

NEONATAL FEEDING REFLEXES

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Objectives

- Describe the main oral reflexes related to breastfeeding:
 - Adaptative reflexes: rooting, suckling, swallowing
 - Protective reflexes: gag, cough
- Describe the new understanding of infant suckling
- Describe the coordination between suckling, swallowing and breathing

PLAN

- **INTRODUCTION & RESOURCES**
- Main oral reflexes
 - Adaptative
 - Protective
- Infant suckling: new understanding
- Coordination suckling/swallowing/breathing
- Conclusion

Introduction

- Newborn: depends primarily on reflexes for feeding.
- **Reflexes:** 'Prewired templates for life-sustaining movements that gradually become integrated in voluntary movement patterns'

Resources

(for content & source of pictures)



A 'Supporting Sucking Skills' Catherine Watson Genna, 2nd Ed. (2013)

B 'BF and Human Lactation' Jan Riordan & K. Wambach 5th Edition (2016)

C 'Core Curriculum' ILCA 3rd Edition (2013)

➤ Geddes DT, Kent JC, Mitoulas LR, Hartmann PE. Tongue movements and intro-oral vacuum in breastfeeding infants. *Early Human Development*, 2008, 84, 471-477

Resources (video)



'The BF Atlas' Wilson-Clay & Hoover, 4th Edition (2008) and CD from 2nd edition

International Breastfeeding Center (Toronto). Breastfeeding videos <https://ibconline.ca/breastfeeding-videos-english/>

D

PLAN

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ADAPTATIVE REFLEXES

- a. Phasic bite
- b. Transverse tongue
- c. Tongue protrusion
- d. Rooting
- e. Suckling
- f. Swallowing

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a. PHASIC BITE Reflex

- Stimulus: gums (not during suckling)
- Behavior: rhythmic up and down jaw movement
- Cranial nerves involved: V (trigeminal)
- Present at: 28 weeks gestation
- Disappears by: 9 to 12 months

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b. TRANSVERSE TONGUE Reflex

- Stimulus: sides of tongue
- Behavior: tongue lateralizes
- Cranial nerves involved: XII (hypoglossal)
- Present at: 28 weeks gestation
- Disappears by: 9 to 12 months (?)

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c. TONGUE PROTRUSION Reflex

- Stimulus: touch tongue tip/lips
- Behavior: tongue protrudes from mouth
- Cranial nerves involved: XII (hypoglossal)
- Present at: 38 - 40 weeks gestation (28 weeks in ref. C)
- Disappears by: 6 months

N-B: 'These reflexes diminish by around 6 months in preparation for introduction of solid foods.' (A)

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d. ROOTING Reflex

- Stimulus: stroke cheek or near mouth (lips/cheeks)
- Behavior: infant localizes toward source, opens mouth (gape), extends and depresses tongue to grasp breast (*tongue protrusion reflex*), creates seal against breast
- Cranial nerves involved: V (trigeminal), VII (facial), XI (spinal accessory), XII (hypoglossal)
- Present at: 32 - 37 weeks gestation; peaks at 40 weeks gestation
- Disappears by: 3 to 6 months

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e. SUCKLING Reflex

- Stimulus: touch to junction of hard/soft palate (A), mouth/tongue (C)
- Behavior: wavelike tongue movement, coordinated with up/down jaw movement
→ initiation of a four-part swallowing process
- Cranial nerves involved: V, VII, IX (glossoph.), XII
- Present at: 15-18 weeks gestation (C), 18 weeks (A), 24 weeks (B); strongest first hours after birth
- Disappears by: 6 to 12 months

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Rooting & Suckling



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f. SWALLOWING Reflex

- Stimulus: Pharynx
- Behavior: deglutition
- Cranial nerves involved: V, VII, IX, X (vagus), XII
- Present at: 12-14 weeks gestation
- Disappears by: persists

N-B: 'Both suckling and swallowing are not simple reflexes, but encompass complex highly orchestrated sensory and motor events, that are both under voluntary and involuntary control.' (A)

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12-week Swallowing US Scan Video



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Swallowing: 4 phases

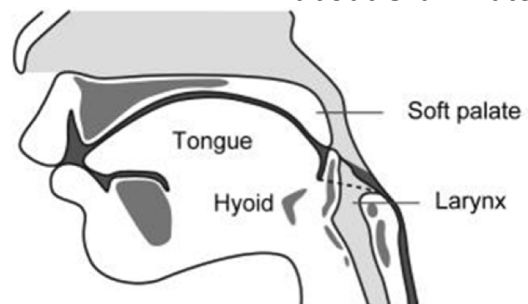
1. Oral preparatory phase: sucking to bolus formation
2. Oral transitory phase: propelling the bolus posteriorly in the mouth
3. Pharyngeal phase
4. Esophageal phase

N-B: Primary focus of lactation consultants: phase 1 & 2 (= 'feeding').

