LENA Pro

LENA Research Foundation
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Boulder, CO 80301-2820

The LENA Research Foundation is a not-for-profit 501(c)(3) charitable organization.

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LENA™ Pro

Advanced technology to accelerate language development of children 0–5 and for research and treatment of language delays and disorders.

LENA™
RESEARCH FOUNDATION

The LENA Research Foundation is a not-for-profit 501(c)(3) charitable organization.

Contents

"LENA has the potential to radically transform child education and parenting, and is also providing a pioneering and invaluable technological breakthrough in the understanding of children's intellectual development."

~ Frank J. Sulloway, Ph.D.,

Institute of Personality and Social Research, University of California, Berkeley;
MacArthur Fellow; and author of Born to Rebel: Birth Order, Family Dynamics, and Creative Lives

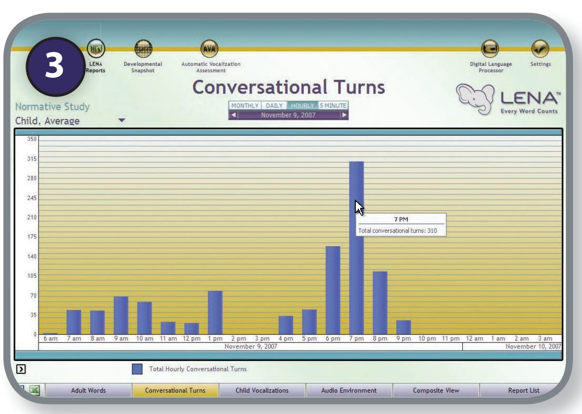
LENA Pro

The most advanced product in the LENA System portfolio, LENA Pro enables researchers, speech-language pathologists (SLPs), audiologists, and pediatricians to collect, manage, and analyze multiple recordings of children ages 2 months to 48 months. LENA Pro reports offer count and percentile data on speech-language measurements, such as estimates of adult words spoken to and around the key child (i.e., the child wearing the LENA Digital Language Processor — DLP), adult-child conversational interactions, and child vocalizations. The system also segments and labels audio waveforms and conducts advanced analyses when used with the LENA Advanced Data Extractor (ADEX).

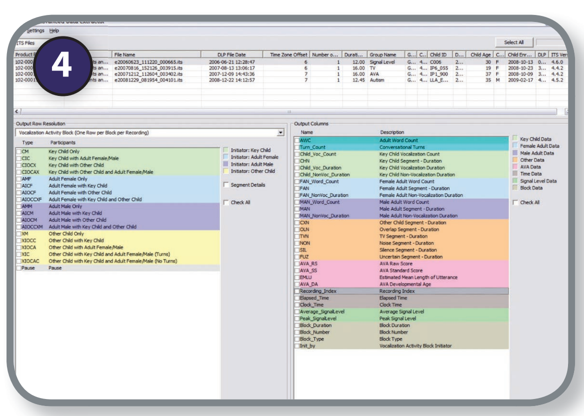
How It Works

Turn on the DLP and place it in the pocket of the child's LENA clothing.

After completing recording, plug the DLP into a PC running LENA Pro. The sophisticated language environment analysis software automatically uploads and processes the audio file.



The software generates the LENA reports and other analyses.



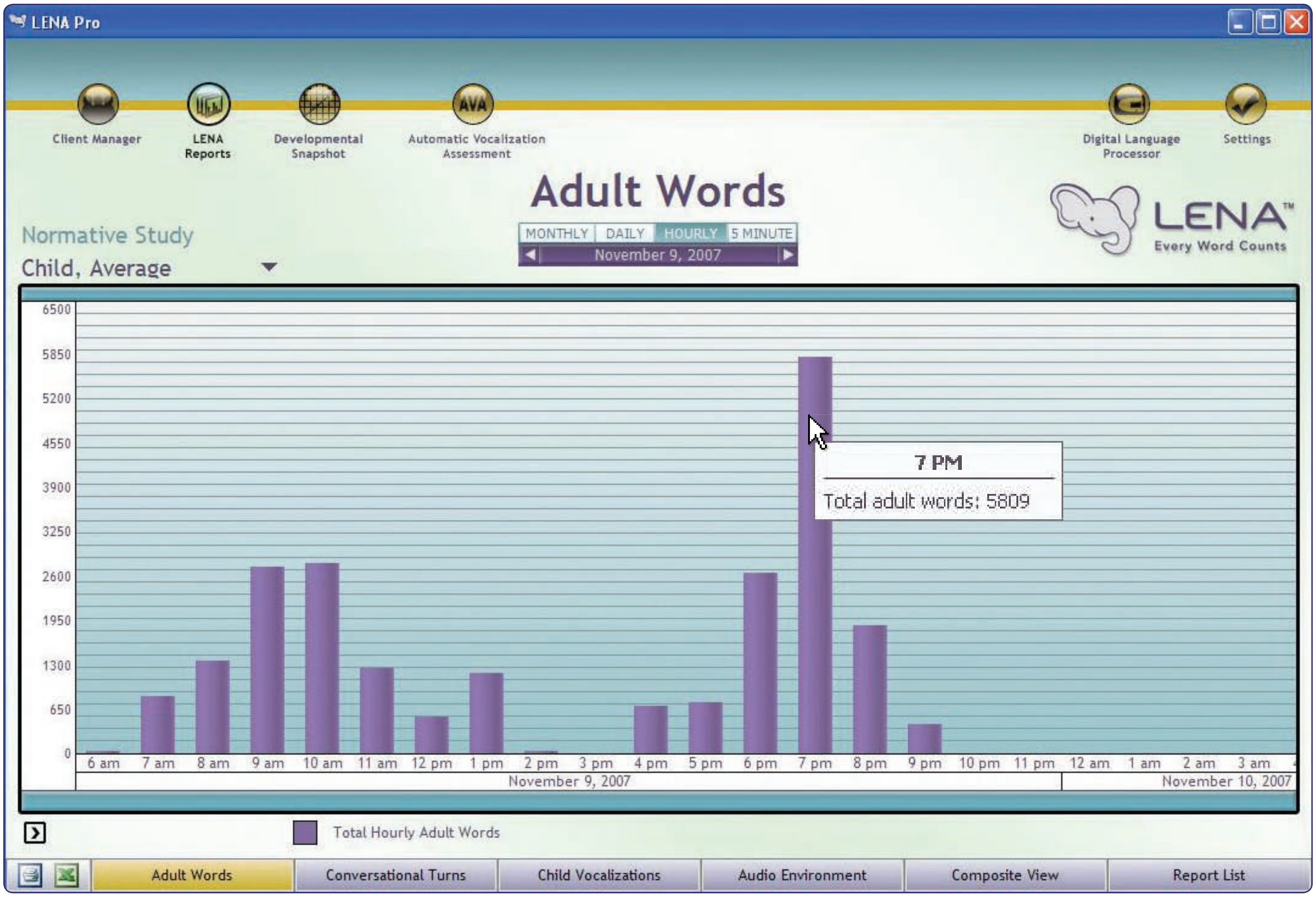
Export data from LENA Pro to mine your LENA data and perform custom in-depth analyses.

Core Reports

The LENA Pro system generates four primary reports plus a composite report that can be viewed in monthly, daily, hourly, and five-minute timeframes. The system provides percentile rankings for recordings of 10 hours or longer. The software does not count speech when speakers are indistinguishable, such as overlapping adult and child speech.

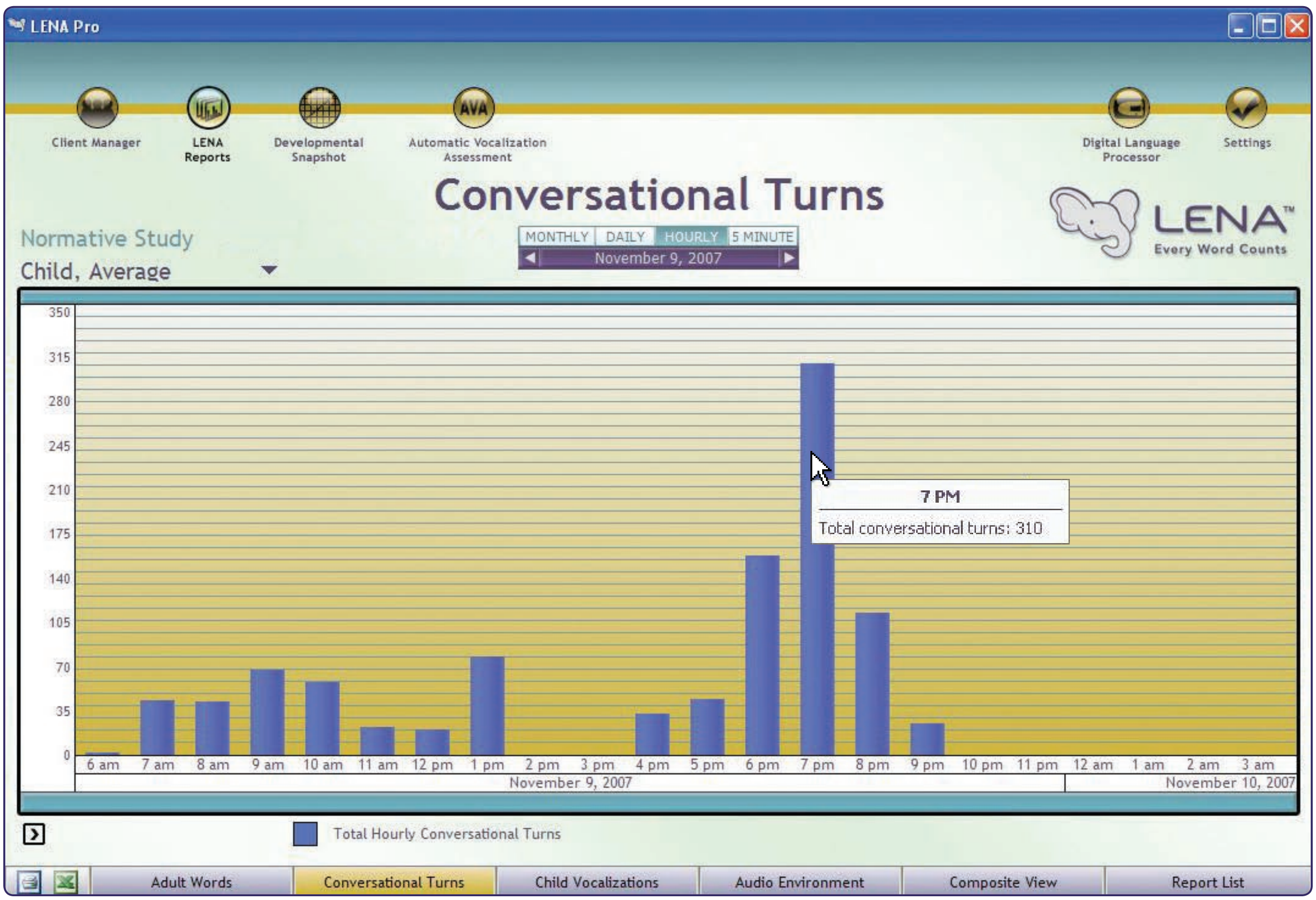
1 Adult Words Report

The Adult Words report provides estimates of the number of adult words spoken to and near the key child; this number is also referred to as the adult word count (AWC).



