

Handout for the Therapro webinar **Understanding the Relationship between Sensory Integration and the Suck/Swallow/Breathe Synchrony (SSB)**
presented by Eileen W. Richter, MPH, OTR/L, FAOTA - June 18, 2019

Understanding the Relationship Between Sensory Integration and the (SSB) Suck/Swallow/Breath Synchrony

Eileen W. Richter, MPH, OTR/L, FAOTA

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Brief Overview of the SSB Synchrony

- Most organized sensory motor system at birth
 - Primitive survival mechanism
- Model represents development from synchrony to synergy and its influence on development
- It functions womb to tomb

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Essential to Survival

The SSB is functioning in utero –

- The perioral area is the first to respond to touch stimuli (7 weeks gestation)
- Suck/swallow patterns are established by 15-18 weeks
- Even respiratory muscles are engaged in utero and ready to work in the extra uterine environment at birth

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Immediately at Birth

The SSB will be available for:

- Feeding
- Self soothing
- Oculomotor control
- Head/neck control




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Quickly Adapts from Synchrony to Synergy

As babies use the SSB structures and patterns for nutrition, they quickly begin to use them for other purposes such as calming, exploration, visual attention and learning.

This transition from synchrony to synergistic interaction with other muscles and structures sets the conditions for the rest of development, including sensory (motor) integration, to proceed efficiently.



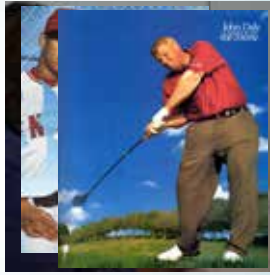
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Womb to Tomb

Strategies continue to be used throughout life for

- Fine motor skills
- Calming
- Alerting/maintaining alertness
- Focusing attention
- Heavy work



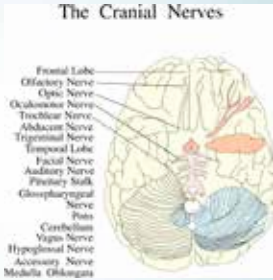
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Neurological Relationships

- Central Nervous System
- Cranial Nerves
- Central Pattern Generators



The Cranial Nerves


Frontal Lobe
 Olfactory Nerve
 Otic Nerve
 Oculomotor Nerve
 Trochlear Nerve
 Abducent Nerve
 Trigeminal Nerve
 Temporal Lobe
 Facial Nerve
 Auditory Nerve
 Primary Stalk
 Glossopharyngeal Nerve
 Vagus Nerve
 Hypoglossal Nerve
 Accessory Nerve
 Medulla Oblongata

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Sensory (Motor) Integration

- Occurs primarily in the central nervous system
- Central Pattern Generators (CPG)
- SSB is enervated by the Cranial Nerves
- Usually most attention to CN VIII - the vestibulocochlear nerve



Cranial Nerve VIII: Vestibulocochlear

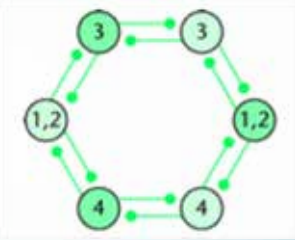
Semicircular canals
 Vestibular ganglion
 Vestibular nerve
 Cochlear nerve
 Vestibular nucleus
 Internal acoustic meatus
 Cochlea
 Vestibulocochlear nerve (VIII)
 Cochlea - containing spiral ganglion

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Central Pattern Generators (CPGs)

Central pattern generators are neuronal circuits that when activated can produce rhythmic motor patterns. Essentially all rhythmic motor behaviors are based on CPGs. CPGs can produce patterned activity in the absence of patterned input (rhythmogenic). Rhythm generation can be based on intrinsically rhythmic neurons or network interactions.




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Rhythmicity and Sensory Integration

- The CNS functions through the GPG networks pointing to the power of rhythmicity to function.
- The SSB is the first and strongest rhythmic sensory motor pattern available at birth and throughout life.
- The rhythmicity of the SSB is part of reason it is helpful in changing states of regulation and supporting sensory motor development.



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SSB, Cranial Nerves, & Sensory Integration

This act involves all 12 cranial nerves when a nursing infant looks up from the mother's breast he is preparing for the sound of his mother's voice.




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SSB, Cranial Nerves, & Sensory Integration

Nursing is using cranial nerves:

- I Olfactory
- V Trigeminal
- VII Facial
- IX Glosso-pharyngeal
- X Vagus
- XII Hypoglossal



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SSB, Cranial Nerves, & Sensory Integration

Looking up is using cranial nerves:

- II Optic
- III Oculomotor
- IV Trochlear
- VI Abducens
- VIII Vestibulo-cochlear




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SSB, Cranial Nerves, & Sensory Integration

Listening is using cranial nerve:

- VIII Vestibulo-cochlear



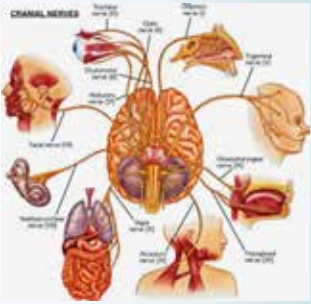
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Significance of Cranial Nerves to Sensory Integration

Cranial nerves send information directly to the central nervous, requiring no intermediate synapses.

The cranial nerves are highly interactive- resulting in extensive integration among them and accounting for the integrated, complex functions they serve.