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Reminder about Oral Anatomy



Matsuo (2008) Part of Figure 2.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2597750/figure/F2/>

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1. Oral Preparatory Phase

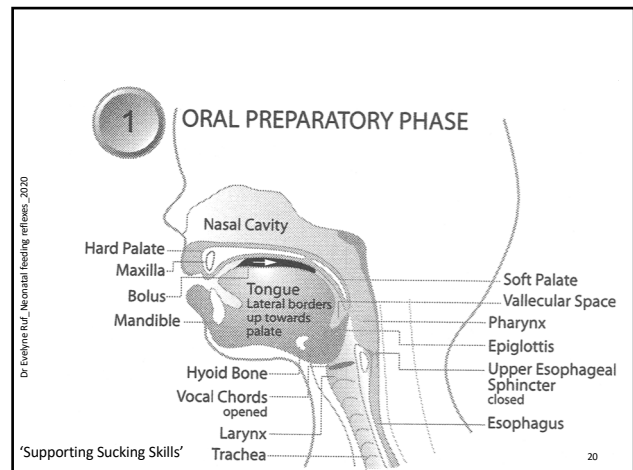
- Structures involved:
 - Lips
 - Tongue/mandible
 - Cheeks
 - Hard palate



- Movement: rooting, attachment, **suckling**, with medial portion of the tongue forming a **groove** (cupping) for channeling the milk posteriorly (towards the valleculae).

! Cupping is normal only during suckling, not during crying (here due to posterior T-T)...

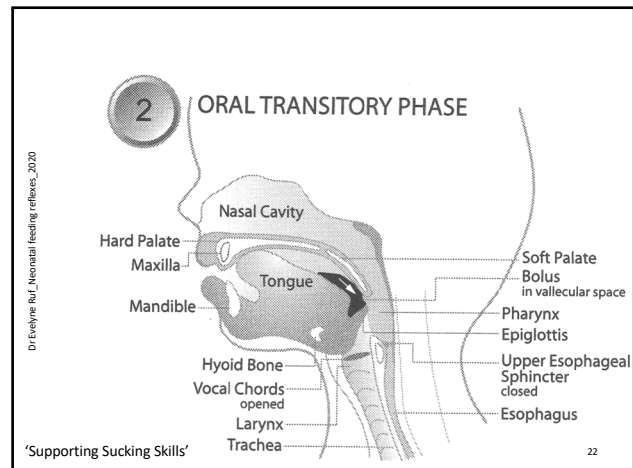
<http://milkmatters.org.uk/2011/04/15/hidden-cause-of-feeding-problems-however-you-feed-your-baby/>



'Supporting Sucking Skills'

2. Oral Transitory Phase

- Structures involved:
 - Tongue/mandible
- Movement: wavelike mechanical movements and pressure changes created by the tongue propel the bolus to the back of the oral cavity (into the valleculae = vallecular space).



