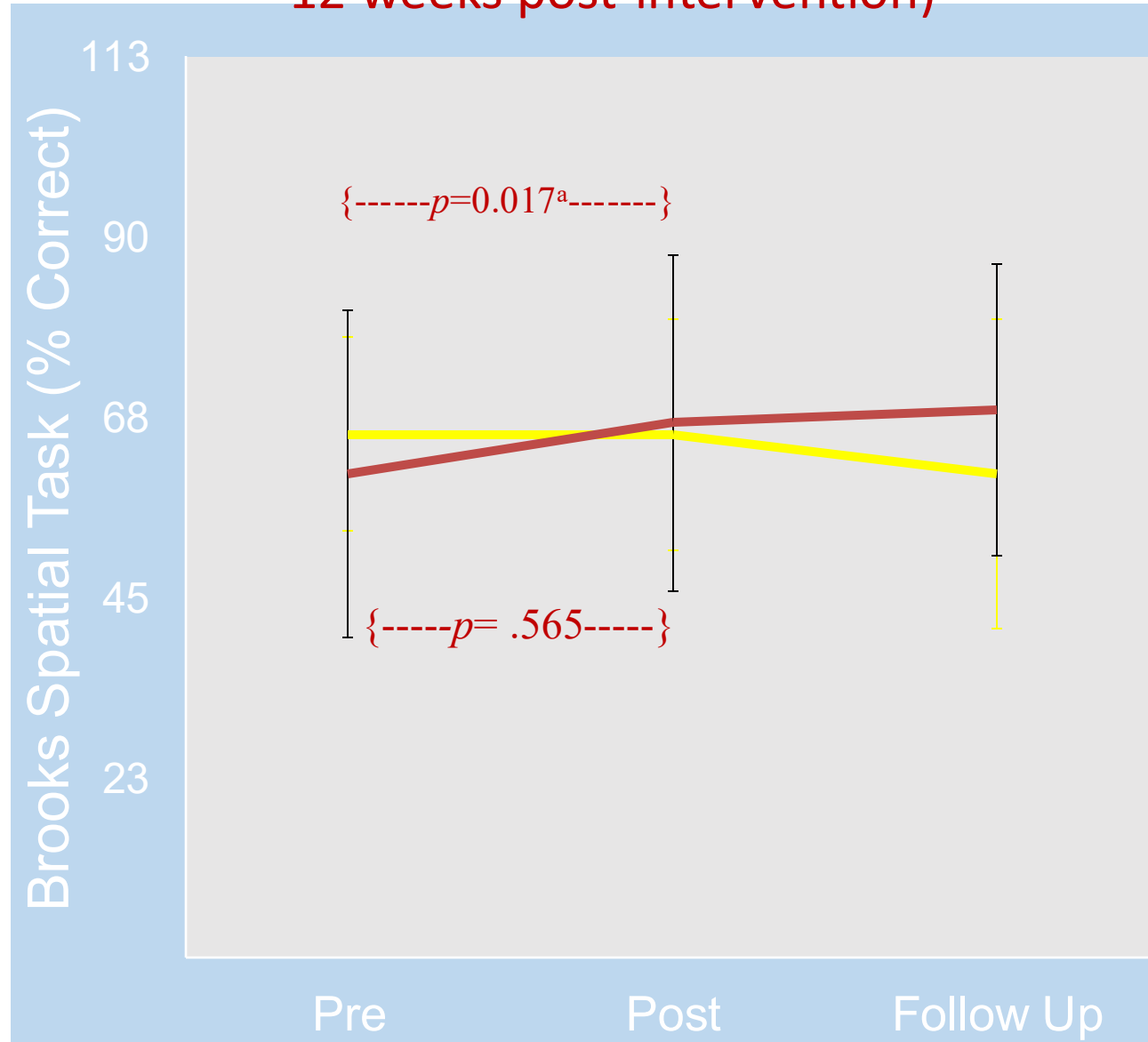
- Tango, n=62
- Education, n= 12
- Age: M=83, SD=9
 - *Hackney et al., J Am Geriatr Soc 2015*

Relative Effect of Adapted Tango vs. Education Control among Older Adults with Cognitive Impairment

Effect sizes expressed as Cohen's *d*



Spatial Cognition improved in Tango but not in Education (maintained 12 weeks post-intervention)



