New Discoveries and Ongoing Research at the LENA Research Foundation

Jill Gilkerson, Dongxin Xu, Jeffrey A. Richards
Presentation Outline

• Recently reported research
• New LENA online parent intervention website
• First LRF experimental study
Discoveries in Autism

Work presented at IMFAR 2012 by Dongxin Xu, PhD
## Data Set of the Study

<table>
<thead>
<tr>
<th>Child Groups</th>
<th>Number of Children (N)</th>
<th>Number of Recordings</th>
<th>Child Segments (number in million)</th>
<th>Phoneme-like Units (number in million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Development (TD)</td>
<td>106</td>
<td>802</td>
<td>2.15 M</td>
<td>8.42 M</td>
</tr>
<tr>
<td>Language Delay but not ASD (LD)</td>
<td>49</td>
<td>333</td>
<td>0.75 M</td>
<td>2.65 M</td>
</tr>
<tr>
<td>Autism (ASD)</td>
<td>71</td>
<td>225</td>
<td>0.53 M</td>
<td>1.82 M</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>226</strong></td>
<td><strong>1363</strong></td>
<td><strong>3.43 M</strong></td>
<td><strong>12.89 M</strong></td>
</tr>
</tbody>
</table>

In the following slides of results of findings

- **Green:** Typical Development (TD)
- **Blue:** Language Delay not Related to Autism (LD)
- **Red:** Autism (ASD)
Frequency of Consonant-like Sound

**t-test**
(Welch 2-sample 2-side)

- TD versus ASD: $t(90) = 7.95^{***}$
- TD versus LD: $t(68) = 5.52^{***}$
- LD versus ASD: $t(118) = 2.62^{**}$

Correlation with age:
- TD: 0.67^{***}
- LD: 0.42^{**}
- ASD: 0.32^{**}

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Probability of Sound Collision

**t-test**
(Welch 2-sample 2-side)

- ASD versus TD:
  \[ t(132) = 3.66^{***} \]

- ASD versus LD:
  \[ t(111) = 2.94^{**} \]

- TD versus LD:
  \[ t(90) = 0.13 \]

*p<0.05*  
**p<0.01**  
***p<0.001***
t-test
(Welch 2-sample 2-side)

ASD versus TD:
\[ t(125) = 5.84^{***} \]

ASD versus LD:
\[ t(117) = 4.78^{***} \]

TD versus LD:
\[ t(97) = 0.45 \]

*p<0.05
**p<0.01
***p<0.001
Characteristics of Female Caregiver
(Vowels inside “Child-directed” Voice)

Mean, Standard Error and t-Statistics

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Vowel Duration</th>
<th>Vowel Volume (dB)</th>
<th>Vowel Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASD-vs-TD</td>
<td>4.63***</td>
<td>8.58***</td>
<td>3.37***</td>
</tr>
<tr>
<td>ASD-vs-LD</td>
<td>3.58***</td>
<td>6.09***</td>
<td>2.25**</td>
</tr>
<tr>
<td>TD-vs-LD</td>
<td>0.91</td>
<td>1.72</td>
<td>0.16</td>
</tr>
</tbody>
</table>

t-test: *p<0.05; **p<0.01; ***p<0.001
Previously Studied

PNAS Article
July 2010, 107(30)

12 features from top-down approach

ASD vs TD + LD:

Equal Sensitivity and Specificity:

79%
New Method:
features derived from bottom-up data-driven approach

ASD vs TD + LD:
Equal Sensitivity and Specificity: 94%
Test with Third-party Data

• Third-Party Data:
  SCMC (TD),   Thanks to Drs. Yiwen Zhang & Fan Jiang of SCMC
  UNC (ASD),   Thanks to Dr. Brian Boyd of UNC
  VU (ASD),    Thanks to Dr. Paul Yoder of VU

• Train a model with LENA-Data:
  LENA.TD, 802 recordings, 106 children
  LENA.LD, 333 recordings, 49 children
  LENA.ASD, 228 recordings, 71 children

• Test the trained model with the third-party data:
  SCMC.TD, 432 recordings, 22 children
  UNC.ASD, 125 recordings, 67 children
  VU.ASD, 59 recordings, 31 children
Autism Screen Test on Third-party Data: SCMC-TD, UNC-ASD, VU-ASD

Autism Probability of SCMC, UNC & VU Recordings Using a Model Trained on LENA Data

ESS = 87.5%
Autism Probability of SCMC, UNC & VU Children Using a Model Trained on LENA Data

ESS = 92.7%
Preschool Environments

Work presented at IMFAR 2012 by
Jill Gilkerson, PhD
Overview

- **Purpose**: examine environments of ASD and TD children in the home setting, during preschool and therapy times.

