

Impact of Language Exposure in the NICU on Vocalizations in Preterm Infants

Melinda Caskey, MD, Bonnie Stephens, MD, Betty Vohr, MD

Data analysis: Richard Tucker, BA

Women & Infants' Hospital

Providence, RI, USA

March 27th, 2010



Melinda Caskey, MD

I have no relevant financial relationships to disclose or COIs to resolve.



Language Delay in Preterm Infants

- Preterm infants have delays in speech and language
 - ☐ Expressive language
 - ☐ Receptive language
 - ☐ Grammar
 - ☐ Vocabulary
 - ☐ Phonological awareness

- Even with no major neurologic insult deficits remain



Environment & Sensory Input



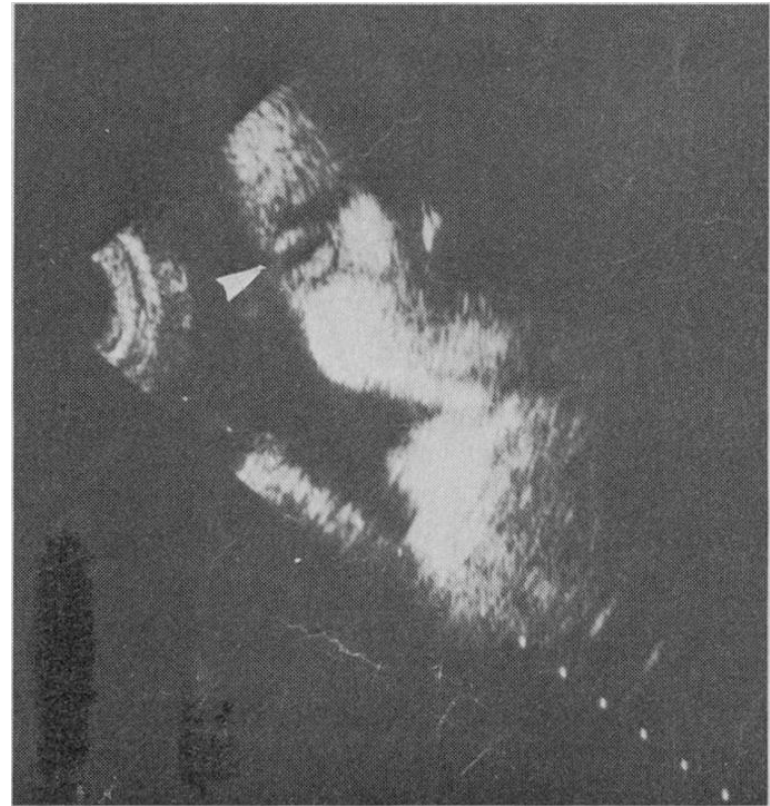


Etiology of Language Delay

- Gestational age at birth
- Neonatal morbidities
 - ☐ Chronic lung disease
 - ☐ Neurologic injury, intraventricular hemorrhage
 - ☐ Duration of hospitalization
- Hearing status

Development of fetal hearing

- Fetus responds to auditory stimulus as early as 24 weeks and consistently after 28 weeks
- By 27 weeks, 96% fetuses respond to tones at 0.25 and 0.5 kHz
- By 33 to 35 weeks, 100% respond at 1 and 3 kHz
- Over time, response can be seen to lower intensity stimulus, so hearing becomes more sensitive



Birnholz, *Science*, 1983



Sound in the Womb

- Hydrophone studies
 - With sheep - Armitage et al. 1980
 - With humans - Querleu & Renard, 1981
- Constant sounds: maternal cardiovascular, respiratory and intestinal noises
 - Low frequency, and high intensity (90dB)
- Intermittent sounds: Maternal movements, vocalizations, external sounds
 - Higher frequency and lower intensity (40dB)
- Mother's voice



Developmental psychobiology

- Early development is experience-dependent
- Typical onset of sensory modalities
 - Tactile → vestibular → chemical → auditory → visual
 - Importance of developmental sensory limitations
- Atypical perinatal sensory input
 - Enhances development or detrimental?
 - No real understanding of what is normal



Psychology

- Prenatal auditory experience affects the post-natal response of the infant
 - ☐ Preference for mother's voice
 - ☐ Preference for native language
 - ☐ Preference for music heard in utero

- Learning of prosodic elements of speech including pitch, rhythm and stress important to build on future language

Moon, 2000



Research Objectives

- To characterize the sound and language environment in the NICU
- To quantify the adult language to which preterm infants are exposed
- To quantify the vocalizations produced by preterm infants in the NICU



