Non-nutritive suck: influences, measurement, and use in predicting premature infants' feeding skills

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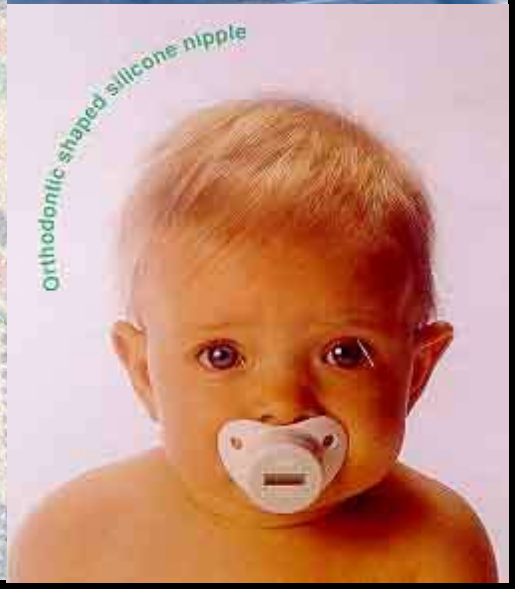
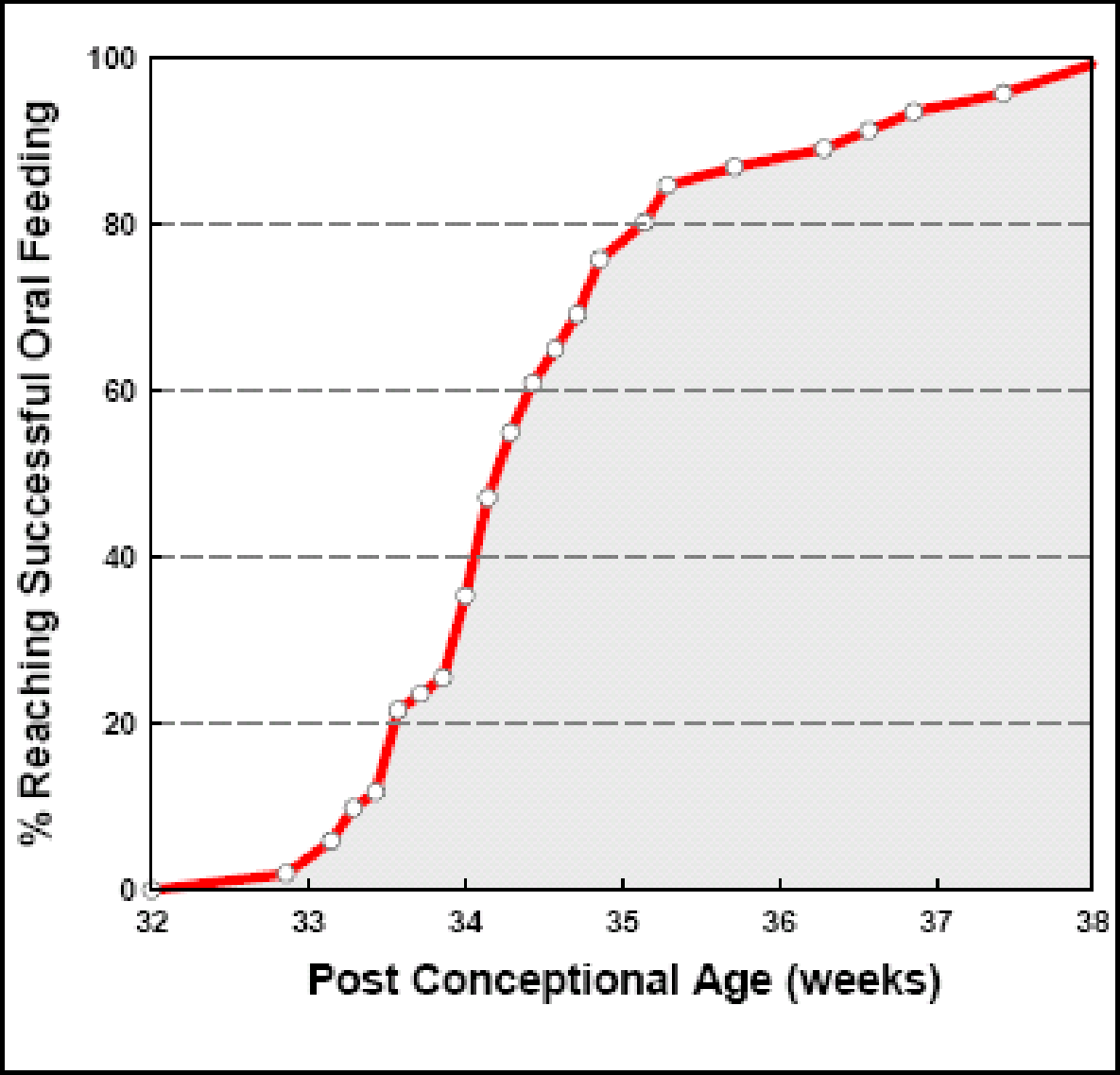
Non-nutritive suck (NNS):

- **Clinical significance** ***(for premature infants)***
- **Neurobiology & Development**
- **Proximate Influences**
- **Predicting feeding outcome**


Orthodontic shaped silicone nipple


13
NICU



Dodrill P, Donovan T, Cleghorn C, McMahon S, Davies PSW. Attainment of early feeding milestones in preterm neonates. *Journal of Perinatology*. 2008;28:549-555.

Clinical importance of NNS to tube-fed premature Infants

- Effects on behavior state regulation
- Attenuates pain behavior
- *Sensorimotor deprivation associated with tube-feeding*

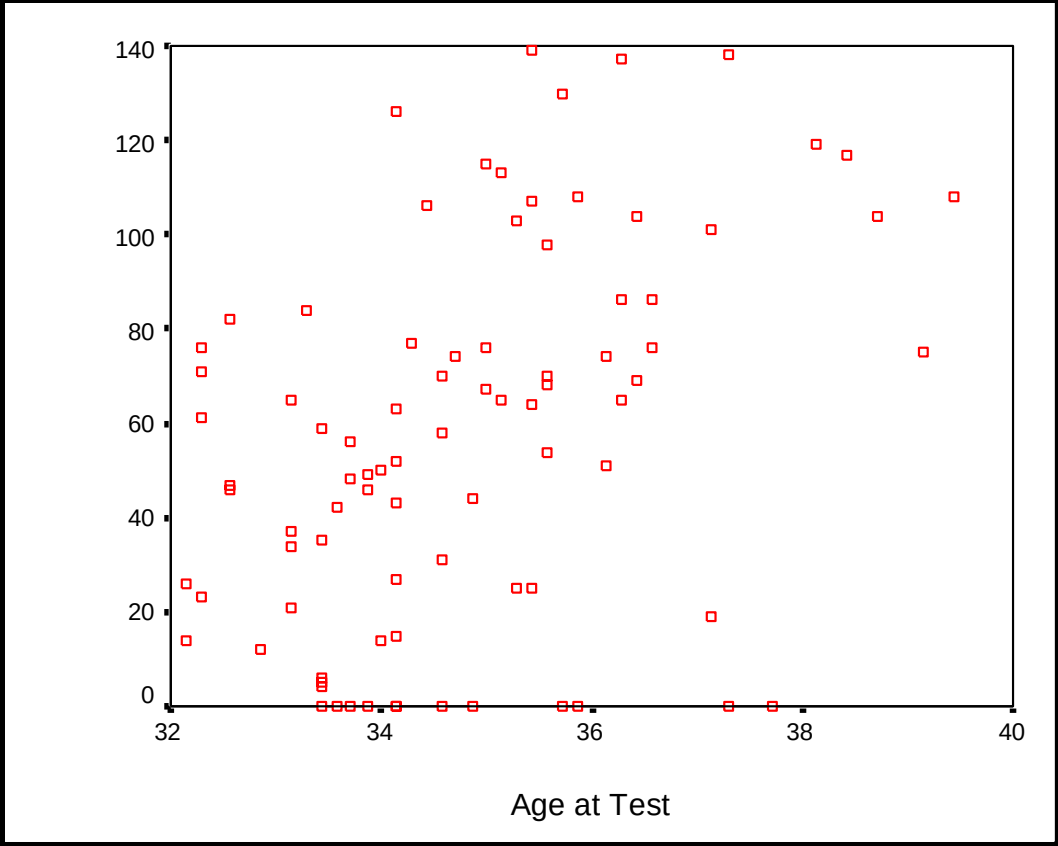
Pickler et al. Effects of nonnutritive sucking on behavioral organization and feeding performance in preterm infants. *Nursing Research*. 1996;45(3):132-5.

