# Outcomes of children identified through Universal Newborn Hearing Screening across the United States: Children with hearing loss only and those with special needs

8TH AUSTRALASIAN NEWBORN HEARING SCREENING CONFERENCE

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# DISCLOSURE

- Employment at the University of Colorado, Boulder
- Grant funding from DRDC, Centers for Disease Control, and OE-NIDRR Rehabilitation Engineering Research Center.
- Member of the LENA Scientific Advisory Board
- Member of the Ida Institute Advisory Board
- Advisory Board NCHAM
- Advisory Board Hands & Voices
- Board of the Marion Downs Center
- AAA representative Joint Committee on Infant Hearing

# Current Status of Newborn Hearing Screening: Are We Closing the Gap?: National Early Childhood Assessment Project: Deaf/Hard of Hearing English/Spanish-Speaking


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# States Represented in Results

## ENGISH SPEAKING

- Arizona
- California
- Colorado
- Idaho
- Indiana
- Maine
- Minnesota
- New Mexico
- Oregon
- Texas
- Utah
- Wisconsin
- Wyoming

## SPANISH SPEAKING

- Arizona
- California
- Idaho
- Indiana
- Texas
- Wyoming

# Assessments Completed

**ENGLISH SPEAKING**

- 1,077 assessments completed (not including Colorado)
- 649 children assessed 1 to 6 times each
- Colorado: 300 assessments per year

**SPANISH SPEAKING**

- 142 assessments completed (not including Colorado)
- 97 children assessed 1 to 4 times each

# Participant Criteria for Language Outcomes Analysis

- Bilateral hearing loss
- English-speaking or Spanish-speaking home
- No other disabilities that would affect speech or language development

# Language Outcomes Analysis: Number of Assessments

**ENGLISH SPEAKING**

- Number of Children = 359
- Minnesota Child Development Inventory = 370 assessments
- MacArthur-Bates Communicative Development Inventory = 560 assessments

**SPANISH SPEAKING**

- Number of Children = 55
- Minnesota Child Development Inventory = 28 assessments
- MacArthur-Bates Communicative Development Inventory = 71 assessments

# Language Outcomes Analysis: Participant Characteristics

## ENGLISH SPEAKING

- Chronological age
  - Range = 6 to 60 months
  - Mean = 24 months
  - 94% of sample: 6 to 36 months of age
- Boys = 55%; Girls = 45%

## SPANISH SPEAKING

- Chronological age
  - Range = 14 to 63 months
  - Mean = 26 months
  - 98% of sample: 14 to 36 months of age
- Boys = 49%; Girls = 51%

**COCHLEAR IMPLANTS: AGE OF IMPLANTATION- MEDIAN 15 MO. MEAN 17 MO (n=99)**

# Language Outcomes Analysis: Participant Characteristics

| Age at… | ENG DHH Median (mos) | SPAN DHH Median (mos) | ENG DHH Range (mos) | SPAN DHH Range (mos) |
|---|---|---|---|---|
| Identification | 2.3* | 3** | .25 to 48 | .25 to 30 |
| Amplification | 5 | 6 | 1 to 48 | 1.5 to 32 |
| Intervention | 5* | 6** | .25 to 44 | 1 to 31 |

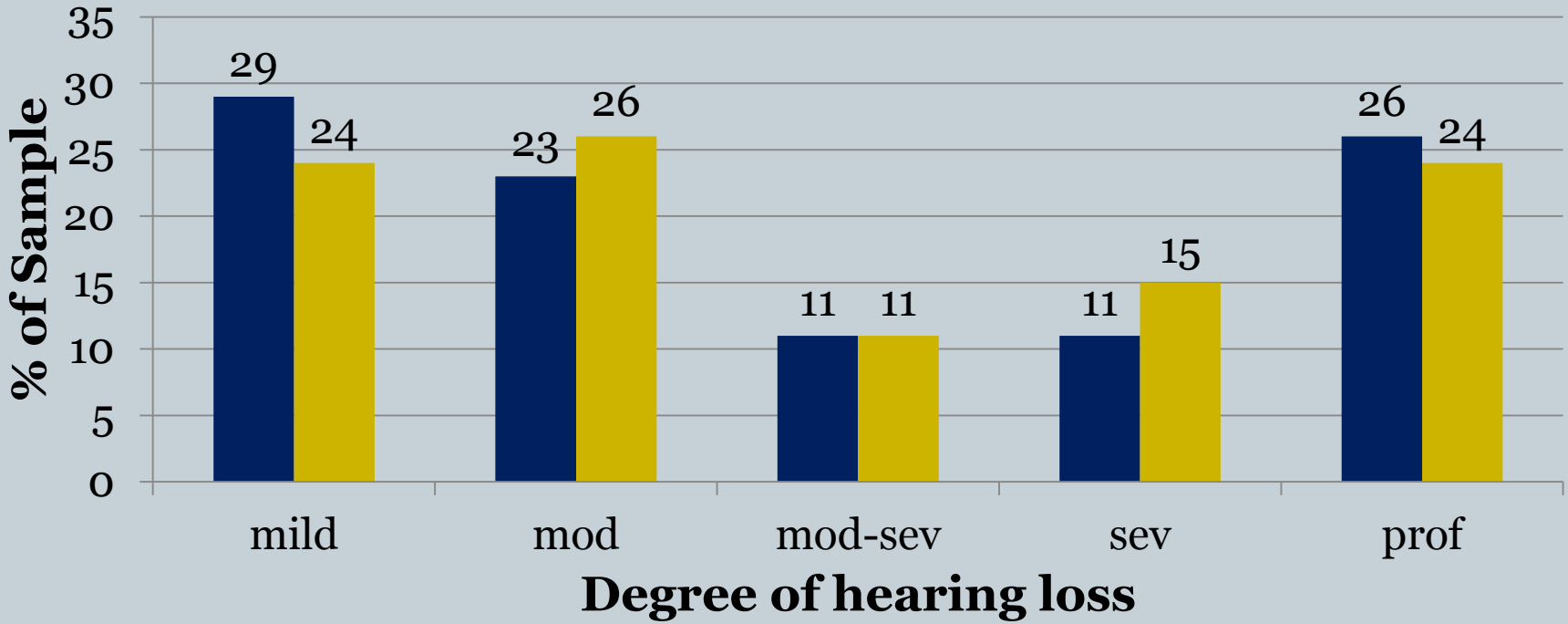
**67% of ENG DHH children were identified by 3 months of age
*66% of ENG DHH children were in intervention by 6 months of age

