EVALUATING AND TREATING BALANCE IMPAIRMENTS IN STUDENTS WITH AUTISM SPECTRUM DISORDER

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THANK YOU

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DISCLOSURE

- **Financial**: Susan Ronan receives an honorarium from Education Resources.
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Objectives

- Compare the neurological differences between children with autism and those with typical development.
- Apply the evidence for gross motor dysfunction to the clinical presentation of children with autism.
- Identify interventions for children with autism based on the science and evidence.
TOPICS

- Diagnosis
- Systems Review
- Neurological Evidence
- Clinical Presentation
- Intervention Evidence
- Nutrition
- What do I do tomorrow?
- Conclusion
AUTISM
ASD?
“I can remember the frustration of not being able to talk. I knew what I wanted to say, but I could not get the words out, so I would just scream.”

“A treatment method or an educational method that will work for one child may not work for another child. The one common denominator for all of the young children is that early intervention does work, and it seems to improve the prognosis.”
ASD: PREVALENCE

- Incidence: 1: 88
- Boys: Girls::4:1 (1 in 54 boys)
- Prevalence: 1% in Asia, Europe, and North America "Increased Prevalence?"
  - Increased awareness
  - Earlier diagnosis
  - Changes in diagnostic practice (screening)
ETIOLOGY

- Unknown
- Theories:
  - “Refrigerator Mother” 1970s
  - Infectious
  - Immunological deficiency
  - Environmental toxins
  - Gastric Inflammatory Disease
  - Genetic - multiple genetic factors
  - Sperm (older fathers)
AUTISM AND ASD
AUTISM

“A developmental disorder that appears by age three and that is variable in expression but is recognized and diagnosed by impairment of the ability to form normal social relationships, by impairment of the ability to communicate with others, and by stereotyped behavior patterns especially as exhibited by a preoccupation with repetitive activities of restricted focus rather than with flexible and imaginative ones.”
DIAGNOSIS³

Diagnostic and Statistical manual of Mental Disorders (V) (2013)
(A) Persistent deficits in social communication and social interaction across multiple contexts.

Including:
- social-emotional reciprocity.
- nonverbal communicative behaviors used for social interaction.
- developing, maintaining, and understanding relationships.
(B) RESTRICTED, REPETITIVE PATTERNS OF BEHAVIOR, INTERESTS, OR ACTIVITIES.

- Stereotyped or repetitive motor movements, use of objects, or speech
- Inflexible adherence to routines, or ritualized patterns or verbal nonverbal behavior
- Highly restricted, fixated interests that are abnormal in intensity or focus interest.
- Hyper- or hyporeactivity to sensory input or unusual interests in sensory aspects of the environment
C. Symptoms must be present in the early developmental period
D. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning.
E. These disturbances are not better explained by intellectual disability (intellectual developmental disorder) or global developmental delay.
Questions

- What are the main areas of impairment in the diagnosis of Autism?
EARLY DETECTION

When is the earliest time to detect autism?
WHEN CAN A DIAGNOSIS BE MADE?

- “By 3 yrs.”
- “As early as 18 mos.”
- “12 mos.?"
- “Earlier?”
PEDIATRICIANS

- Pediatrician 82% routinely screening for general developmental delays, but only 8% screened for ASD.
- Why?
  - Insufficient time.
  - Lack of familiarity with screening tools
  - Reliance on referral to specialists.
PARENTS

- Early detection/ suspicion
- Notice with peer interaction opportunities: Birthday part/ family event/ Play date
- Medical professionals may disregard parental observations
PRESENTATION

- Social
- Communication
- Repetitive Behaviors/ play
- Others
  - Sz (25- 33%)
  - Sensory- heightened sensory (smell/ taste?)
  - MR
PRESENTATION

- Sleep difficulties
- Self Injurious Behavior
- Special Skills (Savant skills)
INDICATIONS

- Poor eye contact
- Doesn't seem to know how to play with toys
- Excessively lines up toys or other objects
- Is attached to one particular toy or object
- Doesn't smile
- At times seems to be hearing impaired
BY 12 MOS.:

**Red Flags:**
- Failure to orient to name
- Lack of nonverbal showing
- Lack of eye contact
- Lack of initiative/ hypoactivity
- Lack of emotional regulation
- Poor social interaction
- Orienting, smiling and vocalizing to objects.