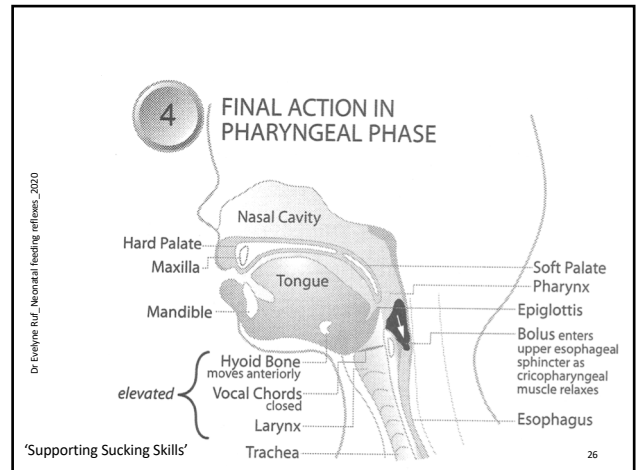
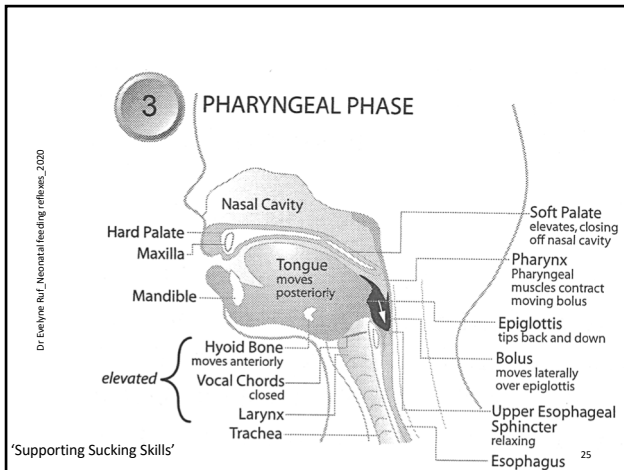
'Supporting Sucking Skills'

3. Pharyngeal Phase

- Structures involved:
 - Soft palate/velum
 - Pharyngeal muscles surrounding the throat
 - Epiglottis
 - Laryngeal muscles
 - Arytenoid mass (true & false vocal cords, arytenoid cartilage)
 - Upper esophageal sphincter
- Trigger: bolus at the valleculae (base of the tongue)

3. Pharyngeal phase (cont.)

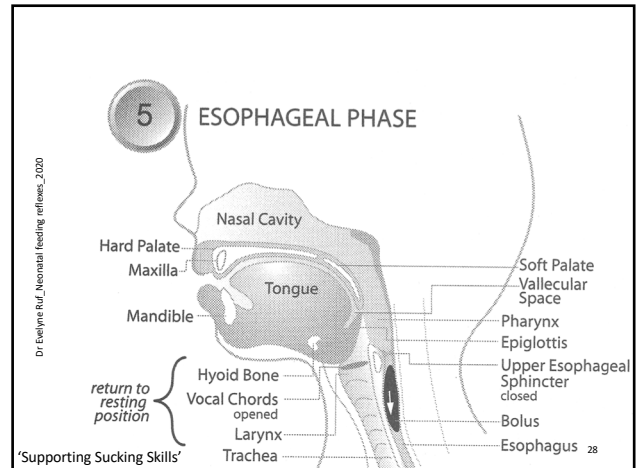
- Mechanisms for protection of the airway:
 - Breathing stops
 - Velum elevates to close off nasal cavity
 - Hyoid bone moves up and anteriorly
 - Larynx elevated by the same upward movement
 - As tongue moves posteriorly, epiglottis moves back and downward over larynx → bolus diverted laterally and back toward the esophagus.
 - Opening of the upper esophageal sphincter



4. Esophageal Phase

- The bolus moves through the esophagus toward the stomach by:
 - Peristaltic movement of the bolus through the esophagus
 - Opening of the lower esophageal sphincter to allow the bolus to enter the stomach

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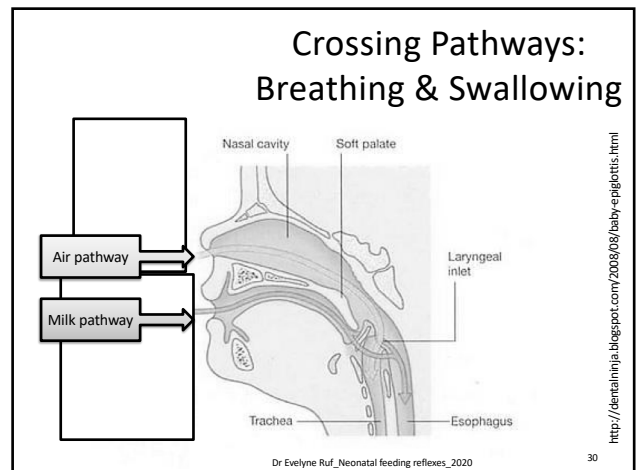


Phase with greatest risk of aspiration?

