



Posture: A Foundation for Function

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Making Sense of Posture Within the Context of Motor Functioning

Relations Among:

Motor Skills

Postural Abilities

Muscle Tone

Balance Control

Core stability



What is Posture?

Simply stated:

Postural control is the achievement, maintenance or regulation of balance during any static posture or dynamic activity for regulation of stability and orientation (Massion, 1994)

The interaction of the individual with the task and the environment develops postural control
(Pollack, Duward & Rowe, 2000)



What Contributes to Postural Control?

- Tone
- Alignment
- Balance
- Core Stability



Why Posture?

- Outcome of postural control is the ability to sustain muscle activation in order to meet the demands of daily life activities
- Impacts motor performance and gross motor skills (Mache & Todd, 2016)
- Motor performance impacts social and communication abilities



Importance of Posture

- Foundational to motor development
 - Core stability necessary for everything we do
 - Motor abilities support social interaction – physical abilities to participate in playground social interactions
 - Physical activity across the lifespan– exercise is critical to self regulation, to preventing obesity, to health and wellness
- Critical for balance
 - Actions are based on stable base of support
- Central to endurance
- Impacts respiration , swallowing
 - Related to activation of autonomic nervous system



What does the literature say about posture and movement in individuals on the autism spectrum?

- Motor deficits reported in autism in the 1990s
 - Rapin (1996) – 25% reported to exhibit hypotonia
 - Kohen-Raz, Volmar & Cohen (1992) – reported to exhibit hypotonia
- Ming, et al. (2007) reported that 51% of their sample of children and adolescents on the autism spectrum exhibited hypotonia and
 - % greater in the younger children aged 2 to 6 years (i.e. 63%)
 - 19% were toe walkers
 - 9% had gross motor delay



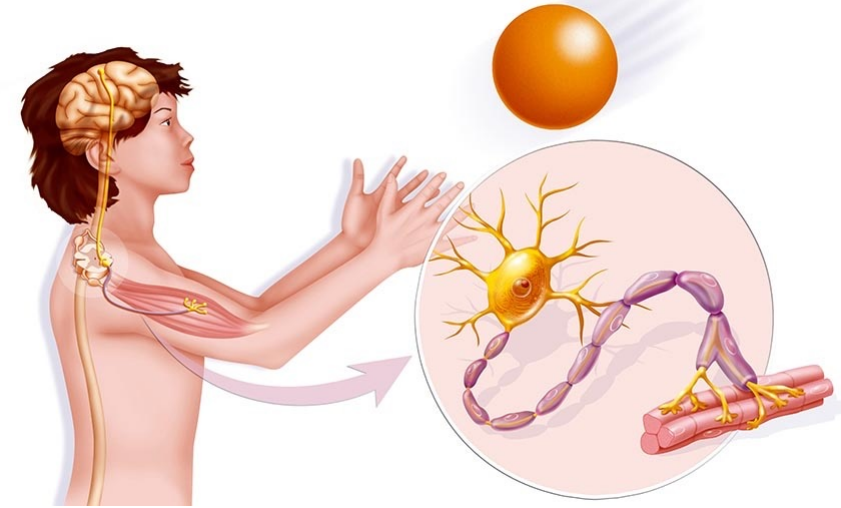
Current thinking

- Increasing recognition of the prevalence of motor dysfunction, which includes posture, over the past 10 years (Gowen & Hamilton, 2013)
- Increasing exploration of underlying neurobiological disruptions (Memari, et al. 2014)
- May be considered a cardinal feature
- Association between motor deficits and social communication needs to be further explored
 - Children with weaker motor skills have greater social communication skill deficits. How this relationship exists behaviorally needs to be explored further (MacDonald, et. al. 2013)