2 Conversational Turns Report

The Conversational Turns report estimates the number of adult-child conversational interactions, referred to as the conversational turn count (CTC). A conversational turn is defined as a vocal sound initiated by the key child or an adult to which the other responds within five seconds; vocal sounds include coos, squeals, babbles, and words.



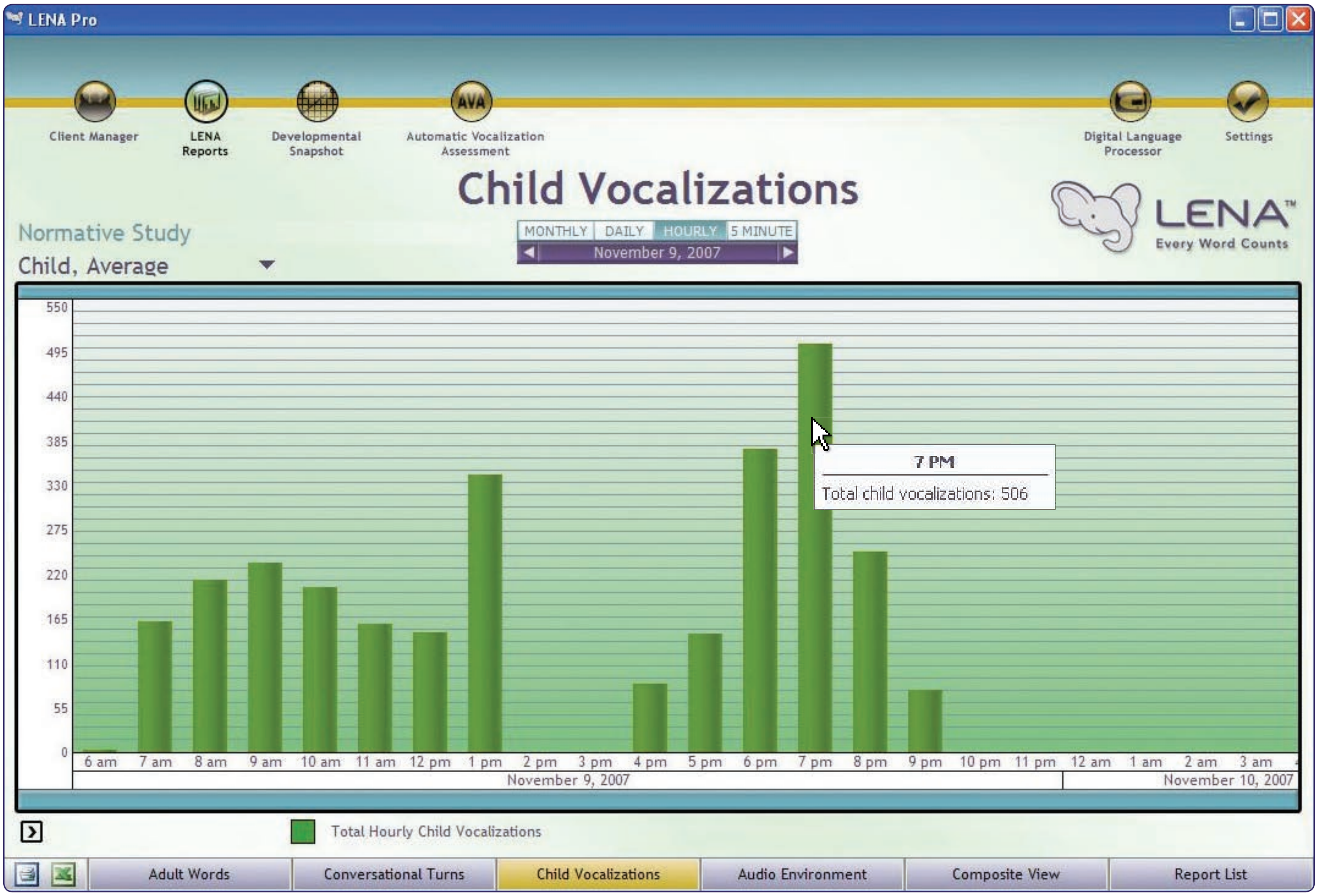
"LENA Pro's beauty lies in its intrinsic ability to stimulate incisive hypotheses on vital issues, such as the link between socioeconomic inequity and knowledge gaps in early childhood. These inquiries could lead to a 'leveling of the playing field' for historically disadvantaged segments of society."

~ Dana Suskind, M.D.,

Associate Professor of Surgery and Pediatrics, Director of the Pediatric Cochlear Implantation Program, Comer Children's Hospital at the University of Chicago

3 Child Vocalizations Report

The Child Vocalizations report estimates the number of key child vocalizations, also referred to as the child vocalization count (CVC). A child vocalization is defined as key child speech (e.g., coos, squeals, babbles, and words) surrounded by a vocal break or pause of longer than 300 milliseconds. The software separates out speech-related sounds from coughs, cries, and other vegetative sounds and fixed signals.

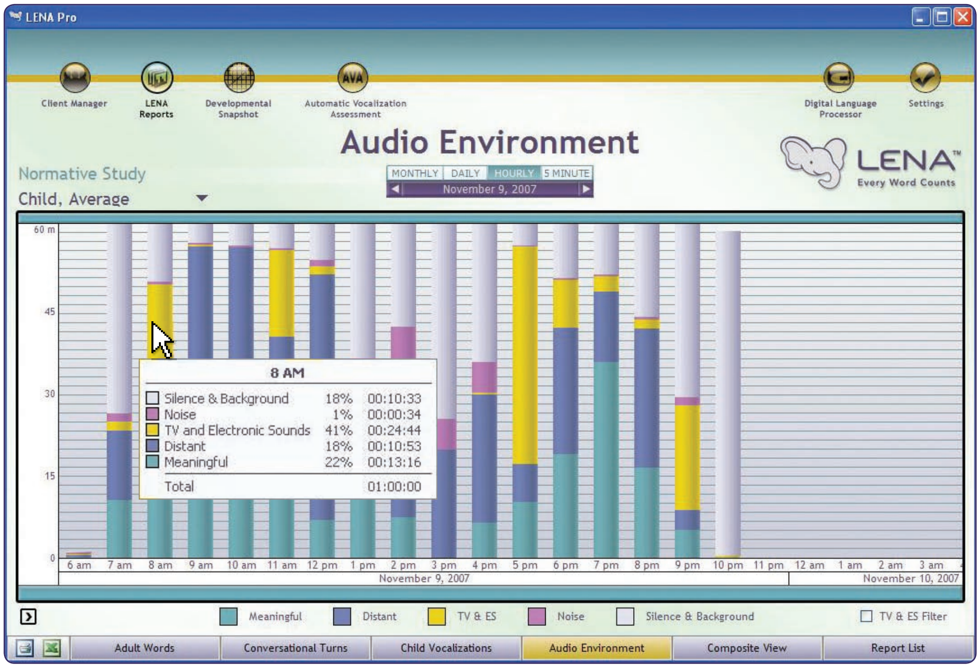


"People today cannot live without their cell phones or iPods. The LENA unit will be the indispensable tool for the speech scientist or speech-language pathologist working with children/infants."

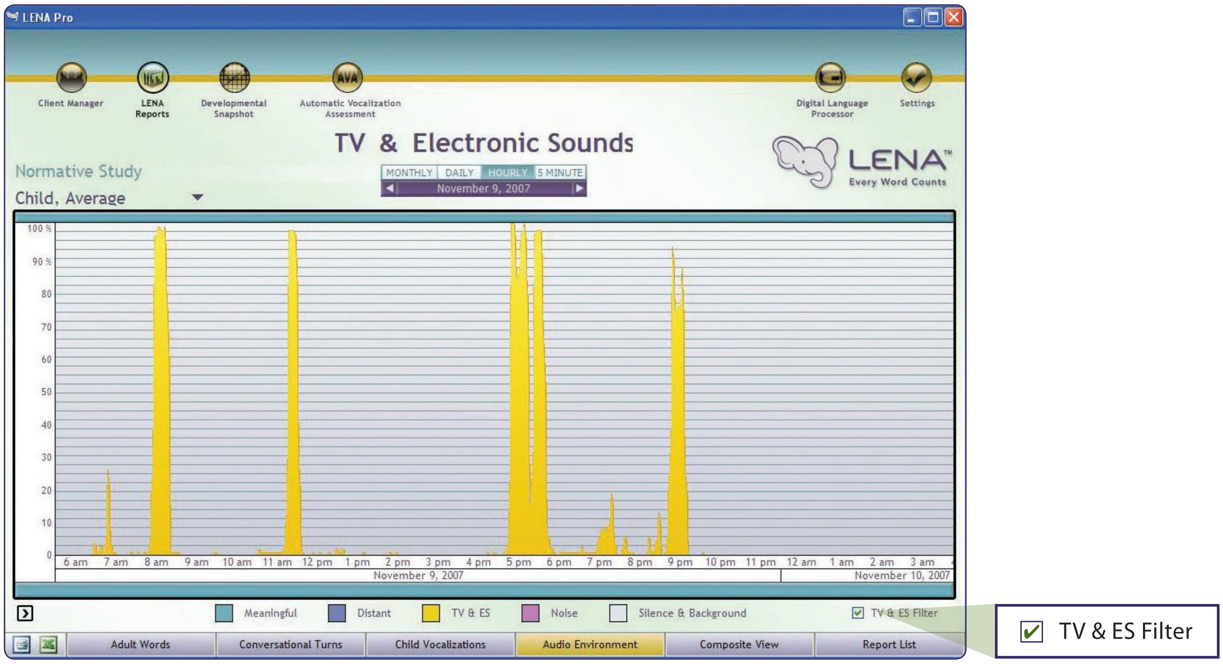
~ John H. L. Hansen, Ph.D.,
Department Chair and Professor, Department of Electrical Engineering, Erik Jonsson School of Engineering and Computer Science, University of Texas at Dallas