Significant group X time interaction; Red: Tango; Yellow: Education McKee & Hackney 2013, J Mot Behav

PRR trains motor, cognitive and social domains:

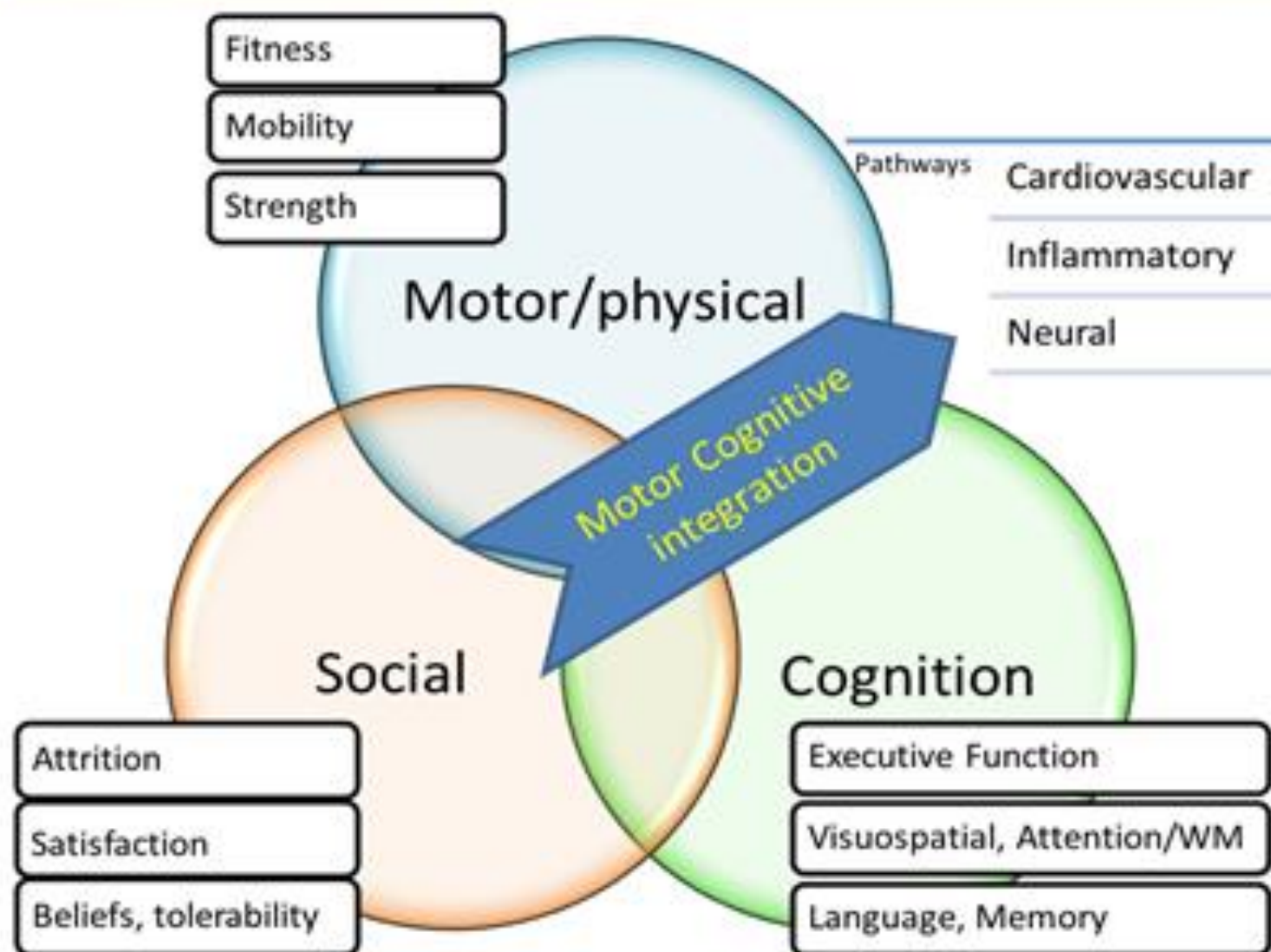


Figure 1. Partnered rhythmic rehabilitation trains motor, cognitive and social domains and may impact cardiovascular, inflammatory and neural pathways. WM: working memory

