

Behavioral and Brain Effects of Videogame-Based Balance Training in Autism

Brittany G. Travers, Ph.D.

Associate Professor

Occupational Therapy Program, Department of Kinesiology

Thank you!

To the participants and their families!

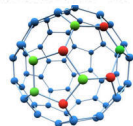
Motor & Brain Development Lab:



Amazing Collaborators on This Work: Andy Alexander, Doug Dean, Anthony Ellertson, Janet Lainhart, Andrea Mason, Leigh Ann Mrotek, Steve Kecskemeti, Greg Kirk, & Nagesh Adluru

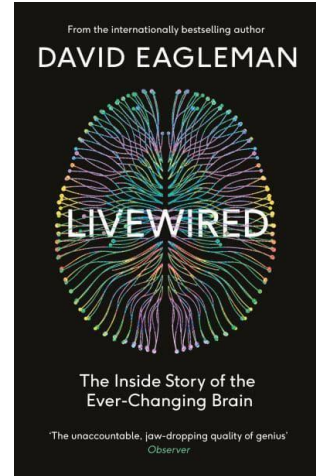


THE HARTWELL FOUNDATION

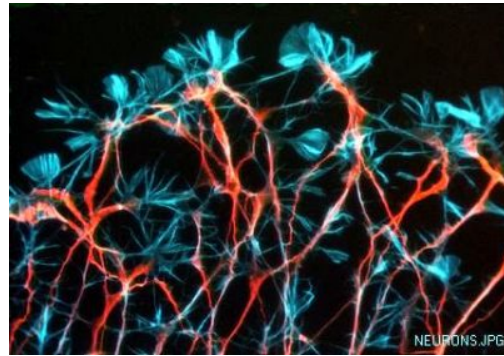


Neuroplasticity:

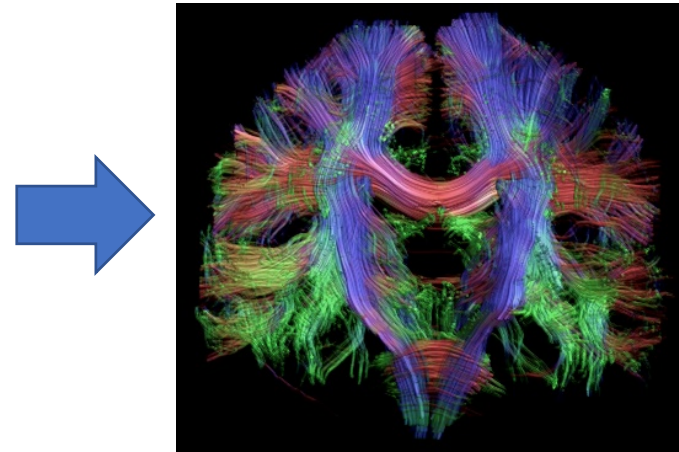
The brain is NOT static, but adapting



Repeated experience



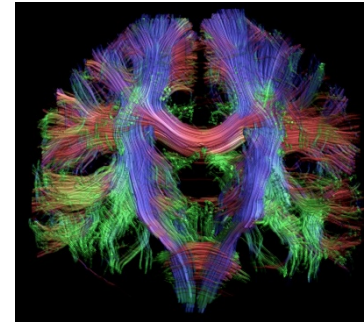
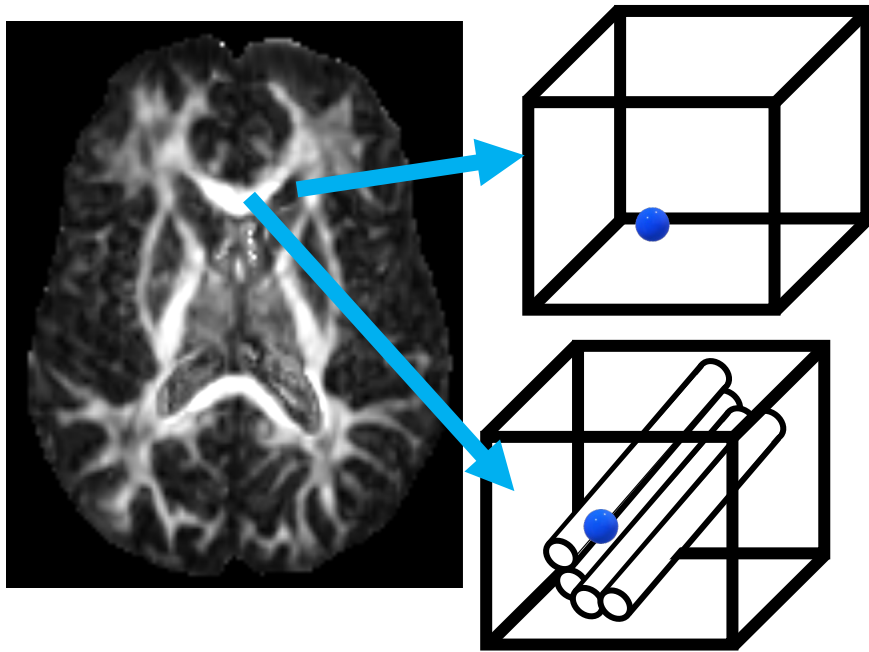
Hebbian: neurons that 'fire together, wire together'.



Changes to the wiring (white matter information highways) of the brain

Promising method to study brain wiring

Diffusion Tensor Imaging



Intracellular Volume Fraction (ICVF)

Amount (volume) of white matter 'wiring'

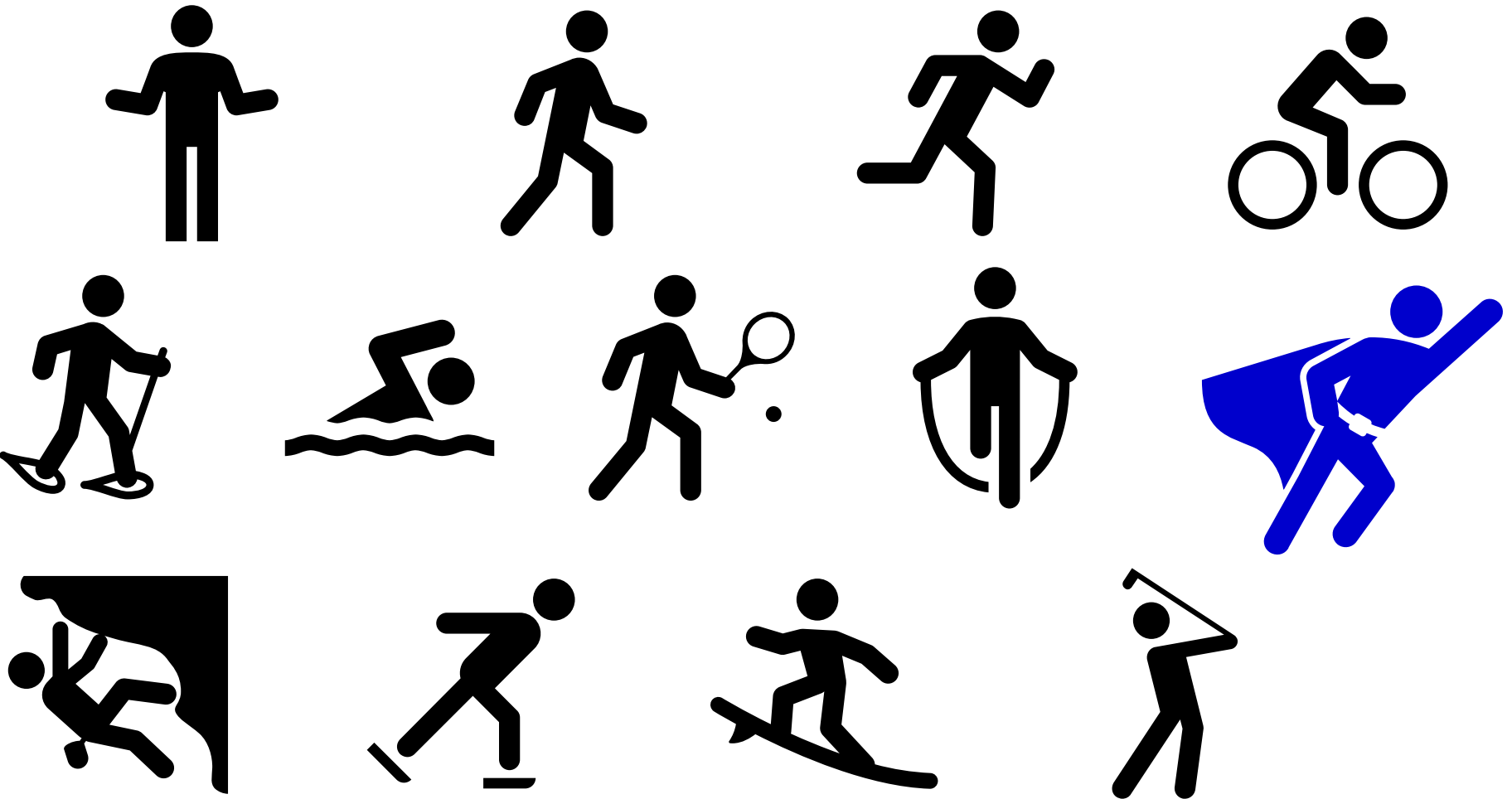


Orientation Dispersion Index (ODI)