4 Audio Environment Report

The Audio Environment report displays the mix of audio components in the key child's environment, including Meaningful speech (i.e., close and clear vocalizations), Distant and Overlapping speech, TV and ES (electronic sounds), Noise, and Silence and Background noise. Moving the cursor over a data bar brings up a window detailing the percentage and time values of each audio component.

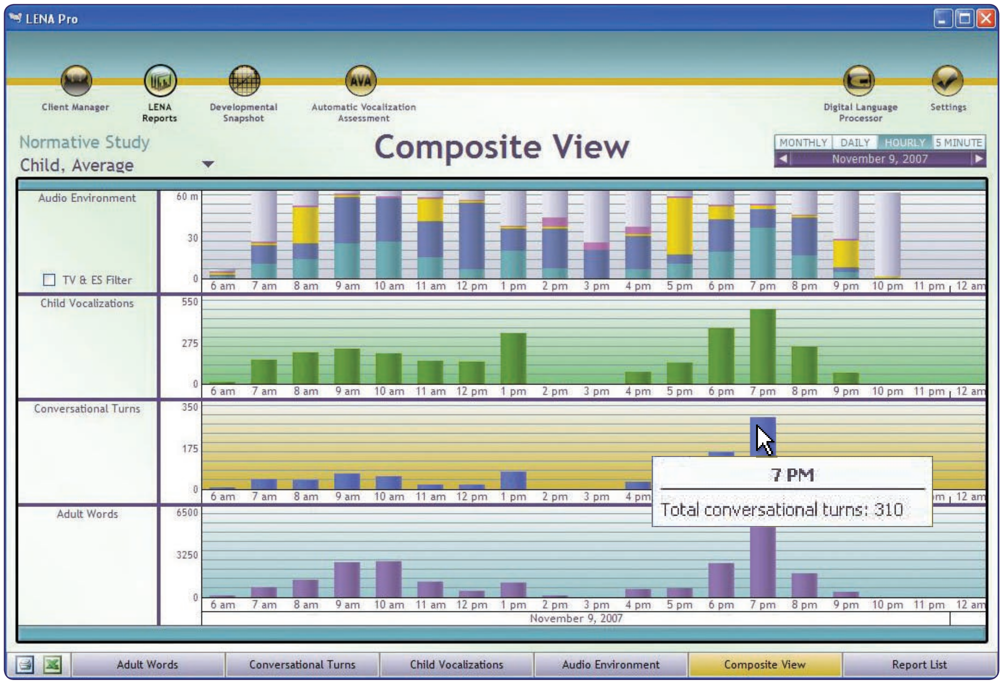


Clicking on the TV Filter box in the lower right-hand corner of the Audio Environment report displays the TV and ES component of the audio file. The filter shows how often television and electronic sounds were dominant in the key child's audio environment and at what times of the day.

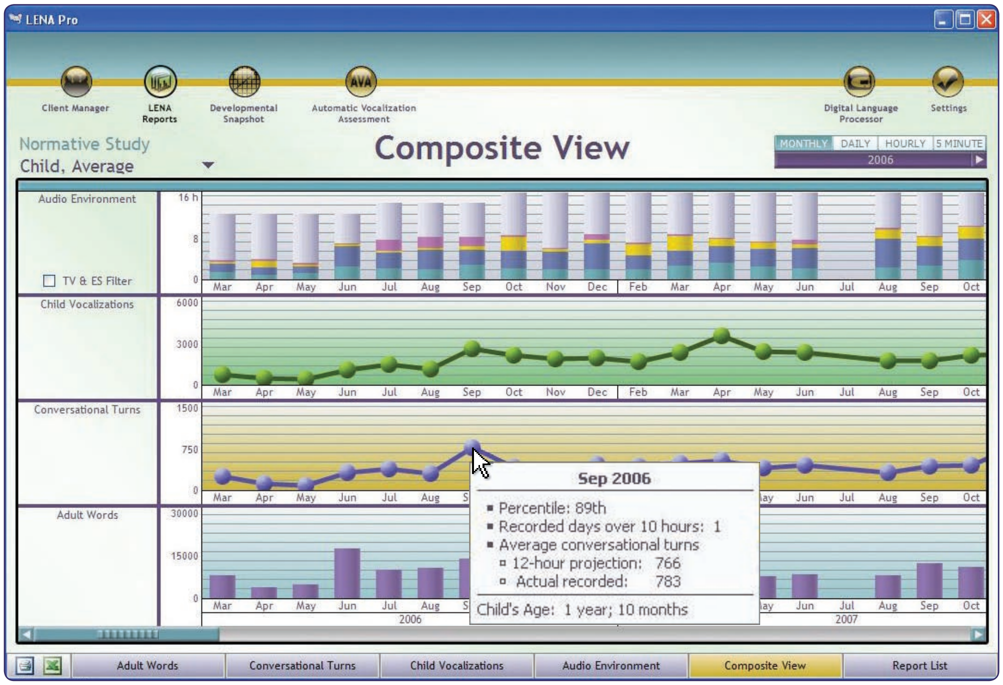


Composite View

The Composite View report offers a comprehensive look at the key child's language and audio environment. The report aligns the Audio Environment, Child Vocalizations, Conversational Turns, and Adult Words estimates on the same time axis, facilitating comparison across categories. Note the high number of conversational turns during the 7 p.m. hour when TV/electronic media (yellow) is relatively low.

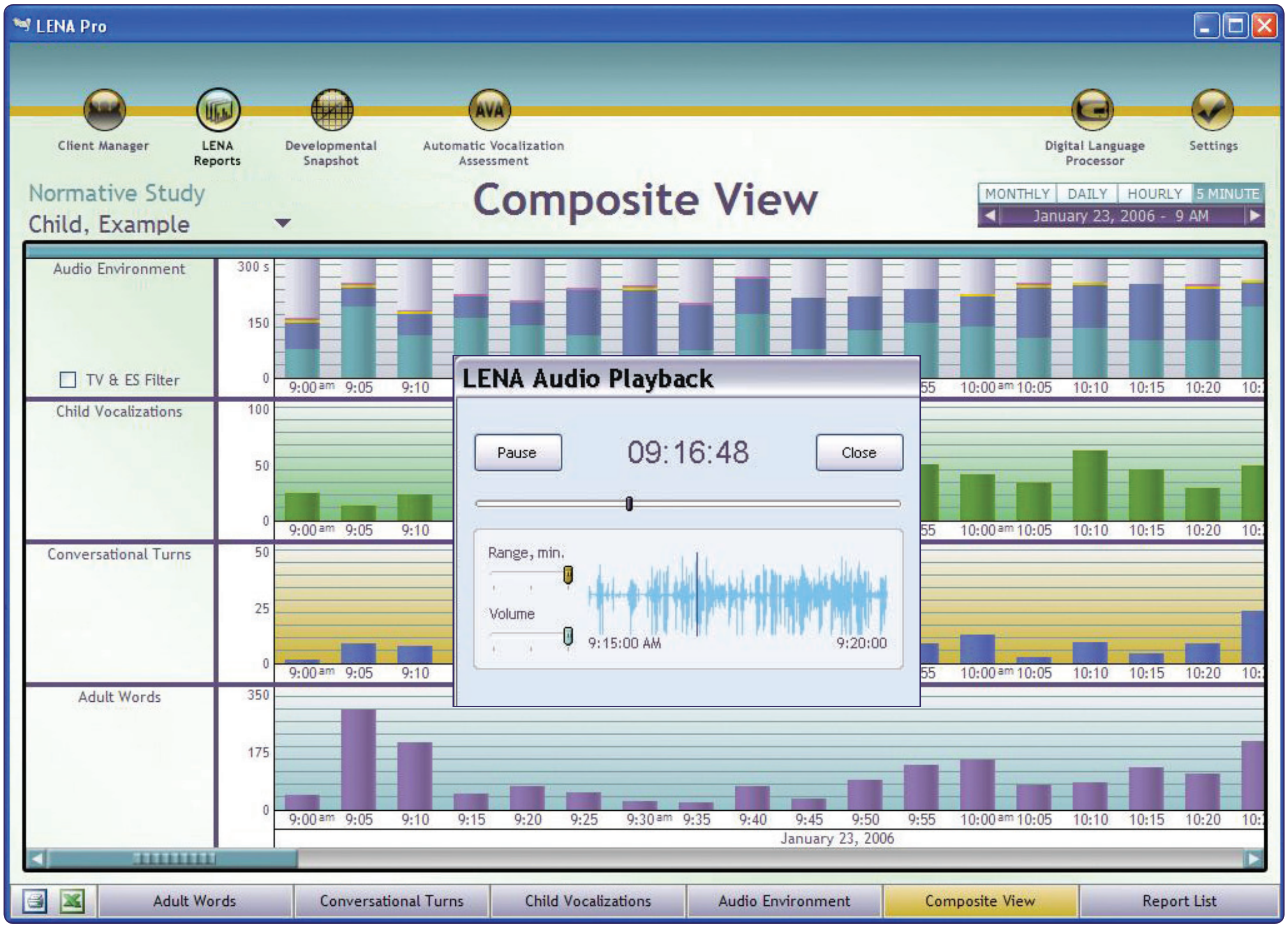


View data from the birds-eye monthly view, below, all the way down to the five-minute view (next page).



