



## The Magic Muscle Sense : Proprioception

Kathryn Smith

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## Analysis of Sensory Integrative Functions

Visual-Praxis	Vestibular Bilateral Integration	Proprioception	Tactile Somato-dyspraxia	Sensory Reactivity (Modulation)
Visual motor	Postural control	Gross motor skills	Praxis	Arousal Affect Activity Level Attention
Visual construction	Bilateral coordination Sequencing	Fine motor skills	Auditory - Language Organization of behavior	State/Self Regulation

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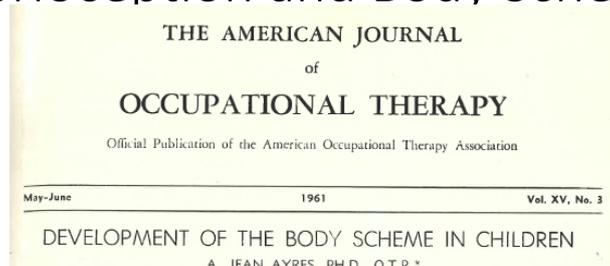
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The human body is made up of systems that keep it alive.  
The one that keeps  
you breathing, the one that keeps you standing, the one that  
makes you hungry  
and the one that makes you happy.  
They're all connected, take a piece out and  
everything else falls apart.  
And it's only when our support systems look like they  
might fail us that you realize how much we depended on them all  
along.

Greys Anatomy - Season 8, episode 9

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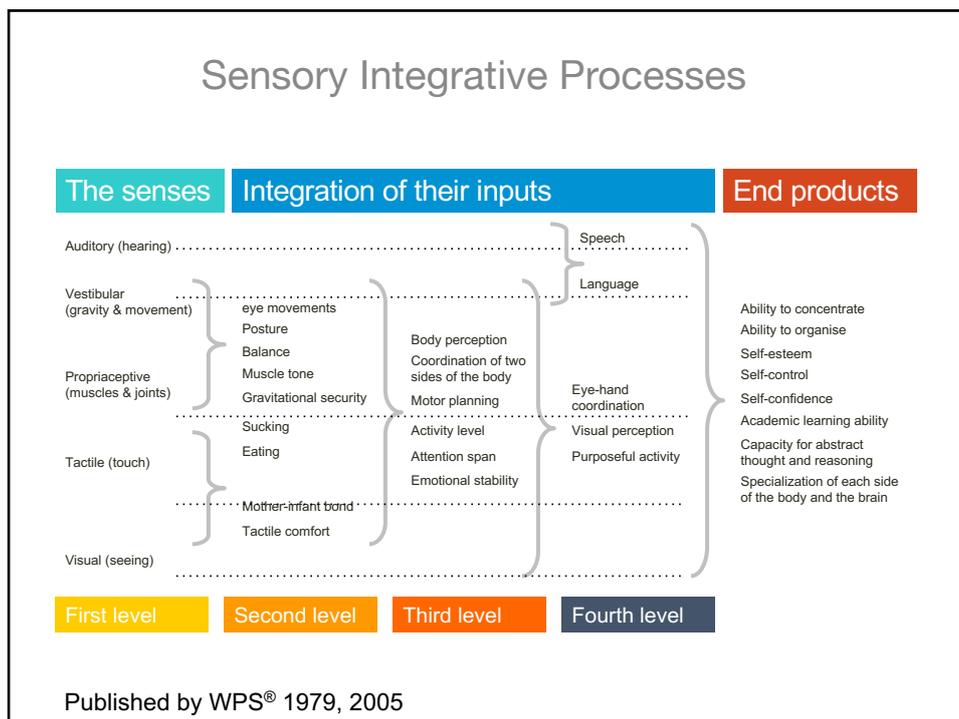
## Proprioception and Body Scheme



Acquisition of a body scheme is dependent upon synthesis of sensory stimuli, the main ones being those of touch, proprioception, and vision. As an

