



# #368.20/JJ23 EFFECT OF AUDITORY STIMULATION WITH VOCAL MUSIC ON NEUROPHYSIOLOGICAL RESPONSES TO ACUTE PAIN IN PREMATURE INFANTS



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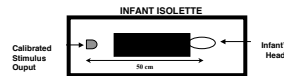
## INTRODUCTION

Throughout the first weeks to months of life, premature infants often need around-the-clock medical care associated with recurrent pain, emotional distress, chaotic acoustic environments, and relative deprivation of linguistic, paralinguistic, social, and cultural communication via the auditory sensory modality compared to newborns in their home environment.

### Working Hypotheses:

1. Pain and emotional distress can be assayed in premature infants over time windows of milliseconds to tens of minutes using neurophysiological responses to acutely painful stimuli that must be delivered during diagnostic and therapeutic medical procedures
2. Neurophysiological and behavioral responses to painful stimuli can be attenuated by auditory stimulation with vocal music

## METHODS



• IRB approval and parental informed consent was obtained, and premature infants without neurological disease who did not require respiratory support were studied using a randomized, case-control clinical study design. All patients were admitted to the MGH Special Care Unit from the Delivery Room and underwent blood tests for medical indications. Thirteen infants (Estimated Gestational Age Mean  $\pm$  SD = 32.0  $\pm$  1.4 wks) have participated thus far.

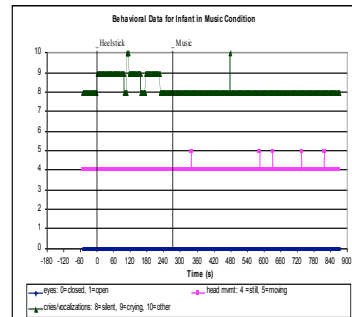
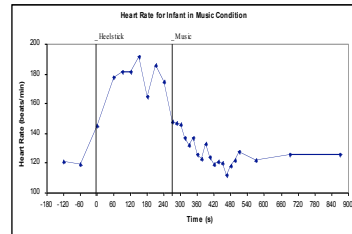
• Participants were randomized to the control condition (no auditory stimulation, oAS) or test condition (auditory stimulation, +AS) in advance of scheduled blood tests performed by experienced SCU nurses using a standard "heel stick" procedure. This procedure entails puncturing the skin on the plantar surface of one heel and squeezing the [venous] blood that comes through the skin into a tube. Seven neonates received auditory stimulation within 115 seconds after pain onset (latency = 69 $\pm$ 32 s; duration = 10 mins); six neonates were not stimulated.

• In the test condition, auditory stimulation started within 2 mins after skin puncture and continued for a total duration of 10 minutes. Intensity = 60 dBA at infants head.

• Heart rate (HR), respiratory rate (RR), limb and trunk movements, and vocalizations were recorded continuously by EKG, respiratory monitoring, and video. The experimental apparatus for both the control and test conditions consisted of the infant's isolette, associated cardiorespiratory SCU monitoring monitoring devices, a digital videocamera, a CD-amplifier-speaker system, and a sound level meter.

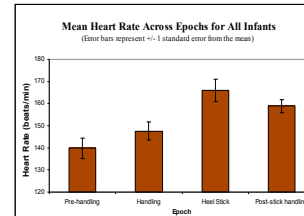
## SINGLE-NEONATE DATA: NEUROPHYSIOLOGICAL AND BEHAVIORAL RESPONSES TO PAIN (+AS Condition)

Data from a single premature infant showing neurophysiological responses (top) and behavioral responses (bottom) typical of those observed in the population before, during, and after delivery of a painful stimulus (heel skin puncture and foot manipulation) and auditory stimulation (+AS Condition) with vocal music (traditional Western lullabies sung by a woman in the infant's native language (English) with guitar accompaniment)



## NEONATE POPULATION DATA: NEUROPHYSIOLOGICAL RESPONSES TO PAIN

• Skin puncture evoked a sudden increase in Heart Rate in each of the 13 premature infants and, consequently, the Mean Heart Rate of the entire population.

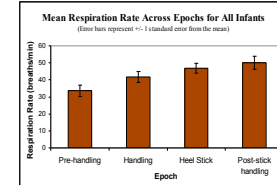


The increase in heart rate during and immediately following the pain stimulus brought the heart rate above the upper limit of normal in all neonates (Diagnosis: Sinus Tachycardia). No Ventricular or Atrial Tachyarrhythmias were observed in this sample of premature infants without major respiratory, cardiac, or neurological disease.

Mean Population Heart Rate increased 19% above the Pre-Procedure Baseline  
Mean Population Heart Rate increased 13% above the Post-Unswaddling, Pre-Pain, Pre-Music Baseline

After a blood test, HR increases were sustained for several minutes – throughout the 10-minute observation window in some neonates

Skin puncture also evoked sudden and sustained increases in Respiratory Rate in each of the 13 neonates that were above normal limits (Dx = Tachypnea and, likely, Respiratory Alkalosis.)



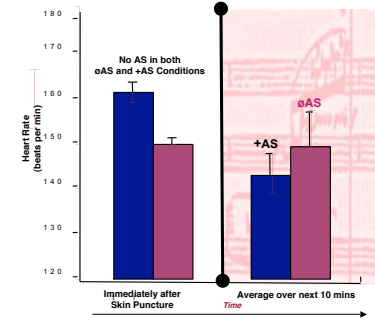
• Mean Population Heart Rate increased 53% above the Pre-Procedure Baseline

• Mean Population Heart Rate increased 24% above the Post-Handling Pre-Music Baseline

• Procedure-evoked HR increases were sustained for several minutes post-handling and re-swaddling in all infants.

## NEONATE POPULATION DATA: MODULATION OF PAIN-EVOKED CHANGES IN HEART RATE BY AUDITORY STIMULATION

In the minutes following acute pain and manipulation, premature infants in the test condition (+AS) showed an average decrease of 12% in Mean Heart Rate, but patients in the control condition (oAS) showed no change in Mean Heart Rate.



## CONCLUSIONS

1. A routine diagnostic procedure required for serologic analyses – heel skin puncture, performed dozens of times over days-to-months in some critically-ill premature infants – caused sudden, sustained increases in heart rate, respiratory rate, and motor and vocal behaviors in our population of 13 neonates who were delivered a mean of ~8 weeks prematurely and admitted to the MGH Neonatal Special Care Unit.
2. During the 10 min period following skin puncture and handling, auditory stimulation with vocal music attenuated an autonomic-physiologic index (heart rate) of emotional distress and pain that persisted well after cessation of noxious tactile stimuli.
3. Larger populations and future clinical trials that tease out the effects of numerous subject, stimulus, musical, linguistic, and response parameters are needed.

## ACKNOWLEDGMENTS

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