Ontogeny & Function of NNS

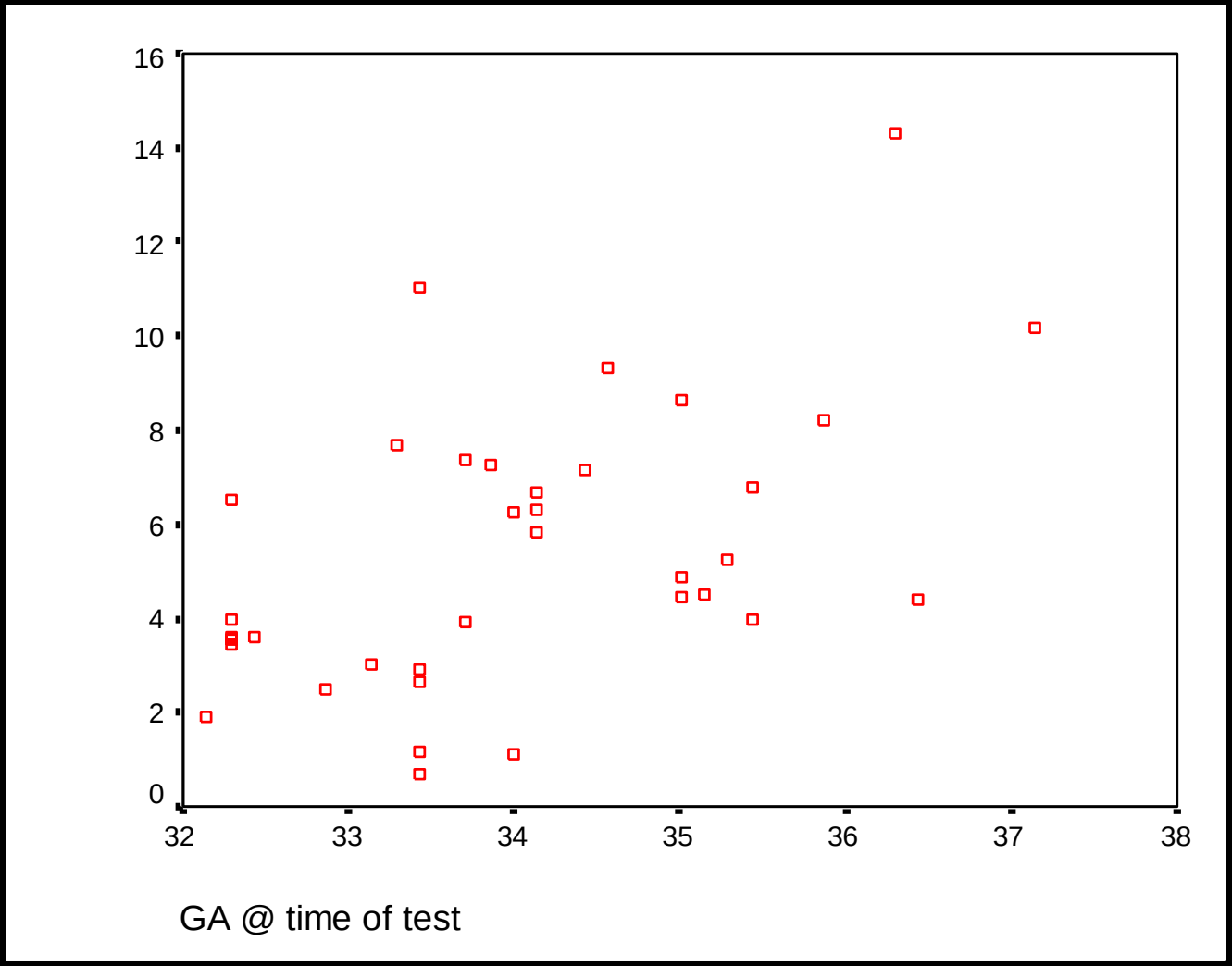
- Fetal period observations
- Oxytocin/neuroendocrine aspects
- NNS has a developmental ontogeny all its own:
  - suck ‘organization’
  - levels of rhythmicity- sucks within a burst, bursts themselves, gaps *between* bursts

Hack et al. 1985. Development of sucking rhythm in preterm infants. *Early Human Development*. 11:133

Number of bursts vs. Gestational Age (n-85; r=0.42)

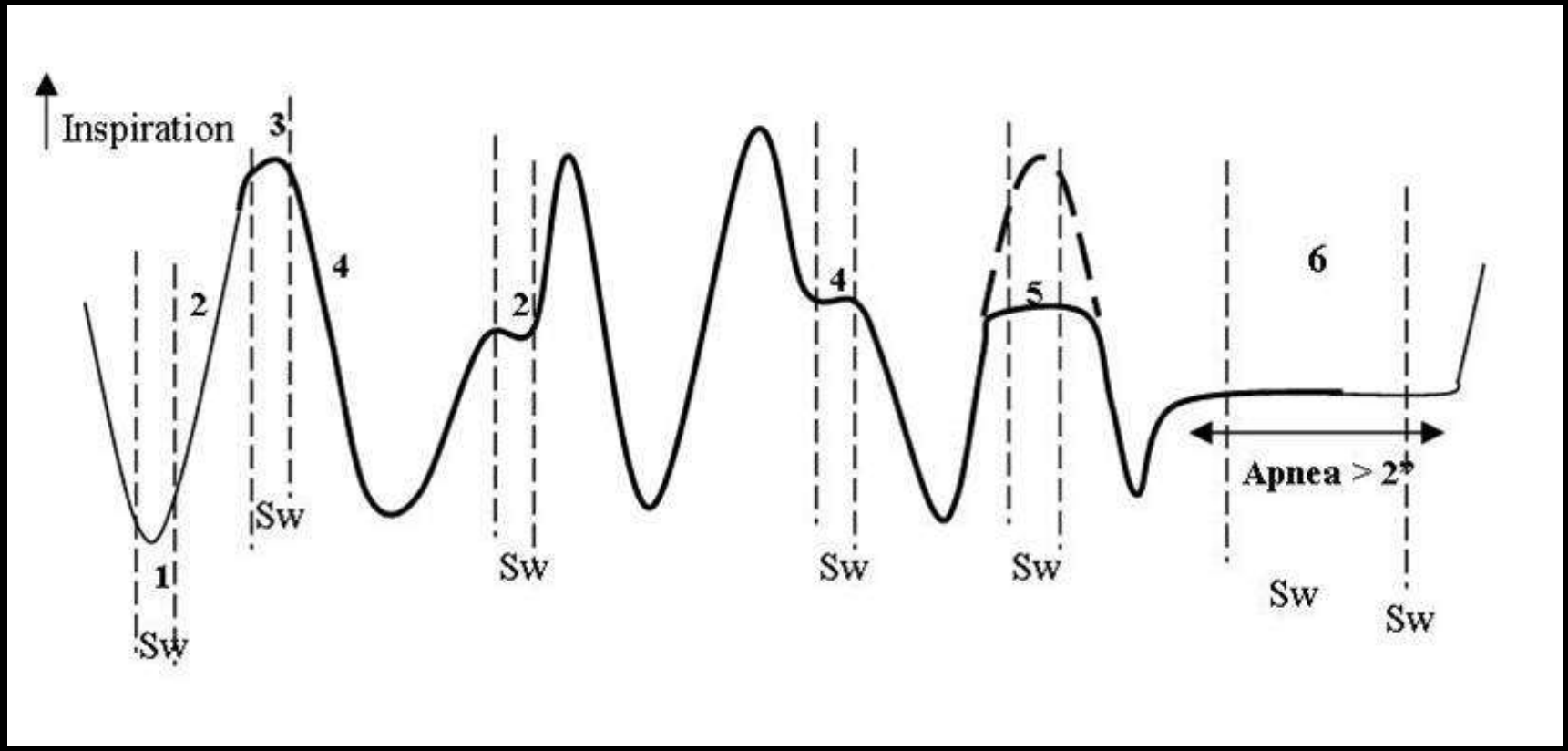


GA is related to number of sucks ($f_{1,34}$=11.3, p=0.002), bursts ($f_{1,34}$=7.47, p=0.010), and average number of sucks per burst ($f_{1,34}$=11.96, p=0.02)