The Touch Task: A Novel Assessment of Neural Activation during Visual and Motor Touch Interactions



SETUP:

Left side – bimanual touch from a research assistant on the forearm

Right side – index finger taps along to the music with the MRI compatible Celeritas bear claw

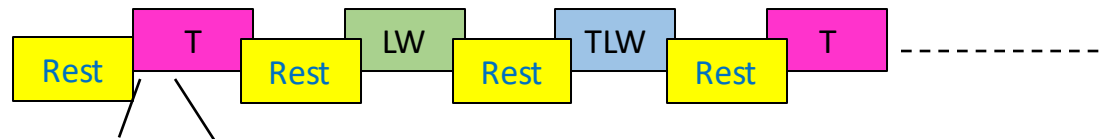
Touch (T): Receive manual touch



Listen and Watch (LW): Watch dancing while listening to Tango music



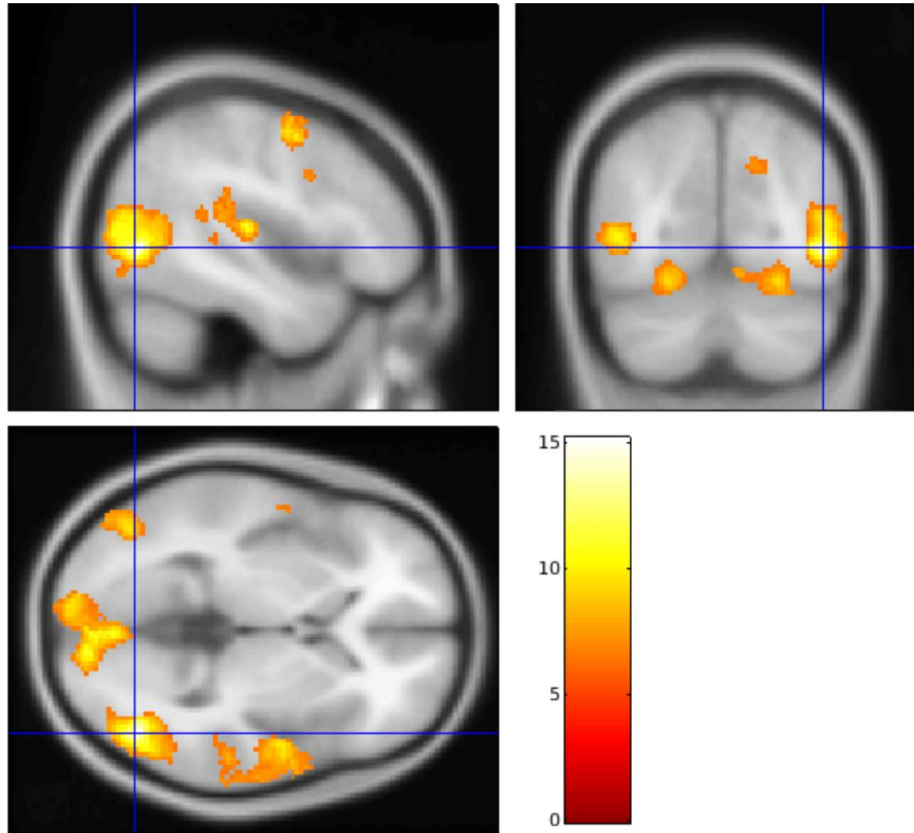
Touch, Listen, and Watch (TLW): Watch dancing while listening to Tango music and receiving manual touch