Listen to Audio

The LENA Pro software allows you to listen to the high-quality audio recordings. By drilling down to the five-minute view you can easily locate specific areas containing speech activity. Simply right-click on a bar of interest to view the audio waveform and to listen to the five-minute segment.



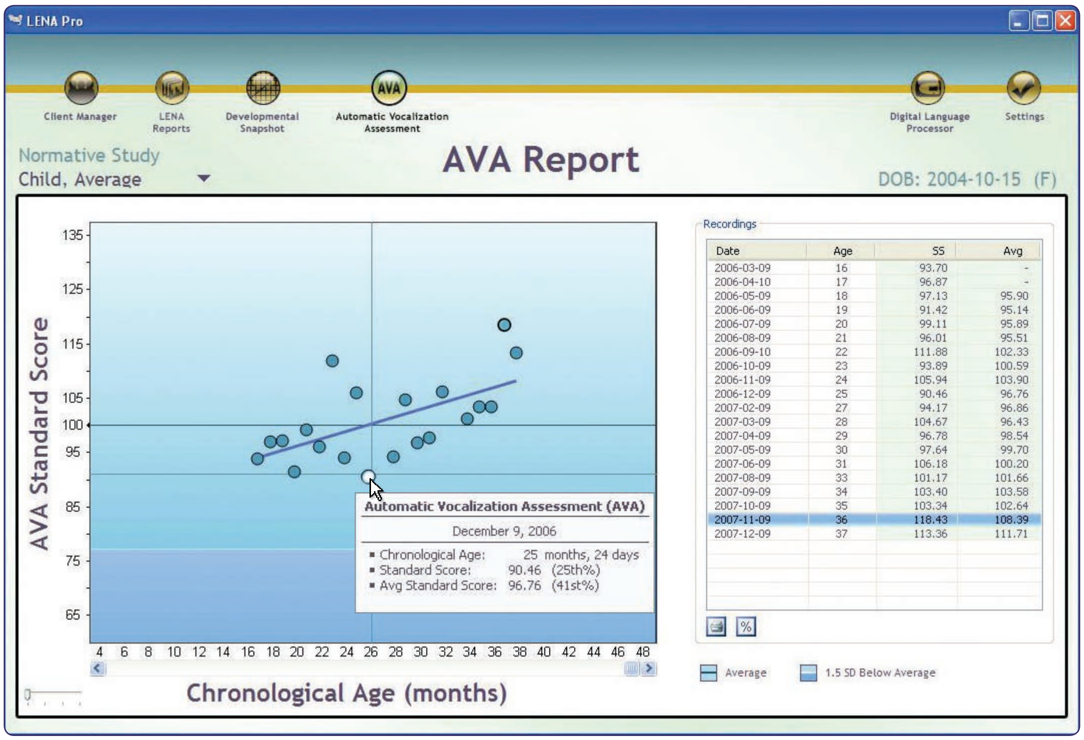
"Language delays are common among preterm infants and infants with permanent hearing loss. LENA provides a novel and easy-to-implement method for assessing language in a number of environments. We are using the technology to examine the early vocalizations and language development of these two high-risk populations."

~ Betty Vohr, M.D.,
Medical Director, Neonatal Follow-Up Program at Women and Infants Hospital, Providence, RI;
Professor of Pediatrics, Warren Alpert Medical School, Brown University

Automatic Vocalization Assessment (AVA)™

AVA automatically analyzes child vocal output to assess vocalization production on a given day.

AVA uses LENA Pro algorithms to isolate key child vocalizations from audio data collected in a child's language environment. By analyzing the distribution of biphones, pairs of linguistic features similar to phonemes, AVA can provide information about the complexity of vocal sound distribution each day, generating a standard score with reliability and validity comparable to those of typical clinical assessments of expressive language skills.



Observed Expressive Language Standard Score and Developmental Age Test-Retest Reliability over Two Months in Children Ages 2 Months to 48 Months

		PEARSON CORRELATION[a]		MEAN DIFFERENCE	
MEASURE	N	STANDARD SCORE	DEVELOPMENTAL AGE	SS MEAN	SS SD
AVA	**318**	**0.65**	**0.98**	**0.34**	**7.9**
PLS-4	218	0.62	0.95	2.00	13.0
REEL-3	188	0.73	0.92	0.85	4.3

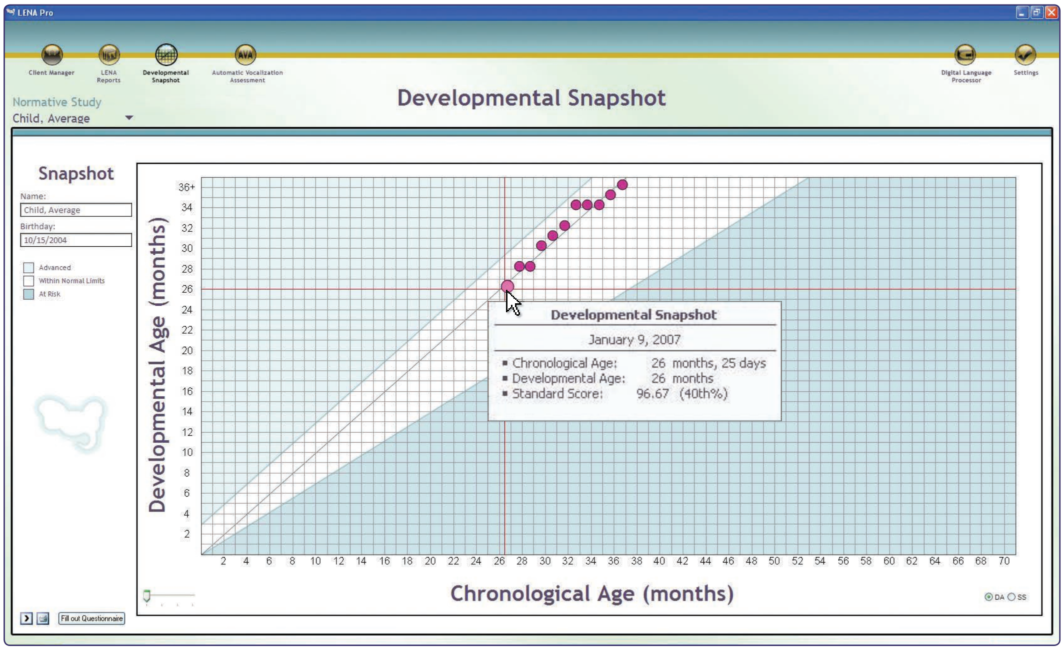
[a]All p< .01.

"There is a potential that this [LENA Automatic Vocalization Assessment (AVA)] score can help us validate that the child has access to the full frequency range of spoken speech. It is an exciting application that with time will become a powerful tool for our population of children who are deaf or hard of hearing."

~ Christine Yoshinaga-Itano, Ph.D., CED, CCC-Aud,
Professor, Department of Speech, Language, and Hearing Sciences, University of Colorado at Boulder

LENA Developmental Snapshot™

An integral component of LENA Pro, the LENA Developmental Snapshot is an assessment of expressive and receptive language skills that gauges language development based on parent responses to a 52-item questionnaire. The Developmental Snapshot automatically generates a standard score and an estimated developmental age, ranging from 2 months to 36 months.



The accuracy of the Developmental Snapshot was tested by comparing the assessment's developmental age estimates with those of commonly used standardized assessments. Results showed that the Developmental Snapshot correlates highly with widely used standardized assessments (including both parent questionnaires and observational SLP-administered assessments (Pearson's $r = .93$, $p < .001$).

LENA Developmental Snapshot Age Correlates Well with Developmental Age from Standard Language Assessments