Changing NNS Measures in Relation to Gestational Age

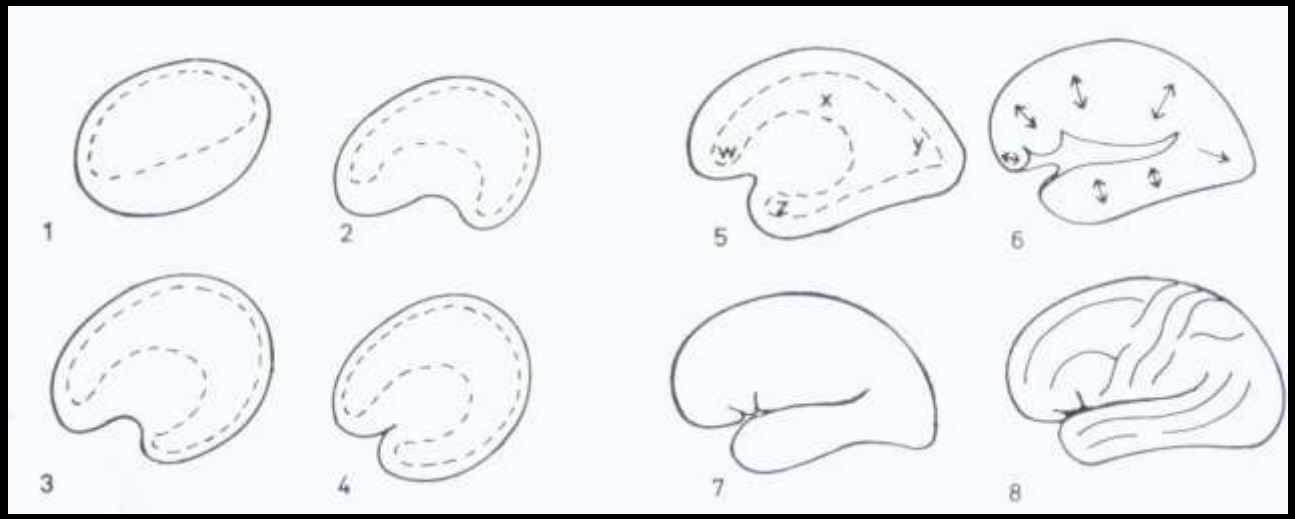
Suck Measures	Entire group	Age <34 weeks (n=18)	Age 34-37 weeks (n=18)
Sucks	348.6 ± 292.6	200.7 ± 207.9	496.4 ± 294.5
Bursts	53.5 ± 32.7	35.3 ± 25.9	71.7 ± 28.9
Sucks per burst	5.4 ± 3.0	4.3 ± 2.7	6.6 ± 2.9



Lau 2003. Acta Pediatr 92:721

Neurobiology of NNS

- Central pattern generators
  - NNS organization reflects “pacing” of lower motor neurons of the *nucleus ambiguus* by brainstem regulatory neurons
  - neural ‘generators’ or networks depend upon afferent input for their
    - maturation
    - survival
- Afferent signals exert a trophic effect on, and increasingly modify the activity of, higher order neurons of motor systems.
  - Tactile (Afferent) pacing and stimulation of NNS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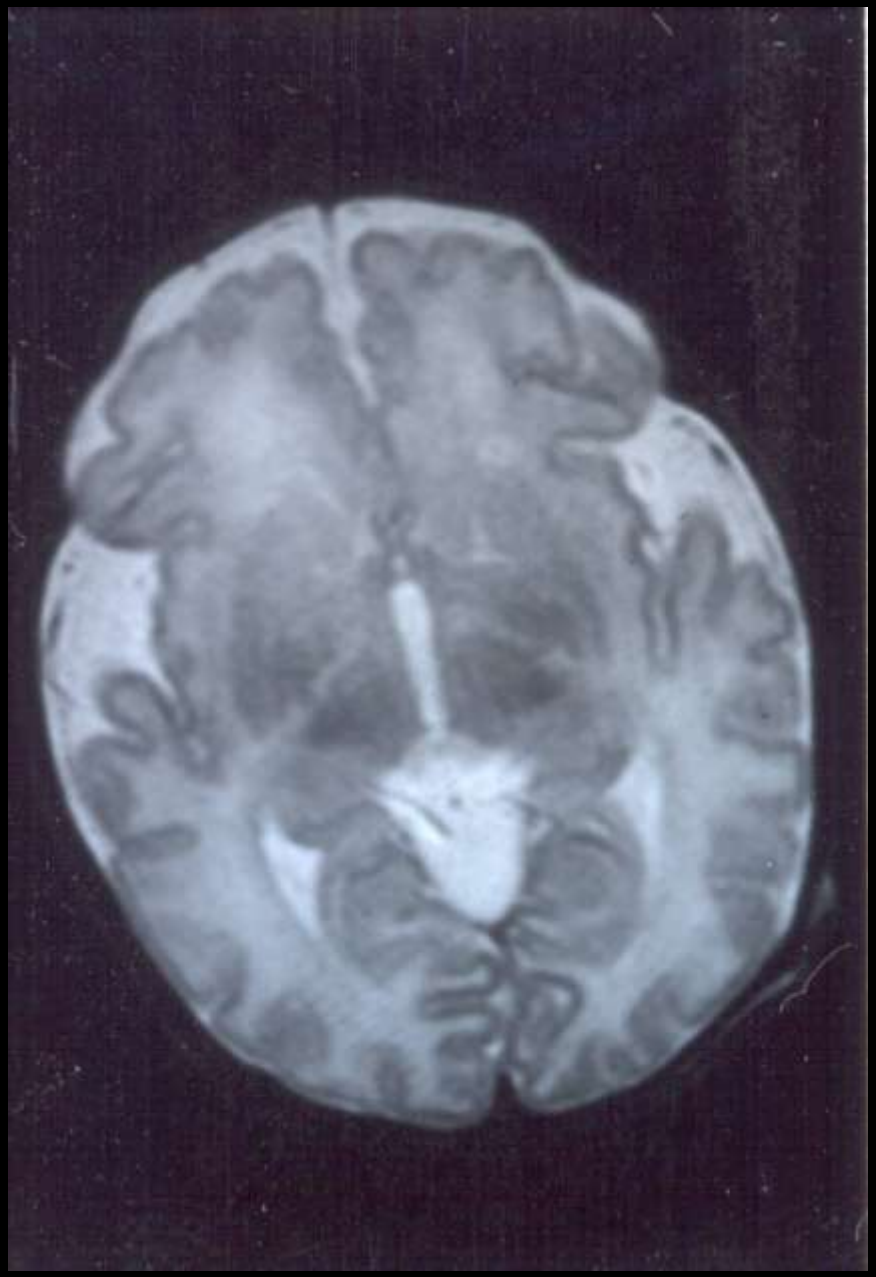