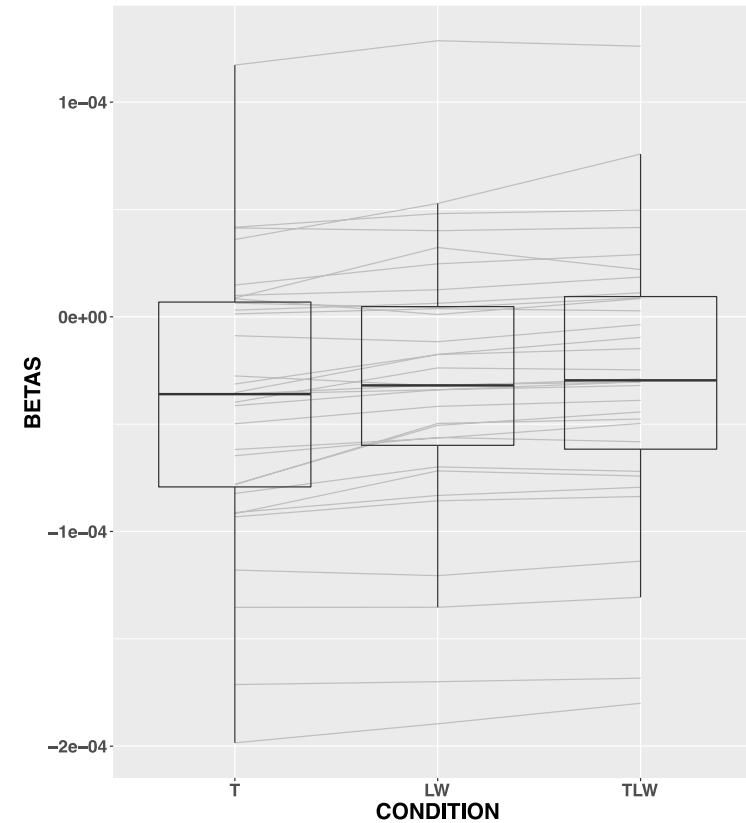
Voice Cue (3s)
(e.g. "Notice the Touch")

... 18 pseudorandomized 18-second Touch, Listen and Watch, and Touch, Listen, and Watch blocks (6 each) interspersed with 12-second rest blocks

TLW vs mean(T, LW)



Posterior Cingulate Cortex



PCC: Cluster unique to TLW vs mean (T + LW)

One other unique cluster: left primary somatosensory cortex

Posterior Cingulate cortex is highly involved in variety of cognitive functions: memory, navigation, decision-making and emotional processing – also part of Default mode network which is active during internally focused thought.



ELSEVIER

Contents lists available at ScienceDirect

Cerebral Circulation - Cognition and Behavior

journal homepage: www.sciencedirect.com/journal/cerebral-circulation-cognition-and-behavior

A Pilot randomized clinical trial of adapted tango to improve cognition and psychosocial function in African American women with family history of Alzheimer's disease (ACT trial)

Whitney Wharton^a, Leanne Jeong^b, Liang Ni^c, Allison A. Bay^c, Ryan J. Shin^b,
Lauren E. McCullough^d, Hayley Silverstein^c, Ariel R. Hart^e, Dominika Swieboda^a, William Hu^f,
Madeleine E. Hackney^{a,c,g,h,i,*}

^a Emory University School of Nursing, Atlanta, GA, 30307, USA

^b Emory University College of Arts and Sciences, 550 Asbury Circle, Atlanta, GA, 30322, USA

^c Division of Geriatrics and Gerontology, Department of Medicine, Emory School of Medicine, 1841 Clifton Rd NE, Atlanta, GA, 30307, USA

^d Emory University Rollins School of Public Health, 1518 Clifton Rd., Atlanta, GA, 30329, USA

^e University of Georgia, Athens, GA, USA

^f Division of Cognitive Neurology, Rutgers Robert Wood Johnson Medical School, 125 Paterson Street, New Brunswick, NJ 08901, USA

^g Atlanta VA Center for Visual and Neurocognitive Rehabilitation, 1670 Clairmont Rd., Decatur, GA, 30033, USA

^h Department of Rehabilitation Medicine, Emory School of Medicine, 1648 Pierce Dr. NE, Atlanta, GA, 30307, USA

ⁱ Birmingham/Atlanta VA Geriatric Research Clinical and Education Center

ARTICLE INFO

Keywords:

Alzheimer's disease
African Americans
Female
Biomarkers
Dance therapy
Caregivers
Inflammation
Pilot Projects