- **Participants**: 74 children with ASD between 24-48 months of age and 44 age-matched TD peers.

- **Procedure**: Participants recorded continuously throughout the day, and parents completed session diaries indicating specific times children attended therapy or preschool.
## Sample Demographics

<table>
<thead>
<tr>
<th></th>
<th>ASD</th>
<th>TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>74</td>
<td>44</td>
</tr>
<tr>
<td>Age Mean (SD)</td>
<td>37 (7)</td>
<td>39 (6)</td>
</tr>
<tr>
<td>Range</td>
<td>24-48</td>
<td>26-48</td>
</tr>
<tr>
<td>% Female</td>
<td>18</td>
<td>64</td>
</tr>
<tr>
<td>Total Recording Hours</td>
<td>3943 (326)</td>
<td>3139 (439)</td>
</tr>
<tr>
<td>(sessions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Hours</td>
<td>2366 (217)</td>
<td>2829 (310)</td>
</tr>
<tr>
<td>(sessions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preschool/Daycare Hours</td>
<td>170 (19)</td>
<td>647 (129)</td>
</tr>
<tr>
<td>(sessions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Therapy Hours</td>
<td>285 (90)</td>
<td></td>
</tr>
<tr>
<td>(sessions)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Children with ASD Experience Different Language Environments in Different Settings

![Bar chart showing conversational turn count and adult word count in different settings: Home Setting, Preschool & Daycare, Treatment Period.](chart.png)
Language Environments in Preschool and Home Settings for ASD and TD Children

![Graph showing conversational turn count and adult word count for Home Setting and Preschool & Daycare settings for ASD and TD children.](image)
Conclusions

• LENA is an effectively way to monitor language environments provided by parents, preschool teachers and therapists.

• In the future, automated analysis could be used to set standards for language enrichment and engagement in both TD and ASD preschools.

• Preschool teachers could be trained using automated analysis and objective feedback.

• The language environment of preschool programs could be monitored at intervals and improved over time.
A New Look at Response Time

Work presented at ISIS 2012 by
Jill Gilkerson, PhD
Overview

**Purpose:** To evaluate the relationship between caregiver response time and child language skills.

**Participants:** 229 typically developing children 2 - 35 months of age from LENA normative corpus.

**Procedures:**
- Participants completed one daylong recording per month (no feedback provided) for 6-38.
- Certified SLPs administered the PLS-4 and REEL-3 to assess language skills at 4-6 month intervals. Analysis includes composite average total language scores.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td><strong>289</strong></td>
</tr>
<tr>
<td><strong>Age range in mo.</strong></td>
<td><strong>2-35</strong></td>
</tr>
<tr>
<td><strong>Mean age (SD)</strong></td>
<td><strong>20.5 (9.1)</strong></td>
</tr>
<tr>
<td><strong>% Female</strong></td>
<td><strong>49.8</strong></td>
</tr>
<tr>
<td><strong>Recording sessions</strong></td>
<td><strong>2,007</strong></td>
</tr>
<tr>
<td><strong>Recording hours</strong></td>
<td><strong>24,084</strong></td>
</tr>
<tr>
<td><strong>Mean PLS-4/REEL-3 SS (SD)</strong></td>
<td><strong>102 (13)</strong></td>
</tr>
<tr>
<td><strong>PLS-4/REEL-3 SS range</strong></td>
<td><strong>60-139</strong></td>
</tr>
</tbody>
</table>
Caregiver Responsiveness in Higher- and Lower-Language Ability Groups