Hypotheses

- Babies will have an increase in the number of vocalizations between 32 and 36 weeks PCA
- Babies exposed to higher adult word counts will have a greater number of vocalizations at 32 and 36 weeks PCA
- Babies will vocalize more during care times when a parent is visiting



Methods

- Infants with birth weight less than <1250g (23-29 weeks)
- Parents approached when patient is nearing 32 weeks and is medically stable
- Informed consent obtained for recordings
- Demographic information on mothers



Methods

- Vest fitted and infant recorded for 16 hours using Digital Language Processor
 - 32 weeks
 - 36 weeks
- Analyze all recordings using LENA[™] and ADEX software



Digital Language Processor





Methods

- Environment during recording
 - ☐ Visitation times
 - ☐ Feeding times
 - ☐ Type of feeding
 - ☐ Respiratory support required
 - ☐ Apnea/Bradycardia/Desaturation spells
 - ☐ Type of bed



Statistics

- Negative binomial regression
 - Appropriate for data involving counts with high variability
- Linear regression



Demographics

N	32
Males	44%
Average Gestational age	26.8 weeks
Average Birth Weight (grams)	903 (\pm 205)
Maternal Age (years)	31 (\pm 7)
Gravida	Gravida 1 50%
Race Caucasian	63%
Hispanic	25%
African-American	13%
Less than HS	3 (9%)
High School/Partial College	19 (59%)
College/Graduate	10 (32%)



Sounds in the NICU

NICU Sounds	32w	36w	Significance
Language	2.1% (SD 0.04)	5.3% (SD 0.07)	<0.001
Television (Monitor)	26.0% (SD 0.28)	37.4% (SD 0.29)	0.03
Silence	37.1% (SD 0.29)	27.5% (SD 0.22)	0.04
Noise	34.7% (SD 0.29)	29.7% (SD 0.21)	0.25