ABSTRACT

Alzheimer's disease (AD) is a devastating, progressive neurodegenerative disease resulting in memory loss and a severe reduction in the ability to perform activities of daily living. Ethnicity-related genetic factors promoting the development of dementias among African Americans (AA) and increased risk among women for developing AD indicates that AA women with a parental history of AD are at great risk for developing AD. This phase I study assessed the impact of a 12 week, 20-lesson adapted Argentine Tango intervention ($n = 24$) to a no-contact control group ($n = 10$) on measures of plasma inflammatory markers, cognition, and motor and psychosocial performance in middle-aged AA woman at increased risk for AD by virtue of parental history. Some woman ($n = 16$) were also caregivers; thus, the impact of the intervention on caregiving burden was examined in this subset. Preliminary analysis of efficacy was conducted with significance tests on biomarkers and key measures of cognition, including visuospatial and executive function, balance, and strength. After 12 weeks, Tango participants had significantly decreased inflammatory cytokine, including reductions in IL-7 ($p = 0.003$), IFN- γ ($p = 0.011$), TNF α ($p = 0.011$), and MCP-1 ($p = 0.042$) compared to controls. Large effects were noted for the Tango group on tests of executive functioning ($d = 0.89$), and inhibition ($p = 0.031$). Participants in Tango improved in dynamic and static balance ($p = 0.018$) and functional lower body strength ($p = 0.023$). Secondary assessment revealed trends favoring the intervention group were noted in spatial cognition and executive function. Moderate effects were noted in caregiving burden measures among the subset of caregivers. These data demonstrate substantial reductions in inflammatory biomarkers along with cognitive and motor improvements through a non-pharmacologic, affordable intervention among a small, well-characterized cohort of AA women with a parental history of AD.

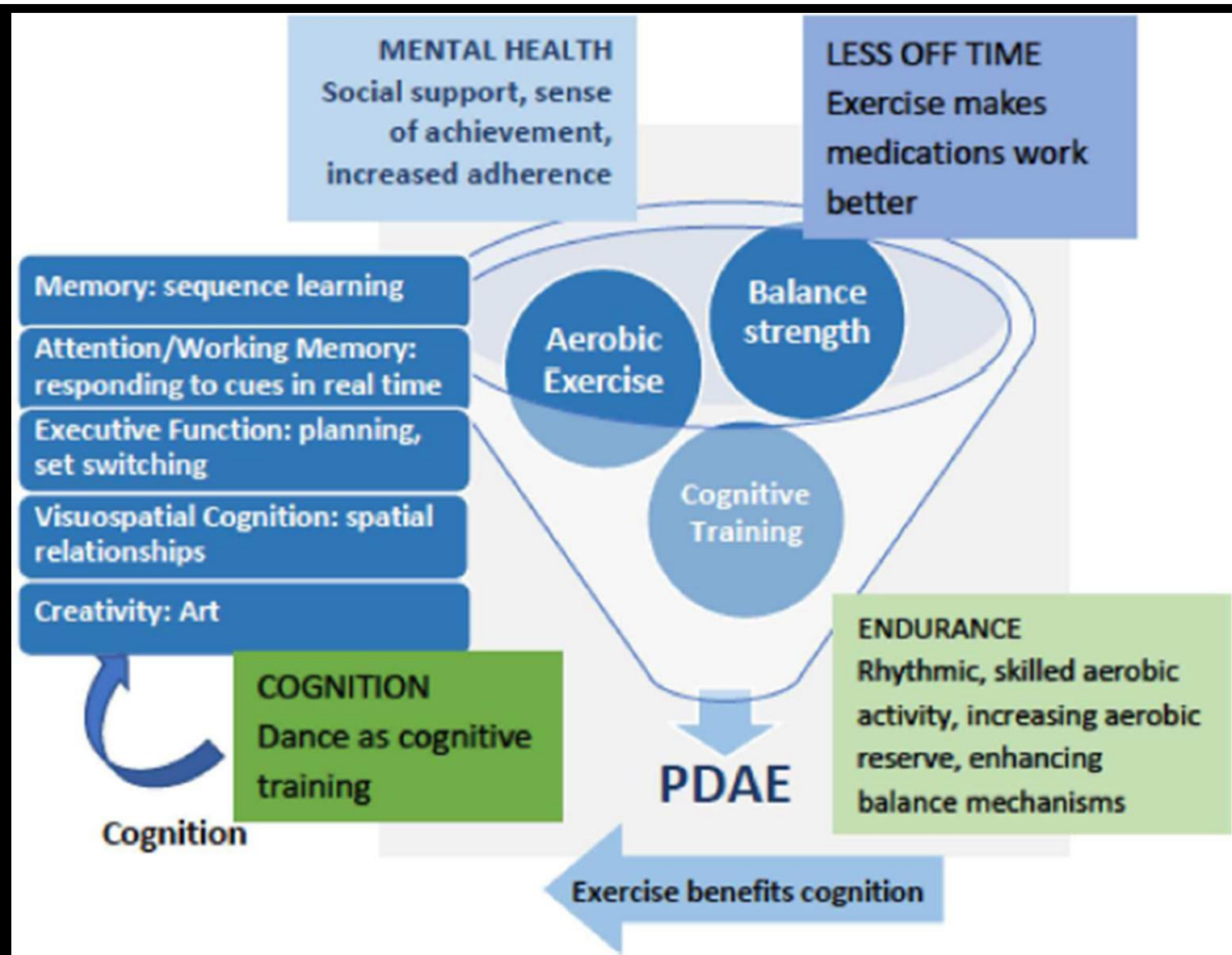
Tango participants had significantly decreased IL-7, IFN- γ , TNF- α , and MCP, compared to control after the 12- week trial