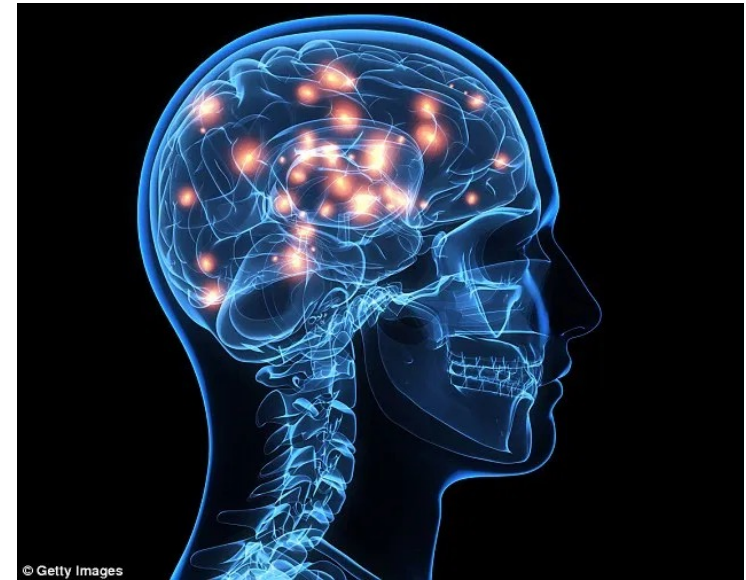
Systems involved

- Muscular skeletal components
- Neuromuscular synergies
- Sensory systems (visual, vestibular, somatosensory)
- Anticipatory mechanisms
- Adaptive mechanisms
- Internal representation
- Functional tasks and environment



Factors that might contribute negatively to postural control

- Underlying Brain mechanisms
- Lack of motor experience
- Poor sensory-motor integration
- Cognition
- Developmental delay
- Task demands
- Environment
- Social Impairments



Meta-analysis of 51 studies (Fournier et al. 2010)

- Immature postural control limits the emergence and performance of motor skills
- Resultant Motor Coordination issues
 - Movement preparation or planning
 - Upper Extremity function
 - Gait and balance



Posture and Core Symptoms (Memari, et al., 2014)

- Posture might be an early diagnostic marker of the autism spectrum (Memari, et al. 2014)
- Deficits in infancy persist into childhood
- Data indicates that impaired motor functions may be present before social problems
 - Abnormal postural control /motor functioning can exacerbate core symptoms
 - Thereby limits social interactions





How Early Motor Behavior Effects Development

Specific studies demonstrate important for
Cognition
Language
Social Development



Importance of Early Motor Behavior

- Infants' spontaneous movement exploration and imitation related to social and communication skills



(Inverson & Fagan, 2004; Meltzoff & Decety, 2003))



Importance of Early Postural Control

- Postural control associated with
 - Self-exploratory behavior
 - Spontaneous motility
 - Hand function



(Inverson & Fagan, 2004; Meltzoff & Decety, 2003; Thelen, 2000)



Importance of Early Postural Control

Abnormality in postural control “disrupts the development of adequate motor behavior and sensorimotor interaction , which can result in faulty perception –action cycle, thus influencing later social and cognitive development.

(DeGroot, 2000, p.65)





Early Motor Skills and the Developing Brain

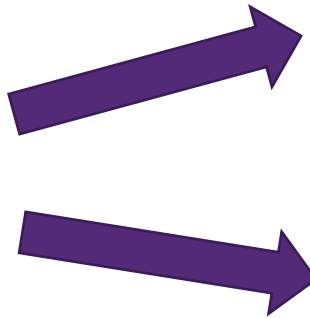
- Motor delays may appear across many disorders before full-blown disorder are evident (Levitt-Binnun, Davidovitch & Golland, 2013; Nayate, et al., 2005)
- Can be an indicator of underlying brain network aberrations





Motor Deficits in Older Children and Adults on the Autism Spectrum

- Poor postural stability
- Poor postural anticipation



- Poor motor planning
- Poor grading of movement
- Poor quality of imitation
- Gait abnormalities
- Fine /gross motor deficits

(Fournier, et al. , 2010; Minshew et al. , 2004; Rinehart et al. , 2006; Dowell , Mahone & Mostofsky, 2009)



Early Detection: Retrospective Studies

- Core features related to motor behaviors:
 - Showing
 - Pointing
 - Orienting to name
 - Smiling
 - Eye Contact
 - Lack of appropriate gestures and/or expressive positions



