



How are professionals using LENA in research and clinical applications?

LENA SP provides a rich picture of a child's language environment for anyone in need of detailed, scientifically reliable speech-language measurements of children 2 months to 48 months old. This document is designed to help you get a sense of LENA's potential for use in research and clinical settings.

Bilingualism

Marchman, V. A., Martínez, L. Z., Hurtado, N., Grüter, T., & Fernald, A. (2017). Caregiver talk to young Spanish-English bilinguals: Comparing direct observation and parent-report measures of dual-language exposure. *Developmental Science*, 20(1), e12425. doi: 10.1111/desc.12425

Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. (2017). The impact of early social interactions on later language development in Spanish-English bilingual infants. *Child Development*, 88(4), 1216-1234. doi: 10.1111/cdev.12648

Brain Science

García-Sierra, A., Ramírez-Esparza, N., & Kuhl, P. K. (2016). Relationships between quantity of language input and brain responses in bilingual and monolingual infants. *International Journal of Psychophysiology*, 110, 1-17. doi: <https://doi.org/10.1016/j.ijpsycho.2016.10.004>

Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., Rowe, M. L., & Gabrieli, J. D. E. (2018). Beyond the 30-million-word gap: Children's conversational exposure is associated with language-related brain function. *Psychological Science*, 29(5), 700-710. doi: <https://doi.org/10.1177/0956797617742725>

Romeo, R. R., Segaran, J., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., ... Gabrieli, J. D. E. (2018). Language exposure relates to structural neural connectivity in childhood. *The Journal of Neuroscience*, 38(36), 7870-7877. doi: <https://doi.org/10.1523/JNEUROSCI.0484-18.2018>

Deaf and Hard of Hearing

Benítez-Barrera, C. R., Angley, G. P., & Tharpe, A. M. (2018). Remote microphone system use at home: Impact on caregiver talk. *Journal of Speech, Language, and Hearing Research*, 61(2), 399-409. doi: https://doi.org/10.1044/2017_JSLHR-H-17-0168

Using LENA to understand how conversation affects developing brains

Researchers at MIT and Harvard used LENA technology in two studies investigating how conversational turns relate to brain structure and function. The first study shed light into the underlying neural mechanism that makes conversational turns — the back-and-forth interactions between children and their adult caregivers — so critical for early brain development. The second study investigated how conversational turns relate to white matter connectivity between Broca's area and Wernicke's area, two regions of the brain critical for language.



Increased activation in one area of the brain and increased connectivity between one region and another together suggest that when there's more conversational turns the whole brain works together better.

- Dr. Rachel Romeo, lead author on study



Deaf and Hard of Hearing, cont'd

Rufsvold, R., Wang, Y., Hartman, M. C., Arora, S. B., & Smolen, E. R. (2018). The impact of language input on deaf and hard of hearing preschool children who use listening and spoken language. *American Annals of the Deaf*, 163(1), 35-60.

VanDam, M., Oller, D. K., Ambrose, S. E., Gray, S., Richards, J. A., Xu, D., . . . Moeller, M. P. (2015). Automated vocal analysis of children with hearing loss and their typical and atypical peers. *Ear and Hearing*, 36(4), e146-e152. doi: 10.1097/AUD.000000000000138

Intervention Studies

Ramírez, N. F., Lytle, S. R., Fish, M., & Kuhl, P. K. (2018). Parent coaching at 6 and 10 months improves language outcomes at 14 months: A randomized controlled trial. Advance online publication. *Developmental Science*. doi: <https://doi.org/10.1111/desc.12762>

Suskind, D. L., Leffel, K. R., Graf, E., Hernandez, M. W., Gunderson, E. A., Sapolich, S. G., . . . Levine, S. C. (2015). A parent-directed language intervention for children of low socioeconomic status: A randomized controlled pilot study. *Journal of Child Language*. Advance online publication. doi: 10.1017/S0305000915000033

TV/Electronics

Sosa, A. V. (2016). Association of the type of toy used during play with the quantity and quality of parent-infant communication. *JAMA Pediatrics*, 170(2), 132-137. Advance online publication. doi: 10.1001/jamapediatrics2015.3753

Christakis, D. A., Gilkerson, J., Richards, J. A., Zimmerman, F. J., Garrison, M. M., Xu, D., . . . Yapanel, U. (2009). Audible television and decreased adult words, infant vocalizations, and conversational turns: a population-based study. *Archives of Pediatrics & Adolescent Medicine*, 163(6), 554-558. doi: 10.1001/archpediatrics.2009.61

Zimmerman, F. J., Gilkerson, J., Richards, J. A., Christakis, D. A., Xu, D., Gray, S., & Yapanel, U. (2009). Teaching by listening: The importance of adult-child conversations to language development. *Pediatrics*, 124(1), 342-349. doi:10.1542/peds.2008-2267

Coaching parents on early talk benefits children

A 2018 study from the University of Washington shows that coaching parents on how to talk with their babies positively affects child development.