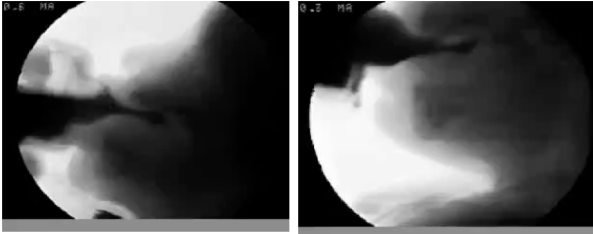
- Phase 1 (oral preparatory)
- Phase 2 (oral transitory)
- Phase 3 (pharyngeal)
- Phase 4 (esophageal)

Newborn feeding "is a very complex activity requiring exquisite coordination of three foundation processes: sucking, swallowing and breathing" Wolf & Glass (in A).

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Swallowing (end): reference / dysphagia



Videofluoroscopic swallow study (VFSS)
Swallowing and feeding in infants and young children
Joan C. Arvedson
GI Motility online (2006)
doi:10.1038/gimo17

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PROTECTIVE REFLEXES

- a. Cough
- b. Gag

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a. COUGH reflex

- Stimulus: Fluid in larynx or bronchii
- Behavior: Upward movement of air to clear the airway
- Cranial nerves involved: X
- Present at: 35 - 40 weeks gestation
- Disappears by: Persists

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a. COUGH Reflex (end)

- Purpose: Protects the baby from aspiration of fluid into the airway.
- Clinical significance:
 - May be immature in preterm and even some term infants → "silent aspiration".
 - Coughing during feeding: generally a response to descending fluids (a swallowing problem).
 - Coughing between feeds might be a response to ascending fluids (reflux).

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b. GAG Reflex

- Stimulus: Touch back of tongue
- Behavior: Mouth opening, head extension, floor of mouth depresses, soft palate elevates
- Cranial nerves involved: IX (glossopharyngeal), X
- Present at: 18 weeks (C), 26 - 27 weeks gestation (A); peaks at 40 weeks gestation.
- Disappears by: diminishes by 6 months but persists

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b. GAG Reflex (end)

- Purpose: Protects the baby's airway from large objects.
- Clinical significance:
 - Sometimes triggered at mid-tongue in young infants.
 - Hyperactive gag reflex → feeding aversion:
 - unusually long nipples,
 - invasive procedures,
 - insensitive feeding practices,
 - forceful milk ejection
 - tongue-tie

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Gag reflex (37-week old, long/large nipples)



BF Atlas, Fig. 51

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PLAN

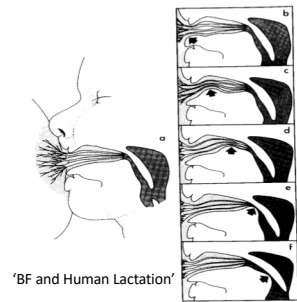
- Introduction & Resources
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Milk removal: Positive or Negative Pressure???

- Vacuum (Waller,1936)
- Compression by infant's jaw and peristaltic action of the tongue (Cooper1840, 1958 [BoF], Woolridge1986)
- This theory presupposes the existence of lactiferous sinuses
- Lactiferous sinuses do not exist → maybe changes also in suckling?



'BF and Human Lactation'

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Imaging used previously

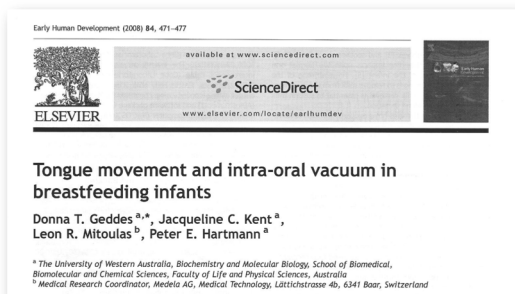
- Fluoroscopy (X-Ray) [1958, 1959]
 - Mother and infant unable to feed in a 'normal position'
 - No identification of milk flow
 - "The mechanisms of BF is probably similar to bottle-feeding."
- Ultrasound imaging [Woolridge, 1986]
 - Large transducers (interference with position)
 - Limited image resolution
 - No identification of milk flow
 - 6 infants (2 to 6 days old)

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High resolution USS → new research

Published in 2008



Tongue movement and intra-oral vacuum in breastfeeding infants

Donna T. Geddes^{a,*}, Jacqueline C. Kent^a,
Leon R. Mitoulas^b, Peter E. Hartmann^a