How spread out the wiring is



Motor interventions particularly effective in changing the brain



Dayan & Cohen, 2011; Draganski et al., 2004; Drijckoningen et al., 2015; Giboin et al., 2019; Rogge et al., 2017; Scholz et al., 2009; Sehm et al., 2014; Taube et al., 2007; Taubert et al., 2011, 2010

Balance training changes the brain in non-autistic individuals

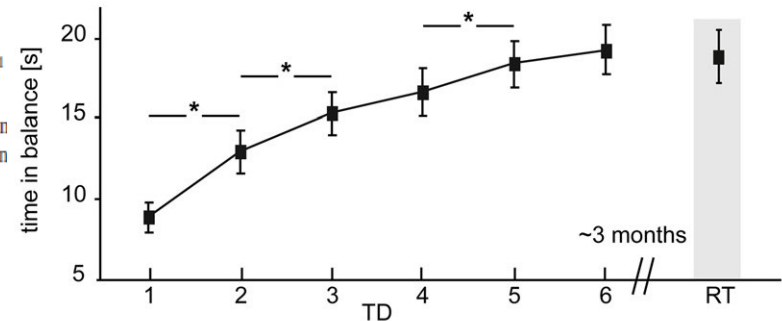
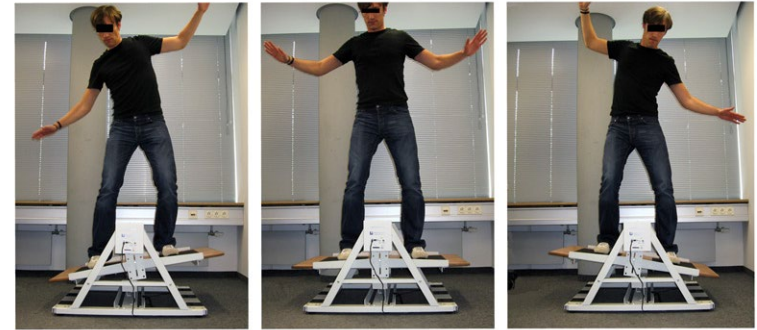
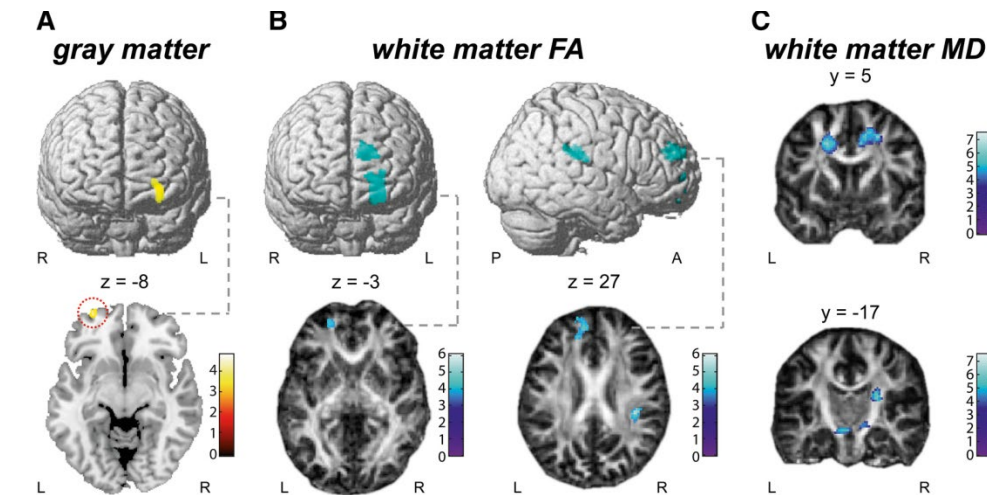
11670 • The Journal of Neuroscience, September 1, 2010 • 30(35):11670–11677

Behavioral/Systems/Cognitive

Dynamic Properties of Human Brain Structure: Learning-Related Changes in Cortical Areas and Associated Fiber Connections

Marco Taubert,¹ Bogdan Draganski,^{1,2,3*} Alfred Anwander,^{1*} Karsten Müller,¹ Annette Horstmann,¹ and Patrick Ragert¹

¹Max Planck Institute for Human Cognitive and Brain Sciences, Department of Neurology, D-04103 Leipzig, Germany, ²Department of Neurosciences, Centre Hospitalier Universitaire Vaudois, University of Lausanne, 1011 Lausanne, Switzerland, and ³Mind Brain Institute, Humboldt University, D-10117 Berlin, Germany



But what about in autism?

Important to study motor interventions in autism



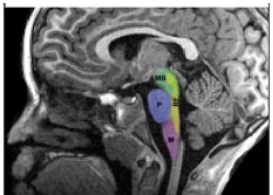
Motor challenges **highly prevalent** (Bhat et al., 2021; Miller et al., 2021; Ming et al., 2007; Surgent et al., 2020)



Balance challenges common (Lim et al., 2017)

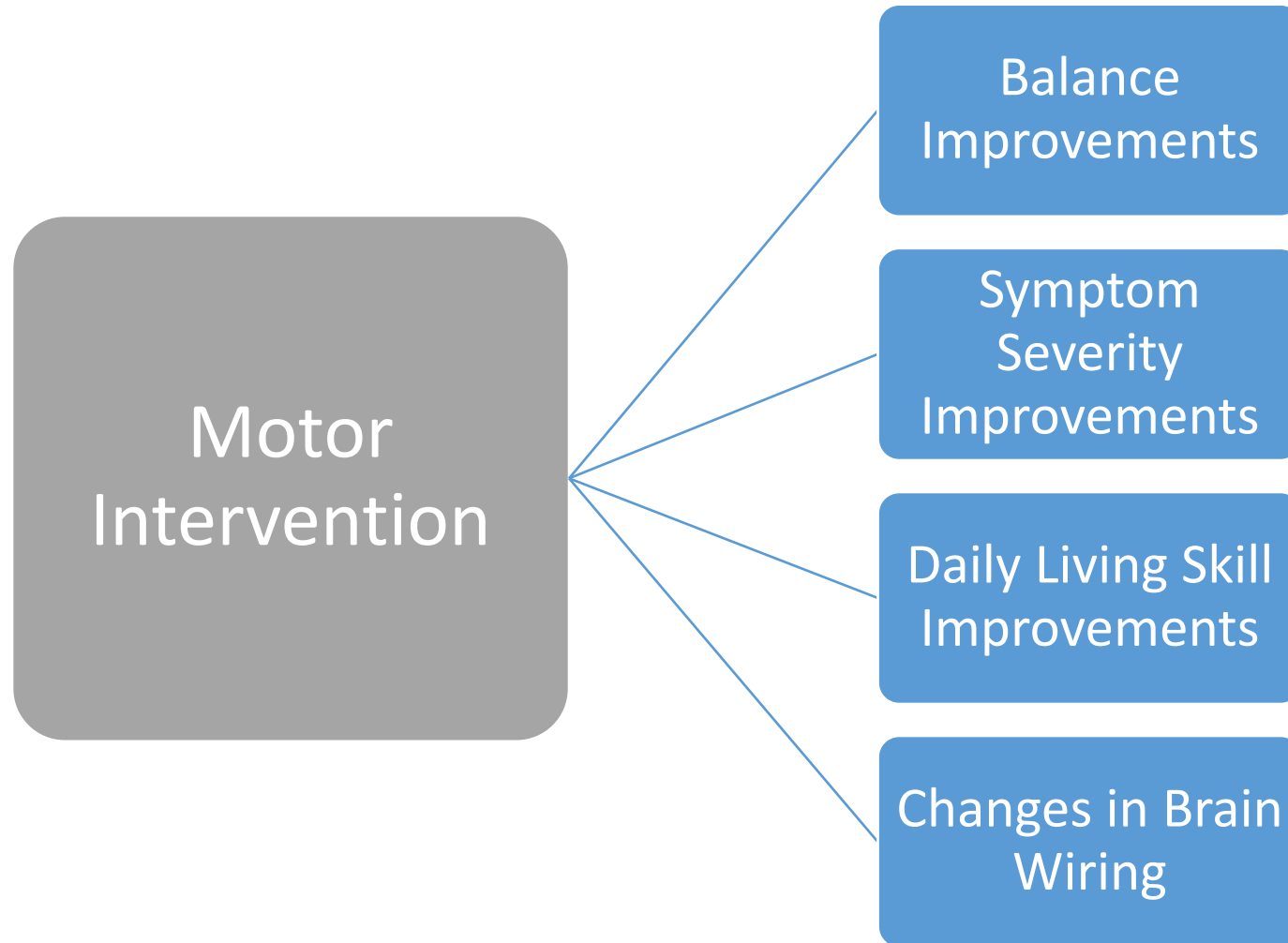


Motor challenges linked with **autism symptom severity** (Ardalan et al., 2020; Radonovich et al., 2013; Travers et al., 2013; 2015) and **poorer daily living skills** (Fisher et al., 2018; Jasmin et al., 2009; Travers et al., 2017)