**Absolute Concern:**
- No babbling
- No pointing/gesturing
- Any loss of language
- Any loss of social skills
SCREENING TOOLS

- M-CHAT (toddlers)
- Gilliam Autism Rating Scale 2 (GARS-2)
- Autism Diagnostic Interview-Revised (ADI-R)
- Autism Diagnostic Observation Schedule-Generic (ADOS)
- Vineland Scale of Adaptive Behavior
EARLIER?

- Dyadic interactions/ imitation
- Emotional discrimination
- Development of attachment\textsuperscript{11}
- Early asymmetry?\textsuperscript{12, 13}
- No early patterns identified\textsuperscript{14}
Questions

- Regarding the diagnosis of ASD
  - What would a parent report?
  - What would a teacher report?
ADDITIONAL CONSIDERATIONS
GI ISSUES

- Constipation and Diarrhea, Chronic Abdominal pain
  - Dysbiosis: Abnormal gastric flora
    - Abnormal gram-negative bacteria
  - Leaky Gut: increased intestinal permeability

- Food Sensitivities/ Allergies
  - Higher antigen specific antibodies for food proteins (IgA, IgG, IgM)
  - Glutens, Casein- may pass through the “leaky gut” and have neurological effects.
NUTRITIONAL DEFICIENCIES\textsuperscript{15}

- Omega-3 Fatty acids- lower in children with autism
  - Metabolism?
Evidence for autoimmune antibodies

- Cortex
- Caudate nucleus (learning/ memory)
- Cerebellum
- Thalamic/ Hypothalamic
METABOLIC\textsuperscript{15}

- Impaired methylation
- Increased oxidative stress
- Lower antioxidants
- Higher organic toxins/ heavy metals
- Higher production of nitric acid (free radical)
HEAVY METAL TOXICITY\textsuperscript{15}

- Mercury
- Thimerisol (Immunizations)
  - Do children with autism have an impairment in the ability to excrete mercury?
  - Not proved
Balance: NEUROLOGICAL EVIDENCE
NEUROANATOMICAL DIFFERENCES

- Macrocephaly (first 2 years of life)
- Enlarged
  - Frontal lobes
  - Amygdala (emotional learning, memory)
  - Cerebellar white matter
- Underdevelopment
  - Cerebellar vermis (vestibular/ proprioception)
ASD: 3 PATHWAYS

- Primary: frontal dysfunction
- Second: brainstem dysfunction.
- Tertiary: cerebellar dysfunction.
NEUROCHEMICAL

- Alterations in\textsuperscript{16}
  - Serotonergic (feelings of wellbeing)
  - Glutamatergic (cellular metabolism)
  - Cholinergic (PSN, SNS, Forebrain, Brainstem)
  - Gabaergic (inhibitory neurotransmitter)
  - Stress response
VISUAL SYSTEM

- Normal retinal organization
- Visual Hyperacuity
- Hypermetriopia (images reach the retina before focusing on the lens)
- Astigmatism
- Strabismus/ optic disc Pallor
- Impaired oculomotor function
  - Difficulty with skill acquisition
  - Communication
  - Social interaction
HYPERACUITY

- Individuals see all objects in the visual field with sharp resolution, making it difficult to focus on one.
- Use of peripheral vision helps with selective attention to a visual target.
  - Head turn
HYPERACUSIS\textsuperscript{19}

- Decreased stapedial reflex
- Results in:
  - Avoiding sounds
  - Covering ears
BASAL GANGLIA