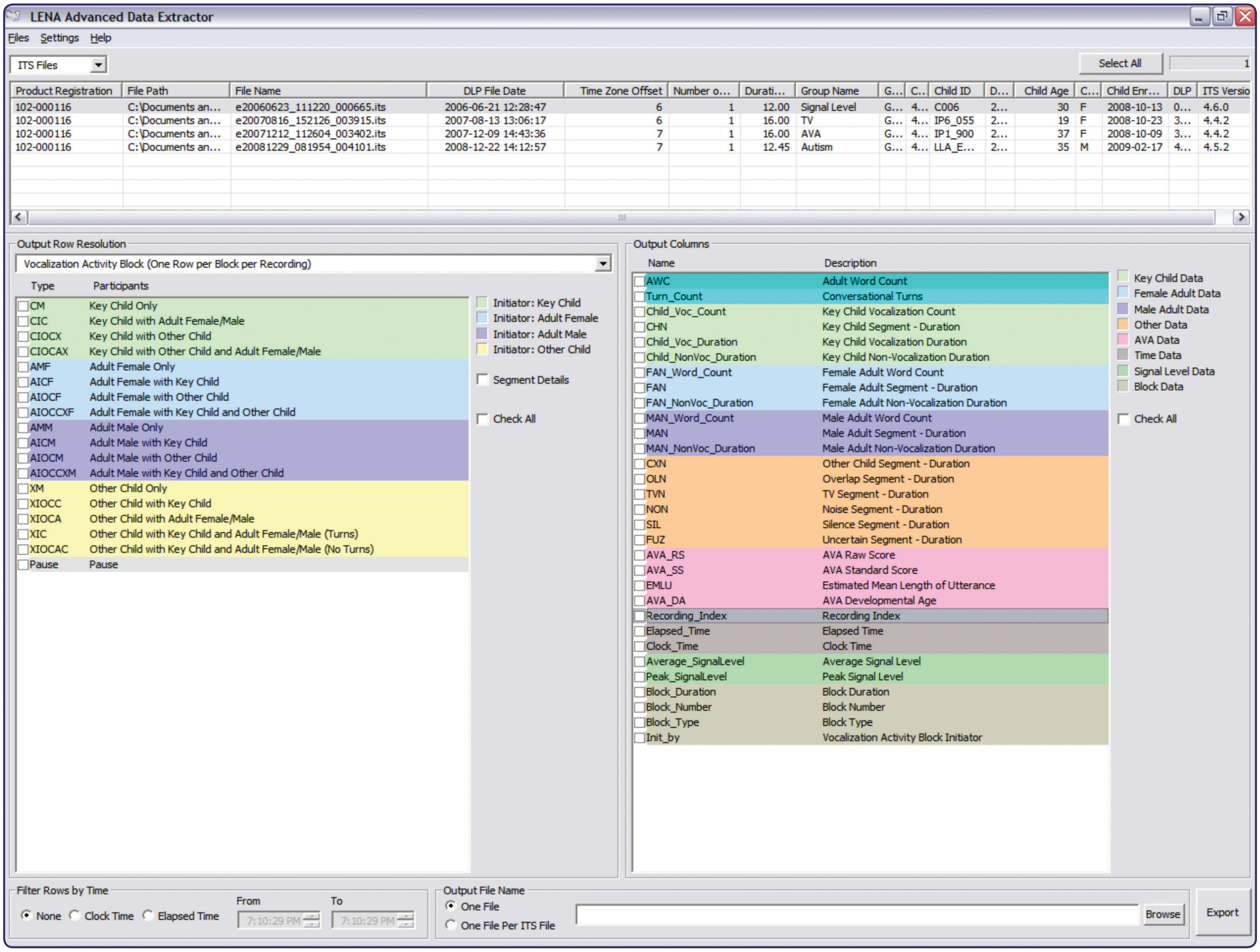
STANDARD ASSESSMENT	N	PEARSON CORRELATION[a]
PLS-4 Receptive Language	51	.93
PLS-4 Expressive Language	51	.92
REEL-3 Receptive Language	75	.96
REEL-3 Expressive Language	75	.96
CDI Receptive Language	143	.84
CDI Expressive Language	142	.81
CLAMS	52	.97
CAT	52	.95
OVERALL AVERAGE		.93

[a]All correlations are significant at the .01 level (2-tailed).

LENA Advanced Data Extractor (ADEX)

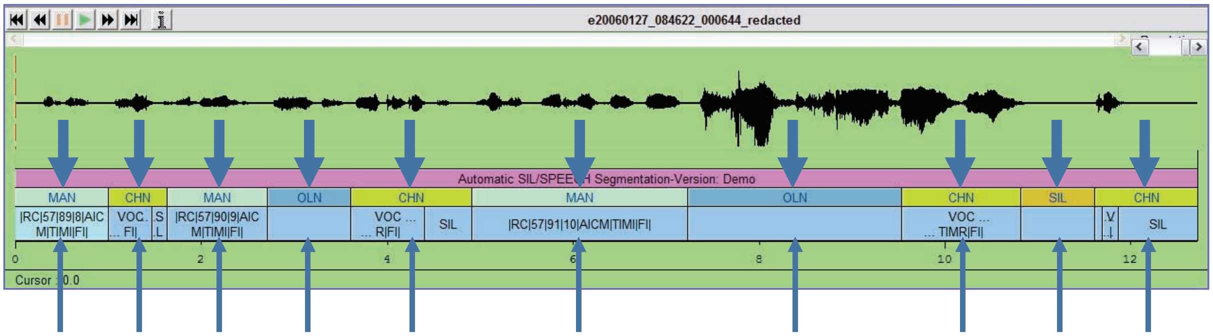
ADEX enables in-depth analysis of data processed by the LENA Pro system.

ADEX allows users to explore LENA Pro information beyond the core-report categories (i.e., adult words, conversational turns, and child vocalizations) and to create data samples based on additional variables and specific types of interactions or time intervals. For example, ADEX users can analyze male and female adult speech separately on both vocalization frequency and duration or determine how many times a key child initiated an interaction with an adult (or vice versa) or calculate the number of adult words spoken from 4 p.m. to 6 p.m. The resolution of the export dataset ranges anywhere from segments only 600 milliseconds in duration all the way up to an entire 16-hour recording, and the convenient comma-delimited (.csv) plain text output file can be accessed directly using a variety of applications (e.g., Microsoft Excel, Notepad, SAS, and SPSS).



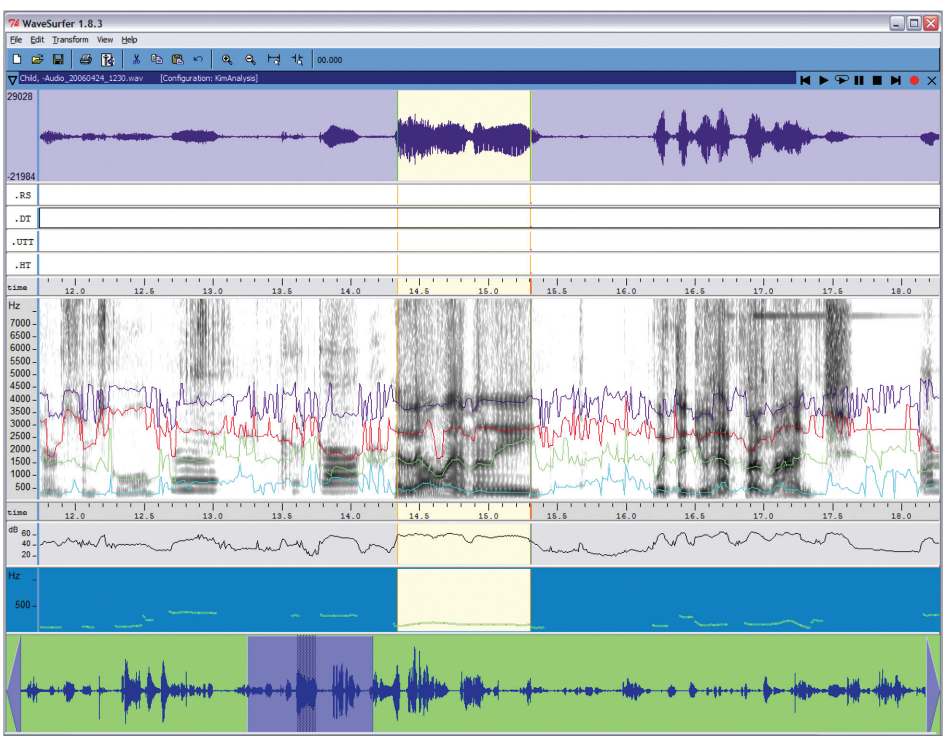
Export High-Quality Audio for Transcription and Analysis

Export a high-quality .wav file of your LENA recording to perform conversational, morphological, or even articulation analyses. LENA Pro labels the audio file with information such as who is speaking, for how long, at what dB SPL level, and more. When used in conjunction with open-source Transcriber software (below) you can see the waveform, the segments (e.g., male adult, key child, overlap, and silence), the segment durations, and specific segments of the child's output automatically coded as speech-related ("VOC") utterances.



MAN Male Adult Near & Clear (3)
CHN Key Child Near & Clear (4)
OLN Overlap Near & Strong (2)
SIL Silence (1)

The .wav file can be exported and analyzed by any phonetic software analysis tool compatible with .wav format. For example, the LENA audio viewed through WaveSurfer below can be analyzed in detail at the spectrographic level.