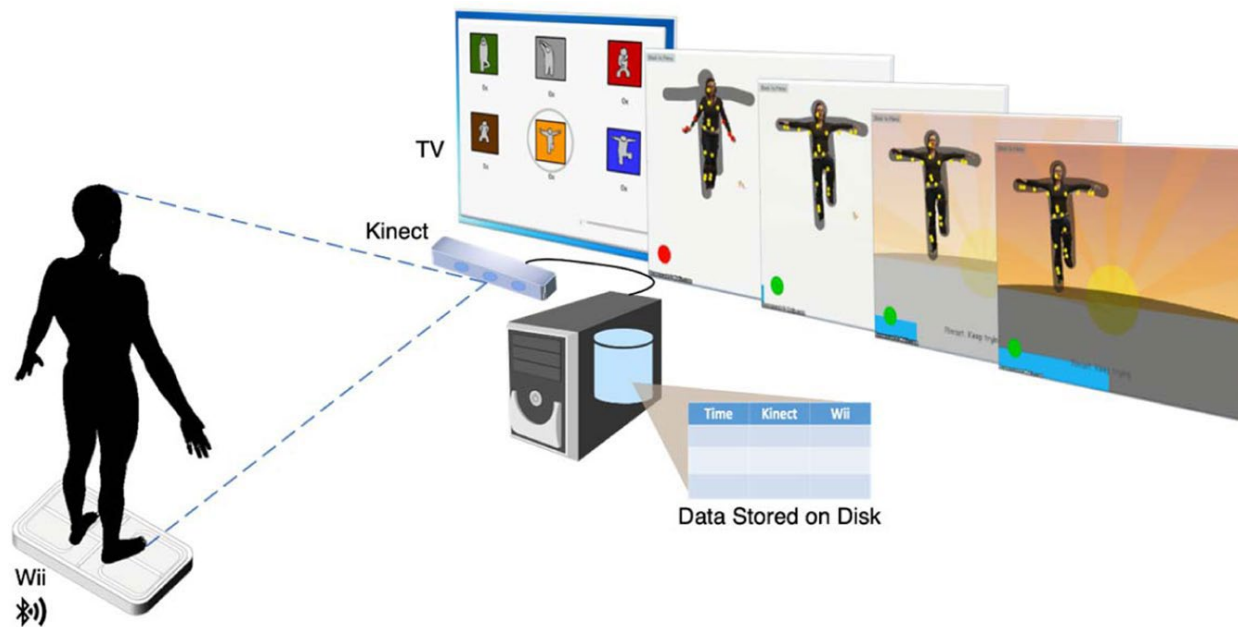


Early-developing **brainstem** linked to both motor challenges and symptom severity (Travers et al., 2013; Hanaie et al., 2013)

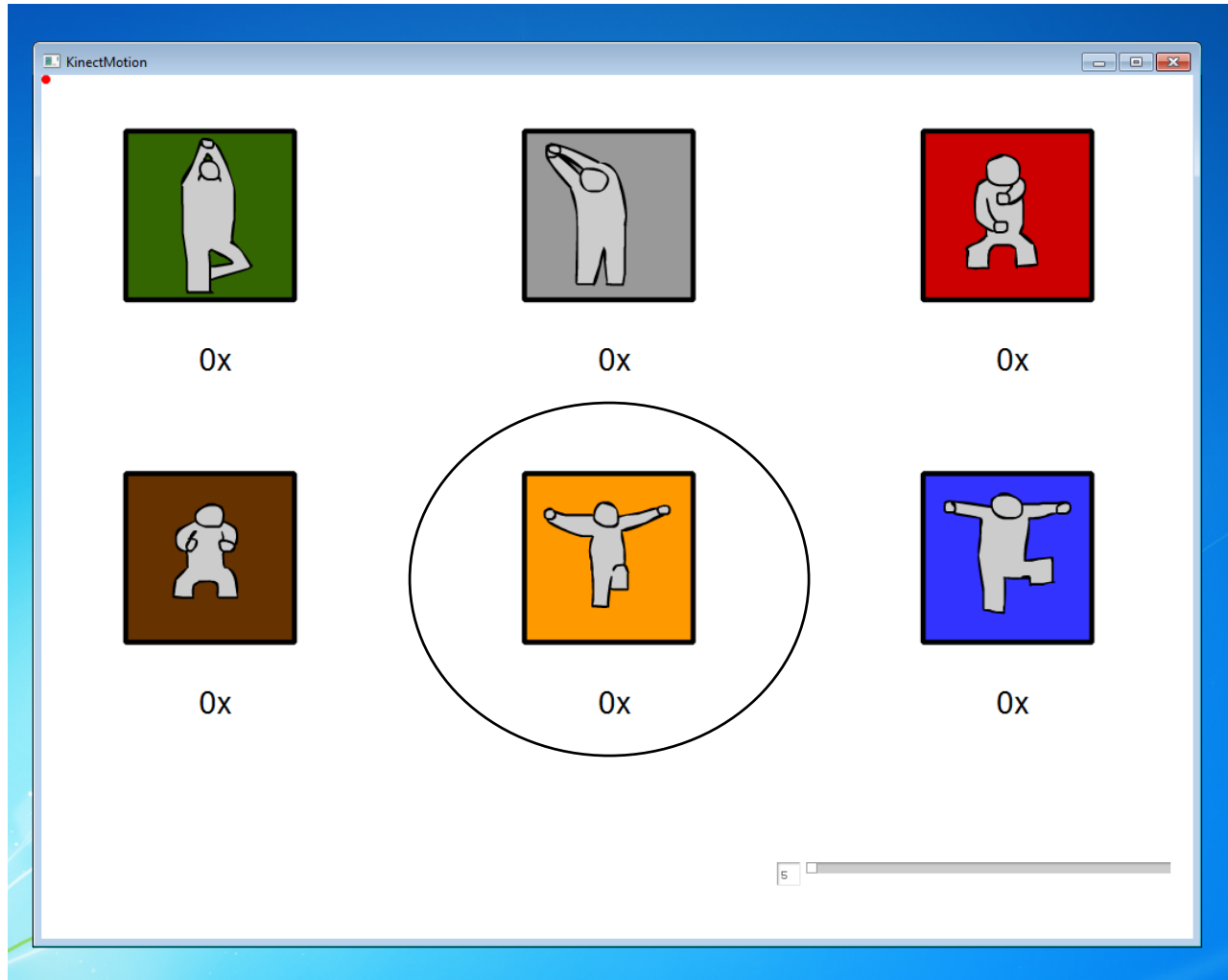
Can motor interventions impact behaviors and the brain in autism?



