Broadening our view of interactions that support early language development

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Jacobs Center – CCWD Workshop
Technologies linked to Child and Youth Development

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Early language experience is associated with language outcomes

Vocabulary growth

Spoken language processing

Hart & Risley, 1995; Huttenlocher et al., 1991; Hurtado et al., 2008; Weisleder & Fernald, 2013
The “30 million word gap”

- High-SES
- Mid-SES
- Low-SES

ESTIMATED CUMULATIVE WORDS ADDRESSED TO CHILD (in millions)

Age of Child (in months)

Hart & Risley (1995)
Poverty-related disparities in vocabulary growth

Hart & Risley (1995)
Early language experience is associated with language outcomes

Vocabulary growth

Spoken language processing

Hart & Risley, 1995; Huttenlocher et al., 1991; Hurtado et al., 2008; Weisleder & Fernald, 2013
There were, however, wide individual differences for both children and parents, as the children were producing as many gesture tokens as their parents. By 22 months, the children were producing an average of 58 gesture tokens during the 90-minute period at all six interactions. Thus, by the parents' values at all time points. Parents produced, on average, between 100 and 115 gesture tokens during the 90-minute period (see Fig. 1 caption).

There is a marked contrast in stability over time for different individuals. Table 18 gives the rotated loadings representing the relation that two principal factors are sufficient to account for most of the measures. In particular, for measures of quantity (number of tokens during the 5 minutes of naturalistic routines), then there would be no reason to expect concordance within education groups. If the tendency to maintain relative position across caregivers is due to factors in addition to educational level, that two principal factors are sufficient to account for most of the measures, and the second factor represents compositional measures. To further address the question of whether the pattern of inter-individual ranges for types averaged about 20 words across the 5 minutes. Across all infants, the intra-individual ranges for structured play were much smaller, appearing against this backdrop of familiarity (see Figures 3a and 3c) and 5 min of structured play (Figures 3b and 3d).

Table 5.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Tertile 1</th>
<th>Tertile 2</th>
<th>Tertile 3</th>
<th>p</th>
<th>p</th>
<th>p</th>
<th>p</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal words per minute</td>
<td>44.1</td>
<td>48.7</td>
<td>53.8</td>
<td>.056</td>
<td>.21</td>
<td>&lt; .01</td>
<td>.90</td>
<td>.10</td>
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<td>Sentence types</td>
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<tr>
<td>Routines and Rituals</td>
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<td>Fluency and Connectedness</td>
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</table>

For the three measures of communication-foundation quality (symbol-infused joint engagement, routines and rituals, and fluency and connectedness), maternal words per minute, and the sensitive-parenting composite score. Each measure is used to create a new set of derived variables (factors), which supports our hypothesis, quality mattered more. To evaluate this possibility, we examined concordance within education groups. If the tendency to maintain relative position across caregivers over time, we computed Kendall’s coefficient of concordance indicates that individuals tend to maintain their rank well across sessions (for all measures, \( \tau = 0.84 \) and for tokens averaged about 43 words at Bobst Library, New York University on June 11, 2015.

**Note:** Variability in early language experience.
Variation in the way families and children spend their time

Different activities and interaction contexts provide different language learning opportunities

Even activities that appear to be “universal” on the surface can vary across communities in structure, organization, and language interaction
Quantitative measures of home language environment based on daylong recordings

Gilkerson et al., 2017
Sources of variability in language input

Caregiver-level factors (stable)
- Education
- Verbal ability
- Knowledge/beliefs
- Maternal depression

Context factors (variable)
- Activities
  - Play, bookreading, meals, routines
- Interaction partners
  - One-on-one vs. multi-party
  - Mom, dad, siblings

Hoff-Ginsberg, 1991; Rowe, 2008, 2017
Advancing in three key directions

1. Obtain more representative and ecologically-valid measures of children’s early language experience

2. Examine what types of language experiences in the home relate to children’s language outcomes

1. Examine how activity and interaction context shape children’s language environments
Ecologically-valid measures of language experience