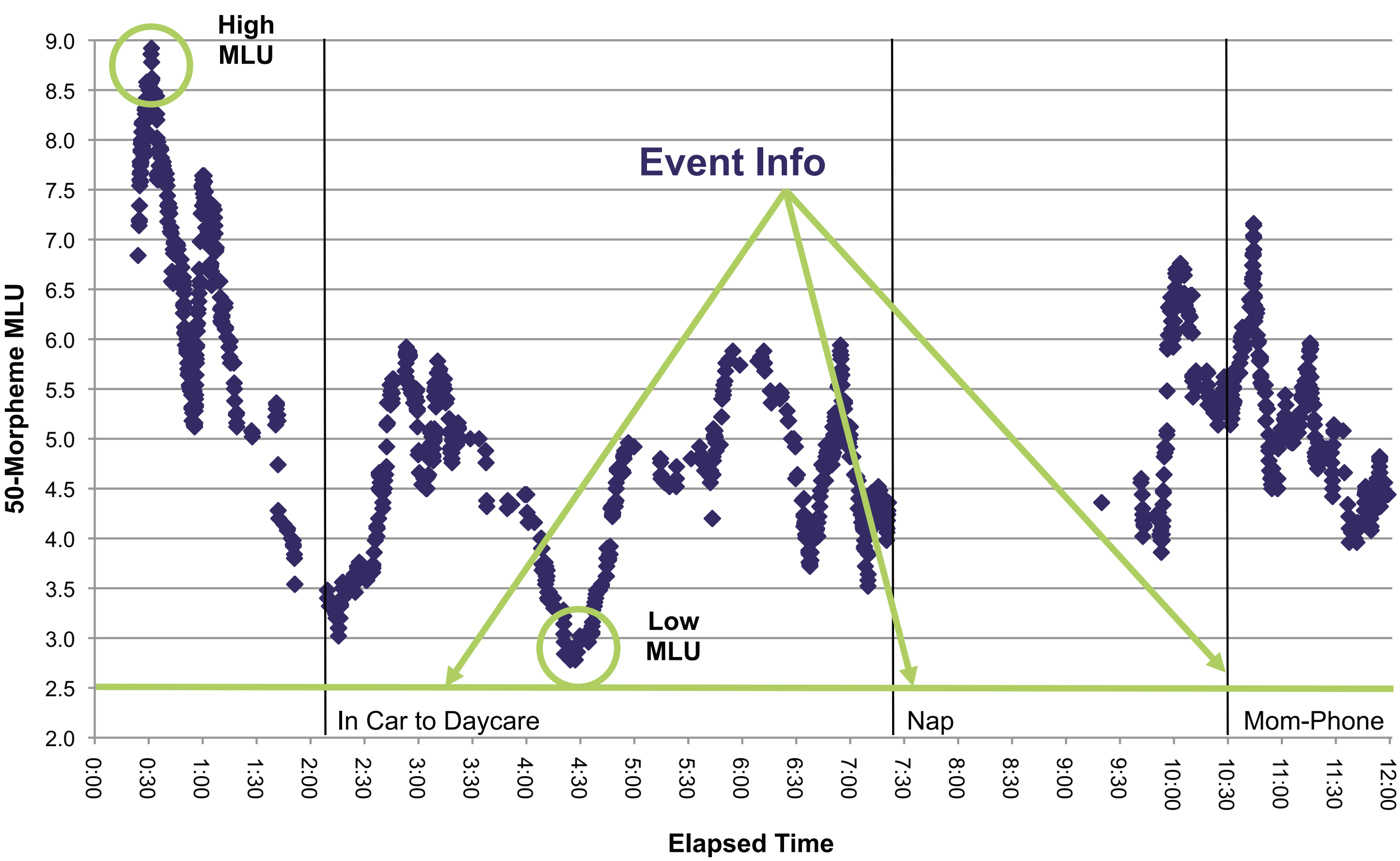


Research Application Examples

As a researcher, you have many questions to answer while attempting to keep your approach as efficient and cost-effective as possible. Simply put, LENA allows you to gather a lot of data in a short amount of time, freeing you up for more in-depth analyses. Below are just a few examples of how LENA Pro has been used to answer some interesting research questions.

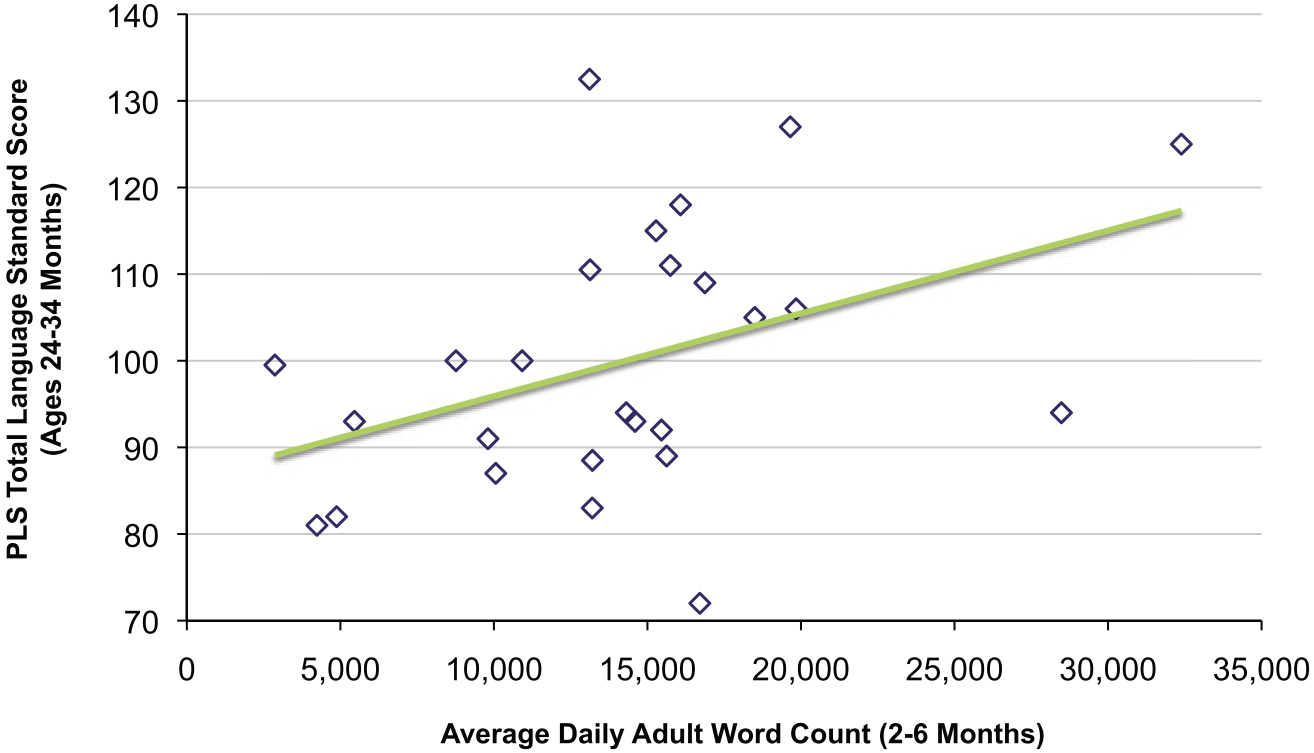
Variation in a Child's MLU Throughout the Day

Have you ever wondered how much a child's MLU, Mean Length of Utterance, can fluctuate throughout the day? To find out, we transcribed a 12-hour file for a 31-month-old girl. Based on previous research, we would expect an MLU of around 2.5 for a 2½-year-old. The X-axis in this plot shows the elapsed time in the file (i.e., 0:00 is when the recorder was turned on first thing in the morning, around 6:30 a.m., and 12:00 is 12 hours later, around 6:30 p.m.). The Y-axis shows MLU calculated over 50 utterances: 1–50, 2–51, etc. The child's MLU peaks within the first ½ hour of the recording, up to nearly 9, and, other than nap time, it's at its lowest (around 2.75) while she's at preschool, showing that even her lowest MLU was higher than the expected 2.5.



Early Parent Talk Predicts Later Language Ability

In a sample of 27 children, the LENA Research Foundation examined the power of adult talk during the first six months of life to predict later language ability. Average adult word counts from recordings completed when each child was between two months to six months of age were compared to average PLS-4 Total Language standard scores from evaluations completed when the children were approximately two years old. As this figure demonstrates, the more adult talk children were exposed to during the first six months of life, the higher their language ability scores were at two years of age. A similar pattern was observed for conversational turns. These results reinforce the importance of adult talk during the first few months to a child's overall language development.



"This technology is truly like opening a window into the home — a natural view into the child's language in his or her own environment."

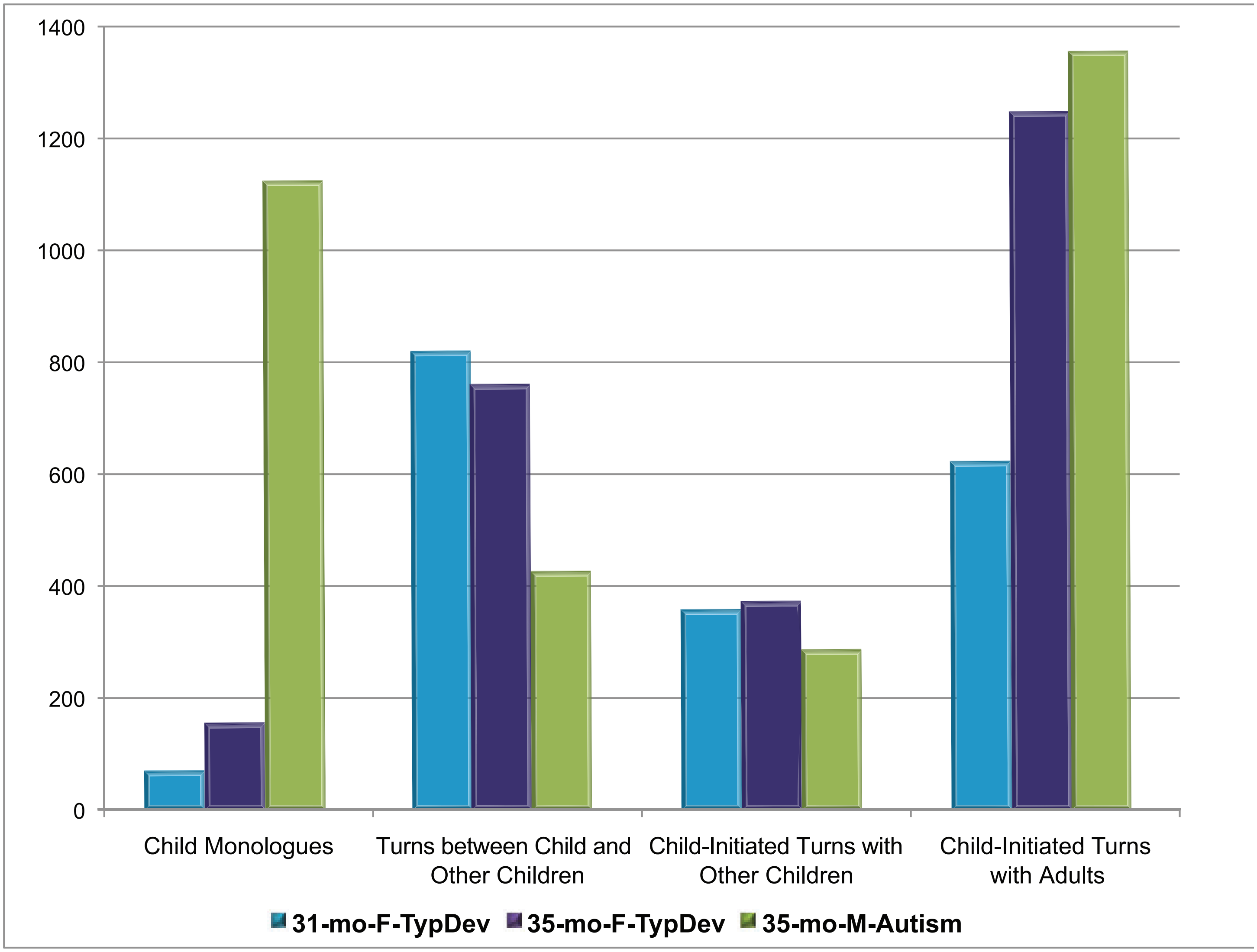
~ D. Kimbrough Oller, Ph.D.,

Professor and Plough Chair of Excellence at the School of Audiology and Speech-Language Pathology, University of Memphis; ASHA Fellow

Research Application Examples (cont.)