(Clifford & Dissanayake, 2008; Maestro et al, 2005; Osterling et al, 2002)



Retrospective Studies: Evidence of Atypical Movement

General movements:

- Indicator of integrity of infant's nervous system during the first several weeks of life
(Ferrari, Cioni & Prechtl, 1990)
- Distinguished infants on the autism spectrum from infants not on the autism spectrum , retrospectively.
(Phagava et al., 2008)



Prospective Studies of Motor Deficits

- Delay in acquisition of early motor milestones, babbling, and postural stability of high-risk infants
(Iverson & Wozniak, 2007)
- Immature object manipulation and reduced grasping activity in high risk infants at 6 mos. of age
(Libertus et al., 2014)



Prospective Studies

- Gross motor delays by 14 mos. in children later diagnosed on the autism spectrum
(Landa & Garret-Mayer, 2006))
- Reported hypoactivity at 6 mos. of age in subset of high risk infants later diagnosed on the autism spectrum at 24 mos
(Zwaigenbaum et al., 2005)
- Declining gaze to eyes and atypical visual orienting in infants later diagnosed on the autism spectrum
(Clifford, Hudry, Elsabbagn, Charman & Johnson, 2013; Elison et al., 2013)

Prospective Studies

- Hypotonia
 - 63% of young children 2 to 6 years present with hypotonia (Ming et al., 2007)
- Head lag on pull to sit
 - Head lag significantly associated with being on the autism spectrum
 - More frequently observed in high risk than in low risk infants
 - Head lag may serve as an early indicator of neurodevelopmental disruption (Flanagan, Landa, Bhat & Bauman, 2012)





Association Between Posture and Motor Impairment

Later Impairments (Memari, et al., 2014)

- Decreased static and dynamic postural stability
- Decreased functional balance
- Decreased motor performance

- Postural control does not begin to improve until the age of 12 and never achieves adult level
- Asynchrony in postural stabilizing muscles



Contributing Factors (Mimari, et al., 2014)

- Requires integration of somatosensory , vestibular and visual inputs
- Most common deficit in posture noted when tactile and proprioceptive inputs are distorted
- Children on the autism spectrum tend to rely on visual input to maintain postural control
- Perceptual and cognitive demands can alter postural control
- Literature suggest multiple mechanisms may be responsible for the postural inefficiency



Structural and Functional Impairments

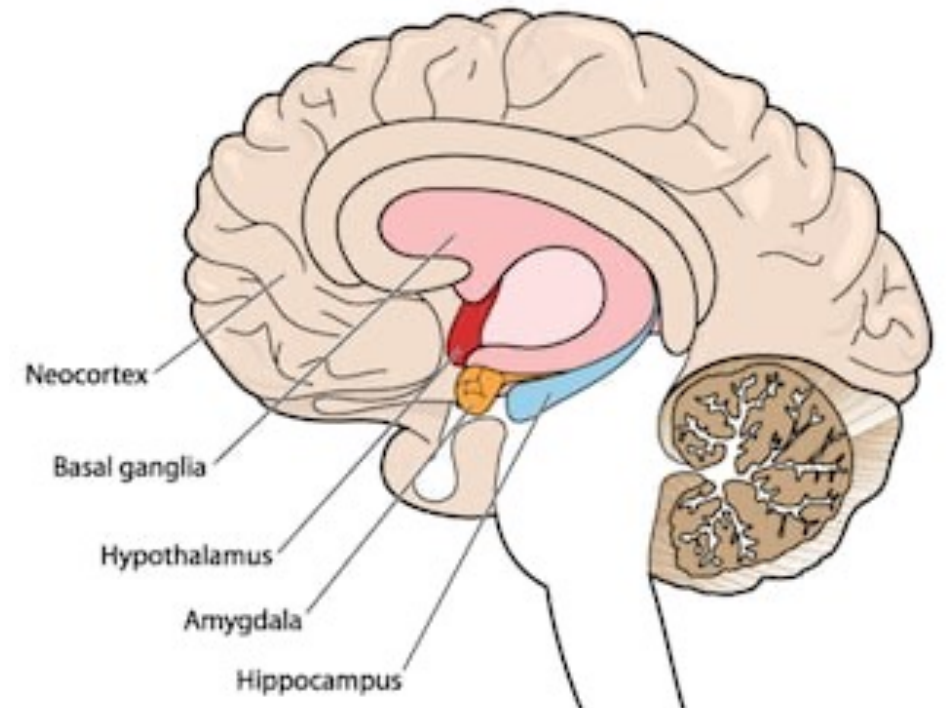
- Cerebellum and basal ganglia (Rinehart, et al. 2006)
 - The presence of hypotonia may be linked impaired functioning of the basal ganglia (Damasio and Maurer, 1978)
- Stronger evidence re. cerebellum as a contributing mechanism to sensory integration , hampering motor functions through connection with brainstem, thalamus and hypothalamus
- Contributing factors revealed decreased activation in the supplementary motor area and greater activation in prefrontal cortex