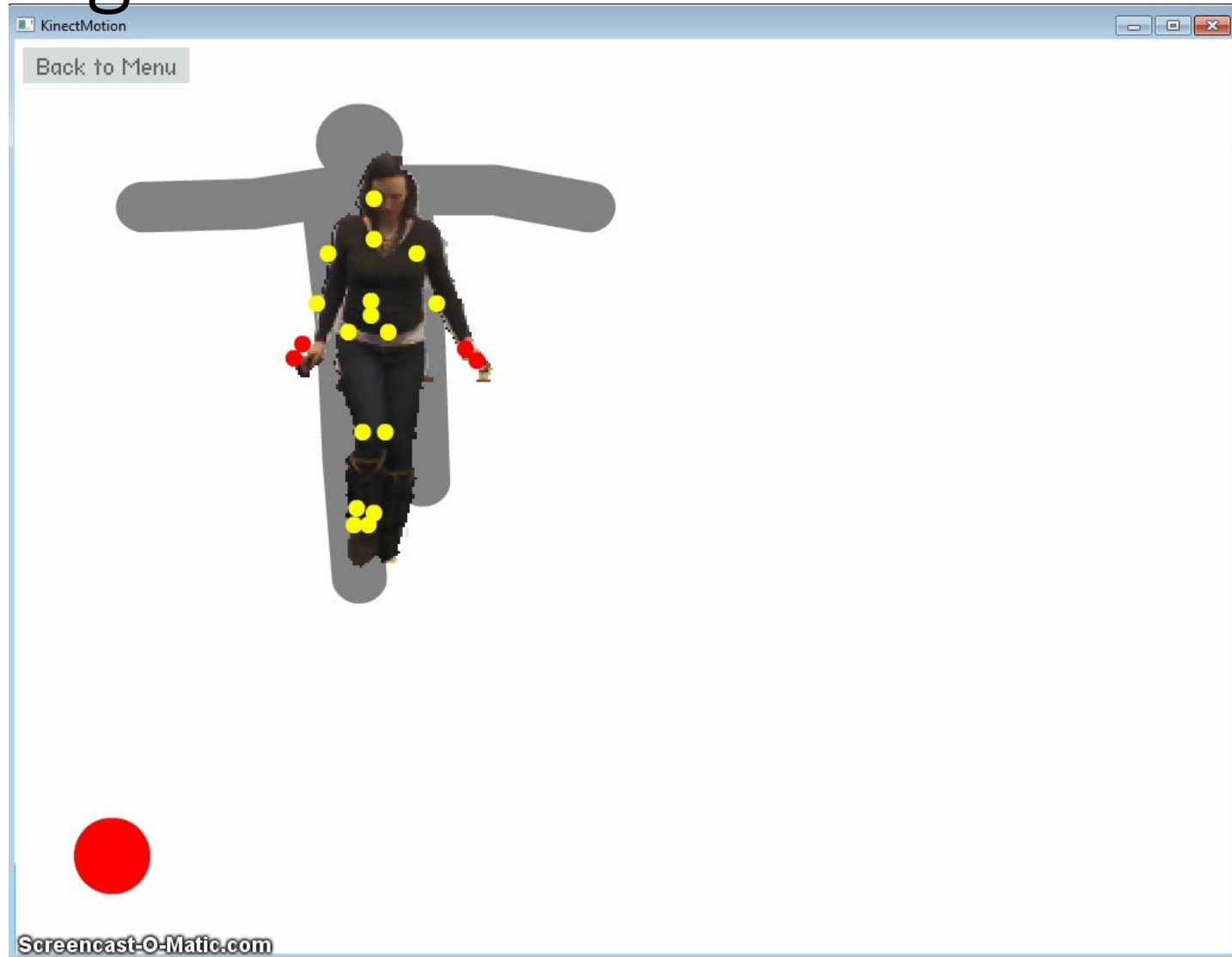
Videogame-based balance training with visual biofeedback



Videogame-based balance training with visual biofeedback



Videogame-based balance training with visual biofeedback



Training found to improve balance and be enjoyable/beneficial

J Autism Dev Disord
DOI 10.1007/s10803-017-3310-2



ORIGINAL PAPER

Biofeedback-Based, Videogame Balance Training in Autism

Brittany G. Travers^{1,2,3} · Andrea H. Mason² · Leigh Ann Mrotek^{4,5} ·
Anthony Ellertson⁶ · Douglas C. Dean III³ · Courtney Engel^{1,2,3} · Andres Gomez³ ·
Olga I. Dadalko³ · Kristine McLaughlin³

© Springer Science+Business Media, LLC 2017

Abstract The present study examined the effects of a visual-based biofeedback training on improving balance challenges in autism spectrum disorder (ASD). Twenty-nine youth with ASD (7–17 years) completed an intensive 6-week biofeedback-based videogame balance training. Participants exhibited training-related balance improvements that significantly accounted for postural-sway improvements outside of training. Participants perceived the training as beneficial and enjoyable. Significant moderators of training included milder stereotyped and ritualistic behaviors and better starting balance. Neither IQ nor BMI moderated training. These results suggest that biofeedback-based balance training is associated with balance improvements in youth with ASD, most robustly in those with less severe repetitive behaviors

and better starting balance. The training was perceived as motivating, further suggesting its efficacy and likelihood of use.

Keywords Postural stability · Motor · Video game · Technology-based interventions

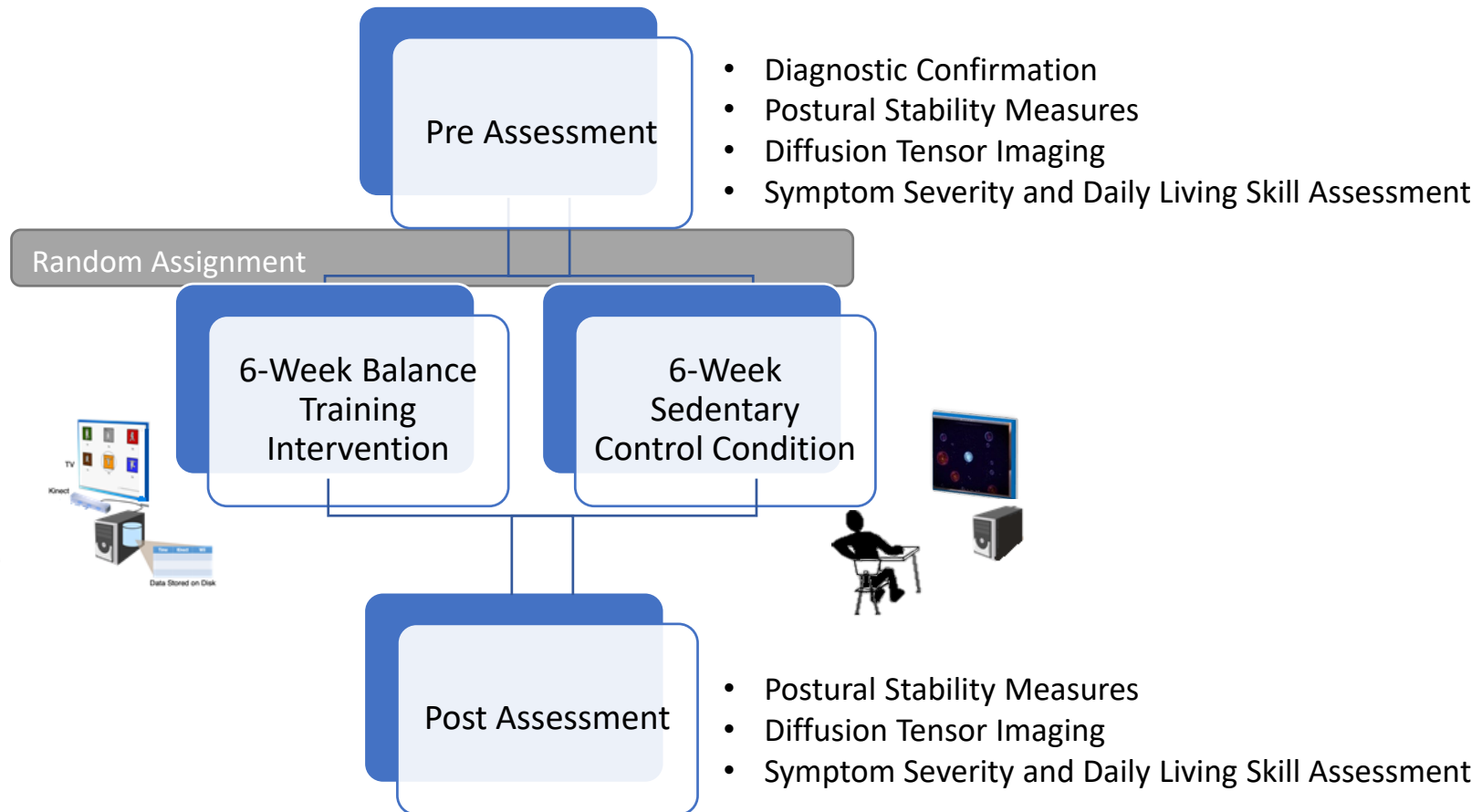
Introduction

As bipedal creatures, postural control is a fundamental aspect of human behavior, allowing us to stand, walk, play, and interact with the world around us. However, a number of individuals with autism spectrum disorder (ASD) struggle with postural stability (for a review see Lim et al. 2017). These postural stability difficulties have been linked to autism symptom severity (Radonovich et al. 2013; Travers

