Evolution of the Auditory Environment of Hospitalized Very Preterm Infants in Relation to Room Type and Parental Presence

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Background

- Infants born very preterm undergo critical brain development, including the auditory cortex, while in the neonatal intensive care unit (NICU) before term-equivalent age (TEA)[1]
- Optimal meaningful auditory exposures may enhance brain development while undesired exposures adversely impact cortical development[2]
- The effect of the NICU environment, such as room type, on brain structure and activity may impact later neurodevelopment[3]
- NICU auditory environment may consist of alarm noises, excessive silence, and insufficient meaningful auditory exposures such as human voice, especially when parental presence is limited[4]

Objective

To examine auditory exposures of infants born very preterm before TEA and assess how they relate to room type and parental presence

Methods

Study design Prospective observational study of infants born very preterm in a level-III NICU

Study population

- Sample size of 20 infants
- Inclusion criteria: Gestational age (GA) at birth <33 weeks, infants admitted to the BWH NICU with post-menstrual age ≥ 30 weeks

Data collection

- 16-hour measurements, approximatively weekly for up to 6 weeks, using the Language Environment Acquisition device (LENA)
- Covariates at baseline and time of measurement
  - Post-menstrual age
  - Parental presence (6 hours or more vs less than 6 hours)
  - Room type (single-family room vs open bay)
  - Basic infant information (GA, birth weight, comorbidities, etc.)



https://shop.lena.org/products/lena-device

Data analysis Descriptive statistics and linear regression analyses

Results

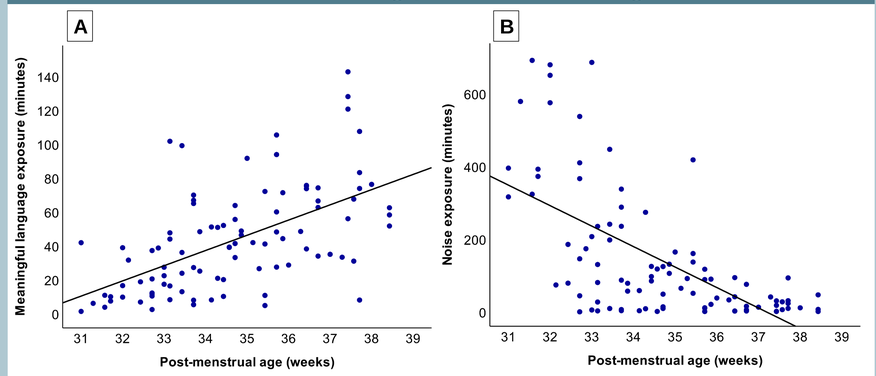
96 recordings from 20 infants (mean GA = 30.3±2.5 weeks; mean birthweight = 1458±400g)

- 51 measurements (53.1%) were performed in a single-family room
- 34 measurements (35.4%) were obtained for infants whose parents were present 6 hours or more in the NICU

On average, the auditory environment was composed of

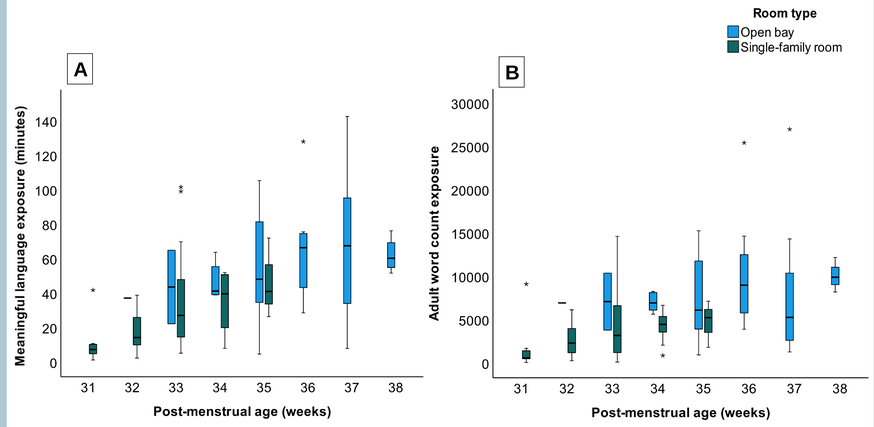
- Silence (58.5±23.6%)
- Noise (14.9±18.7%)
- Electronic sounds (14.2±13.9%)
- Distant language (6.5±6.2%)
- Meaningful language (4.5±3.2%)

Figure 1 Evolution of meaningful language and noise exposure with advancing post-menstrual age[a]



[a]Total minute number of (A) meaningful language and (B) noise exposure during 16-hour recordings according to post-menstrual age

Figure 2 Evolution of meaningful language and adult word count exposure with advancing post-menstrual age by room type[a]



[a]Total (A) minute number of meaningful language and (B) adult word count exposure during 16-hour recordings according to post-menstrual age and room type

Main findings

Very preterm infants in the NICU were exposed to

- **A predominance of silence and electronic/alarm sounds**
- **A limited amount of meaningful language**

Meaningful language exposures increased

- **As infants advanced in post-menstrual age (β=0.57, p<0.001)**
- **In open bays vs single-family rooms (β=0.49, p<0.001)**

Higher parental presence surrounding recording was associated with

- **Increased exposure to distant language (β=0.26, p=0.015)**
- **No association with adult word count**

Implications and next steps

- The optimal composition of the NICU auditory environment for very preterm infants before TEA remains incompletely understood
- The NICU environment and parental presence may help enhance infants' auditory experiences before TEA
- More studies are needed to understand how the NICU environment can be further optimized through family-centered developmental care to improve very preterm infants' outcomes

Limitations

- Serial 16-h measurements may not fully reflect continuous auditory exposures of very preterm infants
- Parental presence was documented surrounding recordings, but may fluctuate over time
- Not able to investigate the effect of room type for all post-menstrual ages
- Results may not be fully generalizable to different NICU settings

Acknowledgments

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References

1. Tierney AL, Nelson CA. Brain Development and the Role of Experience in the Early Years. *Zero Three*. 2009;30(2):9-13.
2. Maitre NL, Key AP, Chorna OD, et al. The Dual Nature of Early-Life Experience on Somatosensory Processing in the Human Infant Brain. *Curr Biol*. 2017;27(7):1048-1054.
3. Pineda RG, Neil J, Dierker D, et al. Alterations in brain structure and neurodevelopmental outcome in preterm infants hospitalized in different neonatal intensive care unit environments [published correction appears in J Pediatr. 2015 Apr;166(4):1097]. *J Pediatr*. 2014;164(1):52-60.e2.
4. Pineda R, Durant P, Mathur A, Inder T, Wallendorf M, Schlaggar BL. Auditory Exposure in the Neonatal Intensive Care Unit: Room Type and Other Predictors. *J Pediatr*. 2017;183:56-66.e3.