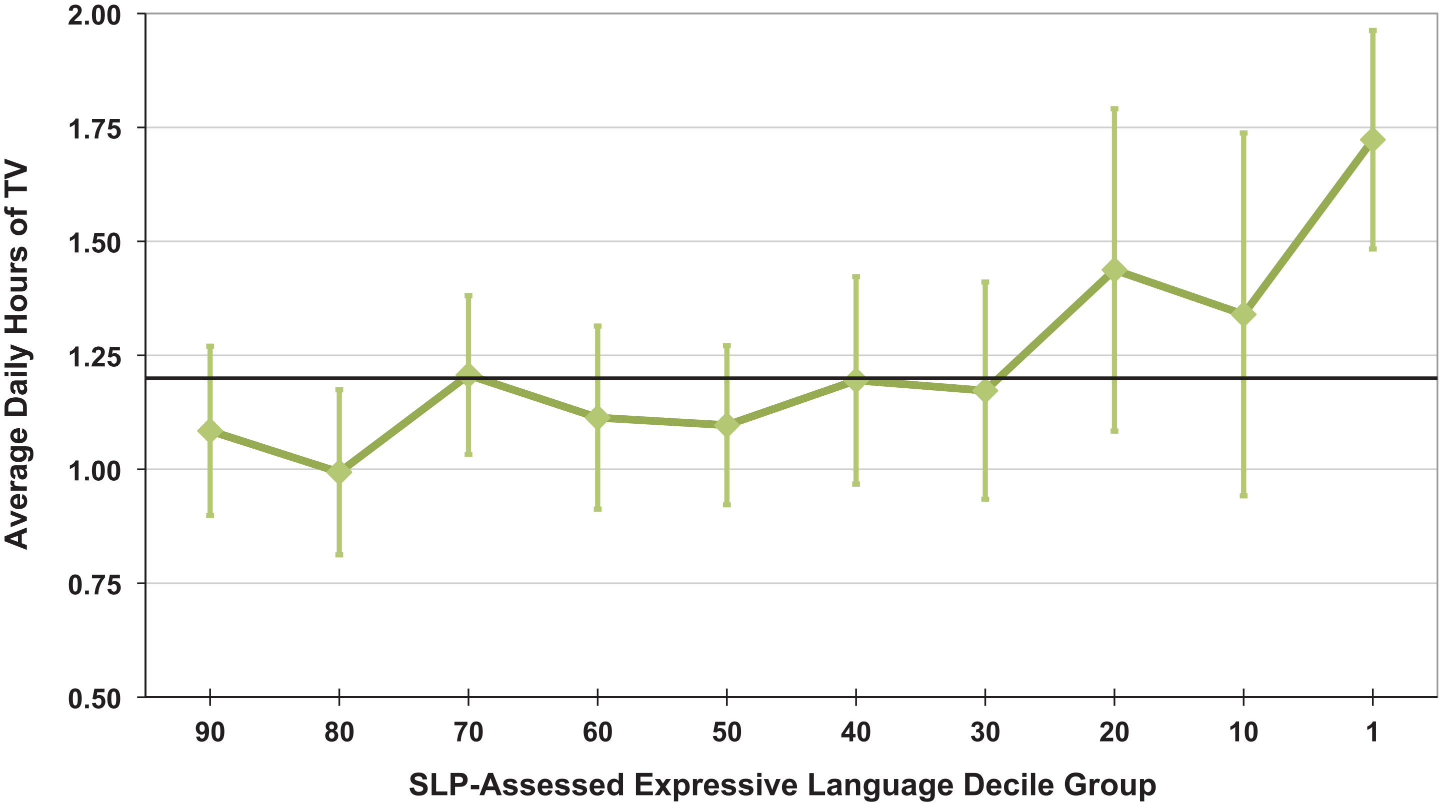
Comparing Children's Conversational Interactions

Here we compared LENA data for three children: two typically developing children and one child with Autism Spectrum Disorder. We found that the child with autism exhibited more child monologues than the two typically developing children, and he also initiated the most turns with adults. By contrast, the typically developing children engaged in and initiated more conversations with other children.



Language Ability Decreases With An Increase In TV Exposure

Researchers who are experts on the relationship between television and child development, Zimmerman and Christakis, conducted independent analyses of the impact of television time on parent-child interactions using data from the LENA Natural Language Study. They confirmed the negative impact of TV, importantly discovering that adult-child conversations (i.e., Conversational Turns) are a crucial aspect of a child's language learning environment, even more powerful than the quantity of adult words. In addition, they showed that at least one measurable effect television viewing may have is to reduce the number of such parent-child interactions.



"The LENA System is to speech and language what the MRI is to medicine. We clinicians know what we hear in the office, but until now we have never been able to indirectly experience language and conversation at home."

~ Judy Montgomery, Ph.D., CCC-SLP,

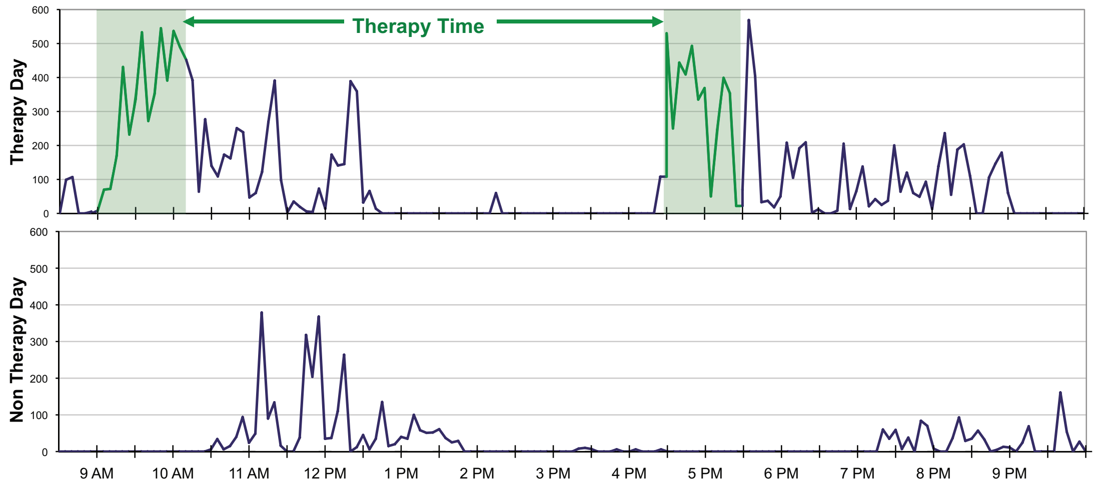
Professor of Special Education and Literacy, Chapman University; former President of ASHA

Clinical and Intervention Application Examples

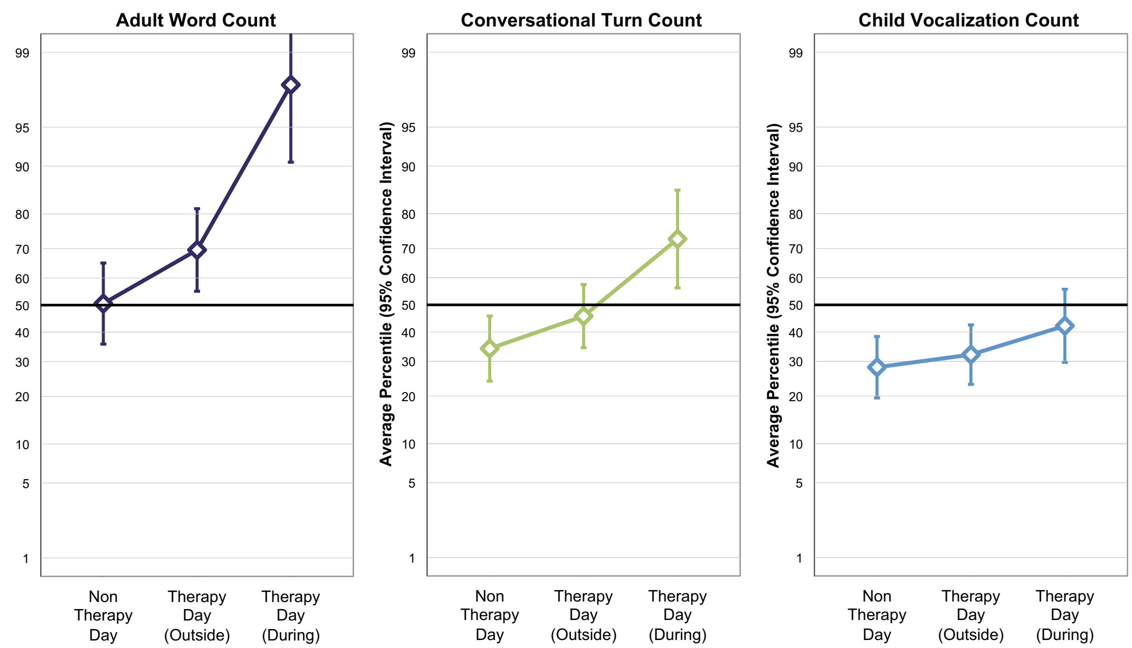
As a clinician you may be interested in knowing more about a child's home language environment, preschool environment, or maybe you want to know whether or not a child's audio environment supports the types of goals you've set for a family. Here are a few examples of different types of information LENA can give you.

Adult Word Counts During Therapy and Non-Therapy Days

The figure below demonstrates the use of LENA to examine a child's language environment at the micro level, in this case adult word counts during therapy and outside of therapy for a participant from the Childhood Autism Study. Adult word counts displayed at five-minute intervals over the course of an entire day clearly show the impact of treatment. In fact, roughly half of the total adult speech in the child's environment on the therapy day occurred during the two hours or so of treatment.

