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

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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

NIH
Eunice Kennedy Shriver National Institute of Child Health and Human Development
Health research throughout the lifespan
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’
  - Low to High

- **Orientation Dispersion Index (ODI)**
  - How spread out the wiring is
  - Low to High
Motor interventions particularly effective in changing the brain

Dayan & Cohen, 2011; Draganski et al., 2004; Drijkoningen 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.

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?

Motor Intervention

- Balance Improvements
- Symptom Severity Improvements
- Daily Living Skill Improvements
- Changes in Brain Wiring
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

Can this training change symptom severity, daily living skills, and the brain?
Goal: Test neuroplasticity effects

Random Assignment

Pre Assessment
- Diagnostic Confirmation
- Postural Stability Measures
- Diffusion Tensor Imaging
- Symptom Severity and Daily Living Skill Assessment

6-Week Balance Training Intervention

6-Week Sedentary Control Condition

Post Assessment
- Postural Stability Measures
- Diffusion Tensor Imaging
- Symptom Severity and Daily Living Skill Assessment

pre-registered at clinicaltrials.gov (#NCT02358317)
Participants

Ages 13.0-17.9, communicate verbally, average IQ

Random Assignment

- Autistic Balance Group N=17
- Non-Autistic Balance N=15
- Autistic Sedentary Control Group N=17
- Non-Autistic Sedentary Control Group N=13
Hypotheses

Videogame-Based Balance Training

- Balance Improvements
- Symptom Severity Improvements
- Daily Living Skill Improvements
- Changes in Brain Wiring
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Distinct in autism?
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?

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

Videogame-Based Balance Training

- Balance Improvements
- Symptom Severity Improvements
- Changes in Brain Wiring

Some overlap but largely distinct in autism
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!

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