Homeostasis as the Foundation for Feeding

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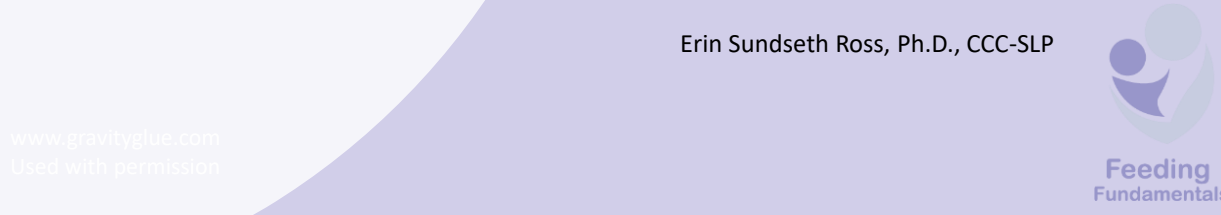

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Financial Disclosures

Erin Sundseth Ross, Ph.D.

Paid
- Intellectual Property, SOFFI™
- President, Feeding Fundamentals, LLC

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- Advocacy Chair, Feeding Matters

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Objectives

- List the four subsystems of the Synactive Organization of Behavioral Development
- Define "Homeostasis" as it relates to development

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How Do We Develop?

How Do We Learn?

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Dynamic Systems Theories

- All systems interact with each other
- All systems influence neonatal functional performance
- Biological components are not independent of each other, nor of physical and sociocultural environments

Sweeney, et al., 2010

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Synactive Organization of Behavioral Development

- Behavioral organization process
  - Subsystem interaction
  - Interdependence (*synaction)* of subsystems
- Behavioral organization supports the neonate in responding to the challenges presented by the extrauterine environment
- Caregivers observe and respond to the infant's behavior, which reflect the current functioning of the infant

Als, 1982

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Synactive Organization of Behavioral Development

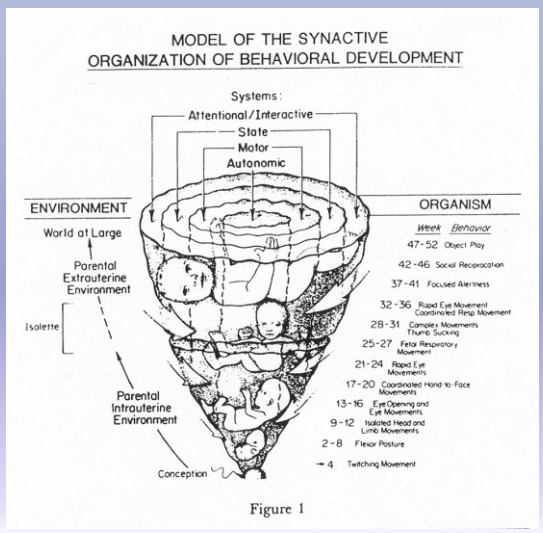

Figure 1

Als, 1982
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Synactive Organization of Behavioral Development

4 subsystems:

- Autonomic
- Motor
- Behavioral State
- Attention/Interaction

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Homeostasis

"The ability to maintain internal regulation in the face of increasing challenges and demands (internal and external)"

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Homeostasis

Development of Homeostasis is supported in the uterine environment by the mother's body

- Allows a focus on internal regulation
  - Physiologic and motor system
  - Establishment of general behavioral state regulation
- Limited external demands

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Interaction

- Organization (or disorganization) of one system similarly influences the other systems through synaction
- Through organization, the infant can reach homeostasis (first internal, then external)
- Homeostasis supports infant's striving for the next challenge (e.g., feeding)

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Homeostasis

Preterm babies:

- Underdeveloped internal regulation
- Increased external demands in the NICU

Medical comorbidities:

- Interfere with internal regulation
- Limit ability of infant to tolerate external demands

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Internal Regulation is Key!

- Once regulation is achieved, the infant can focus attention outward
- Regulation is NOT the absence of medical problems…
- Feeding requires an ability to focus attention outward

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Oral Feeding Readiness

- Oral feeding readiness is affected by :
  - Neurodevelopmental maturity
  - Behavioral state organization
  - Physiologic stability
- And, is influenced by:
  - Caregivers
  - Environmental factors

Kish, 2013

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Experience

"Practice is everything. This is often misquoted as practice makes perfect."

-Periander

665-580 BC

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Theory of Neuronal Group Selection

- The brain is a selective system
- The brain is strongly influenced by signals, provided by the infant's body and the infant's interactions with the environment (internal and external challenges)
- The brain is continually changing in response to these signals

Edelman, 1987

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Experiential Selection

- After birth, infant interacts with environment

(distal and proximal)

- Environment provides experiences that drive changes in development
- Synaptic connections are either strengthened through repetitive activation, or weakened through "disuse"

Edelman, 1987

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Re-Entrant Mapping

- Neural maps are selected through past and present experiences, and link to form integrated connections
- Global mappings are created that involve motor and sensory systems
- Through repetition, infant selects patterns that most successfully support their developmental strivings

Edelman, 1987

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All Experience Matters!

The pathways you intend to create may not be the only pathways you are creating

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What Goes Wrong?

- Through repetition, the infant selects patterns that **most successfully support their developmental strivings**
- If an infant is not improving, is regressing in feedings, or developing an oral aversion, **ASK WHY**
  - Why is stopping eating or not eating BETTER than eating??