Table 2

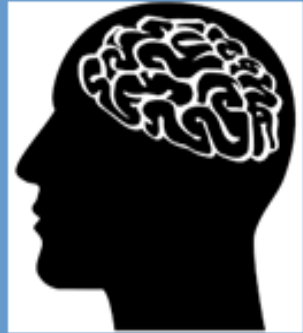
Pre-test, post-test and change score values for Biomarkers (pg/mL) in Tango and Control groups (N Tango: 24, N Control: 10).

	Pre-test Tango	Control	Post-test Tango	Control	Change Tango	Control	Mean Difference (CI)	P- value	FDR (l/ m) Q ²	Cohen's D (95% CI)	N
IL-7	1.19 ± 1.36	1.13 ± 1.58	0.94 ± 1.02	1.4 ± 1.53	-0.49 ± 0.83	0.55 ± 0.95	-1.04 (-1.7, -0.4)	0.003	0.005	-1.2 (-2, -0.4)	34
IFN-γ	11.68 ± 7.03	11.18 ± 6.17	10.23 ± 5.85	12.55 ± 5.59	-1.45 ± 2.99	1.37 ± 2.14	-2.82 (-4.9, -0.7)	0.011	0.009	-1.02 (-1.8, -0.2)	34
TNF-α	10.71 ± 4.67	10.66 ± 4.54	10.26 ± 4.42	10.91 ± 3.63	-0.2 ± 0.56	0.42 ± 0.7	-0.62 (-1.1, -0.2)	0.011	0.014	-1.03 (-1.8, -0.2)	33
MCP-1	979.67 ± 355.42	843.48 ± 288.69	939.62 ± 353.53	896.99 ± 310.68	-4.05 ± 30.3	21.57 ± 36.46	-25.62 (-50.3, -1)	0.042	0.018	-0.8 (-1.6, 0)	34
TGF-α	0.6 ± 1.1	0.33 ± 0.56	0.46 ± 0.89	0.39 ± 0.54	-0.25 ± 0.66	0.27 ± 0.76	-0.52 (-1, 0)	0.053	0.023	-0.76 (-1.5, 0)	34
IL-8	4.45 ± 1.19	3.99 ± 1.35	3.96 ± 1.1	4.54 ± 0.93	-0.64 ± 2.86	0.56 ± 1.43	-1.2 (-2.7, 0.3)	0.122	0.027	-0.47 (-1.3, 0.3)	33
MDC	7.54 ± 12.26	4.04 ± 1.89	6.9 ± 9.73	4.6 ± 1.96	-40.05 ± 145.55	53.51 ± 185.1	-93.56 (-214.4, 27.3)	0.125	0.032	-0.59 (-1.4, 0.2)	34
IL-9	170.78 ± 53.22	166.26 ± 52.13	166.72 ± 48.99	187.83 ± 65.05	-0.13 ± 0.35	0.06 ± 0.31	-0.19 (-0.5, 0.1)	0.149	0.036	-0.56 (-1.3, 0.2)	34
IL-10	5.46 ± 1.42	5.45 ± 1.9	5.26 ± 1.24	5.87 ± 1.77	-0.45 ± 2.33	0.25 ± 1.65	-0.7 (-2.4, 1)	0.397	0.041	-0.32 (-1.1, 0.4)	34
CRP	0.35 ± 0.37	0.4 ± 0.61	0.27 ± 0.32	0.41 ± 0.25	-0.08 ± 0.27	0.01 ± 0.44	-0.09 (-0.4, 0.2)	0.581	0.045	-0.26 (-1, 0.5)	34
SAP	0.27 ± 0.1	0.28 ± 0.08	0.28 ± 0.12	0.31 ± 0.07	0.02 ± 0.06	0.02 ± 0.1	-0.01 (-0.1, 0)	0.764	0.050	-0.11 (-0.9, 0.7)	34