Electronic supplementary material The online version of this article (doi:10.1007/s10803-017-3310-2) contains supplementary

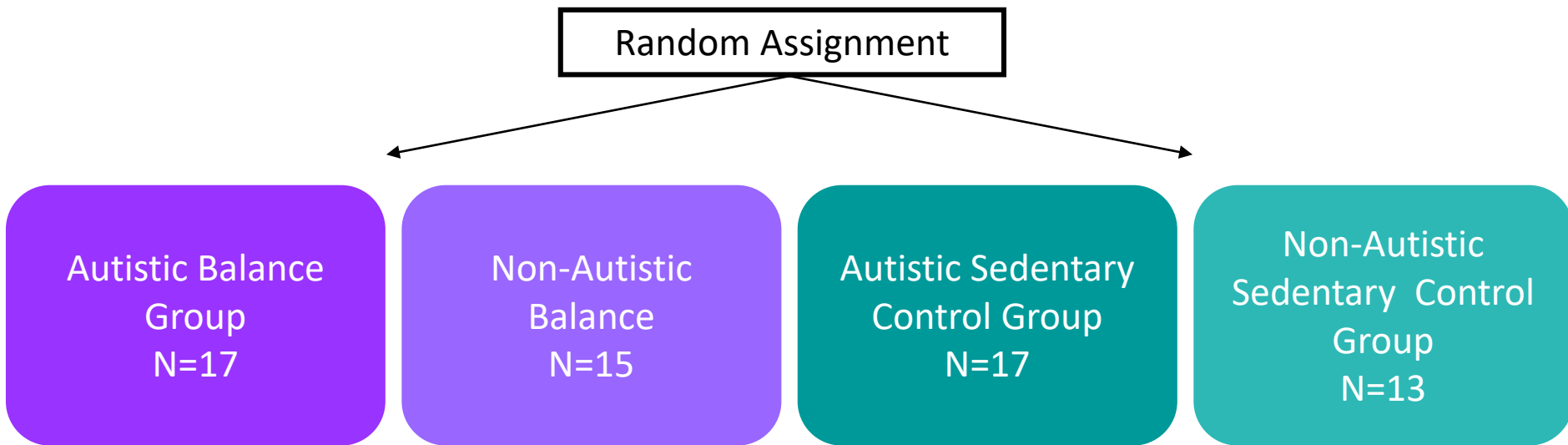
Can this training change symptom severity, daily living skills, and the brain?

Goal: Test neuroplasticity effects



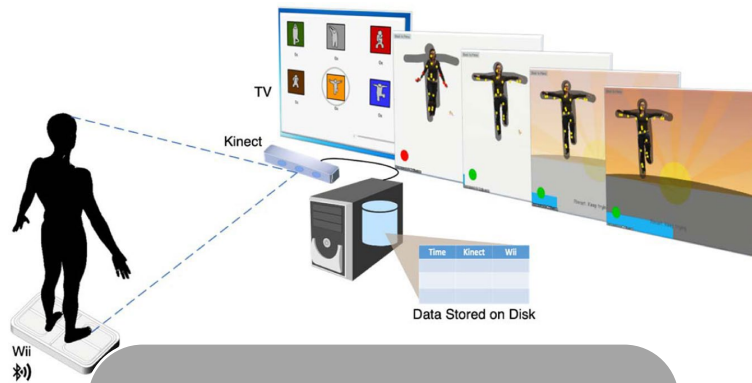
pre-registered at clinicaltrials.gov (#NCT02358317)