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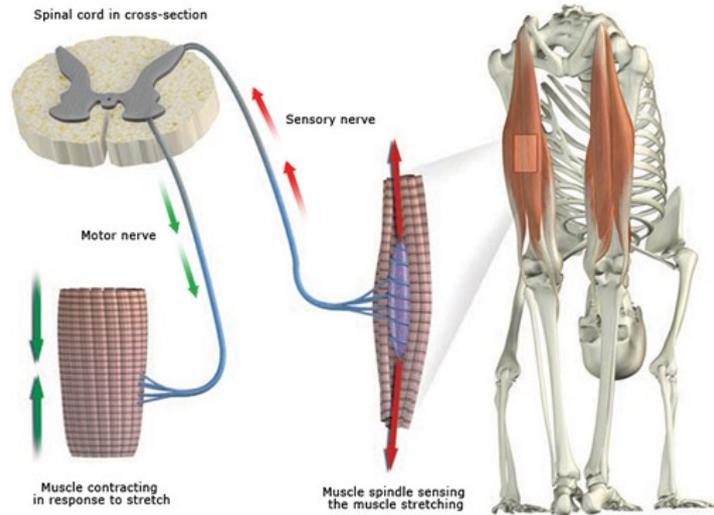



**Movement is life; without movement  
 life is unthinkable.**

Moshe Feldenkrais 2010

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# Proprioceptive Receptors



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## Proprioception:

The sum of neuronal inputs from the joint capsules, ligaments, muscles, tendons, and skin...

is a multifaceted system that influences behavior regulation and motor control.

Blanche et al 2012

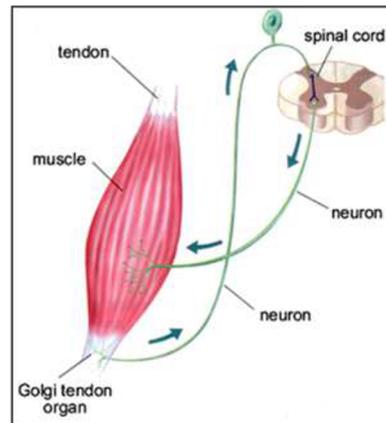


Figure 2.5 MUSCLE SPINDLES SENDING INFORMATION TO SPINAL CORD  
Kirwan, 2009:n.p.

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Proprioception was first described by Sherrington as the the perception of joint movement and position in space.

This definition was later refined to include kinesthesia (awareness of passive or active joint movement) plus position sense



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Nowadays we consider that proprioception affects the rate and timing of movements so influences:

- the regulation of muscle force
- the regulation of muscle stretch
- it affects people's ability to motor plan
- time their actions
- maintain the fluidity of their movements
- calibrate their actions in space
- use feedback from the outcome of the action
- stabilize their joints
- Estimate muscle force according to the task
- orient their body segments

Adapted from Blanche 2012



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A physio definition...

This ability enables us to know where our limbs are in space without having to look.

It is important in all everyday movements but especially so in complicated sporting movements, where precise coordination is essential.

This coordinated movement is a result of the normal functioning of the proprioceptive system.

physioroom.com



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Once a joint has been damaged, or a ligament has been torn or partially torn, there will be a deficit in the proprioceptive ability of the individual. This can leave the person prone to re-injury, or decrease their coordination during sport.

Proprioceptive ability can be trained through specific exercises and, in the case of the injured athlete, the improvement can compensate for the loss caused by injury. This has the effect of decreasing the chances of re-injury. The exercises should be initiated as soon as possible following injury.

physioroom.com



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## Autism and Sensory Processing – What is the connection?

70% have sensory modulation difficulties

Adamson et al, 2006

80-90% atypical responsivity

Rogers & Ozonoff 2005, Tomchek & Dunn, 2007

90 % of children with ASD have motor difficulties: this does not necessarily relate to functional impairment

Green, 2006



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## Autism and Sensory Processing – What do we know?

Significant difficulties with movement performance and with processing proprioceptive and vestibular information  
Siaperas et al 2012

Children Autism Spectrum Disorder may fall into 2 categories;

- sensory hyper reactivity
- difficulties with multisensory processing

Lane A, Malloy C & Bishop S, 2014

Difficulties in maintaining postural control in infancy, persisting in later years

Memari et al, 2014

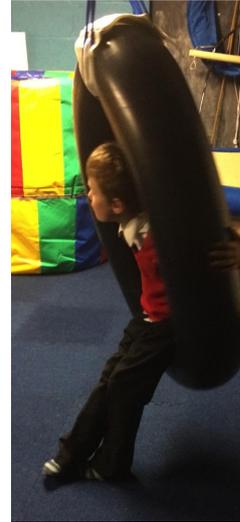


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## Autism and Sensory Processing – What do we know?

