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-COVER PAGE-

ACTIFIER II: THE DYNAMICS OF SENSORIMOTOR INTEGRATION DURING SUCK IN NEONATES AND INFANTS

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<u>Abstract</u>: ACTIFIER II: THE DYNAMICS OF SENSORIMOTOR INTEGRATION DURING SUCK IN NEONATES AND INFANTS

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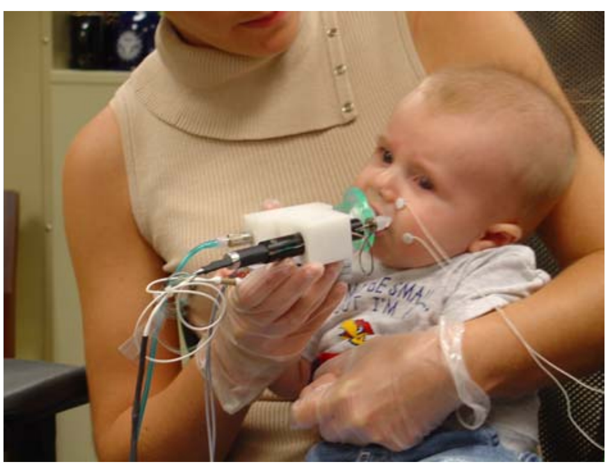
Recent work in adults has shown that the excitability of trigemino-facial pathways modulates in a phase-dependent manner during evolving motor action. Key determinants include the level of active lip force, and the rate of force recruitment during lip compression maneuvers (Andreatta, Barlow, Finan & Biswas, 1996, *JSHR*; Andreatta & Barlow, 2003, *Exp Brain Research*). The ontogeny and specificity of sensorimotor integration among orofacial muscle systems remains largely unknown in neonates and infants. The current report considers the modulation of somatic sensory pathways during spontaneous, centrally patterned motor output in neonates and infants. ACTIFIER II technology was used to deliver punctate mechanical inputs under force-feedback to the face during non-nutritive suck (NNS). Stimulus timing was referenced to a series of suck pressure thresholds using real time waveform discrimination on the NNS suck pressure signal. Evoked activity among lip muscle sites was sampled using a new miniature hydrogel Ag/AgCl electrode array. Mechanical stimuli generated by the ACTIFIER II system are effective in evoking the early component of the trigemino-facial response among perioral muscles of infants. Developmentally related changes in the latency, specificity, and growth function of the R1 component of the mechanically evoked perioral response is consistent with observations of upper limb motor function suggesting that the transition of simple reflex processing to more elaborate forms of sensorimotor actions for voluntary reactions is fundamental to motor skill acquisition (Bawa, 1981).

Introduction.

Premature birth is associated with a variety of medical and developmental conditions that may disrupt motor skill acquisition. The orofacial anatomy represents a complex muscle system whose early function is integral to nutritive and non-nutritive suck behaviors, and to later emergent activities including vocalization, babbling, and speech. Unfortunately, many neonates in the neonatal intensive care unit (NICU) exhibit disordered patterning of suck, aversive reactions to somatosensory inputs, and subsequently poor feeding ability. Significant questions surround the nature of the links, if any, between pre- and postnatal motor control and those behaviors which speech physiologists have traditionally ascribed as precursors to speech (cooing and babbling). Premature and brain-damaged infants' ability to adapt oromotor skills in disorganized, depriving environments is dramatically compromised. To date, quantifiable neurophysiological assessment of the preterm neonatal oromotor system is limited to a few reports (Barlow, Dusick, Finan, Coltart, Biswas, & Denne, 1999; Barlow, Dusick, Finan, Biswas, Coltart, & Flaherty, 2000; Barlow, Dusick, Finan, Coltart, & Biswas, 2001; Barlow, Finan, & Park, *in press*). Thus, the goal of the current report is to detail our continued progress on the



dynamics and neurophysiology of the orofacial apparatus during nonnutritive suck in the NICU using the new ACTIFIER II technology. This 18-month engineering effort has resulted in a new system capable of capturing the modulation of sensorimotor activity in the trigeminofacial complex during non-nutritive suck in preterm neonates and infants using rapid (4 ms rise/fall), punctuate mechanical stimulation of perioral tissue. A specialized load sensor built into the ACTIFER II permits the use of a stimulus contactor that operates under force-feedback to maintain proper pre-load on the baby's face to effectively track skin deflections as the baby's face contracts. This feature provides for greatly simplified stimulus control. This is a powerful method for examining trigeminofacial nerve pathways and the emergent control of the oromotor system. The ACTIFIER II consists of 2 independently controlled servo linear motors; one to drive circumoral cutaneous mechanoreceptors, and a second to produce conformational changes in the silicone pacifier baglet using rapid adjustments in intraluminal air pressure. Improved electrophysiological recordings of facial EMG signals are achieved with new 4 mm diameter Ag/AgCl thick film hydrogel electrode. This sensor was engineered specifically for use in the NICU with the ACTIFIER II system (Barlow & Manoli, 2003). The cutaneous servo motor can be rotated to various positions around the oral opening to stimulate mechanoreceptors represented by either the trigeminal V2 or V3 distribution fields. The punctate mechanical stimulus is now automatically triggered by a protocol control table that is latched to a 16-bit digital-to-analog converter which sets a reference signal used by waveform discriminator. This permits precise study of perioral R1 (trigeminofacial) specificity and growth functions as the facial motor nucleus is activated during the non-nutritive suck cycle. Testing is currently underway at 3 test sites, including two NICU's and one follow-up laboratory at the University of Kansas. The present report will include R1, IEMG, and oromotor dynamics data collected from preterm and term infants through the 1st year of life. Inclusion criteria include normal vital signs, oxygen saturation, and neurologic exam for gestation at the time of testing. Preliminary results indicate that the ACTIFIER II is highly effective in evoking the early component of the trigeminofacial reflex (R1) among perioral muscle recording sites in neonates and infants during the non-nutritive suck. Results from the NEOFLEX analysis routine, written in LabView and MatLab, reveal developmental changes in the latency, specificity, and growth function of the R1 component related to suck pressure dynamics. These findings are consistent with observations of upper limb motor function suggesting that the transition of simple reflex processing to more elaborate forms of sensorimotor actions for voluntary reactions is fundamental to motor skill acquisition (Bawa, 1981). Changes in the neurophysiological status of the perioral system are paralleled by changes in suck dynamics, including burst length and complexity, burst amplitude, and production frequency. In addition, the experiments thus far demonstrate that the excitability (gain) of R1 is also dependent upon the phase of the suck pressure cycle in the pre-term neonate. The growth of R1 with increases in baglet pressure is positively correlated to increased neural drive at the level of the lower motor neuron. These findings provide electrophysiological demonstration of modulation between cortical and bulbar pathways in preterm neonates during a centrally patterned motor output. (Funded by the National Institutes of Health R01 DC03311-02).

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