Participants



Ages 13.0-17.9, communicate verbally, average IQ

Hypotheses



Videogame-
Based Balance
Training

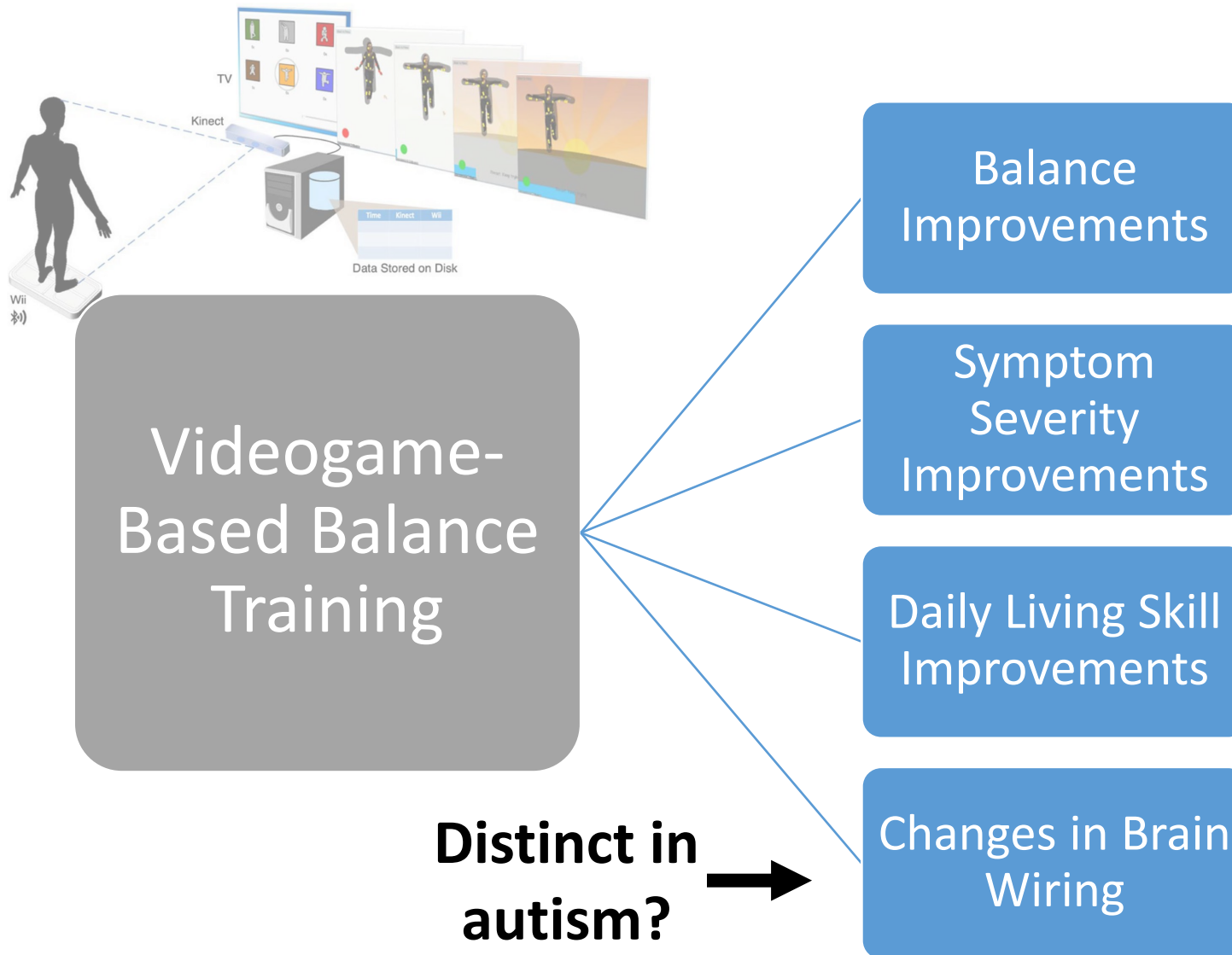
Balance
Improvements

Symptom
Severity
Improvements

Daily Living Skill
Improvements

Changes in Brain
Wiring

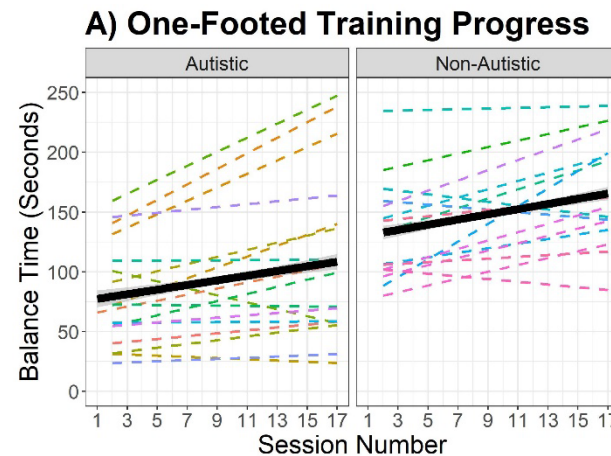
Hypotheses



Balance training led to improved balance

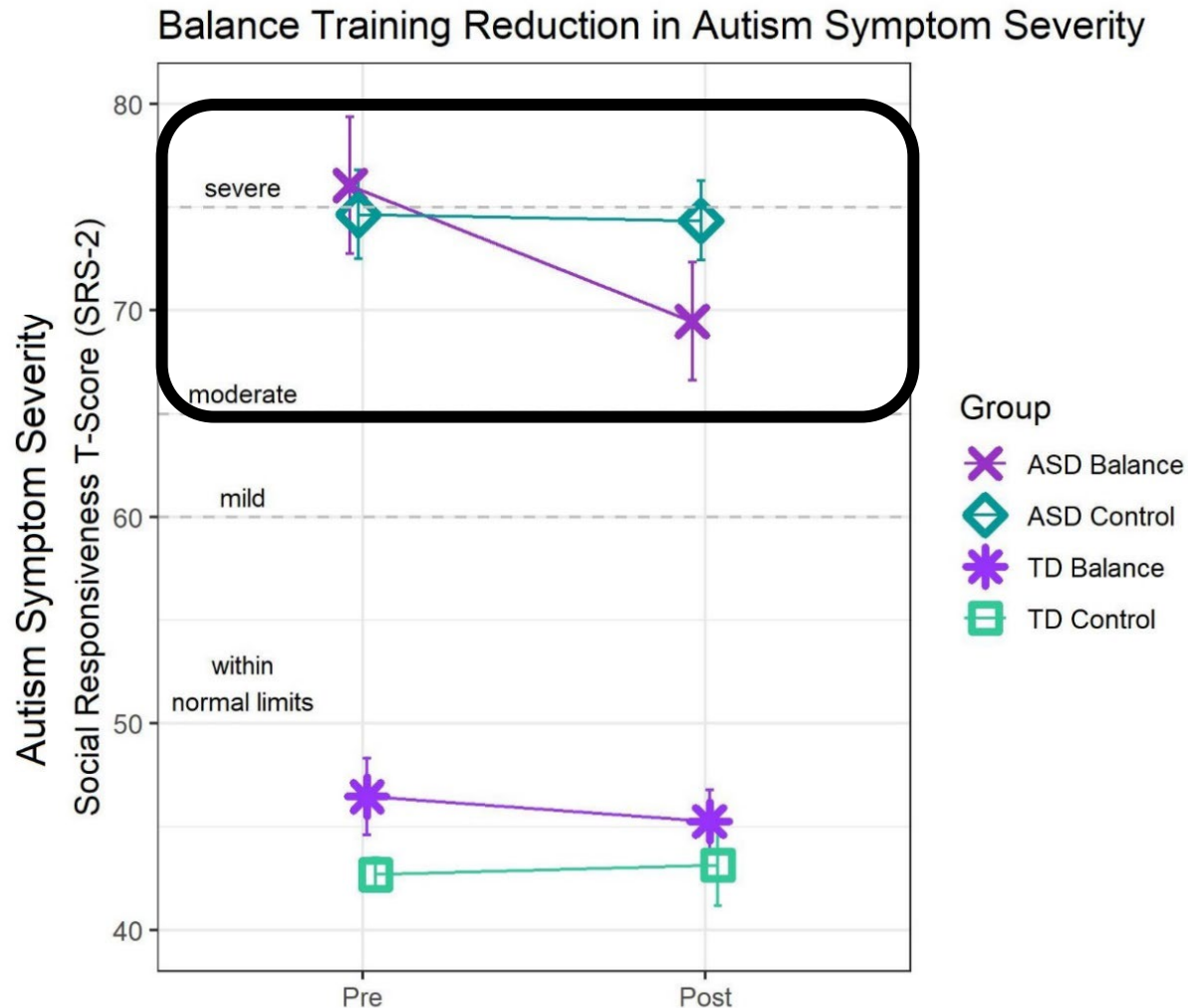


- Longer balance times (~36 sec improvement)
- Almost identical balance gains between the autism and non-autism groups

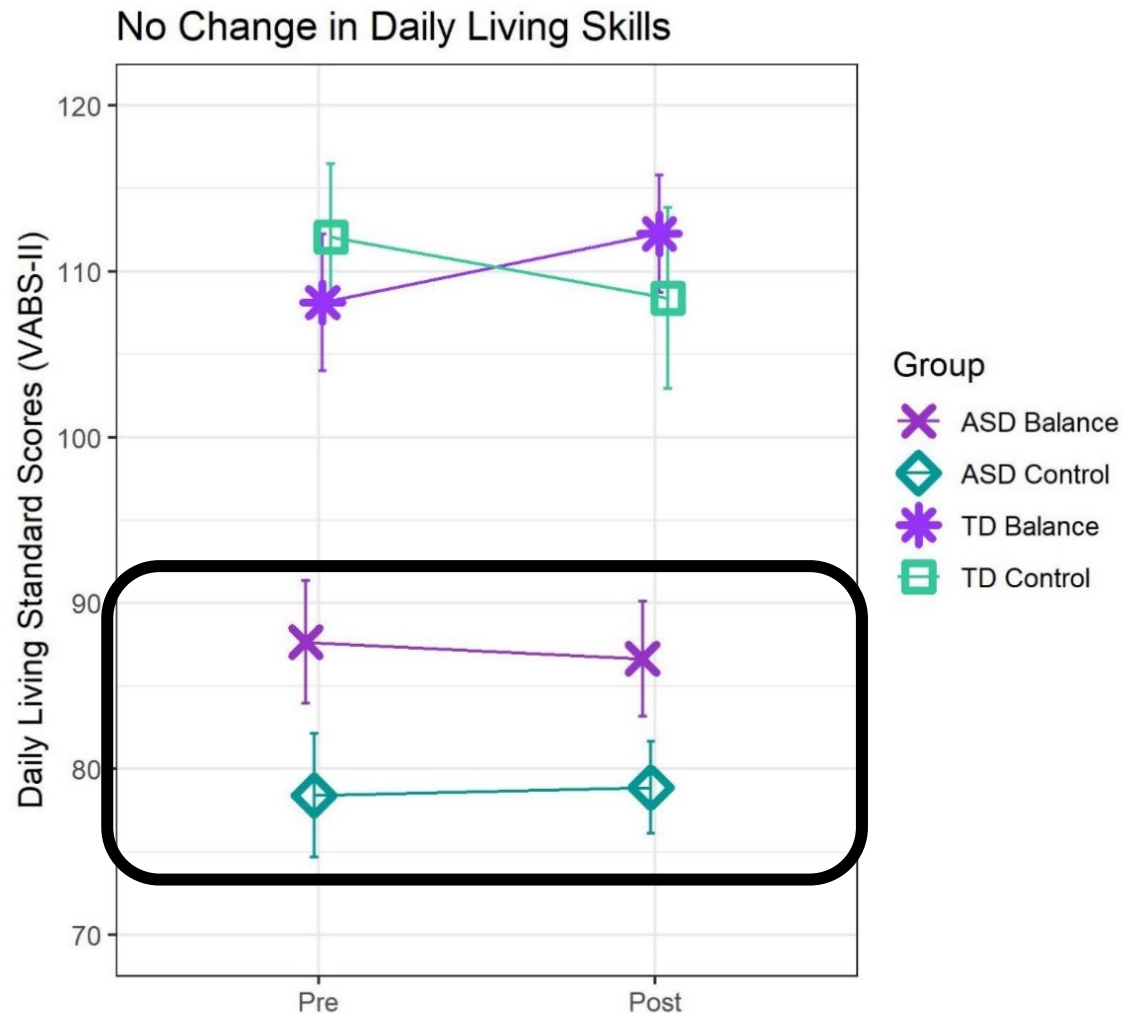


- Balance-training group showed improved balance outside the game, above and beyond that of the sedentary-control group; driven by the autistic participants

Balance training led to decreased autism symptom severity

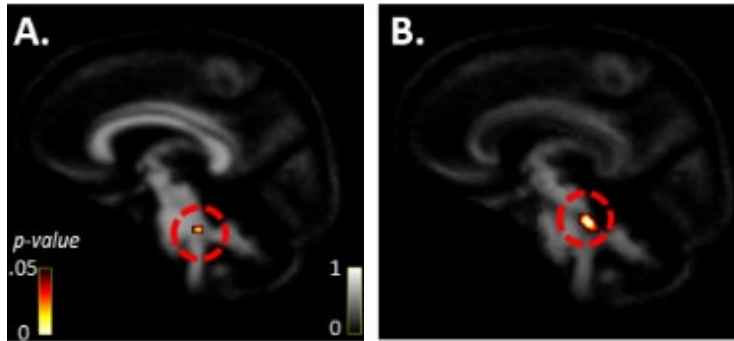


Balance training did not change daily living skills

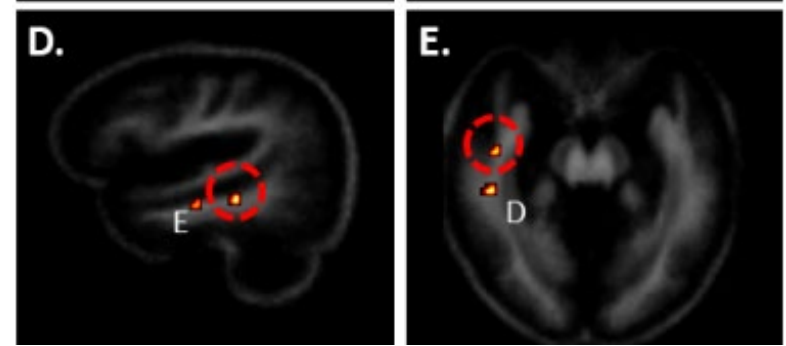


Neuroplasticity: Brain wiring changes from balance training?