Children with ASD characteristically display relative strengths in visuopraxis and difficulties with somatopraxis and vestibular functions, which appear to greatly affect participation. Roley et al 2015

ASD demonstrated a different pattern of parasympathetic activity during sensory stimulation  
Schaaf et al 2015



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- 1 Decreased muscle tone
- 2 Joint hypermobility
- 3 Poor joint alignment and cocontraction
- 4 Inefficient ankle strategies
- 5 Inadequate weight-bearing and weight-shifting patterns
- 6 Decreased postural control
- 7 Decreased feedback-related motor planning abilities
- 8 Decreased feedforward-related motor planning abilities
- 9 Inefficient grading of force
- 10 Decreased fluidity of movements (not included in factor analysis)
- 11 Decreased mid-range control (not included in factor analysis)
- 12 Tiptoeing
- 13 Pushing others or objects
- 14 Enjoyment when being pulled
- 15 Tendency to lean on others
- 16 Over active
- 17 Overly passive
- 18 Crashing, falling, running



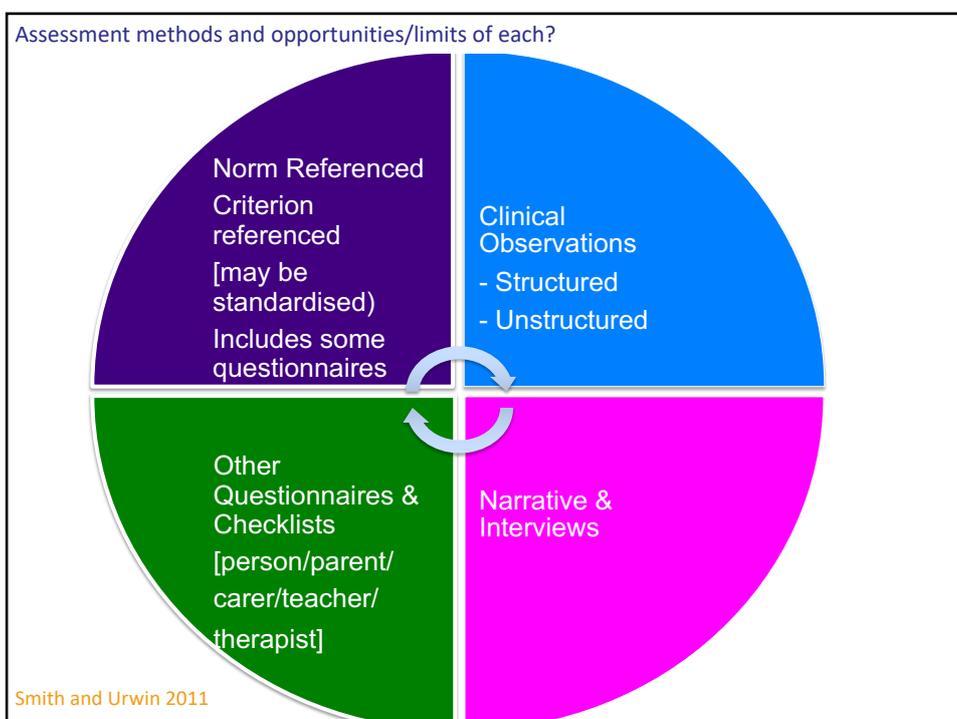
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Factor	COP Item
1. Tone and joint alignment	2. Joint hypermobility 1. Decreased muscle tone 3. Poor joint alignment
2. Behavioral manifestations	13. Pushing 16. Overactive 18. Crashing, falling, running 14. Enjoyment when pulled 12. Tiptoeing
3. Postural motor	6. Decreased postural control 15. Tendency to lean 9. Efficient grading of force 5. Inadequate weight bearing 4. Inefficient ankle strategies
Motor planning	7. Decreased feedback planning 8. Decreased feedforward planning 17. Overly passive
Not included in factor analysis	10. Decreased fluidity of movements



Blanche 2012

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## Proprioceptive Assessments Sensory Integration and Praxis Tests



- Kinesthesia
- Standing and Walking Balance

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## Proprioceptive Assessment