"We wanted to explore whether parents benefit from 'coaching' by adapting their own speaking style and whether this would affect their child's language outcomes," said Patricia Kuhl, co-director of I-LABS, in a press release.



Using LENA technology, researchers provided parents with feedback on their child's language environment and strategies for increasing interactive talk and "parentese," a form of speech that's slow and clear, with exaggerated vowels and intonation.

Babies whose parents received coaching during the study were significantly more verbal by 14 months of age. Parents in the coaching group increased speech directed at their child and increased their use of parentese by 15 percent, compared to a seven percent increase in the control group.

Preschool

Burgess, S., Audet, L., & Harjusola-Webb, S. (2013). Quantitative and qualitative characteristics of the school and home language environments of preschool-aged children with ASD. *Journal of Communication Disorders*, 46(5-6), 428-439. doi: 10.1016/j.jcomdis.2013.09.003

Degotardi, S., Han, F., & Torr, J. (2018). Infants' experience with 'near and clear' educator talk: Individual variation and its relationship to indicators of quality. *International Journal of Early Years Education*, 26(3), 278-294. doi: 10.1080-09669760.2018.1479632

Irvin, D. W., Hume, K., Boyd, B. A., McBee, M. T., & Odom, S. L. (2013). Child and classroom characteristics associated with the adult language provided to preschoolers with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 7(8), 947-955. doi: 10.1016/j.rasd.2013.04.004

Perry LK, Prince EB, Valtierra AM, Rivero-Fernandez C, Ullery MA, Katz LF, et al. (2018) A year in words: The dynamics and consequences of language experiences in an intervention classroom. *PLoS ONE* 13(7): e0199893. <https://doi.org/10.1371/journal.pone.0199893>

Wiggin, M., Gabbard, S., Thompson, N., Goberis, D., & Yoshinaga-Itano, C. (2012). The school to home link: Summer preschool and parents. *Seminars in Speech and Language*, 33(04), 290-296. doi:10.1055/s-0032-132691910.1097/AUD.0000000000000138

Low Socioeconomic Status Populations

Wood, C., Diehm, E. A., & Callender, M. F. (2016). An investigation of language environment analysis measures for Spanish-English bilingual preschoolers from migrant low-socioeconomic-status backgrounds. *Language, Speech, and Hearing Services in Schools*, 47(2), 123-134. doi: 10.1044/2015_LSHSS-14-0115

Suskind, D. L., Leffel, K. R., Graf, E., Hernandez, M. W., Gunderson, E. A., Sapolich, S. G., . . . Levine, S. C. (2015). A parent-directed language intervention for children of low socioeconomic status: A randomized controlled pilot study. *Journal of Child Language*. Advance online publication. doi: 10.1017/S0305000915000033

See also Wiesleder, A., & Fernald, A. under "Validation in Other Languages"

Conversational turns with teachers are positively related to language skills in children who are at risk

A team of researchers at the University of Miami (UM) used LENA technology to evaluate how interactive talk in child care settings influences the language development of children from low-income or high-risk circumstances.

Over the course of a year, Dr. Lynn Perry collected hundreds of hours of audio from the child language environment at the UM Linda Ray Intervention Center, which LENA technology turned into data.

Analysis of the data suggests that children who experienced more conversational turns with their teachers developed better language skills. These language skills form the foundation for later school readiness skills like literacy and social/emotional skills, Perry said.



The use of cutting-edge LENA recording devices has broadened our data collection options and allowed us to work as a team to both examine language experiences and utilize data to provide feedback to teachers upon which to build their strategies for infants and toddlers with developmental delays.



- Lynne Katz, director of UM Linda Ray Intervention Center

Linking Early Measures to Outcomes

Ambrose, S. E., VanDam, M., & Moeller, M. P. (2014). Linguistic input, electronic media, and communication outcomes of toddlers with hearing loss. *Ear and Hearing*, 35(2), 139-147. doi: 10.1097/AUD.0b013e3182a76768

Caskey, M., Stephens, B., Tucker, R., & Vohr, B. (2014). Adult talk in the NICU with preterm infants and developmental outcomes. *Pediatrics*, 133(3), 1-7. doi: 10.1542/peds.2013-0104

Gilkerson, J., Richards, J. A., Warren, S. F., Oller, D. K., Russo, R., & Vohr, B. (2018). Language experience in the second year of life and language outcomes in late childhood. *Pediatrics*, 142(4). doi: 10.1542/peds.2017-4276

Research Focusing on Adults

Li, L., Vikani, A. R., Harris, G. C., & Lin, F. R. (2014). Feasibility study to quantify the auditory and social environment of older adults using a Digital Language Processor. *Otology & Neurotology*, 35(8), 1301-1305. doi: 10.1097/MAO.0000000000000489

Wang, Z., Pan, X., Miller, K. F., & Cortina, K. S. (2014). Automatic classification of activities in classroom discourse. *Computers & Education*, 78, 115-123. doi: 10.1016/j.compedu.2014.05.010

Wang, Z., Miller, K., & Cortina, K. (2013). Using the LENA in teacher training: Promoting student involvement through automated feedback. *Unterrichtswissenschaft*, 41(4), 290-305.