<table>
<thead>
<tr>
<th>Ability Group</th>
<th>N</th>
<th>Mean Ability Standard Score</th>
<th>Mean % Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS &gt; 105</td>
<td>145</td>
<td>115</td>
<td>20%</td>
</tr>
<tr>
<td>SS &lt; 95</td>
<td>51</td>
<td>87</td>
<td>16%</td>
</tr>
</tbody>
</table>

\[ t(194)=3.75, p<.001 \]
Caregiver Responsiveness in Higher- and Lower-Language Ability Groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>N</th>
<th>Pearson Correlation</th>
<th>Ability Group</th>
<th>N</th>
<th>Mean Ability Standard Score</th>
<th>Mean % Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Ages</td>
<td>289</td>
<td>.21**</td>
<td>SS &gt; 105</td>
<td>145</td>
<td>115</td>
<td>20%</td>
</tr>
<tr>
<td>&lt;12M</td>
<td>101</td>
<td>.25*</td>
<td>SS &lt; 95</td>
<td>51</td>
<td>87</td>
<td>16%</td>
</tr>
<tr>
<td>12M-23M</td>
<td>154</td>
<td>.28**</td>
<td></td>
<td></td>
<td></td>
<td>t(194)=3.75, p&lt;.001</td>
</tr>
<tr>
<td>24M-35M</td>
<td>167</td>
<td>.20*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<.05; **p<.01
Caregiver Response Time to Child Vocal Output Predicts Child Language Ability

All correlations p<.01.
Conclusions

• There is a relationship between caregiver response time and child language ability.

• Immediacy of response to a child’s initiation may be relevant to communicative development.

• LENA technology can provide this type of feedback to caregivers and parents.
New Online Parent Intervention

• 12-week web-based parent intervention
• Experimental study investigating:
  – change in parent behavior
  – acceleration in child language development
Parent Resources Website

• Talking Tips
• Book Lists
• Videos
• Webinars
• Parent Forums
• Live Chat
Welcome to the LENA Smarter Happier Baby™ site.
Please enter your username and password below to continue.
Welcome to the LENA Smarter Happier Baby™ Program

We are so excited that you've joined our select group of parents committed to advancing their child's language development. Our goal is for you to see your child grow far beyond your expectations!

The Smarter Happier Baby Program uses advanced technological breakthroughs and over 30 years of child language research. The program is going to be easy and fun. The results you'll see will be phenomenal!

Be sure to use the resources at the top of the site - they're designed to help you get the most out of the program. If you've installed the LENA software, it's time to get started! Your schedule is below.

Your Schedule: Week 1 2 3 4 5 6 7 8 9 10 11 12 Schedule Overview

Join Monday All-Day Chat
Live Chat is open all day on Monday, 10 AM - 4 PM MDT. Join us at [...]

Final Coaching Session
Get in touch via email to set up a coaching session at any time. If you [...]

Webinar 4: Sing and Play Throughout Your Day!
Our last webinar, Sing and Play Throughout Your Day! is ready to view. Visit the Webinars [...]

Special Announcement: LENA Stories Contest!
Cute, silly, surprising, enlightening — this is your chance to share your LENA memorable moment with [...]

Home | Additional Resources | Log Out
Talking Tip Videos

Speaking 17,000 words per day to your child is easier than you think. Click on any Talking Tips Video below to learn how easy it is to increase your Adult Word Counts, boost your Conversational Turns and create an everlasting bond between you and your child.

Introduction by Todd Risley

Wardrobe Change

Broadway, Here I Come

Gab It Up at the Grocery Store

Laugh and Talk While Doing Laundry

Slicing and Dicing Doesn’t Have to Be a Solo Effort

The Great Outdoors

Read All About It
Webinars

Our webinars are a wonderful opportunity for you to learn new strategies for enhancing your child's language environment. You can attend the webinars live and ask questions directly to our experts and coaches, or you can view recorded webinars here. Click a webinar below to view!

- Webinar 1: All It Takes Is Turns!
- Webinar 2: Every Book Counts!
- Webinar 3: Talk Around The Clock!
- Webinar 4: Sing and Play Throughout the Day!
- Webinar 5: Ready, Set, Play!
First Recording Results Suprising

Hi Everyone,

My name is Patricia and I am from the Group A study. My LENA baby is Flora and 15 months. I was shocked when I submitted my initial recording and found my adult words were very low. I felt like I talked all day long! The reality was that although I was conversing with my older children, I was not talking directly to Flora much at all. I started reading to her. She is extremely active so mostly that meant following her around the house with a book. It felt pretty silly at first but I would show her pictures and read with lots of expression to keep her interest. I saw a big jump in my adult word count as well as her turns. I was curious to know if anyone else was surprised by their recording results?