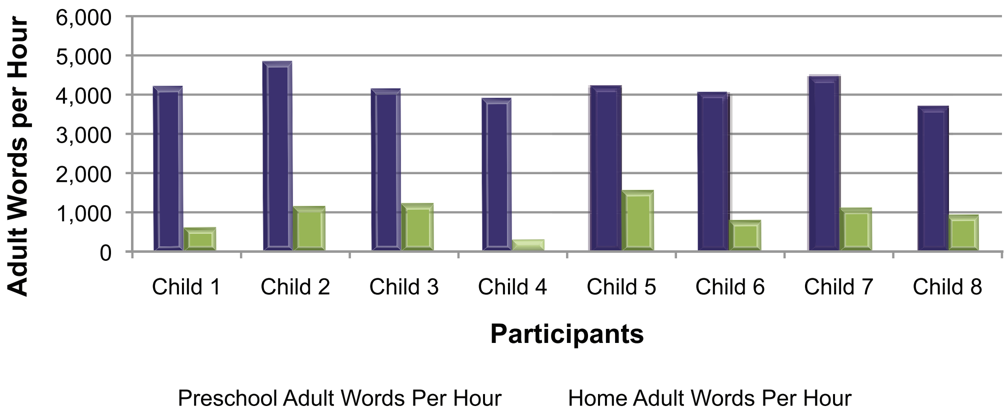


When we looked at information from our autism study in aggregate we found the same results illustrated in the case study above. Adult Word Counts are higher during therapy times compared to non-therapy times, and the same results hold for conversational turns and child vocalizations (Warren et al., JADD, 2010).



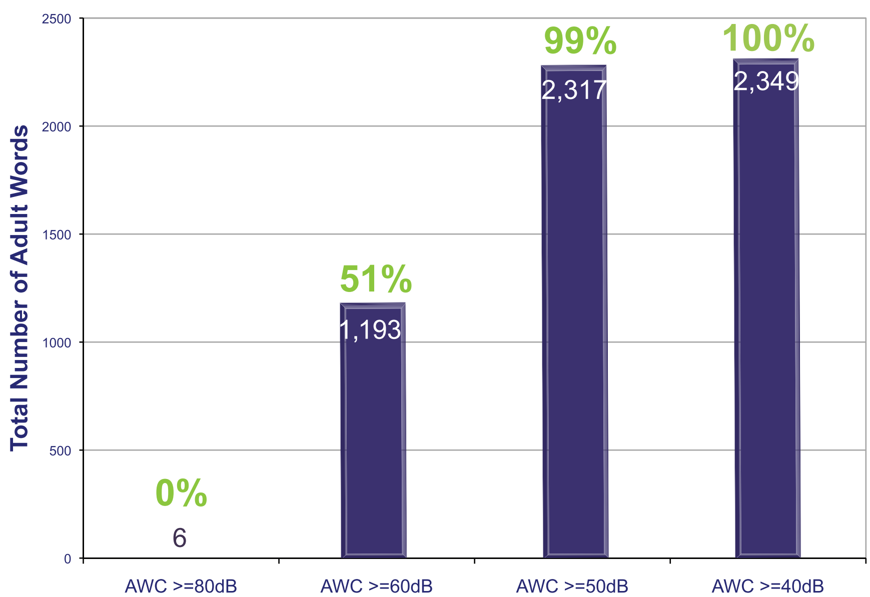
Adult Words Per Hour in Preschool vs. at Home

In this example, a clinician has empirical evidence that she is providing a rich language environment for her children with hearing loss. The mean number of adult words spoken to and near these children in the preschool was over 4,000 per hour compared to just over 900 per hour in the home, and conversational turns showed the same trends. These results indicate that the children had more access to adult words and conversational turns during the three hours spent in the preschool program than they would have received if the entire day had been spent at home (Wiggin et al., LENA User's Conference, 2011).



Number of Adult Words at Various Decibel Levels

The chart below represents one hour in the evening when adults spoke around 2,300 words. Each column represents the number and percent of adult words spoken that were a minimum of 80, 60, 50, and 40 decibels SPL. In this case, a deaf child using amplification would only have had access to around half of the words spoken at the 60 dB SPL level and next to none that were 80 dB SPL or louder. Audiologists could use these data to demonstrate to parents the importance of wearing hearing aids and cochlear implants.



LENA™ Pro Users

Universities and Colleges

Akron University
Arizona State University
Augustana College
Brigham Young University
Brown University
California State University, East Bay
Chapman University
Colorado State University
East Carolina University
East Tennessee State University
Florida International University
Florida State University
Georgia State University
Harding University
Indiana University, Bloomington
Indiana University School of Medicine
James Madison University
Kean University
Kent State University
McGill University, Canada
Michigan State University
Montclair State University
Nazareth College of Rochester
Newcastle University, UK
Northwestern University
Northern Arizona University
Norwegian University of Science and Technology, Norway
Oakland University
Ohio State University
Old Dominion University
Purdue University
Radboud University, The Netherlands
Radford University
RIDBC Renwick Centre, Royal Institute for Deaf and Blind Children/ University of Newcastle, Australia
Saint Mary's College
San Diego State University
Southeast Missouri State University, Autism Center for Diagnosis and Treatment
Southern Illinois University
Stanford University
St. Cloud State University
Tennessee State University
Texas Christian University
University of Alberta
University of Arizona
University of Arkansas, Little Rock
University of Buffalo
University of California, Los Angeles
University of Chicago
University of Colorado, Boulder
University of Georgia, Athens
University of Iowa
University of Kansas, Juniper Gardens Children's Project
University of Manchester, UK
University of Manitoba, Canada
University of Massachusetts
University of Memphis
University of Michigan
University of Minnesota
University of Minnesota, Urban Research and Outreach Engagement Center
University of Montana
University of Nebraska, Kearney
University of North Carolina, Chapel Hill, FPG Child Development Institute
University of North Carolina, Greensboro
University of Northern Colorado
University of Pennsylvania (IBIS Infant Brain Imaging Study)
University of Pittsburgh
University of Rochester
University of Sheffield, UK
University of South Alabama
University of Tennessee Health Science Center
University of Tennessee-Knoxville
University of Texas at Dallas
University of Toledo
University of Virginia
University of Washington
University of Washington, Autism Center (IBIS Infant Brain Imaging Study)
University of West Georgia
University of Wisconsin-Madison, Waisman Center
University of Wollongong, Australia
University of Wyoming
Ursinus College
Utah State University
Valdosta State University
Vanderbilt University
Washington University, School of Medicine
Western Oregon University

LENA™ Pro Users

Children's Hospitals

Akron Children's Hospital
The Children's Hospital, Colorado
The Children's Hospital of Eastern Ontario
The Children's Hospital of Philadelphia (IBIS Infant Brain Imaging Study)
Comer Children's Hospital, University of Chicago
Nationwide Children's Hospital
Seattle Children's Hospital
Shanghai Children's Medical Center, China
Women & Infants Hospital of Rhode Island, Brown University

Nonprofit Agencies

The Learning Center for Families (TLC)
New Mexico Association for the Education of Young Children (NMAEYC)
Siskin Children's Institute

Organizations for Children Who Are Deaf or Hard of Hearing

Center for Childhood Deafness at Boys Town National Research Hospital, NE
The Center for Hearing and Speech, TX
Child's Voice, IL
Children's Hearing Institute, NY
Colorado Home Intervention Program (CHIP), CO
CREC Soundbridge, CT
Hearing House, New Zealand
Heuser Hearing Institute, KY
John Tracy Clinic, CA
Lake Drive School for the Deaf, NJ
Memphis Oral School for the Deaf, TN
National Acoustic Laboratories, a division of Australian Hearing, Australia
Omaha Hearing School for Children, NE
The Shepherd Centre, Darlington, Australia
Sunshine Cottage School for Deaf Children, TX
Telethon Speech & Hearing, Australia

Public Schools

Albuquerque Public Schools, NM
Aurora Public Schools, NE
Central/Western Nebraska Partnership for Children who are Deaf/HH, NE
Conroe Independent School District, TX
Denver Public Schools, CO
Doniphan-Trumball Public Schools, NE
Education Service Unit #9, NE
Hastings NE Public Schools, NE
Syracuse City School District, NY:
William R. Beard School
Tyler Independent School District, TX

Research Institutions

Cold Spring Harbor Laboratory
Carolina Institute for Developmental Disabilities (IBIS Infant Brain Imaging Study)
Johns Hopkins Medicine
King Faisal Specialist Hospital and Research Center, Saudi Arabia
Mount Sinai School of Medicine, Seaver Autism Center
Puckett Institute
University of Colorado School of Medicine—JFK Partners

About LENA

Our Mission: Close the Gap

Our mission at the LENA Research Foundation is to improve the home language environments of disadvantaged children 0-5 by developing advanced technology to accelerate language development and for the research and treatment of language delays and disorders. At heart, our mission is to close the gap between the haves and the have-nots.

Automatic, Objective, and Inexpensive

In the United States, millions of dollars are spent on programs to improve the home language environments of disadvantaged children 0-5. There are additional millions of dollars spent on doctors, clinicians, and speech-language professionals to treat children with language delays and disorders, including autism. In virtually all the programs the primary treatment is the same: It's to teach parents to talk more, converse more, and read more books to their children. However, before LENA there was not a means to automatically, objectively, and inexpensively measure whether these interventions were working; there was no good way to measure the fidelity of treatment or to provide frequent, objective feedback to parents on words and conversational turns so they could take charge to improve the language environment of their child.

LENA provides parents and caregivers with objective feedback on words and turns and can be used as a tool to coach them to talk more, read more, and converse more with their young children. LENA gives intervention consultants and clinicians the ability to objectively monitor the fidelity of treatment to continuously improve intervention effectiveness. LENA also provides the means to frequently measure improvement in language development and to document intervention success. LENA can help to dramatically reduce the cost of screening and diagnosing children with language delays and disorders including autism. LENA provides child development researchers a new low-cost, unobtrusive measurement tool to discover what is really going on in the natural language environments of children.

Help Guide LENA Pro Product Development

Each new version of LENA Pro features new additions or modifications that have been requested by LENA users. Please send requests or suggestions for improving the research capabilities of the system to info@lenafoundation.org.

The LENA Research Foundation is a not-for-profit 501(c)(3) charitable organization.