Developmental
Snapshot



Digital Language
Processor



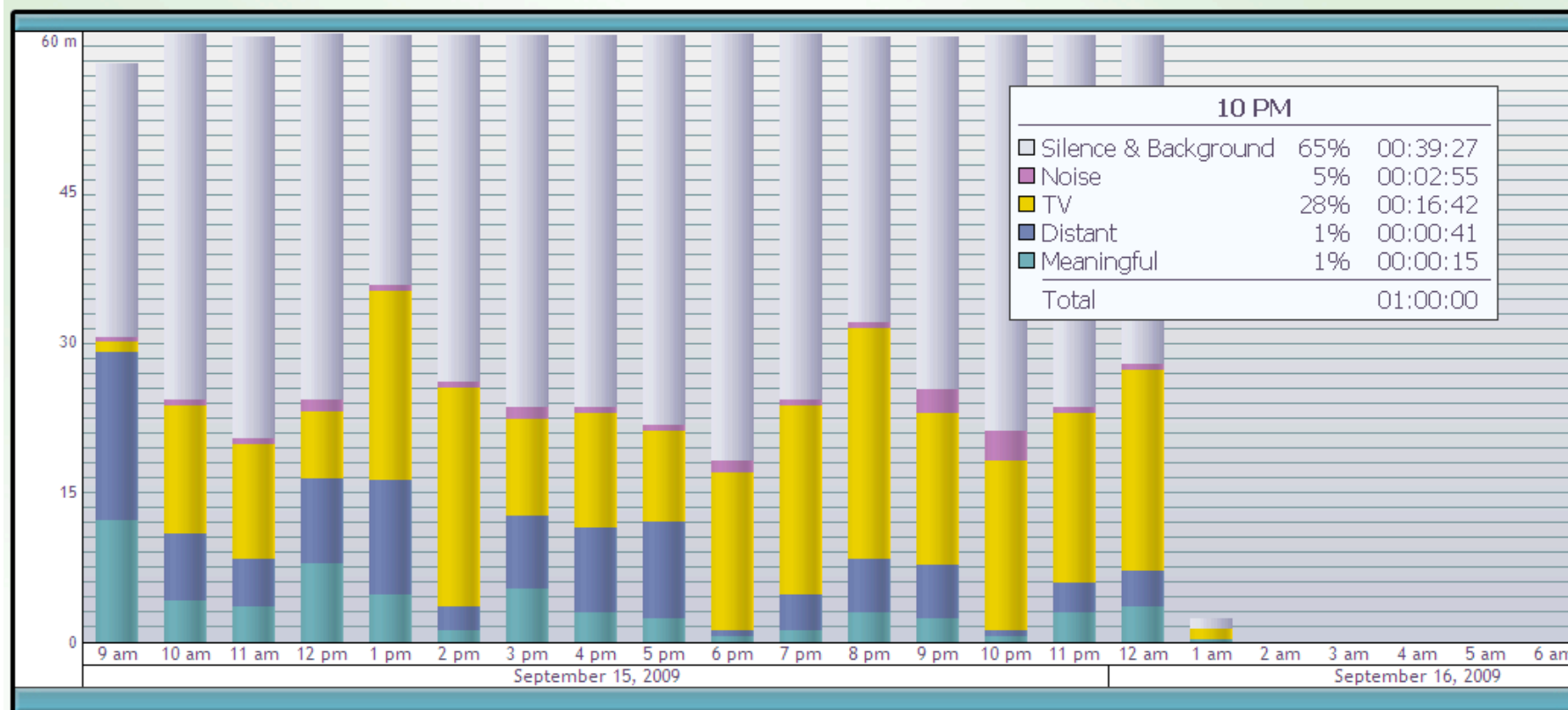
Settings

Audio Environment

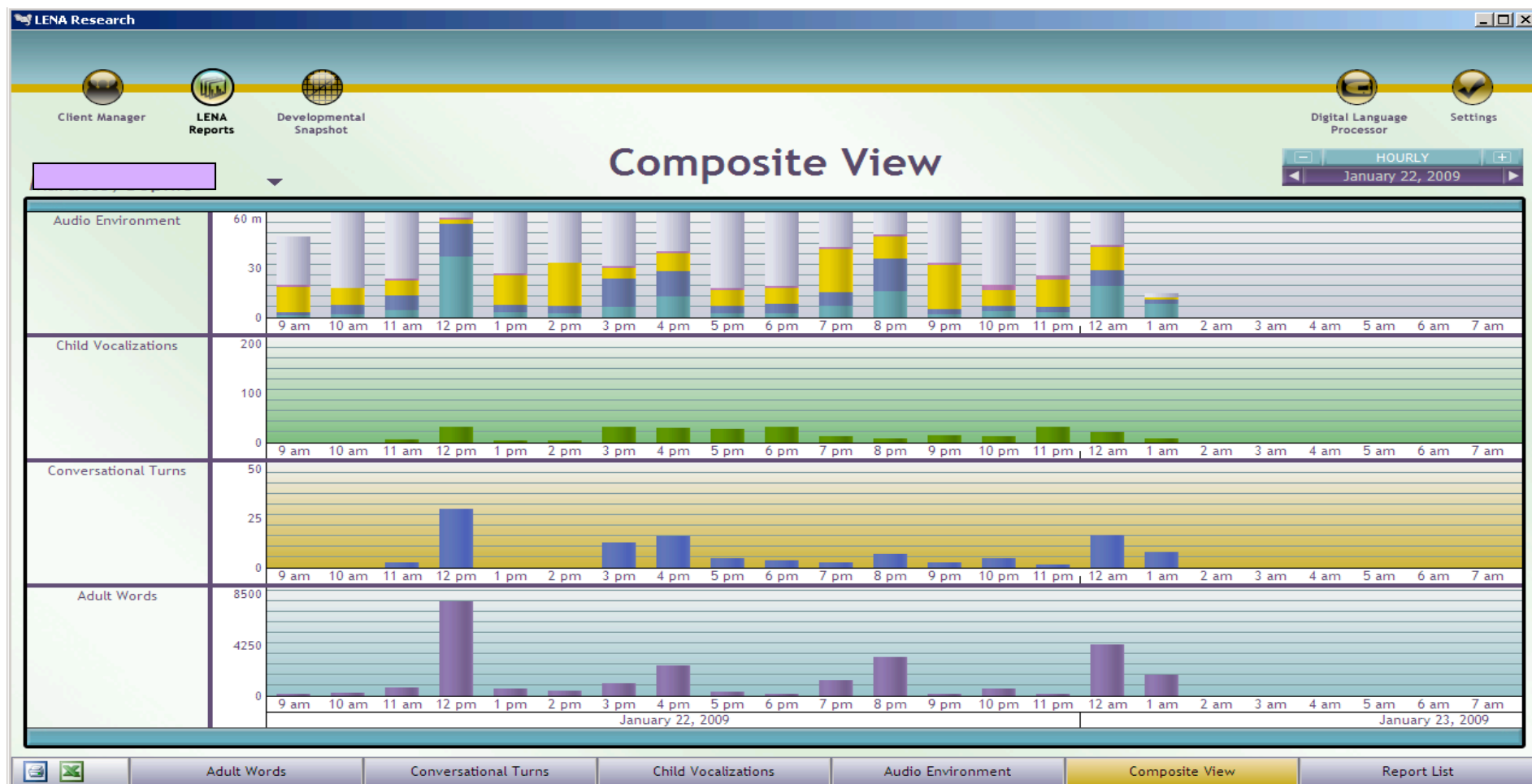