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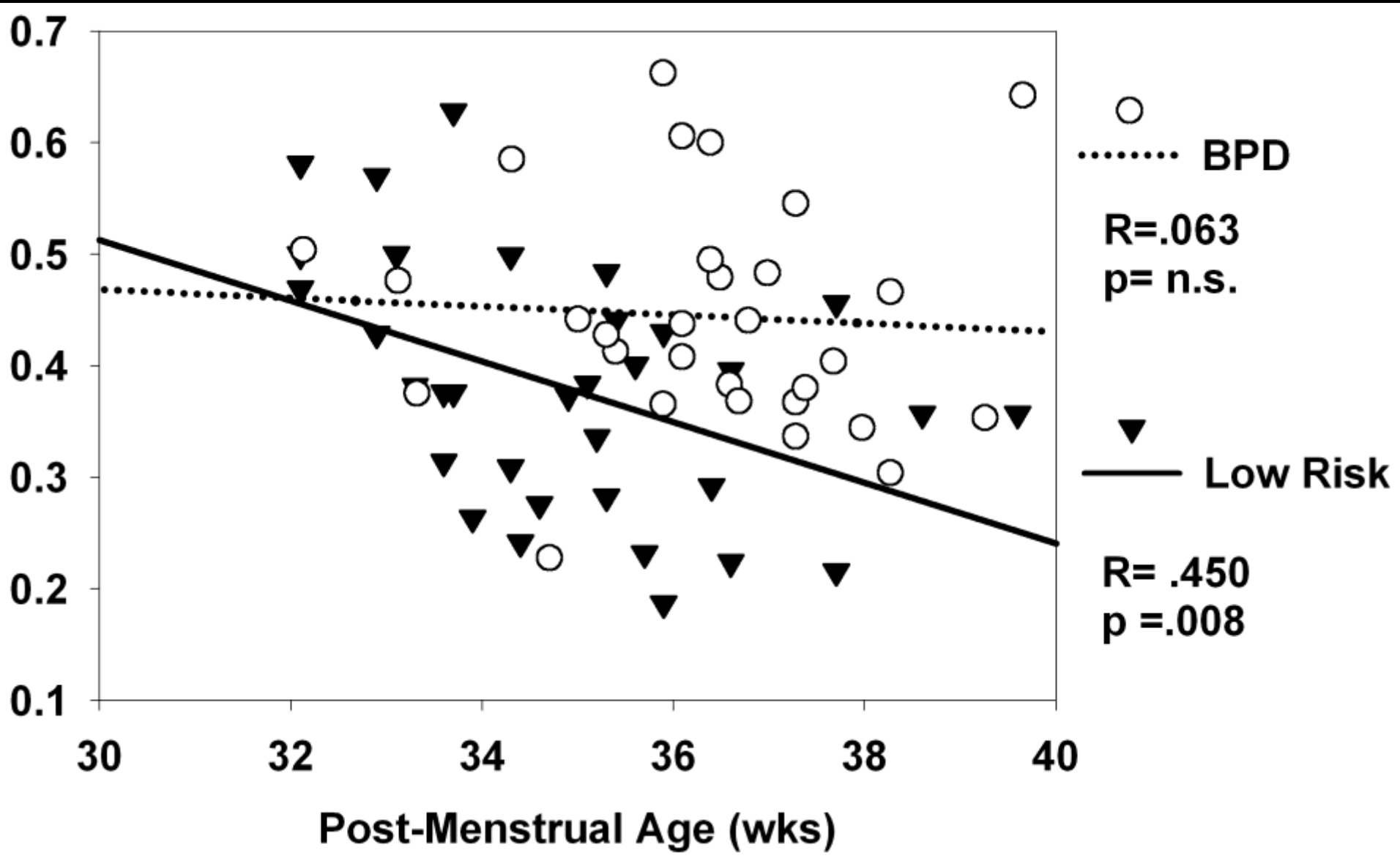
Varendi, et al 1996. Attractiveness of amniotic fluid odor:
evidence of prenatal olfactory learning. Acta Paediatrica *85*, 1223-1227.



Gewolb et al 2003. Dev Med Ch Neurol 45:344

Maternal care, hippocampal synaptogenesis and cognitive development in rats

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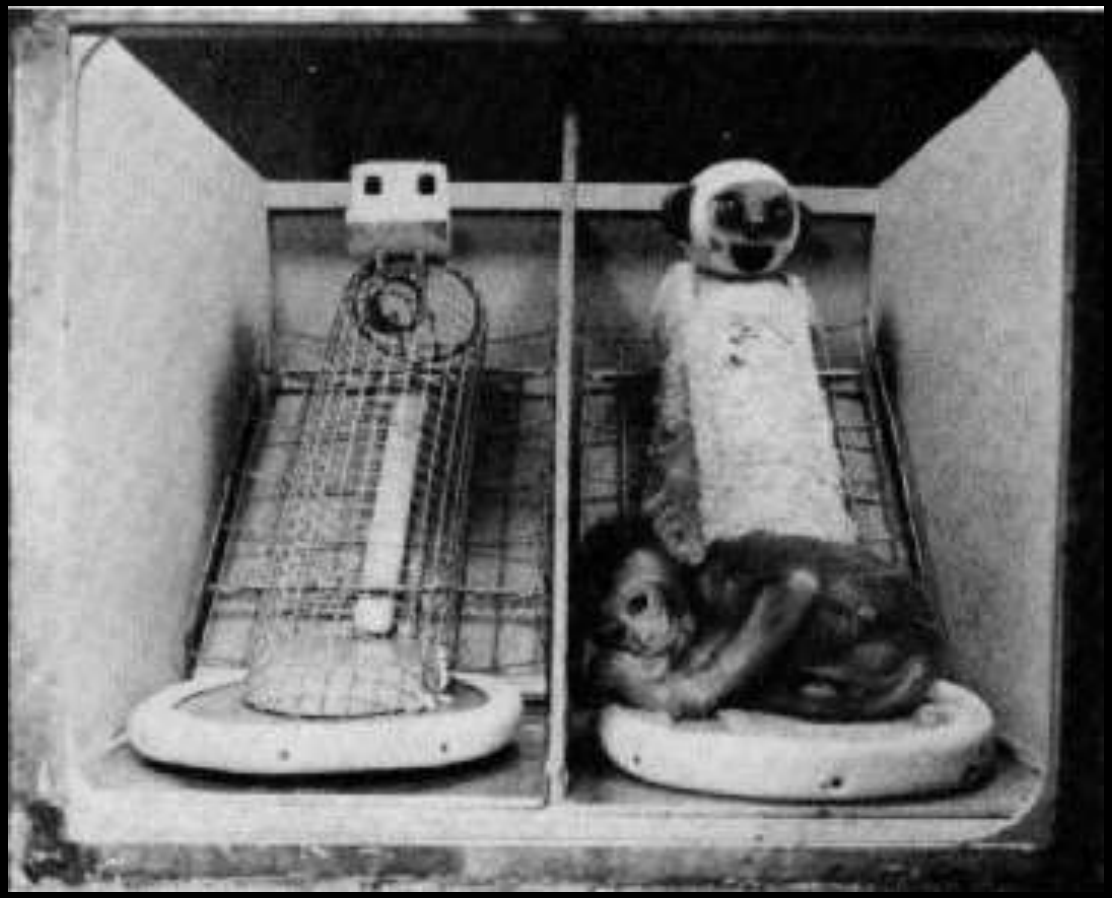
Correspondence should be addressed to M J Meaney. e-mail: mdmm@musica.mcgill.ca

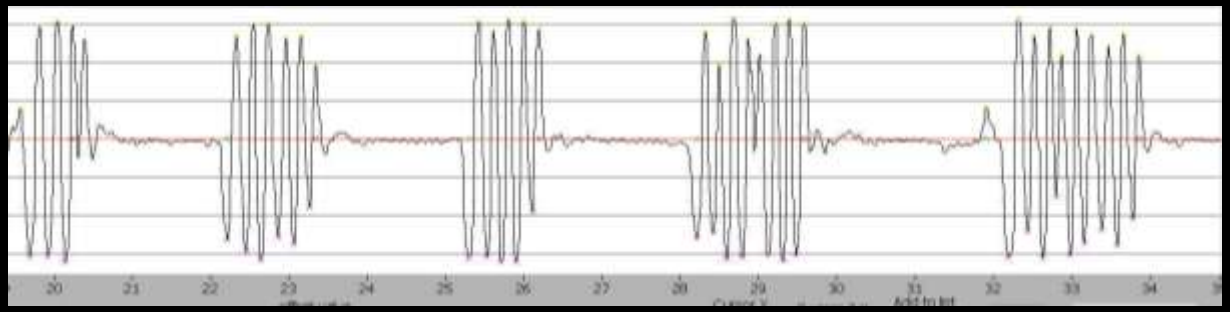


What stimulates NNS?

