Fetal Sound Exposures and Auditory Brainstem Responses at 3 Months of Age

Paige Valente & Ana Sabic, Dr. Brian Monson
Department of Speech and Hearing Science, College of Applied Health Sciences, University of Illinois at Urbana-Champaign

INTRODUCTION

The human auditory system is a special biological system. Unlike many systems, it becomes fully functional in utero. An abundance of studies demonstrate that the auditory system of a human fetus begins receiving input as early as 23 weeks postmenstrual age (PMA). The auditory system is of particular interest because it integrates information from the outside environment, thereby influencing fetal neurodevelopment. A fetus is consistently surrounded by auditory input; it hears the mother's heartbeat, biological digestive sounds, and the extrauterine environment. Current research in this area lacks normative data regarding the types of auditory stimuli heard during prenatal sound exposure. It has been hypothesized that the type and quantity of language and sound exposure in infancy influence language development later in childhood. Clinically, typical fetal sound exposures are not well understood, thus the motivation for our study was to assess the relationship between fetal sound exposures and the maturation of a typically developing auditory system.

AIM

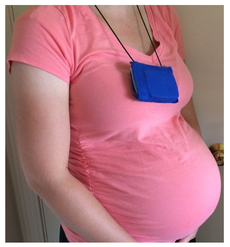
In order to address these questions, we used Language ENvironment Analysis (LENA) audio recording devices to assess and quantify the sound environment that a fetus experiences in the womb. The LENA devices were worn by 25 expectant mothers twice per week for a 24 hour period each time, placing the device by bedside during sleep. Three months after birth, we collected the auditory brainstem responses (ABR) of the infants to auditory click stimuli and analyzed their latencies. The ABR latencies of the these three month old infants were used to investigate how exposure to certain types of sound influenced future auditory development. Decreased ABR latencies are indicative of a more mature brainstem because the quicker the ABR latencies, the shorter amount of time it takes for the infant to process the auditory information. Thus, we hypothesized that higher daily adult word count (AWC) and daily speech exposure would correlate with decreased ABR latencies. This approach could prove useful for understanding typical fetal neurodevelopment, which could then aid us in identifying the effects of different auditory environmental exposures. These findings may help us better understanding developmental differences that occur between full term infants and preterm infants in the neonatal intensive care unit (NICU).

METHOD

Prenatal
- Language ENvironment Analysis (LENA)
- 24 hour recording devices
- Automatic classification of sound into electronic/TV, noise, silence, adult word count, meaningful language, and distant language
- Worn by 25 expectant mothers in pouch around neck
- Recordings twice a week before labor

Postnatal
- Auditory brainstem responses (ABR)
- 11 infants at three months of age
- Click stimuli delivered at 80 dBnHL

Language ENvironment Analysis (LENA) audio recording device

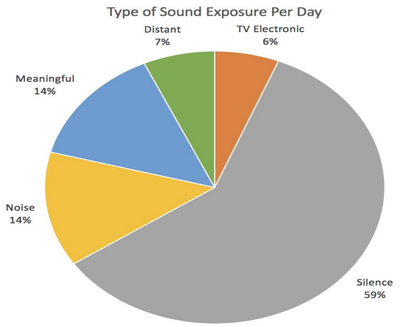


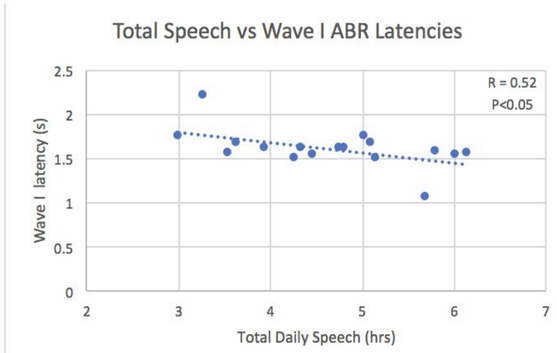
LENA devices were worn by expectant mothers by a pouch hung around their necks.