8 Responses

happybaby041 says:
September 24, 2012 at 2:53 pm (Edit)

Hello everyone,

I'm Meagan from Group B! My LENA baby is Iris who is almost 14 months old. I, too, was surprised by my daughter's first recording results. I've always tried to do my absolute best to constantly be interacting with Iris but when I saw the scores, I was shocked to see I still wasn't communicating enough with her! I'm definitely going to be doing more one-on-one interactions with her. She personally reacts well to playing "Patty-Cake" and "Itsy Bitsy Spider"! She will try to sing and say the words as we make the hand motions together.

I hope that making these little increases in our communications will become a part of our regular routine and will carry on to our future recording sessions!

LENALeader003 says:
September 25, 2012 at 10:46 am (Edit)

Hi Patricia! (That is also my name, by the way!) Hi Iris!
12-Week Online Intervention

• **First Week**
  – Parent receives LENA Home and website login
  – Parent installs LENA
  – Parent records, processes data, views reports
  – Parent accesses internet to pass ITS file
  – Phone meeting with LENA coach to set goals

• **Week 2-12**
  – Parent makes best effort to improve language environment
  – Parent views Talking Tips Videos and Shared Reading Tips
  – Parent participates in Forum and Chat
  – Parent attends live Webinars once every other week
  – Parent completes Snapshot in LENA software once per month
First LRF Experimental Study

- N = 60 “completers” (began with 80 participants)
- 6 - 18 months of age at first recording
- Random assignment to Treatment and Control groups
  - Treatment: Begin using LENA Home immediately, SHBO website
  - Control: Record with LENA but no feedback
    (Control became “delayed treatment” after 3 months)
- Assessments: Snapshot, MacArthur and CDI
  - At baseline, post treatment, 3 and 6 month follow up
- Treatment Phase Recordings
  - Month 1-2: Once per week
  - Month 3-6: Every other week
  - Months 7-12: Once per month
<table>
<thead>
<tr>
<th>Month</th>
<th>Date</th>
<th>Treatment Recordings</th>
<th>Control Recordings</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>June, 2012</td>
<td>4</td>
<td>1</td>
<td>Snapshot, CDI, MacArthur</td>
</tr>
<tr>
<td>2</td>
<td>July, 2012</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>August, 2012</td>
<td>2</td>
<td>1</td>
<td>Snapshot, CDI, MacArthur</td>
</tr>
<tr>
<td>4</td>
<td>Sept, 2012</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Oct, 2012</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Nov, 2012</td>
<td>2</td>
<td>2</td>
<td>Snapshot, CDI, MacArthur</td>
</tr>
<tr>
<td>7</td>
<td>Dec, 2012</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Jan, 2013</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Feb, 2013</td>
<td>1</td>
<td>2</td>
<td>Snapshot, CDI, MacArthur</td>
</tr>
<tr>
<td>10</td>
<td>March, 2013</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>April, 2013</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>May, 2013</td>
<td>1</td>
<td>1</td>
<td>Snapshot, CDI, MacArthur</td>
</tr>
</tbody>
</table>
Maintaining Positive Behavioral Change

Conversational Turns

Baseline | 3 Months | 6 Months | 9 Months

0 | 100 | 200 | 300
100 | 200 | 300 | 400
200 | 300 | 400 | 500
300 | 400 | 500 | 600
400 | 500 | 600 | 700
500 | 600 | 700 | 800
600 | 700 | 800 | 900
700 | 800 | 900 | 1000
800 | 900 | 1000 | 1100

89% | 45% | 24%

LENA Use
Maintaining Positive Behavioral Change

LENATM RESEARCH FOUNDATION

Conversational Turns

Baseline 3 Months 6 Months 9 Months

800 700 600 500 400 300 200 100 0

89% 45% 24%

LENATM Use

Conversational Turns

Baseline 3 Months 6 Months 9 Months

800 700 600 500 400 300 200 100 0

45% 46%

LENATM Use

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Conclusions

• Preliminary data suggest that parent-child interaction increases significantly with LENA use.

• There is indication on some measures that child language skills are accelerated for children whose parents use LENA.

• Both of these changes are holding over time.
Thank You Team!

- Rebecca Mills, M.A. - Research Supervisor
- Kate Lincoln, M.A. - Research Coordinator
- Joanna Lester, B.A. - Research Assistant
Q&A

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