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Application to Feeding Development

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Classical Conditioning

- STEP 1: UCS (food powder) → UCR (salivation)
- STEP 2: UCS - CS (bell) → UCR
- STEP 3: CS (bell) → CR (salivation)

Pavlov, 1927

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Application to Feedings

STEP 1:	UCS nausea pain/discomfort desaturating/choking	→	UCR appetite suppression withdrawal/escape
STEP 2:	UCS - CS (food)	→	UCR
STEP 3:	CS food	→	CR appetite suppression withdrawal/escape

Toomey & Ross, 2011 (unpublished)

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Feeding Problems

- Parental questionnaires at 3, 6, and 12 months (adj)
- Compared early born (25 to 33.6 weeks GA) and later born (34 to 36.6 weeks GA) groups
- No significant differences between groups for:
  - Low appetite - 12-14% across study
  - High avoidant behavior - 2-4% (3, 6 mos)
  - Med-High Maternal anxiety - 25-39% (3, 6 mos)

DeMauro et al, 2011

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Prevalence of Feeding Difficulties

- 48% of infants born 32-36 weeks gestation, compared to 9.5% of term infants had feeding difficulties at discharge (Jonsson, et al, 2013)
- 23% of infants had feeding difficulties at 2 years of age (Crapnell, et al., 2013)
- 7.41% to 11% reported to have feeding difficulties at 3 years of age (Gallardo, et al., 2017)

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Outcomes at 2 years of age

Subjects: 234 preterm born <33 weeks GA

245 term infants

Preterm infants:

- Worse drive to eat score (*P* =0.001)
- Lower food repertoire score (*P* =0.05)

Migraine, et al., 2013

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Eating difficulties at 2 years of age

- Subjects: N=651 late-moderate preterm (32-36 wks), 771 term
- In unadjusted analyses, LMPT infants were at increased risk:
  - Refusal/picky eating (RR: 1.53; 95% CI: 1.03, 2.25)
  - Oral motor problems (RR: 1.62; 95% CI: 1.06, 2.47)
- Independently associated with eating difficulties:
  - Prolonged nasogastric feeding >2 wk (RR: 1.87; 95% CI: 1.07, 3.25)

Johnson, et al, 2016

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HOMEOSTASIS

The ability to

MAINTAIN

internal regulation in the face of increasing challenges and demands

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Effect of Waiting for Better Internal Regulation

- Randomize Controlled Trial (RCT) to assess effect of having a 1 week delay in initiation of oral feeding (skills on Day 0 and 3, achievement of full oral feedings)
  - 18 infants (C) started oral feeding when they were ”physiologically stable” (mean 33.8 wks)
  - 22 infants (E) started one week later (mean 34.7 wks)

Wang, 2018

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Effect of Waiting for Better Internal Regulation

- Non-significant findings:
  - Full oral feedings (36.3wks C, 36.2wks E)
  - Daily weight gain (22.8 grams C, 21.5 grams E)
  - Total intake
  - Feeding duration
  - Feeding efficiency at 2 time points

Wang, 2018

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Effect of Waiting for Better Internal Regulation

- Similar heartrates (HR) prior to feedings
- Increase in HR during feedings noted in both groups on Day 0
- Significantly lower HR in E group by Day 3 (*P* =.04)
- Number of desaturations significantly different during feeding:
  - BEFORE: Day 0 (C=9, E=1, *P* =.002)
  - DURING: Day 0 (C=11, E=2, *P* <.001)
  - DURING: Day 3 (C=13, E=5, *P* =.004)

Wang, 2018

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Shifting the Focus...

- Infant feeding begins with reflexive motor patterns that integrate beginning between 2 and 4 months of age adjusted
- Once the reflexive pathways are integrated, feeding difficulties may become apparent (e.g., refusals)
- If we use interventions to improve comfort during feedings, we can then build global neural networks that support feeding across this time period

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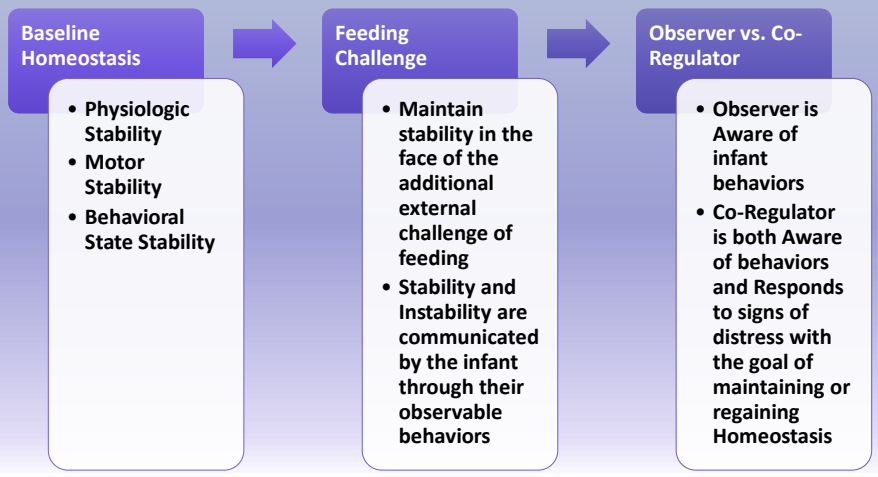
Feeding Model for SOFFI™



Ross, 2017

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Key Take Home Points

- Eating begins with Internal Regulation
- Learning begins with Classical Conditioning
- Feeding should be a positive experience
- The concept of Homeostasis can guide decisions regarding initiation of and progression for oral feedings

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Feeding is the experience…

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