RESULTS

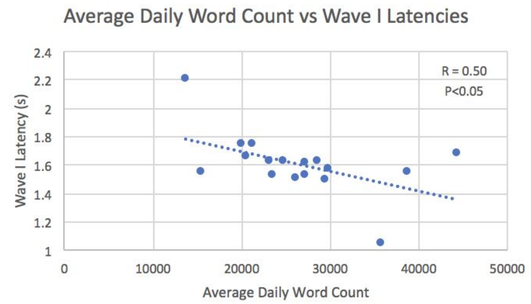
- >14,000 hours of fetal data
- Average daily language exposure (Meaningful and Distant speech):
  - 4.6 hours, range 3-6.1 hrs
- Average daily TV/Electronic noise exposure:
  - 1.4 hours, range 0.3-3.5 hrs
- Average daily silence:
  - 13.3 hours, range 6.1-16.6 hrs
- Average daily noise exposure
  - 3.1 hours, range 0.5-8.6 hrs
- Average adult word count per day:
  - 28,214 words, range 13,729-44,351 words

RESULTS





- Significant inverse relationship between Total Speech and Wave I ABR latencies, P=0.029



- Significant inverse relationship between Adult Word Count and Wave I ABR latencies, P= 0.039
- Non-significant trend for the relationship between Total Speech and Average Daily Word Count with Wave V ABR latencies

CONCLUSIONS

- Significant inverse relationship between the amount of adult words or total speech a fetus hears each day, and the ABR latency of wave I
- An infant that experienced more speech input prenatally led to a quicker maturation of the auditory system by three months of age
- This suggests that the more language an infant experiences while in the womb, the more mature their auditory brain, indicated by ABR wave I (Figure 1, Figure 2)

Limitations:
- Relationship only shown for wave I, not wave V
- Only 17 participants thus far, data collection is ongoing
- Mother's mental health may be a confounding factor in the amount and type of sound input an infant in utero could experience

Applications:
- Mothers should possibly be speaking more to their child or allowing a more rich sound environment for their infant even before birth to result in a more mature auditory system for their child
- A crisis like COVID-19 could affect the type and amount of language and sound in an prenatal infant's environment
- The impact of a NICU sound environment compared to a typically developing infant in utero

ACKNOWLEDGEMENTS

Special thanks to our pregnant women, the ANEx Lab team, and all their work in recruiting participants, data collection, and analysis.

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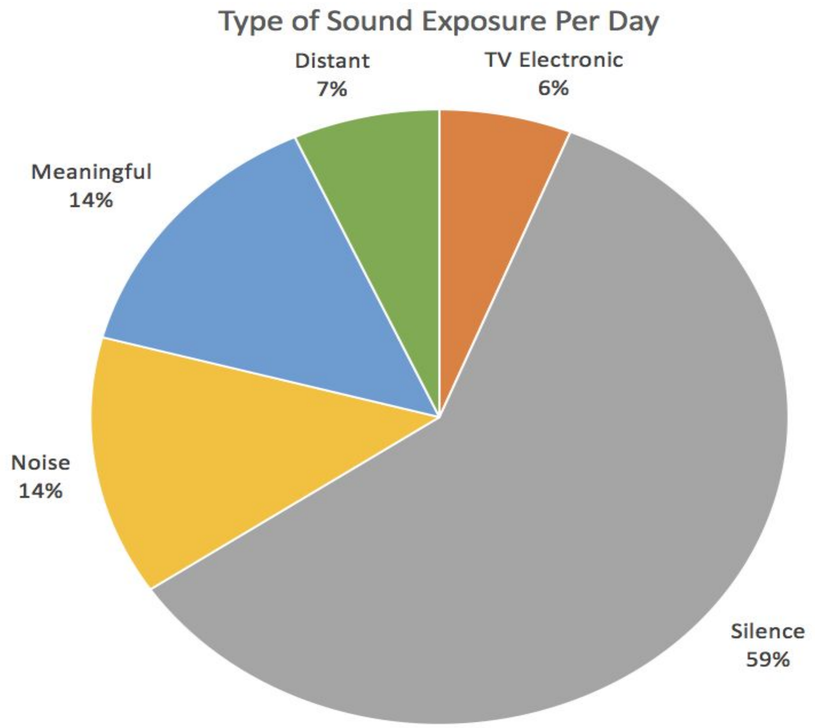