- Dysfunction with Frontostriatal Basal Ganglia pathway

Results:
- Saccadic dysfunction
- Poor feed forward
SPECULATED LOSS OF PURKINJE CELLS

- Purkinje Cells:
  - Cortex of cerebellum
  - Control movement
  - GABA
  - Inhibitory - A decrease would decrease inhibition of the nerves
VESTIBULAR

- Semicircular canal deficits
- Integration deficit between
  - Visual
  - Somatosensory
  - Vestibular system
Motor Planning\textsuperscript{20}

- Simple motor planning may be intact
- Visual feedback, or external guidance is diminished
- Difficulty with integration of visual and vestibular system
- Decreases
  - Motor performance
  - Postural stability
  - Lack of effective sequencing
Question

- What are the main motor impairments you have noticed in children with ASD?
CLINICAL PRESENTATION
POSSIBLE CLINICAL FINDINGS

- Low proximal tone
- Delayed/ Poor postural reflexes
- Poor integration of reflexes
- Gross motor delays
- Limited repertoire of play
- Fine motor delays
- Speech delays
POSSIBLE CLINICAL FINDINGS

- Asymmetries
- Difficulty crossing midline
- Difficulty with visual tracking
- Reliance on peripheral vision (Head posture?)
- Difficulty with feed forward tasks (catching, kicking moving ball) Avoiding gaze
- Echolalia
- Movement Disorder
- Dyspraxia
APRAXIA/ DYSPRAXIA

- Rinehart (2001): Children with autism ages 5-19 yrs.:  
  - Intact movement execution but atypical movement preparation.  
  - Lack of anticipation  
    - Related to motivation, and/or attention?  
  - Children with Asperger’s disorder:  
    Slow motion preparation (fronto striatal)

- Oral:  
  - Drooling  
  - Open mouth at rest  
  - Inability to pucker lips

- Limb  
  - Pen grasp, puzzle piece placement
ERRORS IN IMITATION

- Not related to memory or representing an action
- Deficient activation of the mirror neuron cells
- Deficit in mimicry
- Visual attention - less attention to salient aspects of human interaction.
- Difficulties perceiving biological motion.
STRENGTHS

- Visual spatial perception
  - Better on tasks requiring acute visual perception
  - Visual search
SENSORY DYSFUNCTION

- Elevated sensory awareness.
- Heightened sense of smell/taste.
Gross Motor: 2 Theories

- **Automatization Deficit Hypothesis:**
  - Deficits in cerebellar function causes impairments skill learning and gaining automatic skills leading to poor motor and poor attention. (Visser 2003)

- **Disorder-Specific learning Theory:**
  - Children who cannot cope with balance “threatening situations” (issues with motor learning and cerebellar function) develop anxiety. (Erez 2004)
Less Self Perceived Ability of Motor Performance?²⁶

Deficits in:

- Body Schema
- Time/ Space awareness
- Estimate Distance
- Fear of intimate contact

Children with autism may view themselves as less capable than other children to perform gross motor tasks.
TYPICAL VESTIBULAR DEVELOPMENT

- Broad range of normal for children
- Anatomically and functional at birth
- VOR present in neonates and matures for the first 2 yrs of life.
- Pursuit/ Optokinetic: 3-6 mos of age.
  - Same as an adult by 3-6 yrs of age.
VESTIBULAR SYSTEM\textsuperscript{28}

- Children with high functioning autism- normal post rotatory nystagmus in upright and with head tilt.
VESTIBULAR\textsuperscript{29}

- Vestibular processing is different for children with autism.
MOTOR STEREOTYPIES AND BALANCE

- Suggestions that children with more severe motor stereotypies have worse balance.
- Tested statically
- ? Dynamically

BALANCE

- Abnormal Proprioception.\textsuperscript{30,17}
- More difficulty with balance with eyes closed.\textsuperscript{17}
- Reliance on visual cues to reduce sway and maintain balance.\textsuperscript{17}
- Poor integration of visual, vestibular and somatosensory input for balance.\textsuperscript{17}
GAIT

“Gait in children with autism: consistent with Cerebellar ataxia, difficulty walking on a line, variability in stride length and velocity, postural abnormalities in the head, trunk involvement in the fronto-striatal basal ganglia circuit.”