HOURLY
September 15, 2009



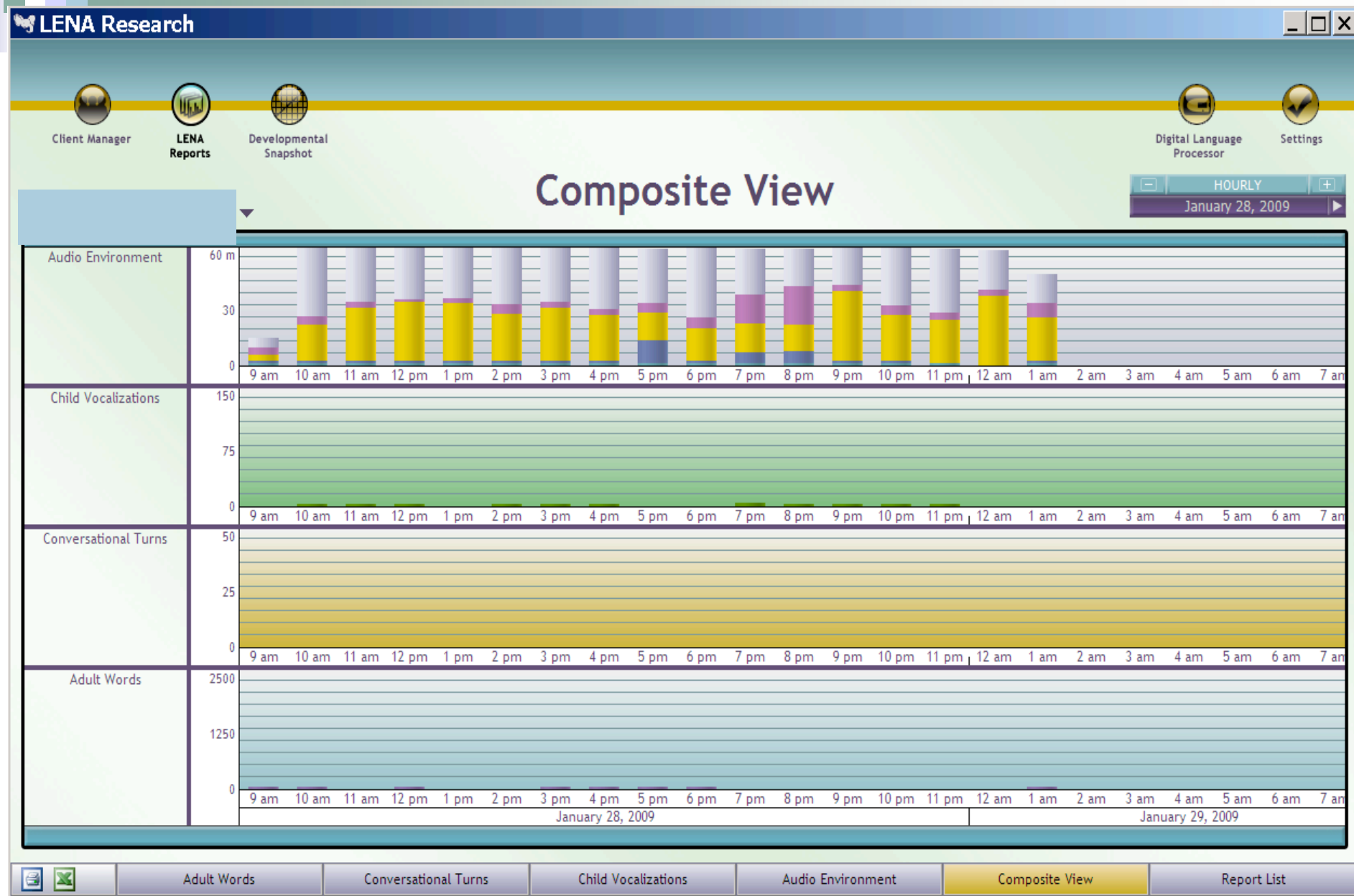
LENA™
Every Word Counts



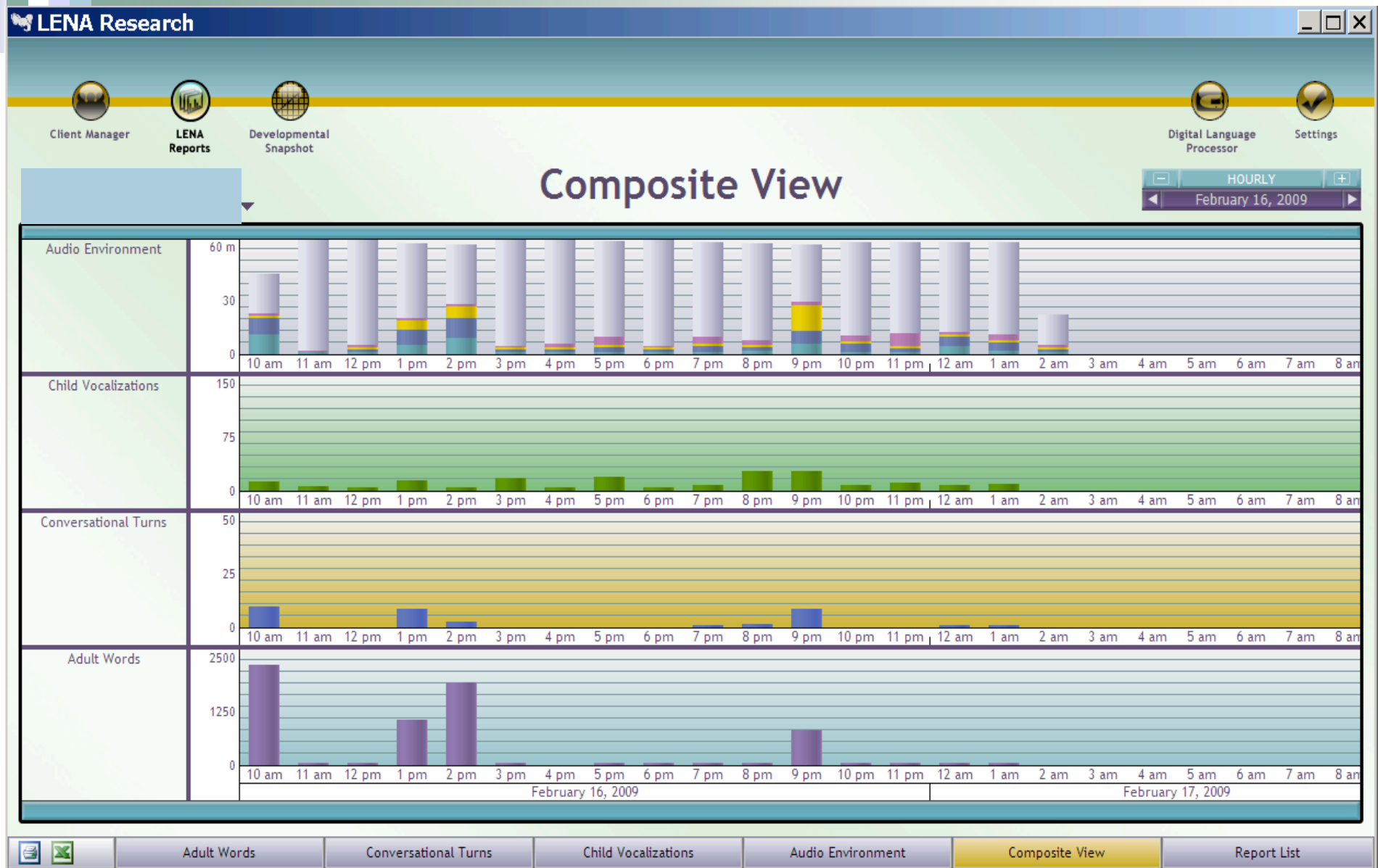
Meaningful Distant TV Noise Silence & Background



25w now at 36 weeks. Room air, crib, feeds all by mouth,
Mother visited at noon, 4pm 8pm and 12am.