^a The University of Western Australia, Biochemistry and Molecular Biology, School of Biomedical, Biomolecular and Chemical Sciences, Faculty of Life and Physical Sciences, Australia
^b Medical Research Coordinator, Medela AG, Medical Technology, Lättichstrasse 4b, 6341 Baar, Switzerland

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Material and method

- 20 exclusively breastfed infants (3-24 weeks old), with good weight gain.
- Submental ultrasound scans of infant's oral cavity during a whole breastfeed, videotaped. *Long-handed transducer.*
- Simultaneous measurement of intra-oral vacuum via a milk-filled supply-line (SNS) connected to a pressure transducer.
- Analysis of movements of the tongue in relation with milk flow and vacuum.

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Measurements done by US

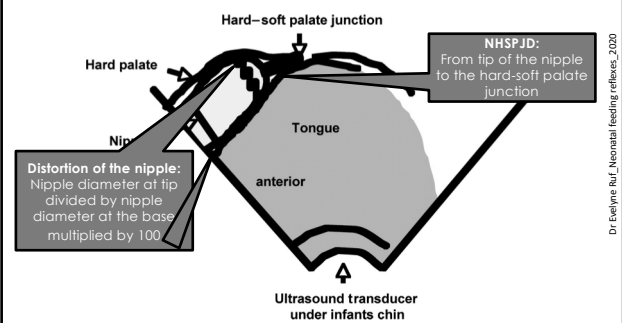
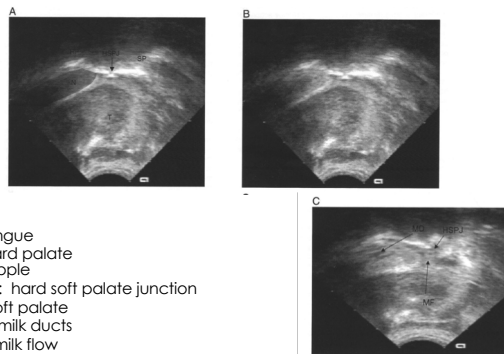


FIGURE 1 Schematic diagram of the submental sagittal view of infant oral cavity with the tongue up in apposition with the palate
Geddes, D. T. et al. Pediatrics 2008;122:e188-e194

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Submental US Images during breastfeeding



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Intra-oral pressure measurements done

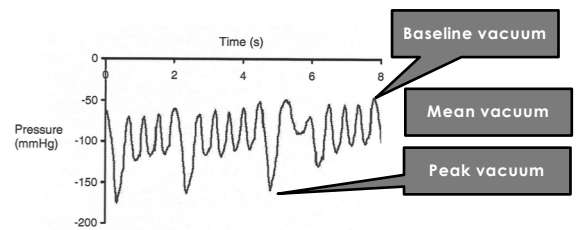


Figure 2 A typical infant intra-oral pressure trace during a breastfeed. Peak vacuum (mean minimum pressure) ranges from -110 to -170 mmHg. Baseline pressure (mean maximum pressure) ranges from -50 to -60 mmHg.

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Changes in tongue position and vacuum in one suck cycle

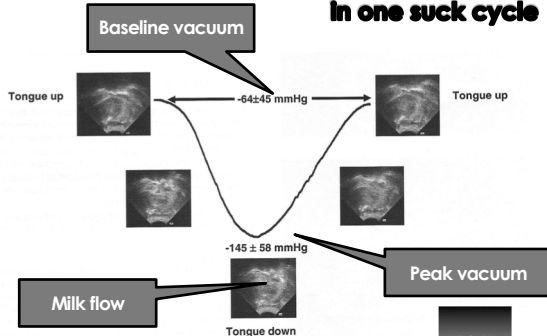


Figure 4 The changes in infant tongue position during one suck cycle.

