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The Invisibles: When the nervous system takes a wrong turn

Guest Editor: Mike Studer, PT, MHS, NCS, CEEAA, CWT

Physical Therapy Virtual Conference

Mon 3/9	Functional Movement Disorders: Restoring Agency Through a Motor Learning Approach Carly Lochala, PT, DPT, NCS
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Fri 3/13	Physical Therapy for Patients with Persistent Pain Bill Rubine, MS, PT

CONTINUED

Dystonia and Neuroplasticity: Evaluation and Treatment

Julie Hershberg PT, DPT, NCS

Special thanks to Ali Elder PT, DPT and the re+active team

USC Division of Biokinesiology and Physical Therapy

re+active
wellness and PT studio

CONTINUED

Rate yourself in your experience and knowledge of dystonia (1-10)

CONTINUED

Learning Outcomes

After this course, participants will be able to:

- Identify at least three common clinical features of dystonia.
- Identify at least two clinical assessment tools for the sensory problem in dystonia.
- Identify all of the steps for a neuroplasticity-driven approach to dystonia treatment.
- Outline at least one learning-based sensorimotor retraining strategy to a patient case.

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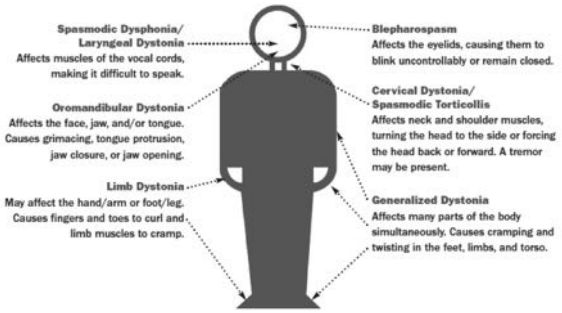
And here's how we will do it

- Introduction into Dystonia
  - Diagnosis
  - Review the sensory and integrative pathophysiology
- Review key assessments
- Neuroplasticity Approach to treatment through LBSMT
  - Prepare the brain
  - Re-train the brain
  - Treat underlying factors
- Apply to cases

What is Dystonia?

- Neurologic Movement Disorder
- Sustained or intermittent muscle contractions causing abnormal, often repetitive movements or postures.



https://www.dystonia-foundation.org

Diagnosis and Medical Management

- Diagnosis
  - Can be inherited, acquired or idiopathic
  - Clinical diagnosis
  - Clinical Syndrome workup
- Medical Management
  - Botulinum Toxin
  - Medications: anticholinergics, Levodopa, benzodiazepines
  - DBS
  - Exploring rTMS

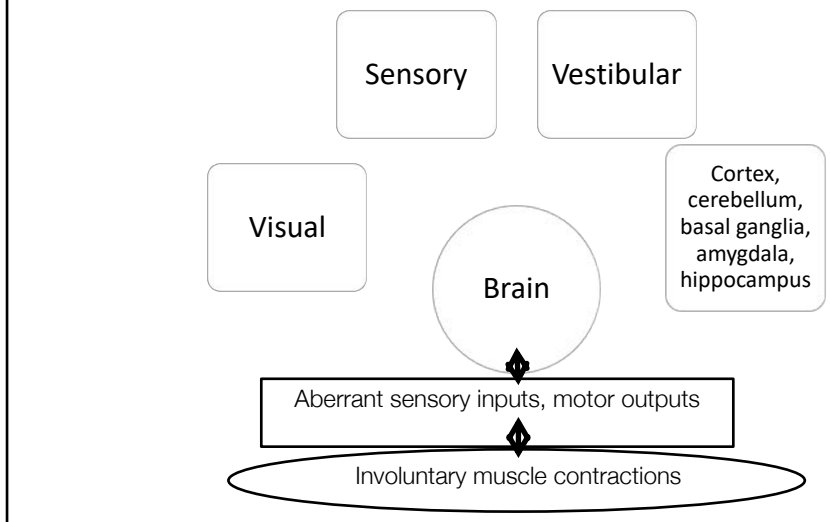
Balint et al, 2018

Pathophysiology

- Loss of inhibition: at all CNS levels
- Impaired sensorimotor integration
  - Temporal, spatial, organization
- Maladaptive neuroplasticity
  - Over-adapted connections
  - Over-excitation, decreased inhibition

(Quartarone, A and Hallett, M, 2013)

Software Problem VS Hardware problem



(Byl, 2013)