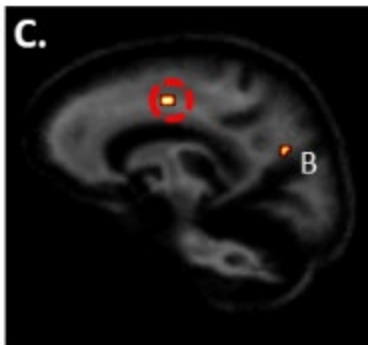
Superior cerebellar peduncle



Sagittal stratum

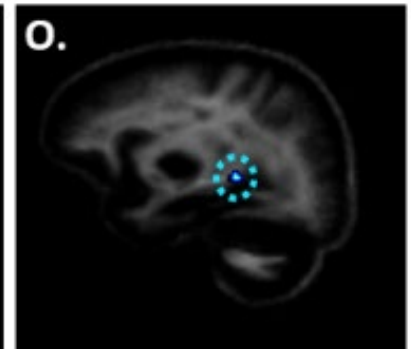
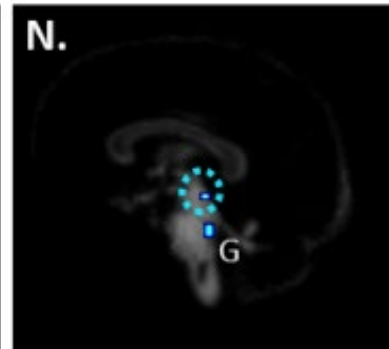
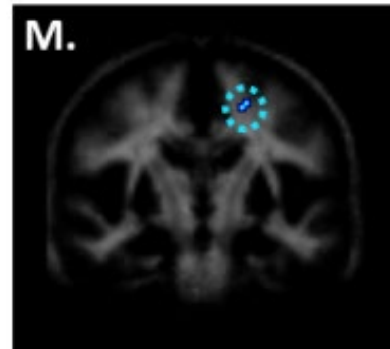
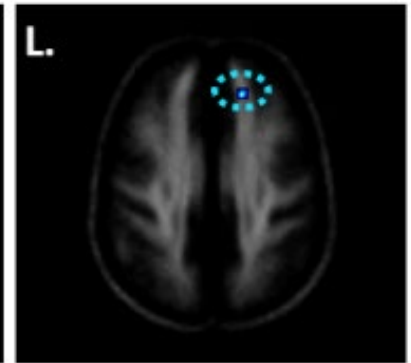
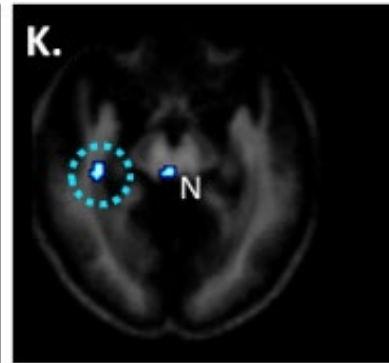
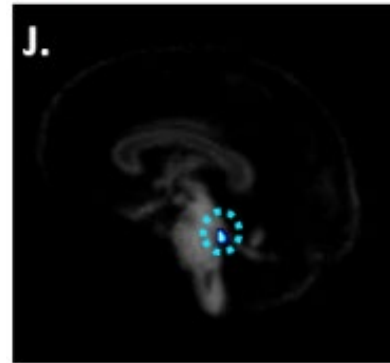
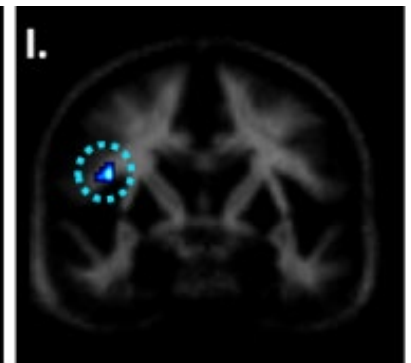
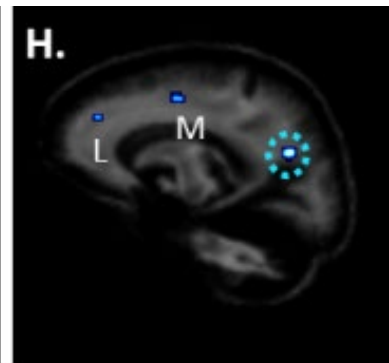
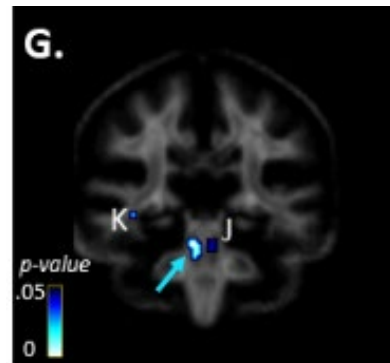
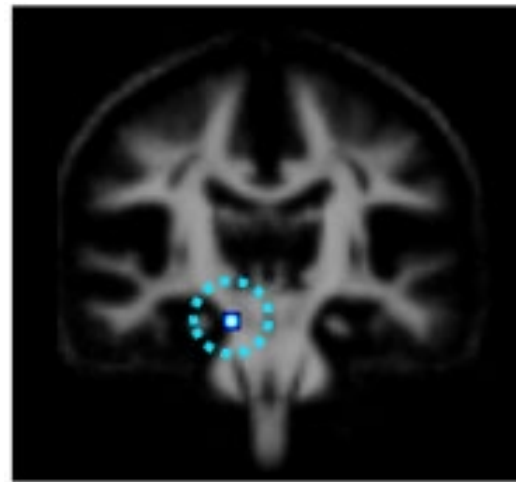
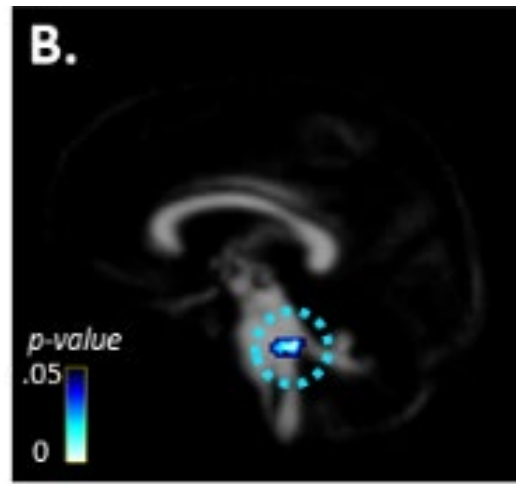