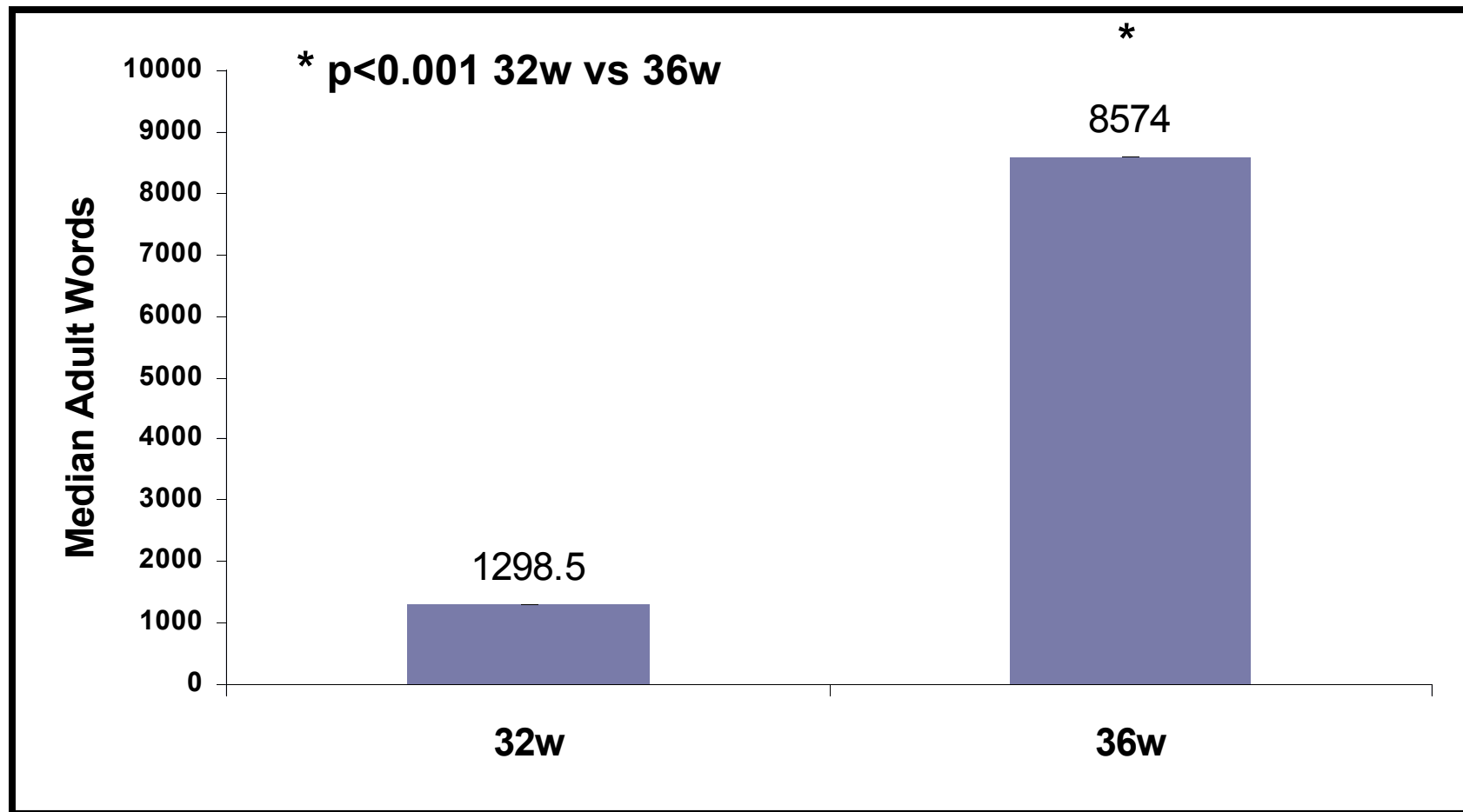
29 weeks, now 32 weeks, Giraffe bed, continuous feeds, RA
No parental visits