Common Sensory Deficits

Cervical Dystonia

- Vestibular
  - Rosengren et al. 2010
- Proprioception
  - Head Repositioning Accuracy/Joint Position Error
    - Michiels et al. 2013
- Sensory perception
  - Subjective Visual Vertical
    - Anastasopoulos et al. 1997
- Sensory organization
  - Perruchoud et al. 2014

Focal Dystonia

- Proprioception/ Kinesthesia
  - Avanzino et al. 2014
- Vibration
  - Yoneda et al. 2000
- Sensory integration
  - Sensory perception
    - Leplow & Stubinger 1994; Tinnazzi et al. 2009
  - Stereognosis/graphesthesia
    - Molloy et al. 2003
- Sensory organization
  - Perruchoud et al. 2014

Dystonia Evaluation

- Key subjective exam questions
- Movement analysis
- Investigate muscle activity
- Sensory testing
- Pre-disposing factors

Subjective

- BoNT cycle
  - Onset of effect 4-7 days
  - Peak effect is at 3-4 weeks
  - Wear off around 12 weeks
- Key questions:
  - Variability in daily routine
  - Trauma
  - Key life stressors
  - Understanding threats/danger signals on pain/movement
  - Lifestyle, health, fitness
  - Support

Higher success with interdisciplinary team

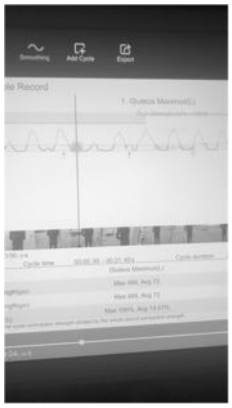
Benecke R, et al. 2005

Movement Analysis

- Analyze the task
- Analyze the task in different environments/contexts
  - Surface or object manipulation
  - Part and whole task
  - Speed
  - Posture (forward, backward, lying down, upside down, head between knees, etc.)
  - Vision (eyes open, eyes closed, eyes fixated)

Investigate Muscle activity

- sEMG
- Palpation
- All in different positions, postures, surfaces, with mental imagery, actual movement, etc)



Evaluate sensation

- General or special sensation
  - Vestibular
  - Vibration
  - Proprioception/kinesthesia
  - Two point discrimination
  - Localization
- Higher order
  - Subjective Visual Vertical (SVV)
  - Joint Position Error (JPE)
  - Laterality
  - Stereognosis/ graphesthesia
  - mCTSIB
  - Postural righting

Joint Position Error Testing

- When might this be appropriate?
  - Dx: Cervical Dystonia
  - Patient tells you- "I don't feel like I know where my head is in space"
  - Observation- The patient has poor head control
    - Can be in specific quadrants
- Goal of this Assessment:
  - Assess head rotation assessment to a neutral head position (HRA-NHP)
  - Get a sense of the smoothness of the patient's head and neck movement

Strimpakos et al, 2011

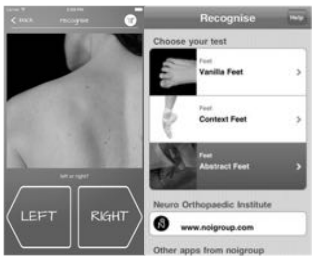
Two Point Discrimination

- This test is best for…..
  - Focal dystonia
  - Report of difficulty with fine control of limb
- Impairments in dystonia
  - Abnormal spatial discrimination thresholds
    - (Tinazzi et al, 2009; Avanzino 2014)

(Molloy et al 2003, Catley et al 2013)

Sensory Perception

- This testing is best for…..
  - Focal and cervical dystonia
- Laterality/ mental rotation: Recognise app
  - Stamelou et al, 2012
- Stereognosis/Graphesthesia
  - Byl et al, 2003



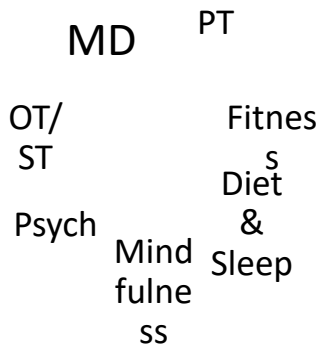
https://www.noigroup.com/product/recognise-app/

Pre-disposing factors

- Weakness/ imbalance
- Poor body awareness
- Flexibility: muscle and joint
- Neural tension
- Breathing pattern
- Personal factors:
  - High achiever
  - Perfectionists
  - Compulsive, impatient

Rate yourself in your comfort level of treating dystonia (0-10)