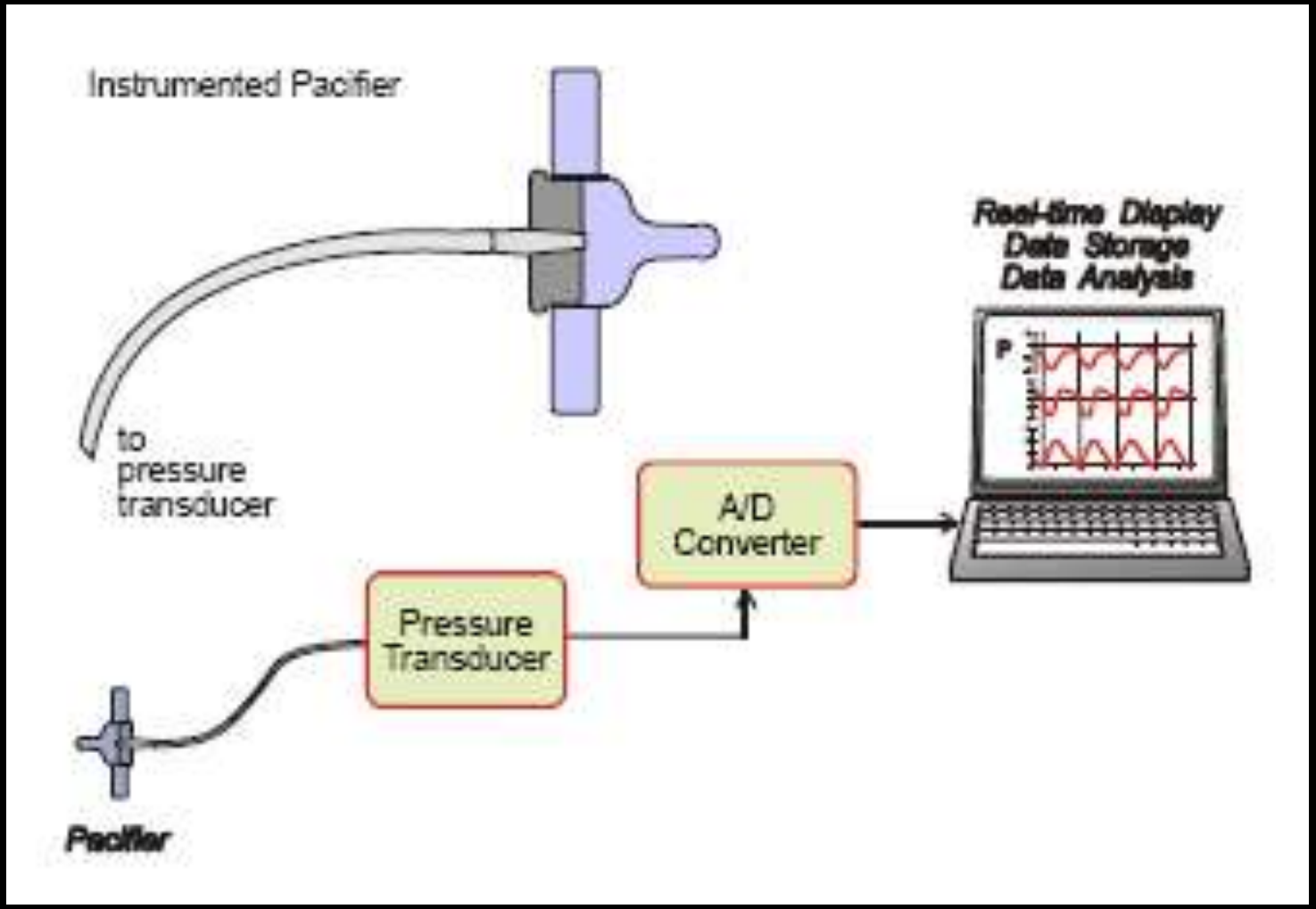
- Tactile
- Acoustic stimuli-maternal
- Olfactory/chemosensory stimuli
- Vestibular

Barlow et al. Synthetic orocutaneous stimulation entrains preterm infants with feeding difficulties to suck. *Journal of Perinatology*. 2008;541:541-548.

Measuring Infant Sucking Behavior



Lau et al. Characterization of the developmental stages of sucking in preterm infants during bottle feeding. *Acta Paediatrica*. 2000;89:846-852.