LENA™

- Digital recorder & software analysis system
- Unintrusive data collection
- Up to 16 hrs of continuous recording
- Automated analysis of:
  - Number of adult words
  - Distant speech
  - TV and other media
Two different studies

1. Spanish-speaking Latino families in California \( (n=29) \)  
   (Weisleder & Fernald, 2013)  
   • Daylong recordings of the home language environment (LENA)  
   • Recorded at 18 months  
   • Activity contexts determined by listening & coding audio recordings  
   • Measures of child vocabulary (MCDI) and language processing at 24 mos

2. Spanish-speaking Latino families in NYC \( (n=22) \)  
   • Daylong recordings of the home language environment (LENA)  
   • Recorded longitudinally at 2, 6, 9, and 12 months  
   • Activity contexts determined by parent logbook on recording day
Two different datasets

1. Spanish-speaking Latino families in California (n=29) (Weisleder & Fernald, 2013)
   - Daylong recordings of the home language environment (LENA)
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Profile of adult speech to 18-mo-old on one typical day

Adult words per 5-min segment

Mom on the phone

Mom changing child’s diaper
- Listened to entire recording for one “typical” day for each child
- Each 5-min segment was coded by ear for:

- Child-directed
  - Child-engaging
    - Book-sharing
    - Child helping adult
  - Play
- “Meaningful” speech
- Other
  - Meals
  - Routines
- Busy adult
- Noise, Silence
- Distant speech
- Overheard

Measuring different streams of talk
Variability in amount of adult speech in a typical day

Mean number of adult words per hour

Weisleder & Fernald, 2013. *Psychological Science*
Variability in amount of child-directed and overheard speech

Weisleder & Fernald, 2013. *Psychological Science*
Variability in amount of child-directed and overheard speech

Mean number of adult words per hour

Individual participant families

Overheard
Child-directed

Weisleder & Fernald, 2013. *Psychological Science*
Child-directed speech predicts later vocabulary size

\[ r^2 = 0.27 \]

Weisleder & Fernald, 2013. *Psychological Science*
Overheard speech is not correlated with vocabulary

Weisleder & Fernald, 2013. Psychological Science
Child-directed speech predicts speed of spoken language processing

Weisleder & Fernald, 2013. *Psychological Science*
Listened to entire recording for one “typical” day for each family

Each 5-min segment was coded by listening

Child-directed speech

Overheard speech

Child-engaging

Book-sharing

Play

Non child-engaging

Meals

Routines

Busy adult

Noise, Silence

“Meaningful” speech

Distant speech

Media

Determining activity context in home recordings

(Weisleder & Fernald, 2013)
Family 1

Family 2

Family 3

Family 4

Amount of CDS per 5-min segment

Time (hrs over the day, from start of recording)

Play  Booksharing  Meals  Routines  Busy adult
Density of talk by activity context

Word density during **book-sharing** is **twice as high** as in other interaction contexts.
Variability in child-directed speech (CDS)

Mean child-directed adult words per day

- Low CDS
- High CDS
Differences in child-directed speech by activity context

Mean child-directed adult words per day

- Play
- Book-sharing
- Eating
- Routines
- Adult-centered

Low CDS vs. High CDS
Differences in child-directed speech by activity context

Mean child-directed adult words per day

Low CDS

High CDS

Differences in child-directed speech by activity context.
Differences in child-directed speech by activity context

Mean child-directed adult words per day

Low CDS

High CDS

Play

Book-sharing

Eating

Routines

Adult-centered
Differences in child-directed speech by activity context

Mean child-directed adult words per day

Low CDS vs. High CDS

Low CDS: 
- Play: 0
- Book-sharing: 0
- Eating: 0
- Routines: 0
- Adult-centered: 0

High CDS: 
- Play: 0
- Book-sharing: 0
- Eating: 0
- Routines: 0
- Adult-centered: 0
Differences in child-directed speech by activity context