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Main points of the new concept

- Nipple does not reach the hard-soft palate junction (distance varies from 1.3 to 6.9 mm).
- Tongue does not indent into the nipple to "pinch-off" the ducts.
- Anterior tongue remains flat – there is no 'wave-like' or 'peristaltic' motion.
- Nipple expands as the tongue moves downwards.
- Milk is drawn from the nipple by a vacuum generated by the tongue:
 - Peak vacuum (when tongue down): -110 to -170 mmHg
 - Baseline vacuum (when tongue up): -50 to -60 mmHg

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Clinical relevance

INSUFFICIENT VACUUM	<ul style="list-style-type: none"> Cleft palate (hard, soft or submucosal) Preterm infants 37-weekers or even full term with weak suction Large nipples <p><i>N-B: vacuum created anteriorly (lips) and posteriorly (tongue)</i></p>
EXCESSIVE VACUUM	<ul style="list-style-type: none"> Persistent nipple pain (despite good latch)
EXCESSIVE TONGUE PRESSURE	<ul style="list-style-type: none"> Poor latch Ankyloglossia

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Main clinical implications

- Effective milk expression useful (if infant not generating optimal vacuum)
- Feeding method matching the infant's ability to create vacuum (e.g. special need feeder, SNS...)
- Flexibility in attachment ('do not fix if not broken!') Golden way: self- attachment
- Nipple shield useful for some cases (temporarily)
- Frenotomy does make a difference in most cases

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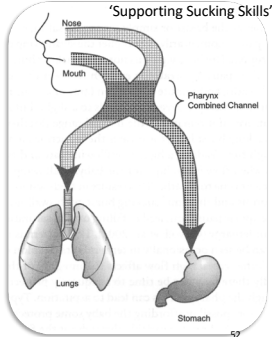
PLAN

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WHY coordination needed?

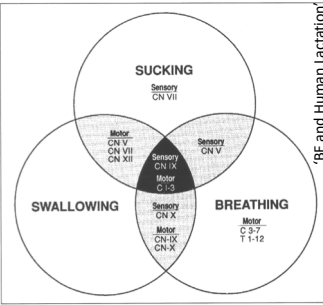
- Dual role of the pharynx:
 - Air from nose/mouth to lungs
 - Food from mouth to stomach
- At rest, structures are used for breathing → needs alteration for swallowing
- Breathing stops while swallowing



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Overlapping Function of Cranial Nerves

- Sucking, swallowing and breathing are interrelated:
 - Functionally (5 pairs of cranial nerves)
 - Anatomically (structures: more than 20 pairs of muscles)



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Suckling (sucking)

- This skill establishes flow rate → determines how suckling, swallowing & breathing are coordinated.
- Burst of sucks, interspersed with pauses, which vary during the course of a feeding:
 - Beginning: long bursts, infrequent and short pauses
 - Gradually: shorter sucking bursts, longer pauses
 - End: occasional sucking with long pauses

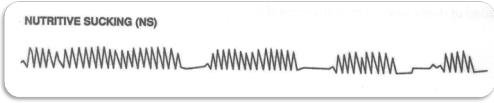


Figure 6-1 (A)

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Suckling (cont.)

<p>Nutritive sucking (NS)</p> <ul style="list-style-type: none"> – Normal term infants: 10 - 30 suck-swallow-breath cycles in a row – Occurs only in the presence of oral fluid (milk flow) – Slower sucking rhythm: 1 per second – Frequent swallowing 	<p>Nonnutritive sucking (NNS)</p> <ul style="list-style-type: none"> – Decreases stress in preterm infants – Facilitating digestion, relaxes (releases cholecystokinin) – On a pacifier, finger, or an emptied breast – Rapid sucking rhythm: 2 per second – Infrequent swallowing
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Suckling (cont.)

NUTRITIVE SUCKING



BF Atlas: 05-Nutritive sucking, 06-Oversupply

NUTRITIVE SUCKING



Good drinking
Jack Newman, iBC
<https://ibconline.ca/breastfeeding-videos-english/>

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Suckling (end)

• NUTRITIVE SUCKING



• NON-NUTRITIVE SUCKING



International Breastfeeding Center (Jack Newman, Toronto, Canada)
<https://ibconline.ca/breastfeeding-videos-english/>

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Swallowing

- Varies according to the flow:
 - High flow: one suck followed by one swallow 1:1
 - Low flow: multiple sucks before one swallow >3:1
- Varies with strength of sucking
- Varies with age and size of oral cavity:
 - Newborn: 1:1
 - Older infant: 2-3:1 (except very rapid flow → 1:1)

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Dysphagia (swallowing disorder)

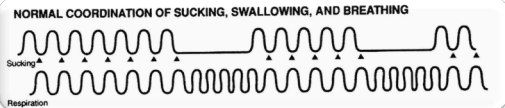
- From mild to severe
- Feeding specialist (LC), speech-language pathologist, occupational therapist +/- specialist physician: 'feeding team'
- Clinical examination during oral and pharyngeal phases: observation, cervical auscultation
- Instrumental procedures: Ultrasound, endoscopy, videofluoroscopy...