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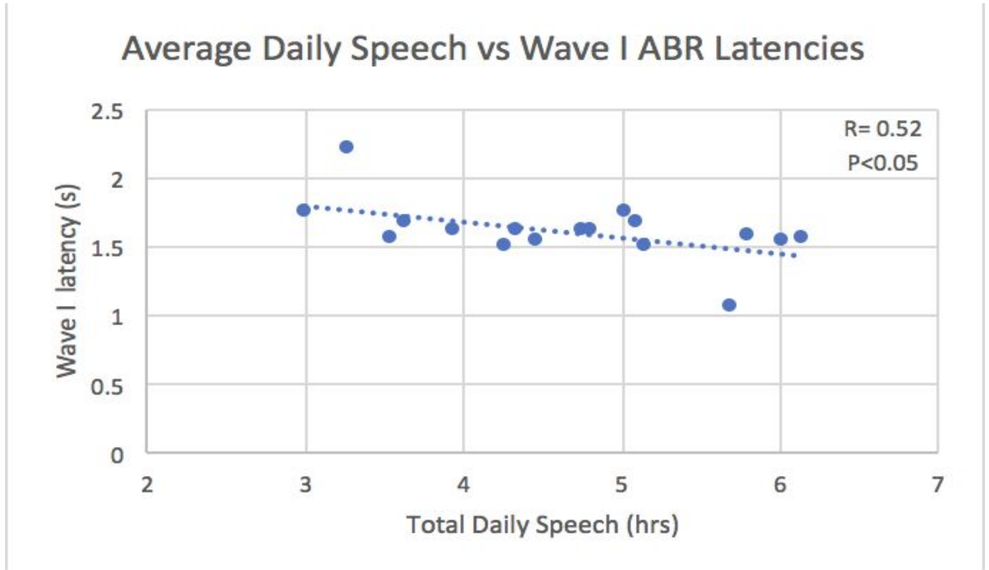

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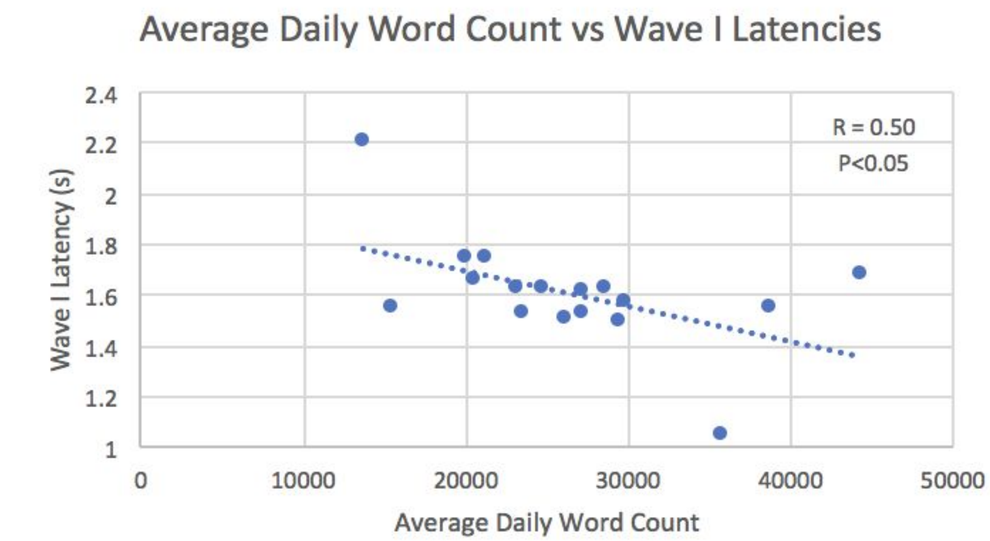

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