Autism Spectrum Disorder

Dykstra, J., Sabatos-DeVito, M. G., Irvin, D. W., Boyd, B. A., Hume, K. A., & Odom, S. L. (2012). Using the Language Environment Analysis (LENA) system in preschool classrooms with children with autism spectrum disorders. *Autism*, 17(6), 582-594. doi: 10.1177/1362361312446206

Oller, D. K., Niyogi, P., Gray, S., Richards, J. A., Gilkerson, J., Xu, D., . . . Warren, S. F. (2010). Automated vocal analysis of naturalistic recordings from children with autism, language delay, and typical development. *Proceedings of the National Academy of Sciences*, 107(30), 13354-13359. doi:10.1073/pnas.1003882107

Researchers use LENA to study how the auditory environment shapes infant cognition



At the University of Oregon, Dr. Caitlin Fausey leads a team of researchers investigating how the everyday experiences of young children shape their development. The team is using LENA technology to understand what auditory information young children experience on a daily basis. They're particularly interested in identifying musical moments that occur in infants' lives on a daily basis.



Knowing more about the everyday soundscape — and how it changes over the first few years of life — will help us understand how children build knowledge about the people, objects, and actions of our world.

- Dr. Caitlin Fausey



Autism Spectrum Disorder, cont'd

Warren, S. F., Gilkerson, J., Richards, J. A., Oller, D. K., Xu, D., Yapanel, U., & Gray, S. (2010). What automated vocal analysis reveals about the vocal production and language learning environment of young children with autism. *Journal of Autism and Developmental Disorders*, 40(5), 555-569. doi:10.1007/s10803-009-0902-5

Neonatal Intensive Care Unit

Caskey, M., & Vohr, B. (2013). Assessing language and language environment of high risk infants and children: A new approach. *Acta Paediatrica*, 102(03), 1-11. doi: 10.1111/apa.12195

Caskey, M., Stephens, B., Tucker, R., & Vohr, B. (2011). Importance of parent talk on the development of preterm infant vocalizations. *Pediatrics*. Online publication. doi:10.1542/peds.2011-0609

Pineda, R., Durant, P., Mathur, A., Inder, T., Wallendorf, M., & Schlaggar, B. L. (2017). Auditory Exposure in the Neonatal Intensive Care Unit: Room Type and Other Predictors. *The Journal of pediatrics*, 183, 56-66.e3.

Validation in Other Languages

Canault, M., Le Normand, M. T., Foudil, S., Loundon, N., & Thai-Van, H. (2015). Reliability of the Language ENvironment Analysis system (LENA™) in European French. *Behavior Research Methods*. Advance online publication. doi: 10.3758/s13428-015-0634-8

Gilkerson, J., Zhang, Y., Xu, D., Richards, J. A., Xu, X., Jiang, F., . . . Topping, K. (2015). Evaluating LENA System performance for Chinese: A pilot study in Shanghai. *Journal of Speech, Language, and Hearing Research*, 58(2), 445-452. doi: 10.1044/2015_JSLHR-L-14-0014

Schwarz, I.-C., Botros, N., Lord, A., Marcusson, A., Tideli, H., & Marklund, E. (2017). The LENA system applied to Swedish: Reliability of the Adult Word Count estimate. *Proceedings Interspeech 2017*, 2088-2092. doi:10.21437/Interspeech.2017-1287

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, 24(11), 2143-2152. doi: 10.1177/0956797613488145

LENA technology helps to evaluate effectiveness of NICU intervention program

Researchers at Teachers College, Columbia University are using LENA to evaluate the outcomes of a program designed to foster connections between babies born prematurely and their parents.



When a baby is born prematurely and needs to be cared for by medical staff in the neonatal intensive care unit (NICU), the family may experience emotional trauma from separation. Premature birth can put children at risk for behavioral problems, learning difficulties, communication problems, and autism spectrum disorders.

To prevent these long-term challenges, Family Nurture Intervention (FNI) teaches parents strategies for creating an emotional connection with their child. The research team is using LENA technology as a tool to capture data for a broader study that will evaluate the effectiveness of the FNI.