Overall Treatment Program



Dystonia: The Evidence

Evidence Based Recommendations

- Sensory tricks (Okun 2009)
- sEMG (Deepak 1999)
- Muscle vibration (Karnath et al 2000, Leis et al 1992)
- Sensory stimulation (Leis et al 1992), TENS (Tinazzi et al 2005)
- Body awareness/perception (Zetterberg et al 2008)
- LBSMT (Byl et al 2008)
- Sensory discrimination (Byl et al 2003)
- Proprioceptive/ vibration training (Rosenkranz et al 2008, Rosenkranz et al 2009)
- Mirror training (Byl, Mckenzie 2000)
- Mental training (Byl, Mckenzie 2000)

Clinical Expertise

- Train JPE
- Sensory stimulation: light touch, vibration, tens
- sEMG
  - Use with different activities, trying to quiet overactive muscles
- Postural alignment and righting
  - Body and head
  - Eyes and head
- OPTIMAL Theory application
- Change in positions and environment with task specific training

Learning-Based Sensorimotor Re-Training

The set up:
prepare the brain

- Enhanced expectancies
- Autonomy
- Quiet the nervous system
- Imagine normal movements (with joy!)

The work:
train the brain

- Decrease amount of abnormal movements
- Slowly re-train normal movements
  - Non-target→target task
  - Improve sensory and motor discrimination
  - External focus of attention

Treat underlying factors

- Biomechanics
- Strength and flexibility
- Nerve mobility
- Balance
- Breathing

Byl, Archer, McKenzie, 2008

The set up: prepare the brain

- Enhanced expectations
- Autonomy
- Quiet the nervous system
- Imagine/ experience normal movements (with joy!)

Expectations

Quiet the nervous system

Imagine and experience normal movements or positions with joy!

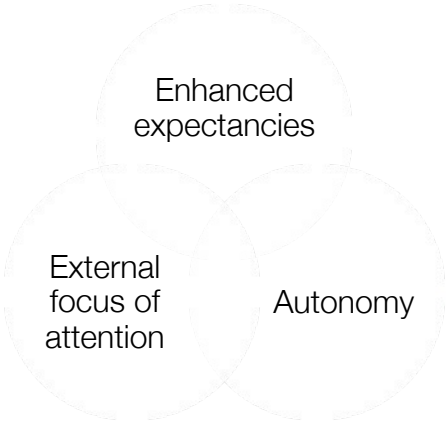
Quiet the Nervous System: Parasympathetic Toning

INDIVIDUALIZED!

- Extended Exhale
  - Non-judgmental attention to breath
  - PNS toning practice = exhale for 2x length of full inhale.
    - Example: full inhale measured at 3 sec; inhale for count of 3, exhale for count of 6.
- Interoception and Grounding:
  - Body scanning to sense/feel where the body is in contact with supporting surfaces
- "Climb inside the body and feel your feet on the floor…"
- Safe Movement with Breath
  - Functional AROM without pain or strain. Set up movement with a stable base of support
  - Awareness to feeling with movement.

Panskepp J 2004

OPTIMAL Theory in Dystonia Treatment

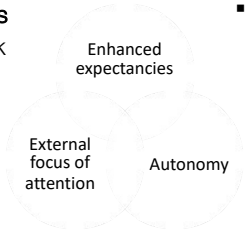


Wulf, Lewthwaite, 2016

The work: train the brain

- Decrease amount abnormal movements
- Slowly re-train normal movements
  - Non-target→target task
  - Improve sensory and motor discrimination
  - External focus of attention

- **Inhibit abnormal movements**
  - Practice a different task
  - Practice in a different environment/ position
  - Sensory tricks



- **Re-train normal patterns**
  - Re-differentiate motor patterns (isolated and discrete movement)
  - Improve sensory input
  - Learning: Incremental challenge and difficulty with positive reinforcement
    - Focus on external goal vs. self
    - Goal-action coupling

Practice, Practice, practice
10x-100x per day

Inhibit with sensory tricks: CD

Sensory trick: physical gesture or position which may serve to temporarily interrupt dystonic symptoms

Common examples in CD

- Inversion
- Elevation of arms
- Chew on toothpick
- Touch face
- Bend down between legs
- Touch chin

Inhibit with sensory tricks: Focal Dystonia

Common examples in focal dystonia

- Change base of support (feet wide, feet narrow)
- Change object (shoes, writing utensil)
- Change speed
- Change direction
- Change weight of limb

Decrease Abnormal movement

Change position/ environment

TENS

Taping

Tinazzi et al, 2005; Rosenkranz et al 2008, 2009, Leis et al 1992

Re-train normal patterns

- Mirror or video training
- Unweighted (pool, AlterG)
- Proprioceptive feedback/ alignment training
- Sensory training
- Surface EMG/ biofeedback