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GAIT CONTINUED

- Increased stride length variability
- No improvements with external cues (visual markers)
- Difficulty using environmental cues to modify movement once in action
- Arm and head/ trunk posture asymmetries
TOE WALKING$^{21}$

- ? Maybe
- Related to: proprioception, kinesthesia, weight line shifted anterior in ambulation, difficulty with moving backward/ posterior in space.
INTERVENTION EVIDENCE
Supply and Demand of State EI programs (Respondents: 47 states, 4 territories)\textsuperscript{32}

- Services most used by children with ASD
  - Speech, OT
  - ABA
  - Psych/ Special Education
  - PT? not mentioned in study

- Recommended Services: 25 or more services hrs./ week (National Research Council)
  - State EI: providing 5 hrs. (more than 1/ 2 states, with 4 states providing 20 hrs./ week)

- Conclusion: EI does not have the resources for the increased demand
THE SEARCH


- SCOPUS, PEDro, CINAHL, OVID, Psych Info, PubMed, Specific Journals
Issues with Evidence- just to start

- Lack of RCT
- Small Sample sizes
- Anecdotal
- Non systematic
- Did not quantify
- Use of parental surveys
- Use of child surveys
- Heterogeneous population
- Huge variety in function
- Concurrent therapies/ treatments/ medications
Sackett’s Levels of Evidence

- 1A = Systematic Review of Randomized Controlled Trials (RCTs)
- 1B = RCTs with Narrow Confidence Interval
- 1C = All or None Case Series
- 2A = Systematic Review Cohort Studies
- 2B = Cohort Study/Low Quality RCT
- 2C = Outcomes Research
- 3A = Systematic Review of Case-Controlled Studies
- 3B = Case-controlled Study
- 4 = Case Series, Poor Cohort Case Controlled
- 5 = Expert Opinion
Interventions for Gross Motor Skills; WHERE IS THE EVIDENCE?

- Sensory Integration
- Auditory Integration Training (AIT)
- NDT
- Vestibular Therapy
- Brain Gym
- Floor Time
- Craniosacral
- Greenspan
- Brushing
- Aquatic Therapy
- “Traditional Therapy”
- Massage
Sensory Integration

- Most commonly used approach for individuals with autism
- Dr. Jean Ayres: Focus on processing of sensory information and the skill attainment.
  - Hierarchical structure to development
  - Child centered approach
  - Just right challenge
- Focus:
  - Modulation
  - Integration
Sensory Integration:  

- Meta Analysis
- SI is as good as other therapies
- May effect psychoeducational and motor skills
- Ayers 1980:
- Outcomes better for those with hyper sensory issues

- Problems with literature:
  - Small sample size
  - Hard to differentiate effect of SI vs. other interventions
  - Characteristics of subjects heterogeneous and highly variable
  - Systematic approach
  - Anecdotal
Auditory Integration Training

- Using headphones with music selected for different frequencies to improve attention, reticular activating and cerebellar performance.

- Evidence:
  - Mixed findings
Weighted Vests\textsuperscript{36}

- Lack of well constructed studies
Treadmill training

  - Decreased BMI
  - Increased Exercise Capacity
  - Increased ability to walk on TM at a faster speed
AQUATIC THERAPY

Benefits for children with Autism
- Improved strength/balance
- Increased social participation
Vestibular stimulation

- No studies
Massage

- Calming effect
- Improved responsiveness
- Improved communication
- Massage: Improves behavior/?Self regulation

- Grandin’s Hug Machine
  - Decreased anxiety

- Problems with literature:
  - Small sample size
NUTRITION: Socialization and language
NUTRITION