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Significance of Cranial Nerves to Sensory Integration

- CN communication
 - Travel together as one
 - Travel on same tract -MLF carries III, IV, VI, and VIII
 - Overlapping neural support of various functions indicating integration among the nerves

SUCKING
Sensory
CN VII

SWALLOWING

BREATHING
Motor
C3-7
T1-12

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“ Knowledge Informed Intervention ”

Neurobiological Development and Function
Human development- sensory, motor, emotional, social, cognitive, etc.
Observation
Research

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Observation of SSB Impact on Behavior


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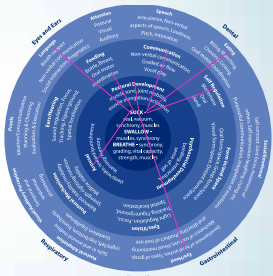
Research Informed Intervention

Research design limits the scope of practice.
 We can also define efficacy by evaluating the outcomes of intervention. (Practice Based Efficacy)
 However, research is useful for informing strategies, and approaches to intervention.



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Research Supporting Sucking and Rhythmicity for Sensory Motor Development, Attention, Fine Motor Skill, etc.



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“...orocutaneous experience is physiologically salient and spectrally patterned to resemble the ‘burst-pause’ structure of the NNS. This form of stimulation serves to entrain the activity patterns of populations of mechanoreceptor afferents located in the lips, tongue, and jaw of the neonate, which in turn influence the firing patterns of the respective orofacial lower motor neurons.”

Barlow, S.M., et al., April 2008. Synthetic orocutaneous stimulation entrains suck in preterm infants with feeding difficulties. Neonatology Today.

“The utility of the NNS (non-nutritive suck) has been shown to benefit growth, maturation and gastric motility, while decreasing stress and enhancing oral feeds.”

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“RESULTS:
 Chewing gum was associated with improved attentional task performance. This finding was not contingent upon a general decrease in attentional performance and was apparent at all stages of the task. Subjective measures of alertness, contentedness, and calmness were higher following the chewing of gum. Changes in sustained attention co-varied with subjective alertness.”

[Johnson AJ, Muneem M, Miles C.](#) Chewing gum benefits sustained attention in the absence of task degradation. *Nutr Neurosci*. 2013 Jul;16(4):153-9. doi: 10.1179/1476830512Y.0000000041. Epub 2012 Dec 6.

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“RESULTS:
 Study 1 showed that chewing gum increased reported alertness and hedonic tone and improved performance on the categoric search task. Chewing gum maintained reported alertness across sessions in study 2. In the first experimental session of study 2 gum improved categoric search performance, and during the second session gum broadened focus of attention and quickened vigilance reaction time. This effect on vigilance reaction time was moderated by time-on-task, with an initial negative effect being replaced by a positive effect.”

[Allen AP, Smith AP.](#) Effects of chewing gum and time-on-task on alertness and attention. *Nutr Neurosci*. 2012 Jul;15(4):176-85. doi: 10.1179/1476830512Y.0000000009. Epub 2012 Apr 3

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SSB Relationship to Posture

- ▀ Studies that have explored the effects of SSB components on posture
 - Chewing
 - Tongue position
 - Intrapulmonary pressure

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“The results show that COG velocity decreased significantly while tongue was positioned against upper incisors in comparison to the habitual jaw resting position. Our findings suggest that the tongue positioning can modulate postural control mechanisms. Tongue positioning against the upper incisors can enhance the postural stability during upright standing on an unstable surface and in the absence of vision in healthy young adults.”

Alghadir, A. et al. 2015. Effect of tongue position on postural stability during quiet standing in healthy young males. *Somatosens Mot Res*, 2015; 32(3): 183-186. DOI: 10.3109/08990220.2015.1043120

These authors were now looking at the tongue's contribution to balance and stability. They also discuss the evidence of the integrated functional coupling between jaw and neck motor systems.

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“The results show that COG (center of gravity) velocity decrease significantly while chewing in comparison to both open and resting jaw position ($p < 0.0001$). Our finding corroborates previous studies and suggests that the jaw sensory motor system can modulate postural control mechanisms.”

Alghadir, A. et al. 2014. Effect of chewing on postural stability during quiet standing in healthy young males. *Somatosens Mot Res*, Early Online: 1-5. DOI: 10.3109/08990220.2014.969837

The research measured levels of postural sway in static postures. Authors suggest the results be taken into consideration for treatment of patients with postural instability.

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“These results show that airway modulation affects postural control during upright perturbations. The thorax was more stable when the glottis was engaged than when it was required to remain open, whereas control of CoP (center of pressure) displacement appeared more optimal during the dynamic midrange modulation of voicing. These data suggest that glottal control influences balance, and that glottal control strategies may be an important consideration for patients with breathing and/or balance disorders.”

Massery, M. et al. 2013. Effect of airway control by glottal structures on postural stability. *J Appl Physiol* 115: 483-490. DOI: 10.1152/jappphysiol.01226.2012.


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When we observe the engagement of tongue and jaw in infancy, we can extrapolate that information to later development. The research is supporting this extrapolation.



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This is just a selection of the research that's being done. The volume of studies on respiration and rhythmicity is too great to cover here.

Technology is allowing very sophisticated brain research that is illuminating more and more how the cranial nerves, central pattern generators and cellular interactions work.

Many of the studies are relating findings to adult diseases and dysfunction as well.

Questions?

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