Instrumented Pacifier
to
pressure
transducer
Real-time Display
Data Storage
Data Analysis
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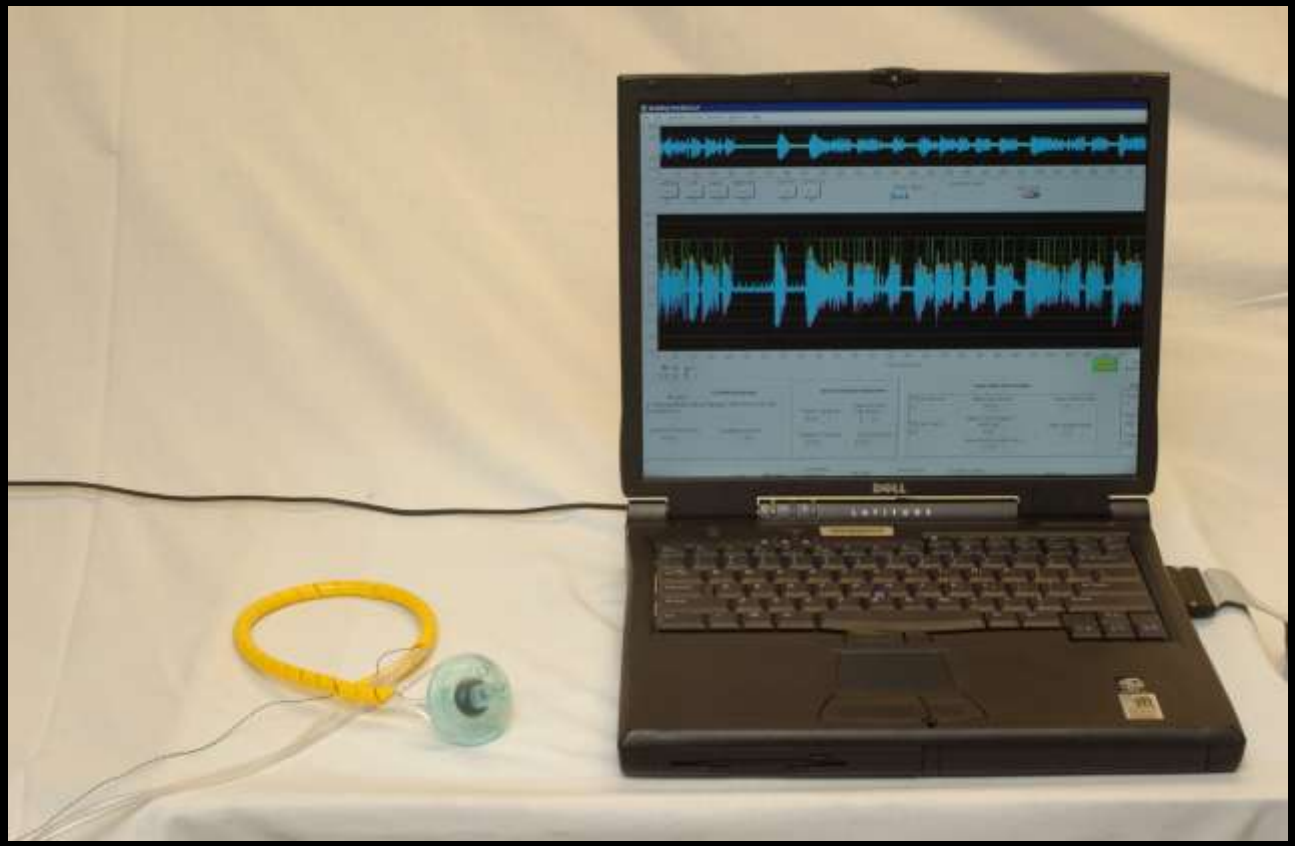
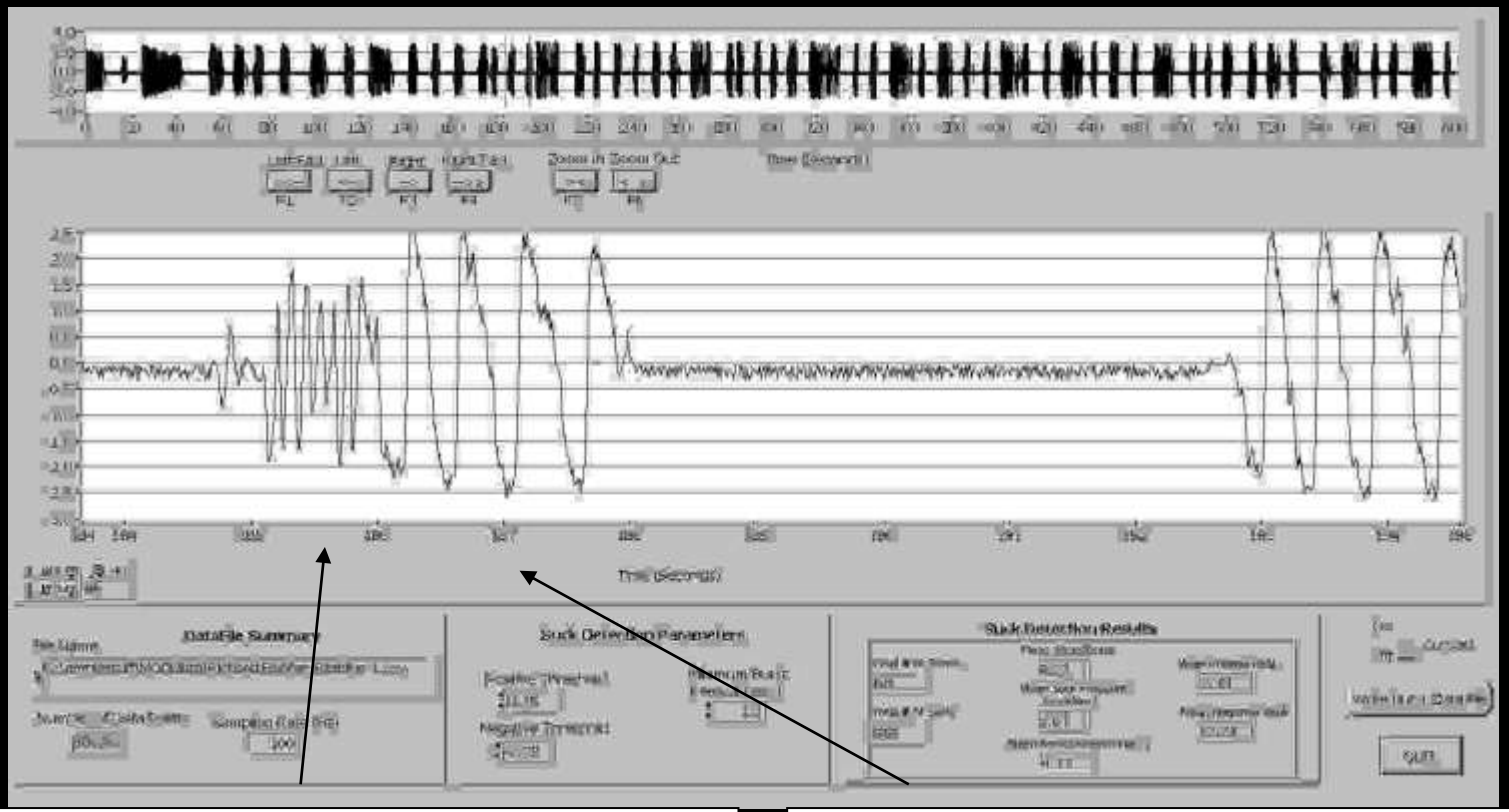
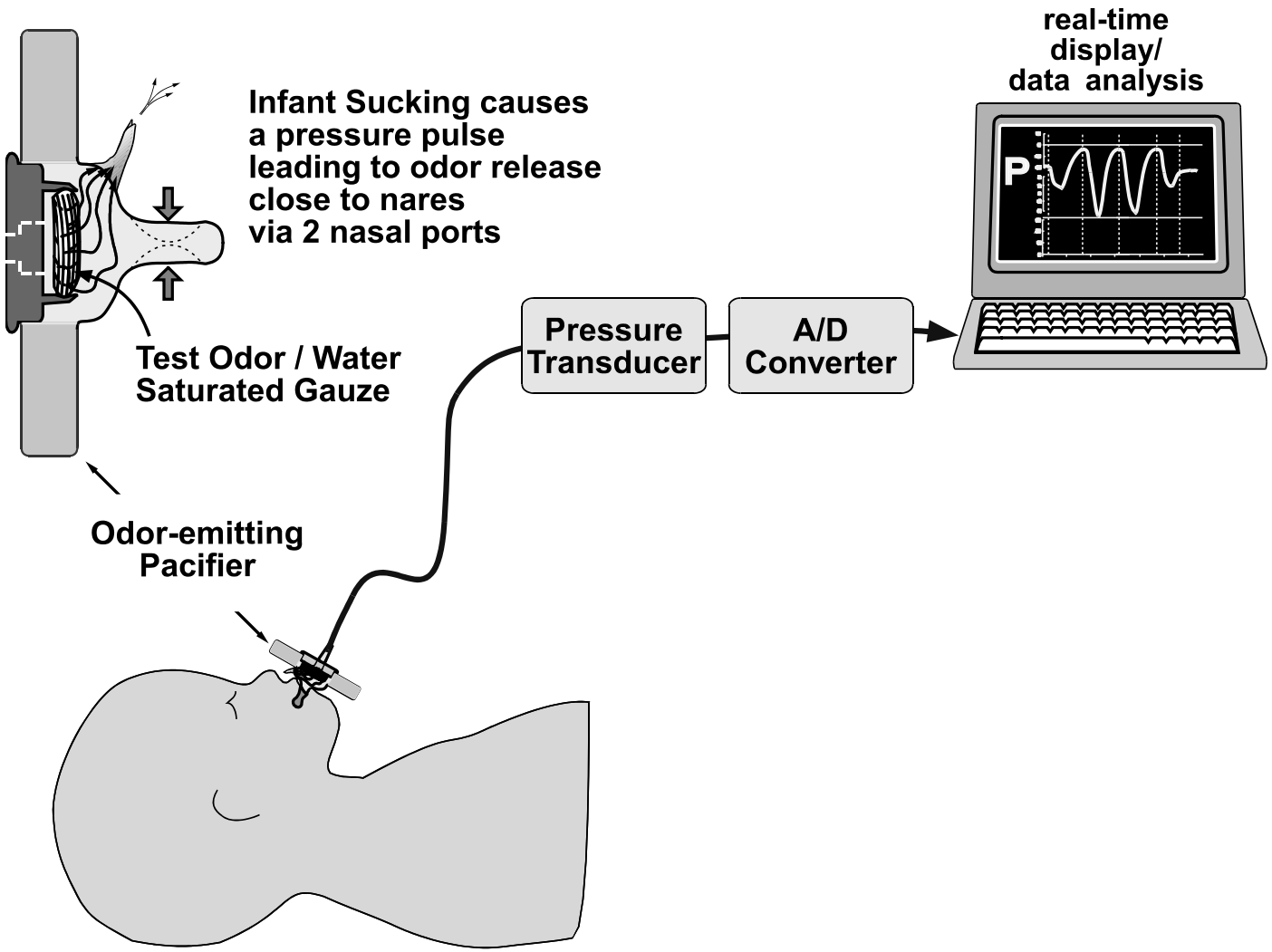
A/D
Converter
Pressure
Transducer
Pacifier