- Gluten/ Casein free diet (avoid for 60 days)
  - Changes in GI
  - Language
  - Socialization
SUPPLEMENTS

- Omega-3 Fatty Acids
  - Improvements in reading
- Probiotics
  - Temporary results in GI (need more info)
- Zinc
  - ? Need more studies
- Vitamin B6 - ?
- Multivitamin - ?
OTHER INTERVENTIONS

- Medications
- Devices/ Orthotics/ Modifications:
  - Compression/ Weighted Vest
  - Foot orthotics
  - Communication Board/ Sign Language
  - “Wiggle seat”
THE CHALLENGE IN INTERVENTION:

- Spectrum of abilities
- Difficult to study because of a lack of homogeneity
- No one intervention has been shown to be beneficial to balance
- Studies tend to focus on children with higher functioning autism
WHAT DO I DO TOMORROW?
Learning strategies for children with autism\textsuperscript{39,40,41}

- **Children with ASD:**
  - Focus on specific items in memory tasks rather than relational processing or seeing the whole task.
  - Implicit learning is intact?

- **Children with Asperger's:**
  - Social Learning: SODA:
    - S: Stop; Where do I go to observe?
    - O: Observe; What is ___ doing?
    - D: Deliberate; What would I like to do?
    - A: Act; When I go to ___ I plan

- **Plan/ Do/ Check/ Evaluate approach may be helpful with children who can participate**
  - Sequencing, execution, using picture cards/ photos
CLINICAL QUESTION?

- Do children with ASD have more difficulty with static or dynamic balance?
Suggestions from the evidence

- Evaluate Eye tracking/ VOR
  - Functional use of vision
- Test static vs. dynamic balance
- Role of vision in balance
- Vestibular/ Cerebellar training
- Proprioceptive feedback
- Feed forward activities (kicking a moving ball)
- Sequencing activities
- Bilateral integration
- Proprioceptive/ Kinesthetic activities
Suggestions from the evidence

- Aquatic Therapy
- Increase self efficacy: gross motor tasks
- Decrease fear of balance activities/ motor tasks
PILOT PROJECT

- 11 males: 9 - 20 years old
- One subject excluded (n = 10)
- Paraprofessional(s) were present
OTHER ASSESSMENTS

- Romberg testing (tandem/ sharpened)
- P-CTSIB
  - Eyes open
  - Eyes closed
  - Eyes open on foam pad
  - Eyes closed on foam pad.
- BOTMP-2
- Pediatric Balance Scale
- Dynamic Gait Index
KEY FUNCTIONAL TASKS

- Standing on one foot
- Alternate step tapping
- Turning to look over shoulder
What are you having success with?
GREG

- Greg is 11 years old. He is receiving related services in 5th grade.
- Greg is unable to stand still and will shift his weight back and forth whenever he is in standing. He requires a handrail to walk up and down stairs. He frequently misses steps when walking up or down a curb. He requires extra time to go up and down the steps of the bus.
- Greg’s weight is shifted to the right in sitting and he has difficulty maintaining a midline position.
- Greg frequently becomes distressed during the day and has a one on one para with him to assist with transitions and school activities.
CASE QUESTIONS

 Evaluation:
  • What balance testing would be appropriate for Greg?
  • What kinds of functional activities would help to assess balance?

 Intervention:
  • What approaches may be the most effective in working with Greg?
Case examples and problem solving

- Psychosocial/ Environmental affordances and barriers
- Systems review
- Body structures/ functions
  - Strengths/ impairments
- Activity
- Participation
- Coordination/ communication with others?
- STG/ LTG
- Create a treatment plan
  - Classroom instruction/ involvement
CONCLUSION

- Team intervention is critical.
- Each child and family must be approached on an individual basis.
- Neuroanatomical/functional differences in children with ASD may help guide intervention.
- Functional assessment of balance may provide useful information.
- Consider dynamic vs. static control.
THANK YOU!

- Questions/ Comments?
REFERENCES