### The Evaluation in Ayres Sensory Integration (EASI)<sup>®</sup>

Training Manual for Administration & Scoring  
Vestibular & Proprioception Tests

Fall 2016  
Zoe Mailloux  
Diane Parham  
Susanne Smith Roley



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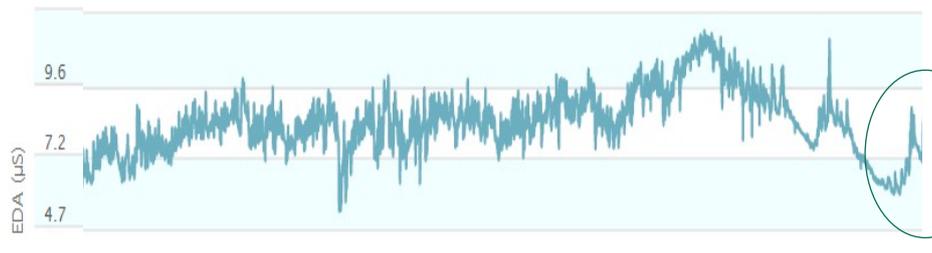
## When it is too heavy, what do we do ?

### Breath-Holding

- for postural stability → increase sympathetic

Postural Change Alters Autonomic Responses to Breath-Holding (2010)

[Indu Taneja](#), [Marvin S. Medow](#), [Debbie Clarke](#), [Anthony Ocon](#), and [Julian M. Stewart](#)



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### Proprioception: Force

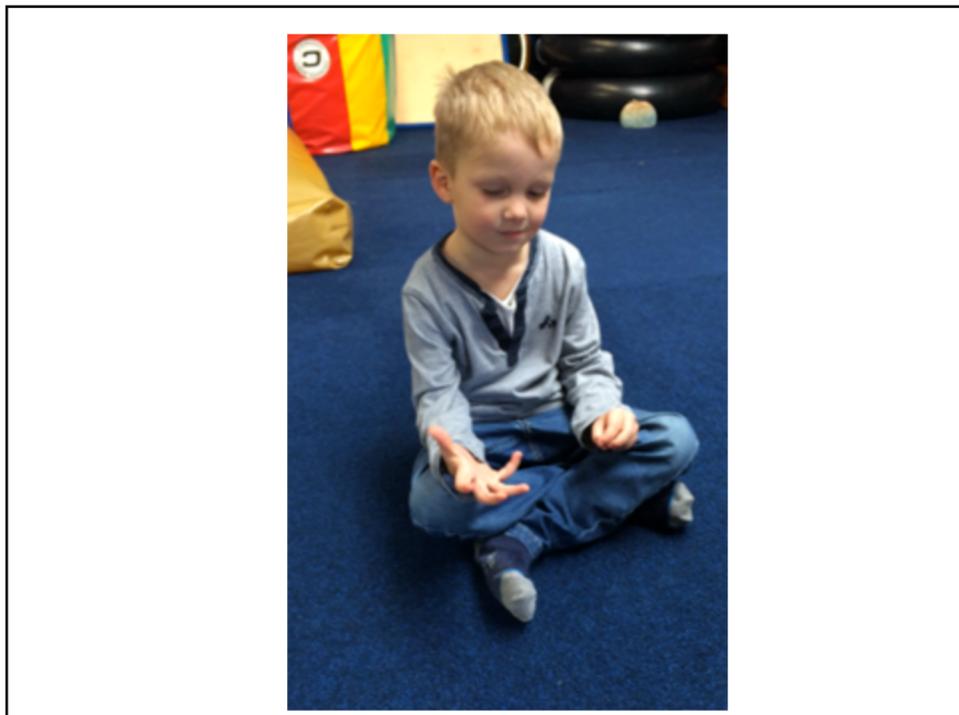


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<b>VARIABLES RELATED TO PROPRIOCEPTIVE SENSATIONS</b>		
<u>Client Factors</u>	<u>Proprioceptive Sensations</u>	<u>Environmental condition</u>
Body position Body scheme/image/concept Grading Muscles used/combinations of muscles used Strength Tone Part of body taking the input FATIGUE AROUSAL LEVEL	<b>Traction – pull</b> <b>Compression – push – weight-bearing</b> <b>Coactivation – cocontraction</b> <b>Isometric/isotonic</b> <b>Vibration</b> <b>??? COMBINATION WITH OTHER INPUT</b>	Experience Weight/Load size dimension distance Force GRAVITY
Interest Active/passive Static/dynamic	RESISTANCE Alternating Speed, Intensity Duration. Rhythmicity Stop and start	Physical Environment Stable Moving