Flutter pattern
Burst of 4 individual sucks

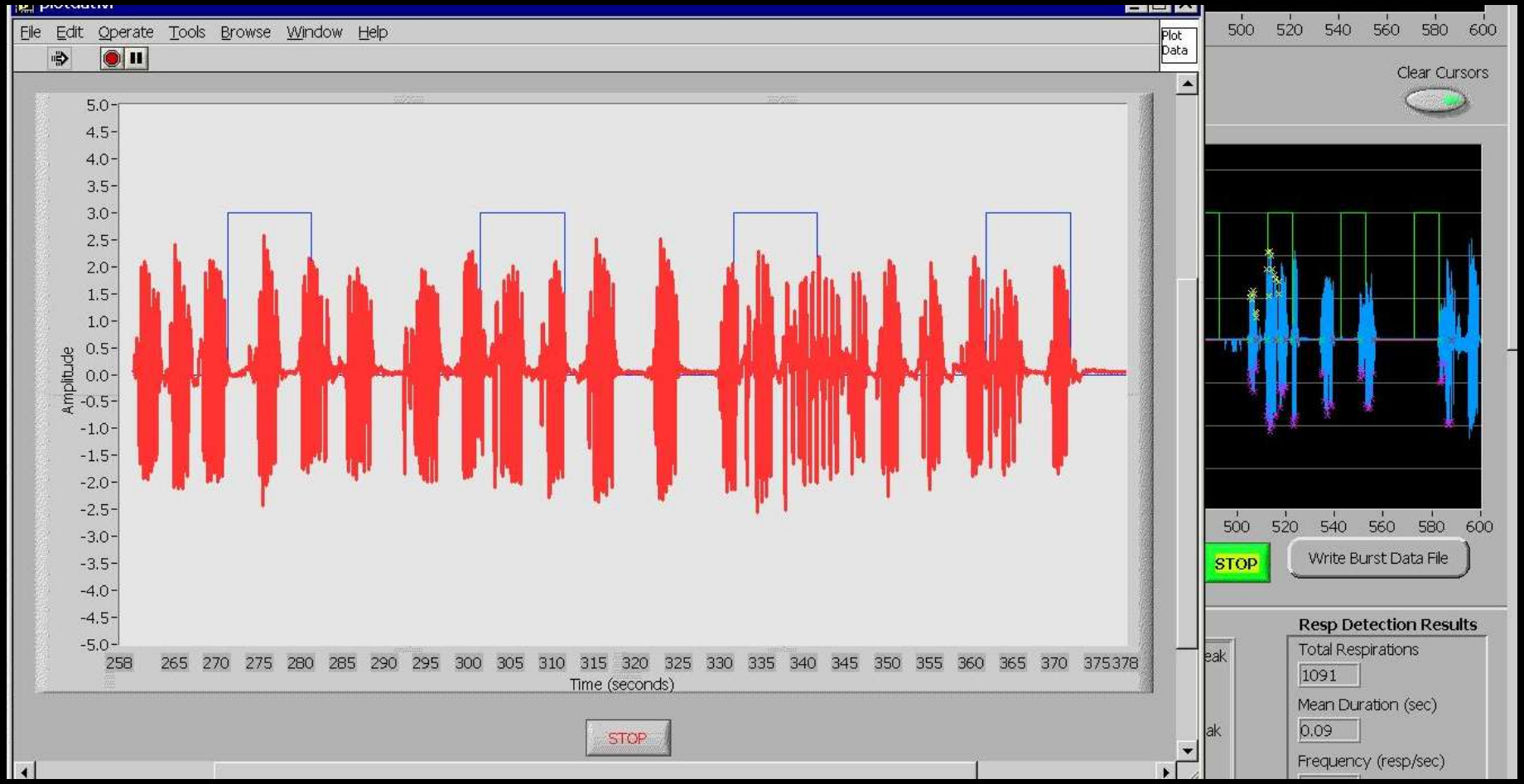

real-time
display/
data analysis
P
Infant Sucking causes
a pressure pulse
leading to odor release
close to nares
via 2 nasal ports
Test Odor / Water
Saturated Gauze
Pressure
Transducer
A/D
Converter
Odor-emitting
Pacifier

Pilot Study of Odor-facilitated NNS

	With odor	Without odor
BMF (n=14)		
Mean number of sucks	290.9±120.8	229.9±157.5
Mean number of bursts	**46.6±13.3***	**35.4±13.0****
F (n=15)		
Mean number of sucks	152.4±160.4	137.3±154.1
Mean number of bursts	27.7±18.1	27.2±16.9

*95% C.I.= 39 - 54; vs. **28 - 43

10 minute observation period


File Edit Operate Tools Browse Window Help
Plot Data
Amplitude
Time (seconds)
STOP
Clear Cursors
STOP
Write Burst Data File
Resp Detection Results
Total Respirations
1091
Mean Duration (sec)
0.09
Frequency (resp/sec)

10 minute NNS Burst Count

~tube-fed, premature infants~

(Mean, Standard deviation; [number of data collection sessions])

Behavioral State	Pre-tube feeding	During Tube Feeding
1	10.9± 13.7 (10)	4.6± 3.5 (12)
2	22.5± 15.2 (54)	18.4 ± 15.0 (102)
3	27.3± 19.6 (46)	23.5 ± 15.6 (64)
4	32.7 ± 18.3 (33)	33.7± 19.1 (65)
5	39.3± 16.7 (12)	27.0 ± 12.3 (33)
6	40.0 ± 7.0 (3)	36.3± 15.0 (4)

Number of sucks during 10 minute sessions ~tube-fed, premature infants~

[Mean, Standard deviation (number of data collection sessions)]

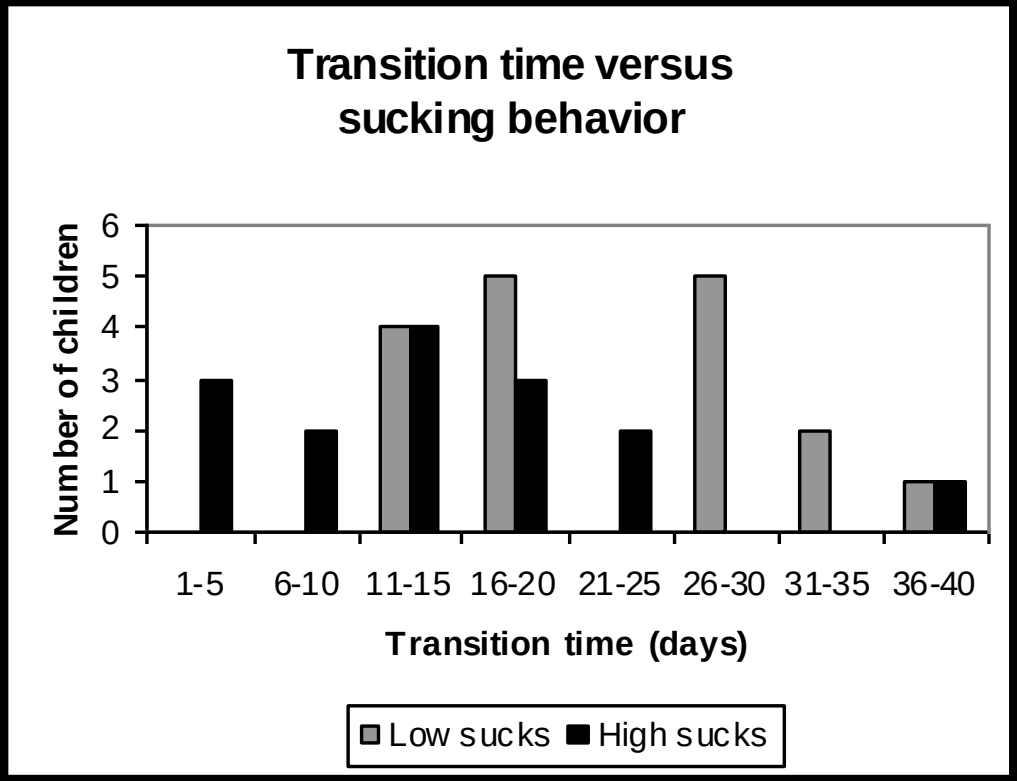
Behavioral State*	Pre-tube feeding	During Tube Feeding
1	64.3 ± 79.7 (10)	12.1 ± 9.0 (12)
2	105.6 ± 93.6 (54)	90.1 ± 92.9 (102)
3	147.2± 119.4 (46)	128.1 ± 102.1 (64)
4	177.3± 109.7 (33)	177.0 ± 109.5 (65)
5	206.7± 98.9 (12)	151.3 ± 96.0 (33)
6	290.7± 101.4 (3)	177.3 ± 121.1 (4)