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Breathing

- Follows swallowing → suck/swallow/breath
- Strong relationship with flow rate: the baby adjusts the rate and depth of breathing accordingly.
 - During NS bursts: short and less frequent breathing
 - During pauses: more rapid and deeper breathing

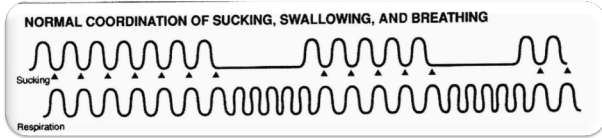
NORMAL COORDINATION OF SUCKING, SWALLOWING, AND BREATHING



'BF and Human Lactation' Dr Evelyne Ruf_Neonatal feeding reflexes_2020 60

COORDINATION SUCK/SWALLOW/BREATHE

- Baby sucks, stops breathing to swallow, then starts breathing again
- ‘Swallowing apnea’ lasts about 0.5 second
- Coordination suck/swallow/breath (NS): **1:1:1**



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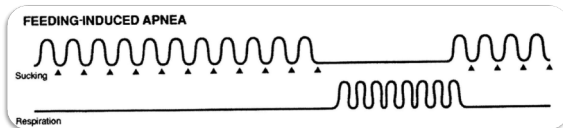


CD BF Atlas, Chapter 17
37-Mature sucking

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Feeding-induced apnea



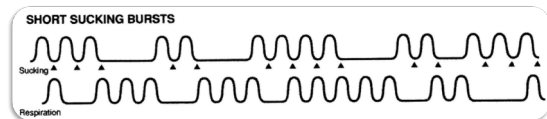
- Happens with high flow (or perceived as such, like for premature infants)
- Catch-up breathing (‘panting’)
- Risk of aspiration

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Short sucking bursts



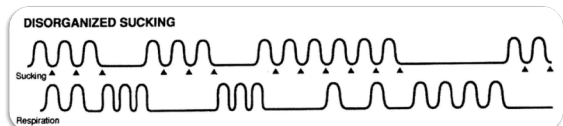
- Only one to three sucks before pausing.
- Frequent pausing
- Seen in low birth weight babies/late preterms (could be first few days in term babies)
- Or to compensate when too high flow.

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Disorganized sucking

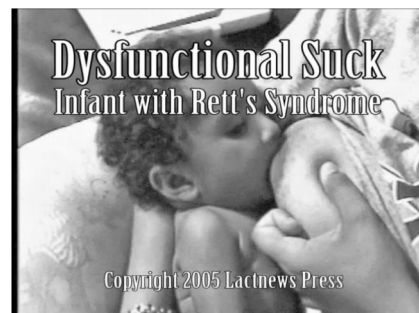


‘BF and Human Lactation’

- Neurological deficit
- Respiratory problems
- Prematurity with high flow

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CD BF Atlas, Chapter 17
10-Dysfunctional suck

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Which is More Stressful?

BREASTFEEDING

- Nutritive Sucking and NNS
- Expiration: shortened
- Inspiration: prolonged
- Oxygen saturation < 90%: 2/10 infants
- No bradycardia
- Silent (except soft swallow sounds or cooing)
- Swallowing non-randomly between breaths

BOTTLE-FEEDING

- Only Nutritive Sucking
- Expiration: prolonged
- Inspiration: shortened
- Oxygen saturation < 90%: 5/10 infants
- Bradycardia (2/10 infants)
- High-pitched squeak at end of intake of air
- Swallowing patterns differ according to type of teat

Adapted from BF & HL, Table 3-4 (term infants)

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BF and orofacial structures

- 'Breastfeeding promotes normal physiological development and optimal growth and function of the orofacial structures.' (Genna)
 - Each step in normal development depends on the step before; compensatory strategies do not promote optimal development
- Early intervention likely to avoid need for more expensive therapy later

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FOR A LACTATION CONSULTANT:

- Practical knowledge of orofacial anatomy, feeding reflexes and the suck/swallow/breathe coordination
- Enables to analyze the cause(s) of the feeding issues and design the management plan accordingly.

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THANK YOU...

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