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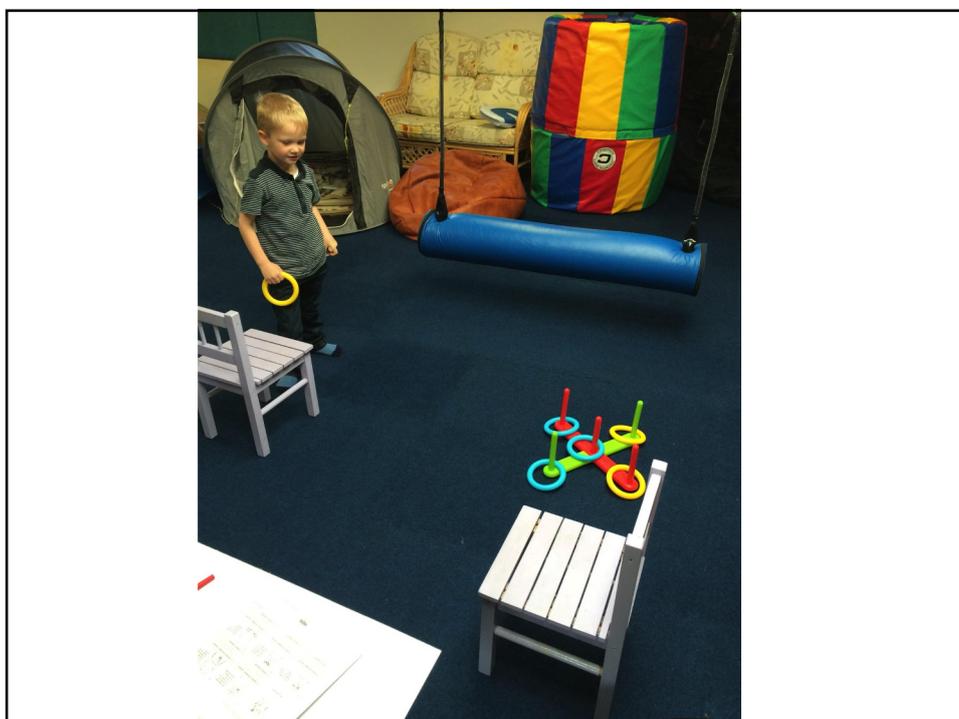
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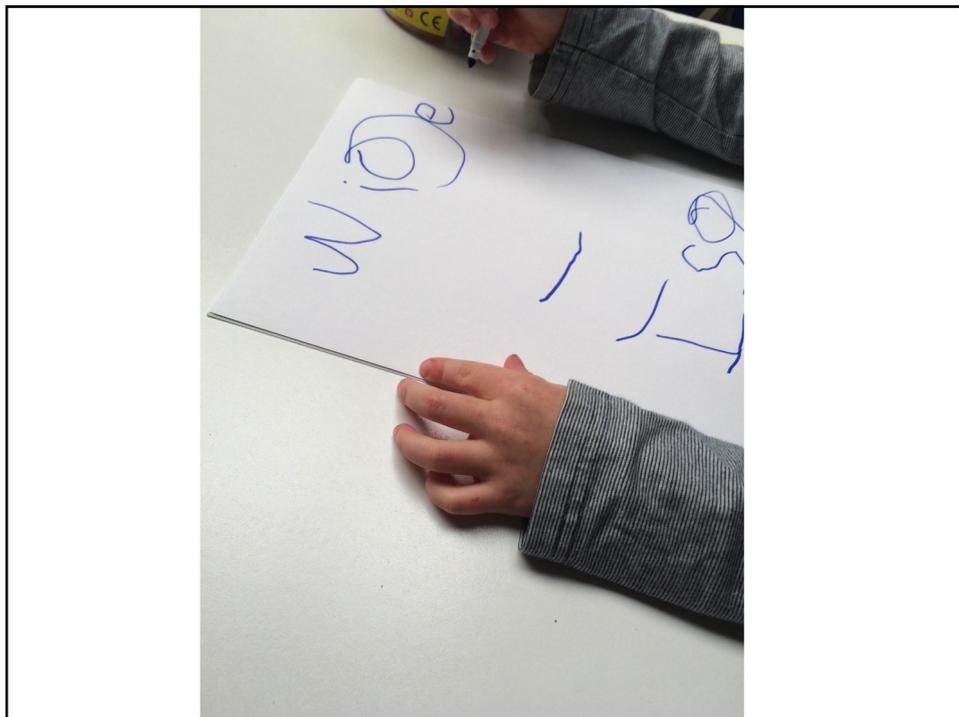
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## Achieving a balance: integration and processing of sensation for a balanced lifestyle