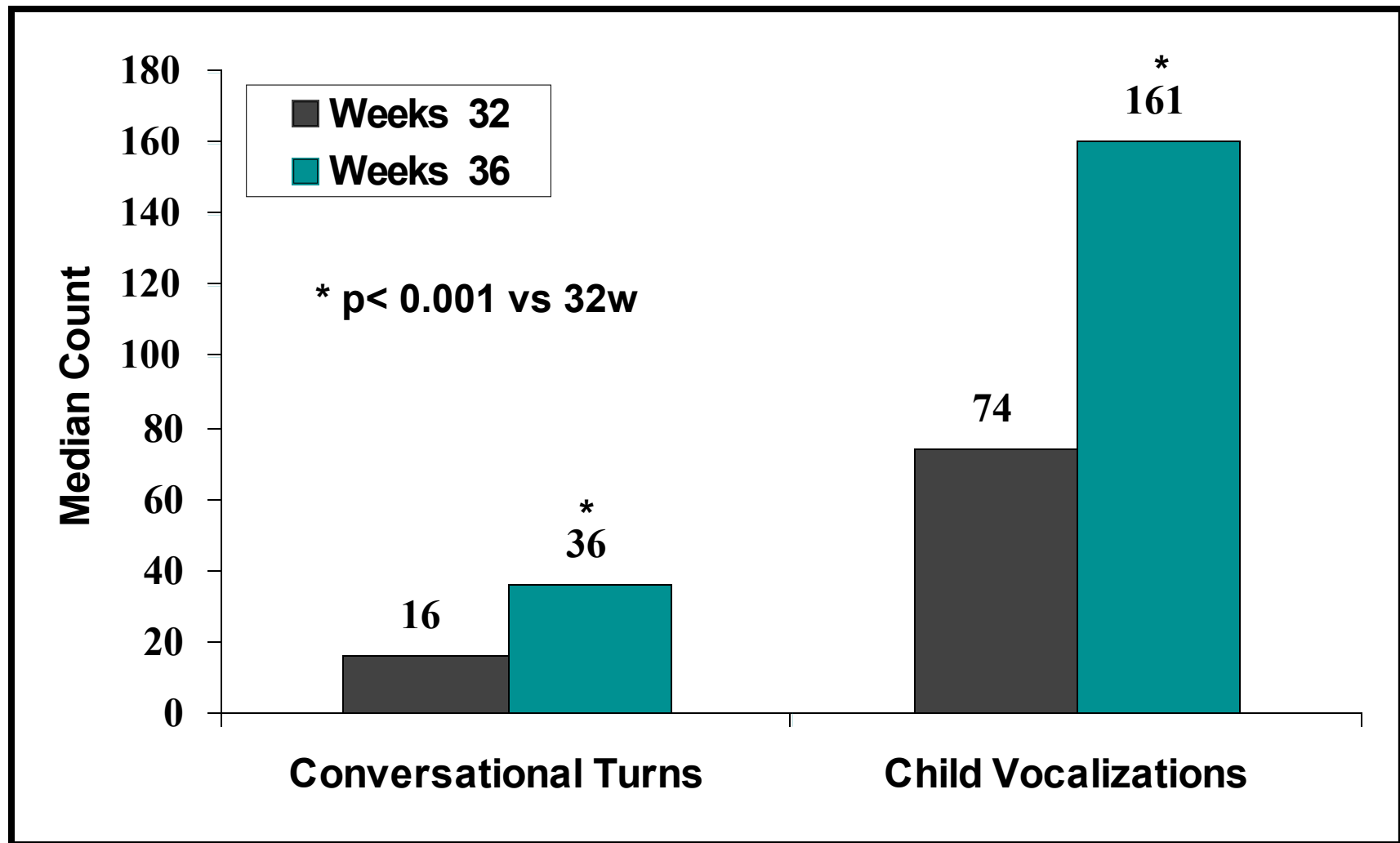
29 weeks at birth, now 36 weeks, nipple/gavage feeds, isolette, RA
Mom visited at 9-10am, 1-2pm and Dad at 9pm