(Memari, et al., 2014)



Neuroanatomical and Neurophysiological Underpinnings

- Disarranged neural organization
- Diffuse decreased connectivity across motor execution networks
- E.g.
 - Cortical and subcortical areas
 - Motor cortex
 - Supplementary motor area
 - Thalamus
 - Cerebellum



Differential Diagnosis

- Postural deficits may be due to factors other than autism
- Role of postural control sensory systems
- Role of attention resources (based on task parameters needed for postural control)
- Postural control more impaired in situations requiring multisensory processing





Impact of Posture and Motor Impairments

Impact of Postural Challenges

- General motor impairments lead to low participation in physical activities, games , and sports
 - Hampers motor experiences
 - Decreases learning opportunities which may limit postural control improvement



Impact of Motor Performance on Social Interaction and Communication (MacDonald, et al. 2013)

- Effect of motor skill play on social development
- 79% of 10-14 years old's had motor skill deficits
 - Decreased postural control one contributing factor
- Social communication practice diminished
- Motor deficit may hinder opportunities for social communication
- Requires motor efficiency to participate (e.g. physical play, schoolyard play)



Implications of Postural Deficits

- Role of Posture in Non-Verbal Communication
- Role of posture in self validation (Brinal, Petty & Wagner, 2009)
 - Association between mood and confidence level can be associated with how one holds one's body (i.e. posture)
 - Feeling positive qualities associated with physical attitude
 - Stressed vs relaxed
 - Confident vs doubtful position
- Role of posture in embodied emotion theory (Oosterwijk, Rotteveel, Fischer & Hess, 2009)
 - Mental event represented by states of the body
 - Words can be influenced by physical posture
 - Concept of 'pride' vs 'disappointment' influenced the show of physical position/behavior.



So what does it all mean?

- Motor impairments are a common early symptom of children with a later diagnosis of autism
 - Therefore posture and movement should be assessed
- Posture is an important domain for intervention
- Early identification can impact emerging development
- Multiple dimensions of function can be impacted



So what does it all mean?

- Unlikely that one single motor factor will be an indicator /predictor of later autism diagnosis
 - Appears to be an integration of sensory and motor signs and abilities
- Supporting postural control and motor performance should be considered as part of a comprehensive treatment program (as needed)



Some Thoughts About Treatment Implications

- Can't teach social skills and communication in isolation
- Addressing balance impairments can impact participation in daily living
 - Tasks and environment need to be taken into consideration
- Addressing motor skills can occur in combination with increased opportunities for social and communication practice
- Import of naturalistic settings
- Better motor skill are associated with better communication and social interaction



Remaining questions....

- Do Motor Deficits Qualify as a Core Feature of Autism Spectrum?
 - Sensorimotor dysfunction considered a causative factor in social communicative impairments
- If balance deficits are associated with age, are adolescents and adults more at risk for postural instability concerns?
- More research is needed





**“We must
perceive in order
to move, but we
must also move
in order to
perceive.”**

(Gibson, 1979, p. 223)





Thank you!





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