**Smith, K 2000**

**Shutdown** 'disconnected brain'  
(eg dissociated/unreal/dream-like/catatonic)  
freeze

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**Over Alert**  
'primitive reptile brain'  
Protective, but can also be defensive/reflexive  
(eg angry/aggressive/irritable but also extreme effort/energy if needed)  
fright – fight or flight

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**Calm and Alert**  
'cerebral cortex human brain' drives optimal functioning  
Mindfulness  
This space enables and promotes:  
• learning  
• remembering  
• make good decisions – 'clear' thinking

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**Under Alert**  
(low/bored/disinterested)

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**Sleep States**  
Reticular Activating System is a key regulator/waker -  
like a sensory scanning background for NB info

**Sensory Ladder  
Levels of Arousal**

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References:  
Breathnach, E: 2009 - Teaching on Sensory Modulation  
Smith, K and Turner, A: 2002 - Sensory Levels  
[www.sensoryproject.com](http://www.sensoryproject.com)

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### SENSORY PROCESSING AND AROUSAL LEVELS

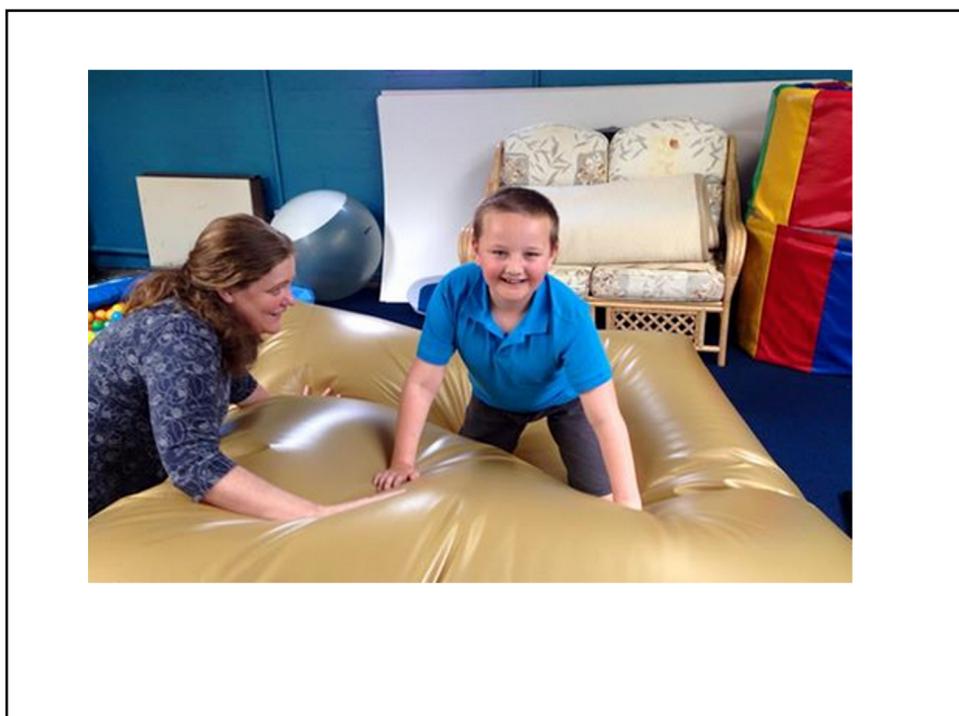
	<b>SHUT DOWN</b>
	<b>OVER AROUSED</b>
	<b>FEELING CALM AND ALERT</b>
	<b>UNDER AROUSED</b>

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## Sensory input

**Ball Chairs** – Positive effect on in seat behaviour for the children who had the most extreme vestibular-proprioceptive seeking behaviour, those with poor postural stability where less engaged on therapy ball (Bagatelle, 2010)

**Chewing Gum** – significant positive effect on concentration performance (Tanzer, 2009)

**Touch/Proprioception** – massage or touch therapy (4 studies): some encouraging evidence that improvements in target behaviours noted  
(NB peer massage = proprioception)

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You have brains in your head.  
You have feet in your shoes.  
You can steer yourself any  
direction you choose.

*-Dr. Seuss, Oh, The Places You'll Go!*

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