Louw et al, 2017

Graded Exposure Progression

- Least provocative to most provocative
  - R/L discrimination
  - Imagined movement
  - Mirror therapy
  - Doing movement in altered environment/context
  - Doing movement in target context

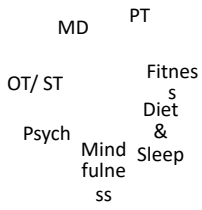
Treat underlying factors

- Biomechanics
- Strength and flexibility
- Nerve mobility
- Balance
- Breathing

- Biomechanics
- Strength
- Flexibility
- Nerve mobility/ tension
- Balance
- Breathing

Treatment Planning

- LBSMT (Byl et al 2008)
  - Fitness exercise (3-5x/wk for 30-40 min, 80% max HR)
  - Brainfit (40 hours, 1 hour/day)
  - Supervised group practice (3 hrs day, 5 days/wk, 2 wks then 5hrs/day for 1 week)
  - Home practice 1hr/day
  - Home group only had about half of the compliance
- Clinical experience (so individualized!)
  - Intensive: 4-5 days per week for 4-6 weeks
  - Progress to 1-2x/week for home maintenance
  - Progress to 1x/month
  - Follow up every 6 months
  - Multi-disciplinary—include yoga, yoga therapy, mindfulness meditation



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Dystonia Case 1

- 63 y/o female with 6 year h/o CD
- Primary issue: pain
- PSFS:
  - sitting prolonged (2), any afternoon activities (0)
- Xeomin injections every 6-8 weeks
- h/o ETOH, depression, traumatic childhood
- Other care: sensory nerve ablation, THC, acupuncture, yoga, body work, Pilates
- Exam: CD with right head turn and tilt, L sided pain, greatly limited ROM, difficulty maintaining straight path with eyes closed, difficulty with eye/head differentiation, JPE error > 6 deg, + vestibular screen (+ HIT on left)

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Learning-Based Sensorimotor Re-Training

The set up: prepare the brain

- Enhanced expectancies
- Autonomy
- Quiet the nervous system
- Imagine normal movements (with joy!)

The work: train the brain

- Decrease amount of abnormal movements
- Slowly re-train normal movements
  - Non-target→target task
  - Improve sensory and motor discrimination
  - External focus of attention

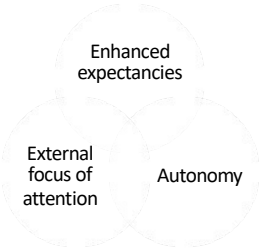
Treat underlying factors

- Biomechanics
- Strength and flexibility
- Nerve mobility
- Balance
- Breathing

Adapted from Byl, Archer, McKenzie, 2008

Preparing the brain

- Enhanced Expectations: people like you with CD…….
- Autonomy: We identified two key areas to address, what would be most beneficial to work on first?
- Quieting
  - Mediation
  - Self compassion
  - Yoga
  - Breath



Train the Brain

Treat underlying factors

- Vestibular: X1 and X2 viewing in standing uneven surface
- Limited cervical ROM and pain: manual therapy
  - C/T junction rotation
  - First rib mobilization
  - Levator and suboccipital STM
  - Suboccipital contract/relax

Treatment Frequency and Outcomes

- 1x per week for 9 months
- 1x every other week for about 9 months
- Follow up in 3 months
- Maintenance 1x/month

- PSFS:
  - PRE: sitting prolonged (2), any afternoon activities (0)
  - POST: sitting prolonged (6), any afternoon activities (7)
- JPE improved to < 6 degree error to all movements accurate
- Neck ROM improved from 35 degrees rotation BIL to 60 degrees rotation BIL
- Ongoing management
  - Exacerbations with stress

Case Application Practice

- 65 y/o male
- 3 year history of toe curling with drumming, now also in other activities
- Referred for opinion about botox
- Exam:
  - Strength intact on R, L hip weakness
  - Impaired laterality and 2 point discrimination
  - Impaired SL balance on R
  - + Sciatic nerve tension
  - Toe curling with mental practice of drumming

Practice

✓How will you stop this patient from drumming? What positions will you try? What other contexts?

✓How will his sensory/proprioceptive changes contribute to his control during drumming?

✓How will you address the underlying issues?

✓How will you help him become more variable during his progression?

✓How will you prevent this from happening again?

Action steps

- For your next person you have with dystonia:
  - Talk through the learning based sensorimotor retraining with one client. Are they ready to commit?
  - Prepare the brain: Try one breathing practice with an appropriate client this week.
  - Train the brain: how will you systematically progress through activity?
  - Let me know how it goes! julie@re-activept.com

CONTINUED

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