Cingulate gyrus



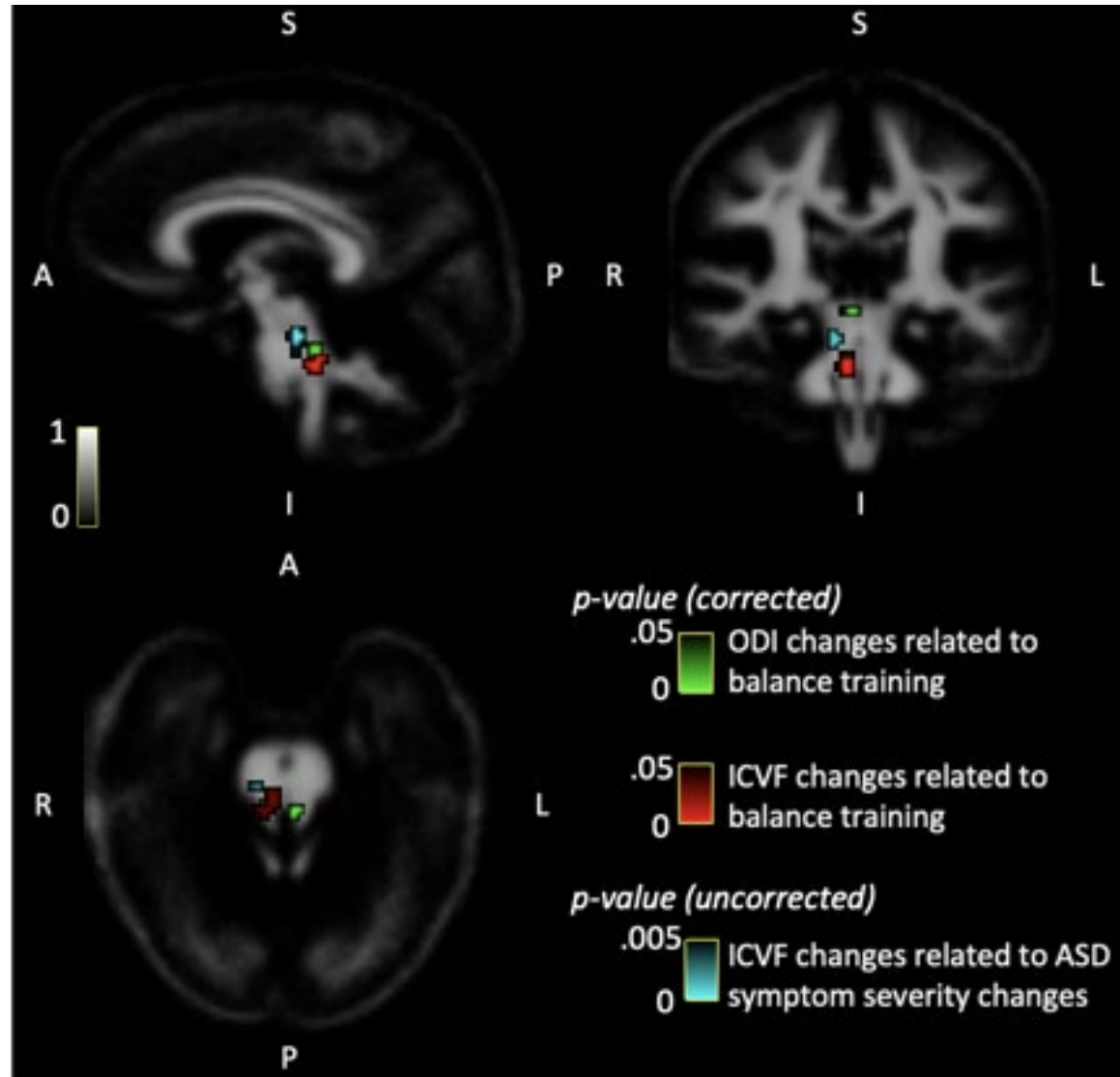
**Increased brain wiring volume (ICVF)
and increased spread (ODI) in balance
training group**

Distinct brain changes in autism

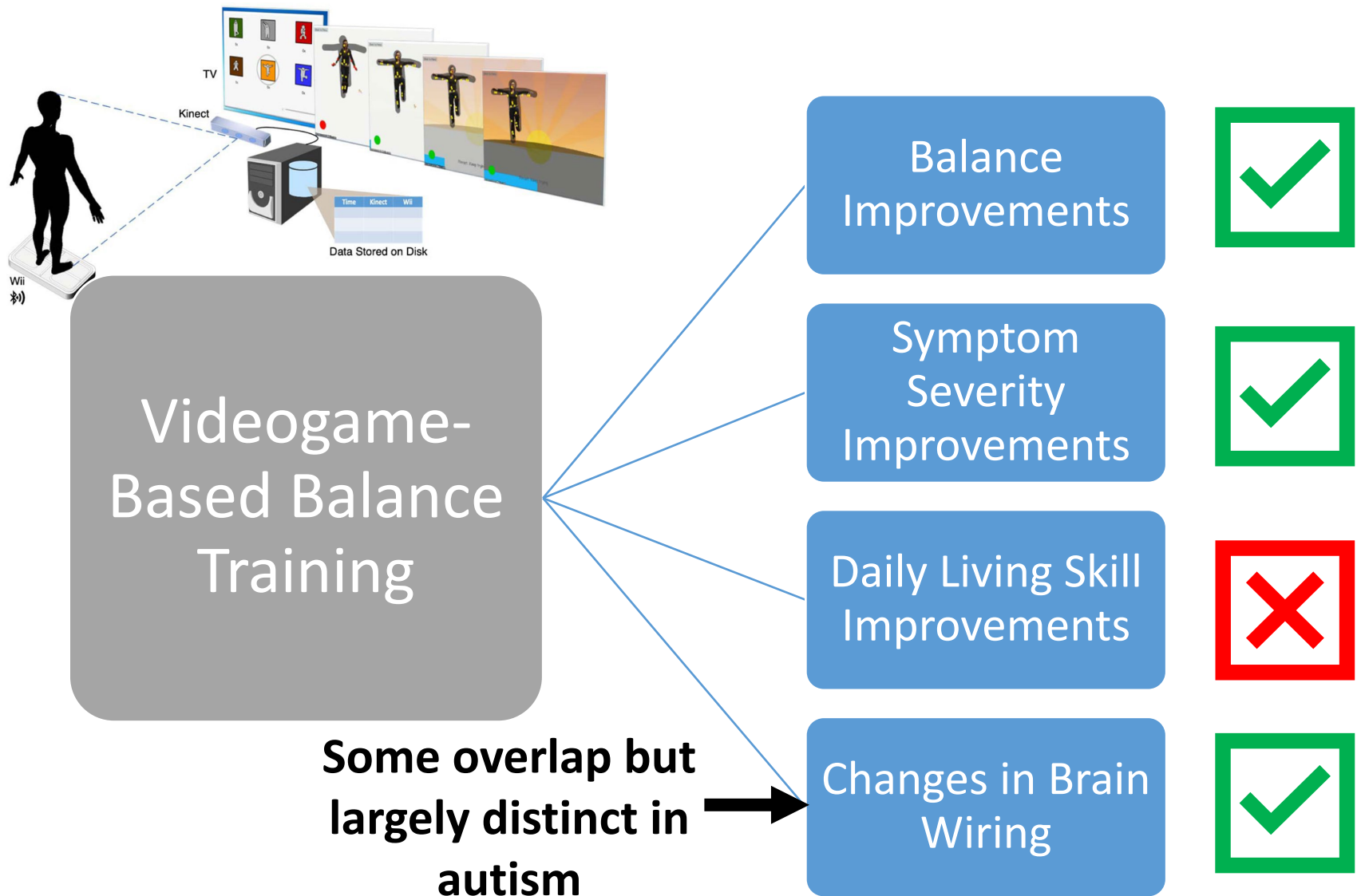


An area of overlap...

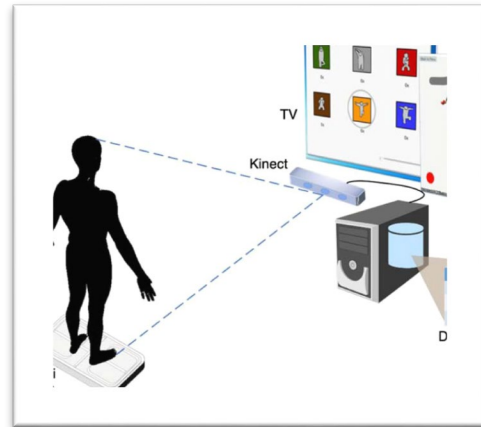
Superior
cerebellar
peduncle



Summary of findings

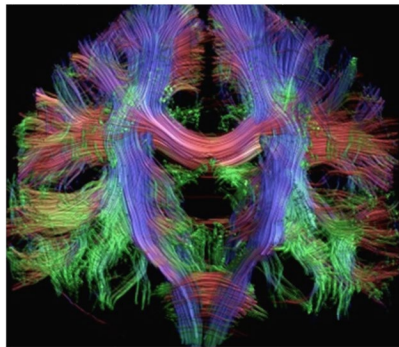


Key takeaways & future directions



Balance training may be an effective method for **improving balance** and decreasing parent-reported **autism symptom severity**

- Larger sample sizes, quality of life, and lasting effects should be studied



The brain may be **wired differently** in autism, such that similar behaviors (like improvements in balance times) may rely on distinct brain mechanisms

- Future work should specifically examine the superior cerebellar peduncle

Thank you!



Contact:
Brittany Travers
btravers@wisc.edu
University of Wisconsin-
Madison