- **Low CDS**:
  - Play: 1000 words
  - Book-sharing: 500 words
  - Eating: 500 words
  - Routines: 500 words
  - Adult-centered: 3000 words
  - Total: 6000 words

- **High CDS**:
  - Play: 4000 words
  - Book-sharing: 2000 words
  - Eating: 2000 words
  - Routines: 2000 words
  - Adult-centered: 5000 words
  - Total: 9000 words
Differences in child-directed speech by activity context

Mean child-directed adult words per day

Low CDS

High CDS

Child-engaging

- Play
- Book-sharing
- Eating
- Routines
- Adult-centered

Non Child-engaging
Differences in child-directed speech by activity context

Mean child-directed adult words per day

- Low CDS
  - Child-engaging
  - Non child-engaging

- High CDS
  - Child-engaging
  - Non child-engaging
Variability in density of CDS

Individual participating families (rank ordered by CDS density)
Variability in density of CDS

- Child-engaging contexts
- Non-child-engaging contexts

CD words per minute

Individual participating families
(rank ordered by CDS density)
Words produced (MCDI, 24 mos) vs. Density of speech in child-engaging contexts: $r = .49, p < .01$

Words produced (MCDI, 24 mos) vs. Density of speech in non-child-engaging contexts: $r = .27, p = .16$
Two different datasets

1. **Spanish-speaking Latino families in California (n=29)** (Weisleder & Fernald, 2013)
   - Daylong recordings of the home language environment (LENA)
   - Recorded at 18 months
   - Activity contexts determined by listening & coding audio recordings
   - Measures of child vocabulary (MCDI) at 24 mos

2. **Spanish-speaking Latino families in NYC (n=22)**
   - Daylong recordings of the home language environment (LENA)
   - Recorded longitudinally at 2, 6, 9, and 12 months
   - Activity contexts determined by parent logbook on recording day
9:00 – 10:00 AM

Where was your child during this time?

☐ At home
☐ Outside of home. Where: ________________________________

Who was with your child during this time?

☐ Mom
☐ Dad
☐ Siblings: Age(s): ________________________________

☐ Other adults How many: ________________

☐ Other children How many: ________________

Was your child doing one of these activities during this time?

☐ Napping
☐ Taking a bath
☐ Feeding
☐ Looking at books / being read to

Was the television on during this time? ☐ Yes ☐ No
Activity contexts

16-hour Recording

Parent logbook:
- Sleeping
- Bathing
- Feeding
- Books / reading
- Other

1-hour long segments
Profile of adult speech to one 2-mo-old infant

Number of adult words vs Time (16 hours from wake time)
Profile of adult speech to one 2-mo-old infant

Graphs by Agegroup v2

Number of adult words

Time (16 hours from wake time)

- Sleeping
- Bath
- Feeding
- Books
- Other
Time in different activity contexts over the first year of life

Mean proportion of time in each activity on a typical day
Density of adult talk by activity context

![Box plot showing density of adult talk by activity context across different age groups (2 months, 6 months, 9 months, 12 months). The plot compares adult words per minute (AWC) across activities such as Bath, Feeding, Books, and Other.]
Conversational turns by activity context
Child vocalizations by activity context
Overall talk in families with and without bookreading

![Bar chart showing total adult words/day by age and bookreading status]

- **2 mos**
  - Families with no BR
  - Families with BR

- **6 mos**
  - Families with no BR
  - Families with BR

- **9 mos**
  - Families with no BR
  - Families with BR

- **12 mos**
  - Families with no BR
  - Families with BR
Overall talk in families with and without bookreading

<table>
<thead>
<tr>
<th>Age (mos)</th>
<th>Families with no BR</th>
<th>Families with BR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 mos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 mos</td>
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<tr>
<td>12 mos</td>
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</tbody>
</table>

- **Non-bookreading intervals**
- **Bookreading intervals**
Overall talk in families with and without bookreading