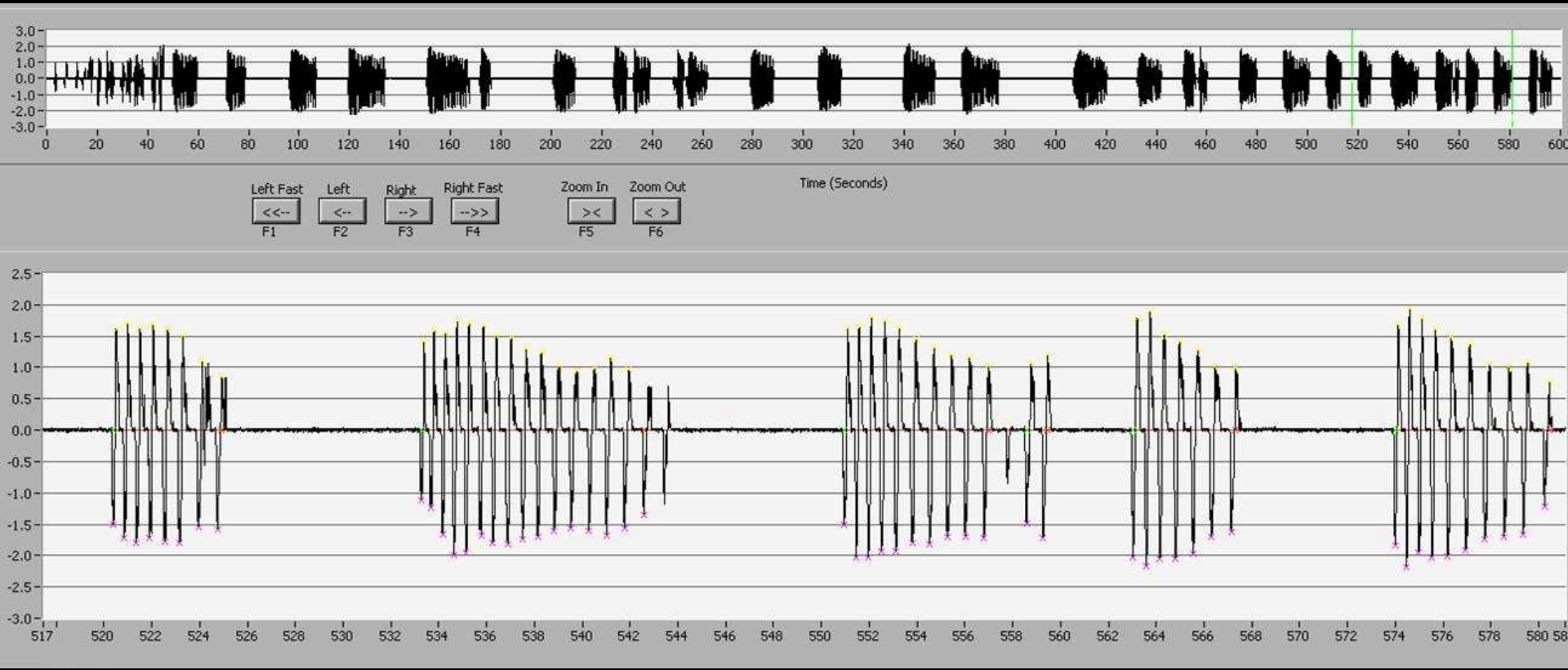
*Modified Brazelton Behavioral State Score:

NNS as a Predictive Developmental Skill

- Predicting feeding skills--practical & heuristic value
- Nurses' Informal observations of NNS
- Existing tools

Medoff-Cooper and Gennaro 1996. The correlation of sucking behaviors and Bayley Scales of infant Development at six months of age in VLBW infants. Nursing Research *45*, 291-296.


Transition time versus sucking behavior
Number of children
0
1
2
3
4
5
6
1-5
6-10
11-15
16-20
21-25
26-30
31-35
36-40
Transition time (days)
Low sucks
High sucks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Suck Consistency Score (if Burst Score > 0)

0 Jagged, differently-shaped, or inconsistently-spaced suck waves; a neat-appearing group of sucks is the exception

1 Odd-shaped, some irregular spacing OR irregular amplitude of suck waves (suck peaks not in a smooth 'up & down' pattern)

2 Very uniform appearance to suck waves

Burst Organization score

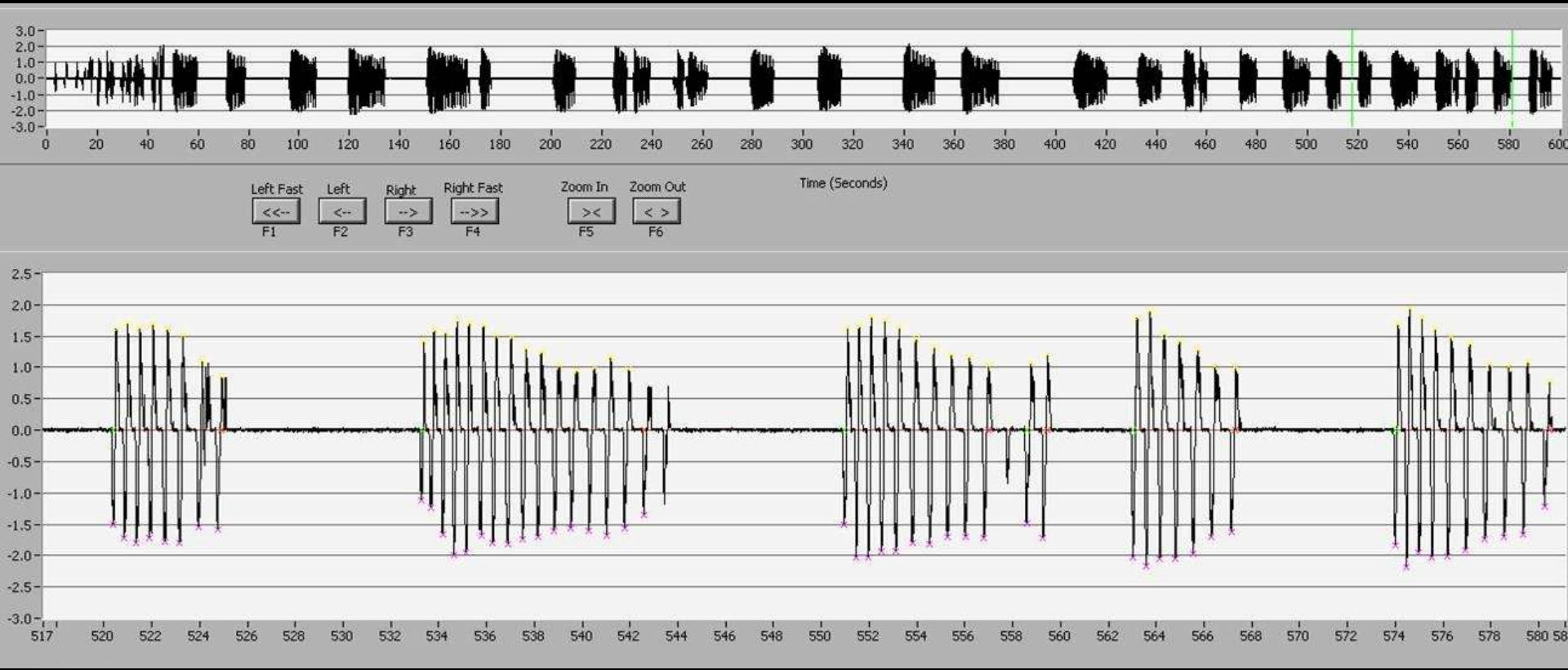
0 No sucks, ± noise

1 Recognizable sucks, no bursts

2 one or more bursts, **not** occurring in regularly spaced 'trains'

3 trains of 3 or more bursts taking up <50% of tracing; bursts are well formed/organized, evenly-spaced

4 Dense, regular bursts throughout/ burst trains >50% of tracing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Quantitative and Ordinal NNS Measures

NNS Measure	Mean ± SD	Median	Range (min – max)
Number of Sucks	132.2 ± 63.3	124.3	(13 - 293)
Number of Bursts	25.0 ± 10.5	22.8	(5 - 54)
Number of Sucks per Burst	4.8 ± 1.4	4.7	(2 - 8)
Peak Number of Sucks/Burst	11.2 ± 4.6	11.2	(3 - 22)
Suck consistency	1.0 ± 0.4	1.0	0 – 2
Burst Score	2.9 ± 0.6	3.0	0 – 4

Feeding Milestones by NNS Groupings *(divided at median)*

		Number of Sucks per Burst		Consistency		Burst Organization	
Transition (days)	**median**	**14.0**	**16.0**	**16.0**	**13.0***	**16.0**	**13.0****
GA @ Full Oral	**median**	**34.4**	**34.1***	**34.6**	**34.1****	**34.4**	**34.1**
Days IOF>SOF	**median**	**7.0**	**7.0**	**7.0**	**6.0**	**8.0**	**6.0***

Kruskal-Wallis Rank Sum Test: * p < 0.10, ** p < 0.05

What makes breastfeeding work for premature infants?

Non-nutritive sucking:

- Stimulation influences prematures' outcomes
- Characteristic developmental pattern
- Adaptive behavior relative to stresses and behavior state
- Predictive of feeding skills

What makes breastfeeding work for premature infants?

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… Thank you!