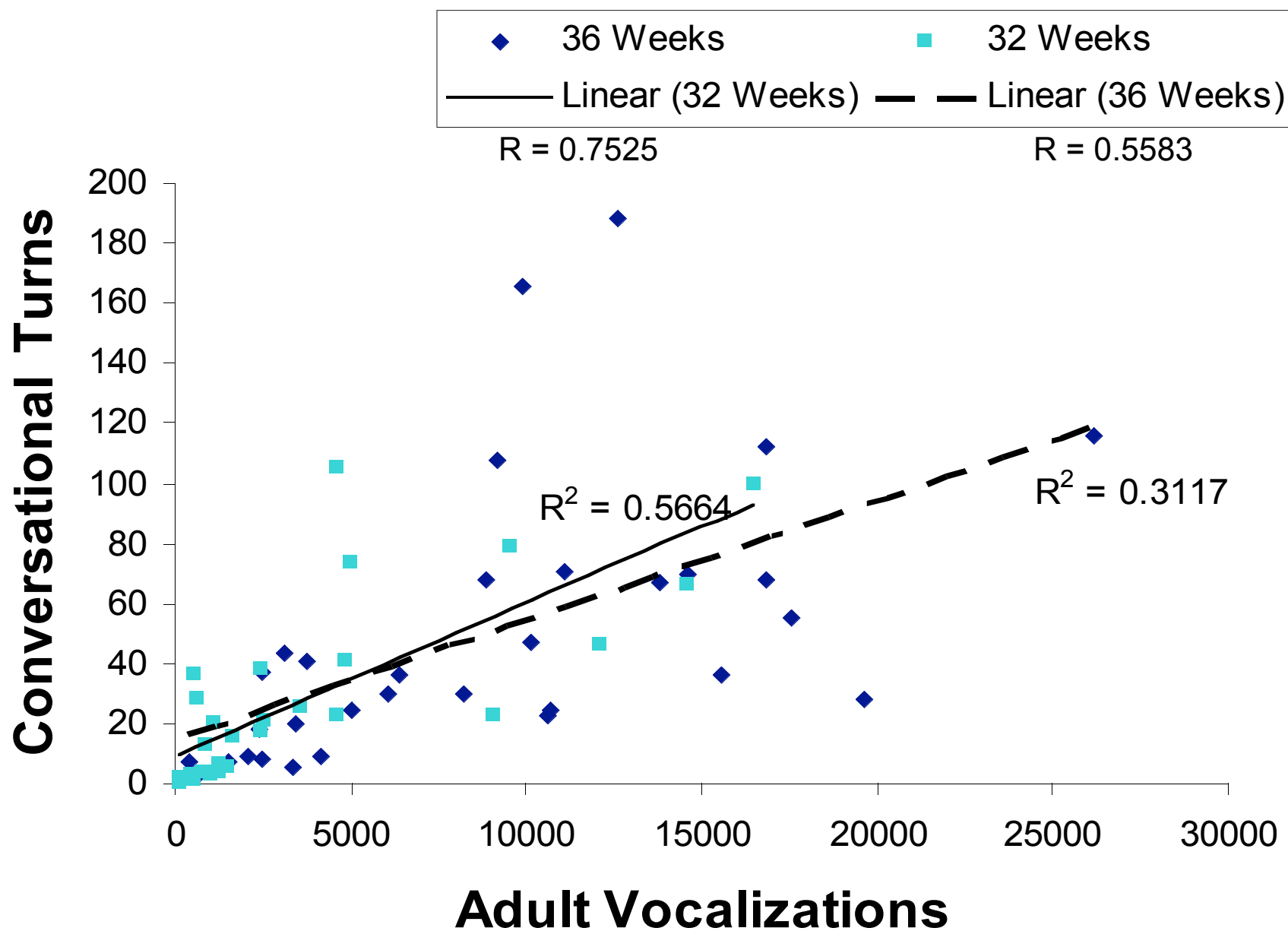


Total Adult Word Count



Child Vocalizations and Conversational Turns







Feeding Times

Variable	Feeding Time	Non-Feeding Time
Mean Hourly Adult Word Count	722* (SD 1107)	262 (SD 587)
Mean Hourly Conversational Turns	4.0* (SD 6.7)	1.7 (SD 4.5)
Mean Hourly Child Vocalization count	13.5* (SD 16.4)	8.0 (SD 15.2)

* p<0.001



Parent Visits

Variable	Parent Visiting	No Parent Visiting
Mean Hourly Adult Word Count	1178* (SD 1344)	276 (SD 604)
Mean Hourly Conversational Turns	6.7* (SD 10.0)	1.8 (SD 4.2)
Mean Hourly Child Vocalization count	15.6* (SD 19.4)	8.5 (SD 15.1)

* $p < 0.001$



Conclusions

Preterm Infants in the NICU

- Are exposed to increasing numbers of words between 32 and 36 weeks of gestation; Language, however, accounts for only a small percentage of all of the sounds to which infants are exposed in the NICU
- Preterm infants begin to make vocalizations prior to their projected due date, increasing from 74 per hour @ 32w to 161 per hour at 36 weeks.



Conclusions

- Preterm infants in the NICU are exposed to significantly more words from their parents than from other caretakers.
- Conversation turn rates indicate preterm infants are significantly more responsive to their parents than other caretakers.
- These findings support the importance of visitation in the NICU.



Future Research

- Comparison of open bay NICU with single patient per room NICU
- Comparison of 32 and 36 weeks recordings when born at 24-28 weeks versus late preterm
- Longitudinal study
- Bayley Scales of Infant & Toddler Development scores at 7 months and 18 months corrected age
- Characterization of preterm infant vocalizations



Thank you