**Conversational turns / day**

- **Non-bookreading intervals**
- **Bookreading intervals**

<table>
<thead>
<tr>
<th>Age (mos)</th>
<th>Families with <strong>no</strong> BR</th>
<th>Families with <strong>BR</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mos</td>
<td></td>
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<tr>
<td>12 mos</td>
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</tbody>
</table>
Overall talk in families with and without bookreading

<table>
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<tr>
<th>Time</th>
<th>Families with no BR</th>
<th>Families with BR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mos</td>
<td>Child vocalizations</td>
<td></td>
</tr>
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<td>6 mos</td>
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<tr>
<td>12 mos</td>
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</table>

- **Non-bookreading intervals**
- **Bookreading intervals**
Who participates in bookreading?

- Non-bookreading intervals:
  - Mom present: 100%
  - Dad present: 100%
  - Siblings present: 40%

- Bookreading intervals:
  - Mom present: 100%
  - Dad present: 100%
  - Siblings present: 80%

- One-on-one: 40%
- Multi-party: 60%
- Children only: 20%
Types of interactions during booksharing

Mean proportion of segments with each interaction type:

- Teaching
- Reading from book
- Singing
- Playing
Interaction partners

16-hour Recording

- Mom only
- Dad only
- Mom & Dad
- Mom/Dad & Siblings
- Children only
- Extended family
- Other caregiver(s)
Profile of adult speech by interaction partners for one 2-mo-old infant

Graphs by ID#

Number of adult words

Time (16 hours from wake time)

- Mom only
- Dad only
- Mom and Dad
- Mom/Dad & Sibs
- Children only
- Extended family
- Other adult caregiver
Profile of adult speech by interaction partners for one 2-mo-old infant

Number of adult words vs. Time (16 hours from wake time)

- Mom only
- Dad only
- Mom and Dad
- Mom/Dad & Sibs
- Children only
- Extended family
- Other adult caregiver
Time with different interaction partners over the first year of life

Mean proportion of time with interaction partners on a typical day

<table>
<thead>
<tr>
<th>Child age</th>
<th>Mean proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mos</td>
<td></td>
</tr>
<tr>
<td>6 mos</td>
<td></td>
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<tr>
<td>9 mos</td>
<td></td>
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<tr>
<td>12 mos</td>
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</tbody>
</table>
Amount of language by interaction partners

**Adult words**

- **Mom only**: 
- **Mom & Dad**: 
- **Mom/Dad & siblings**: 
- **Extended family**: 

**Conversational turns**

- **Mom only**: 
- **Mom & Dad**: 
- **Mom/Dad & siblings**: 
- **Extended family**: 

### Graphs

- **Adult words**
  - **Mom only**: 40
  - **Mom & Dad**: 60
  - **Mom/Dad & siblings**: 100
  - **Extended family**: 120

- **Conversational turns**
  - **Mom only**: 1
  - **Mom & Dad**: 2
  - **Mom/Dad & siblings**: 3
  - **Extended family**: 4
Analyses of daylong recordings help us understand the ecological context of the 30 million word gap

- Differences in amount of speech reflect different contexts of interaction
- These interactional contexts are likely to concentrate correlated features of experience that are beneficial for language learning

Findings have implications for how we measure differences in children’s language experience

- Need to understand not only how parents talk when they interact with their child, but also the contexts in which this happens in everyday environments
- Lots of within-family variation to understand

Implications for efforts to reduce poverty-related disparities in children’s language development

- Booksharing (and play) may be a lever for increasing language interactions
- Understand what “child-engaging” contexts look like in different groups
- Take other interaction partners seriously
Technology: New and exciting directions

• Combining LENA with digital sensors
  – spatial location sensors to investigate the distribution of talk in
    different locations, by different people
  – eye-tracking to investigate properties of the visual environment
  – accelerometers to study infant movements

• Incorporate new developments in speech analysis technology (DARCLE.org)
  – Automated detection of:
    • child-directed vs overheard speech
    • different speakers
    • different languages
  – Open source tools