The PAIRED Merit Trial I01 RX002967



PAIRED Study
*Partnered Dance Aerobic
Exercise:
A Neuroprotective, Motor
and Cognitive
Intervention in
Parkinson's Disease*



**Help us find out how
exercise affects the brain**

DANCE



WALKING

**We are looking for Parkin-
son's patients who experi-
ence OFF time and are willing
to dance or walk twice a
week for 3 months and then
once a week for 13 months**

. Are you interested?

IRB112770; Grant RX002967

Dr. Madeleine E. Hackney, Principal Investigator
mehackn@emory.edu

- Different types of exercise may improve patient perception of medication effectiveness and slow neurodegeneration.
- We will examine the effects of walking versus partnered dance on OFF-time, rate of brain degeneration and spatial cognition.

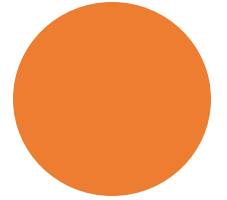


EMORY
UNIVERSITY
SCHOOL OF
MEDICINE

U.S. Department of Veterans Affairs
Atlanta VA Health Care System

DREAMS (Developing Research Education and Advocacy for Multicultural Seniors)

- Program developed with funding from the Emory Roybal Center
- TOTALLY REMOTE
- 8-week distance-learning and caregiver empowerment program delivered in podcast and text formats
- Care partners and people with LBD and PD are invited



Other studies!!

- HILITE: PD – dance and walking
- STEADI-AVATAR: Adults aged 65+years, some with dementia, some with MCI, exercise program, mostly remote!
- Fall Prevention Pathways: Adults aged 65+ years, exercise program, mostly remote!
- ZEST-E: PD, Exercise with a robot
- Contact me at mehackn@emory.edu if interested!

Meet the Team



Manager

- Allison Bay

Nurse

- Angela Welch Stong

Coordinators

- Tharushi Samaraweera
- Ariyana Bozorg
- Ariel Hart
- Hayley Silverstein
- Shamekia Winding
- Amber Martinez

Collaborators

- Ihab Hajjar, MD
- Whitney Wharton, PhD
- Lauren McCullough, PhD
- Molly Perkins, PhD, MA
- Rebecca Dillard, MA
- Lena Ting, PhD
- J. Lucas McKay, PhD, MSCR
- Jonathan Drucker, PhD
- Venkatagiri Krishnamurthy, PhD
- Crystal Bennet, RN, PhD
- Felicia Goldstein, PhD
- Deqiang Qiu, PhD

Funding:

- Department of Veterans Affairs Career Development Award N0870W
- Parkinson's Foundation, National Institutes of Health
- National Science Foundation
- Patient Centered Outcomes Research Institute
- Emory Roybal Center

Post docs

- Jolie Barter, PhD
- Amit Abraham, PhD

Graduate Students

- Morgane Prime (MS)
- Chaejin Kim (MPH)
- Amrit Kashyap (PhD)
- Xuan Zhang (PhD)
- Eliza Lewis
- Riana Peskopos

Undergraduate Students

- Ruhee Patel
- Hannah Lally
- Nicole Schindler
- Smrithi Ramachandran
- Ahauve Orusa
- Isaac Andrade
- Anjali Shah
- Maria Ramos
- Emmie Cohen
- Manal Zafar
- Jessica Battisto

Mentors

- Krishnankutty Sathian, PhD
- Steven Wolf, PhD, Bruce Crosson, PhD, Daniel Corcos, PhD



Questions?

mehackn@emory.edu