**59% of SPAN DHH children were identified by 3 months of age
**57% of SPAN DHH children were in intervention by 6 months of age

# Language Outcomes Analysis: Participant Characteristics

| Highest degree completed | % of ENG primary caregivers | % SPAN Primary caregivers |
|---|---|---|
| Less than HS | 8% | 47% |
| High school diploma | 46% | 33% |
| Vocational or Associates | 16% | 9% |
| Bachelor's degree | 18% | 11% |
| Graduate degree | 12% | 0% |

# Degree of Hearing Loss (available for 256 ENG DHH children and 46 SPAN DHH children)



# Assessment 1: Minnesota Child Development Inventory (1992)

- 8 areas of development assessed
  - Language, Motor, Social, Self Help, Pre-Literacy
- Parent report
  - Parents respond “yes” or “no” to a variety of statements about their child
  - Example: “Has a vocabulary of 20 or more words”
- Scales adapted to reflect abilities in both spoken and sign language
- Translated into Spanish; English norms

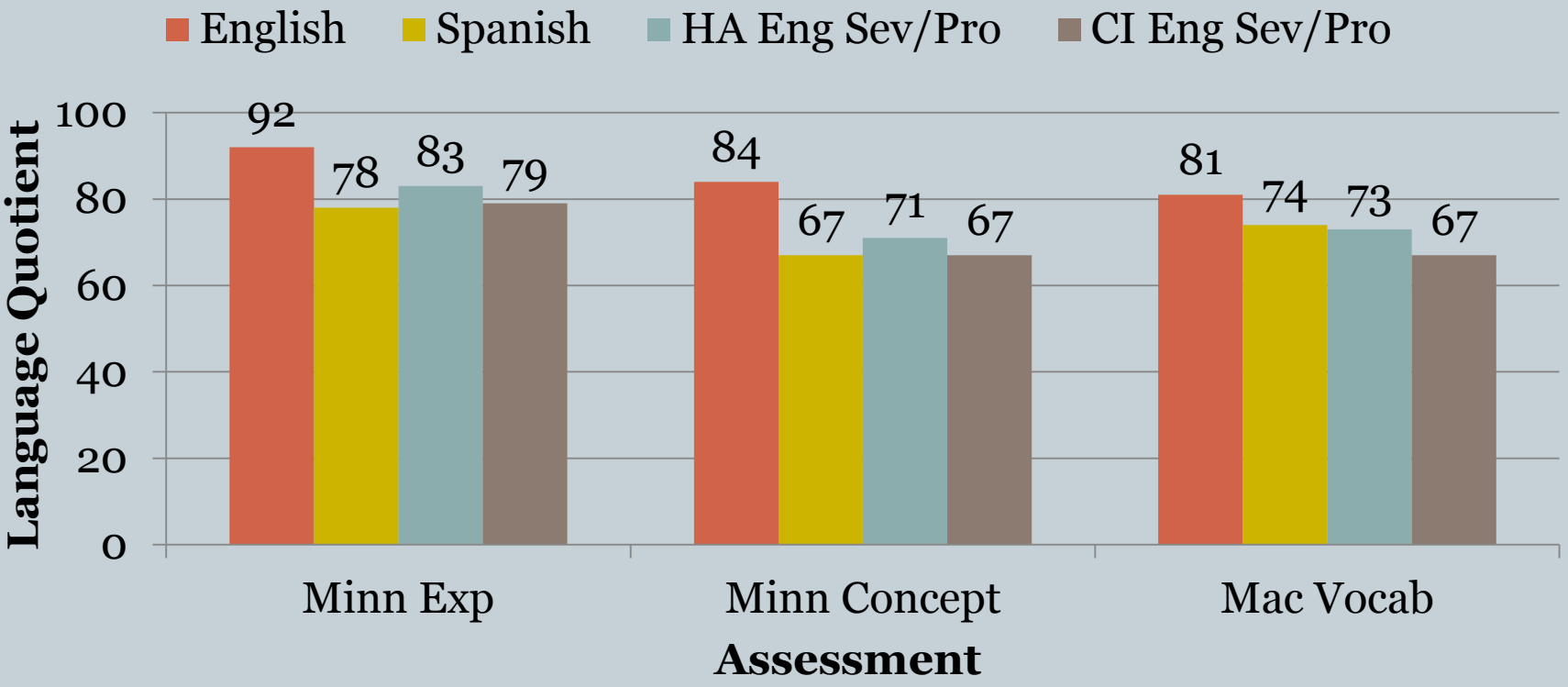
# Assessment 2: MacArthur-Bates Communicative Dev. Inventories

- Assesses spoken and sign vocabulary
  - Expressive and receptive for younger children
  - Expressive vocabulary for older children
- Parent-report instrument
- Norms reported for children from English-speaking
- Norms reported for children from Spanish-speaking families

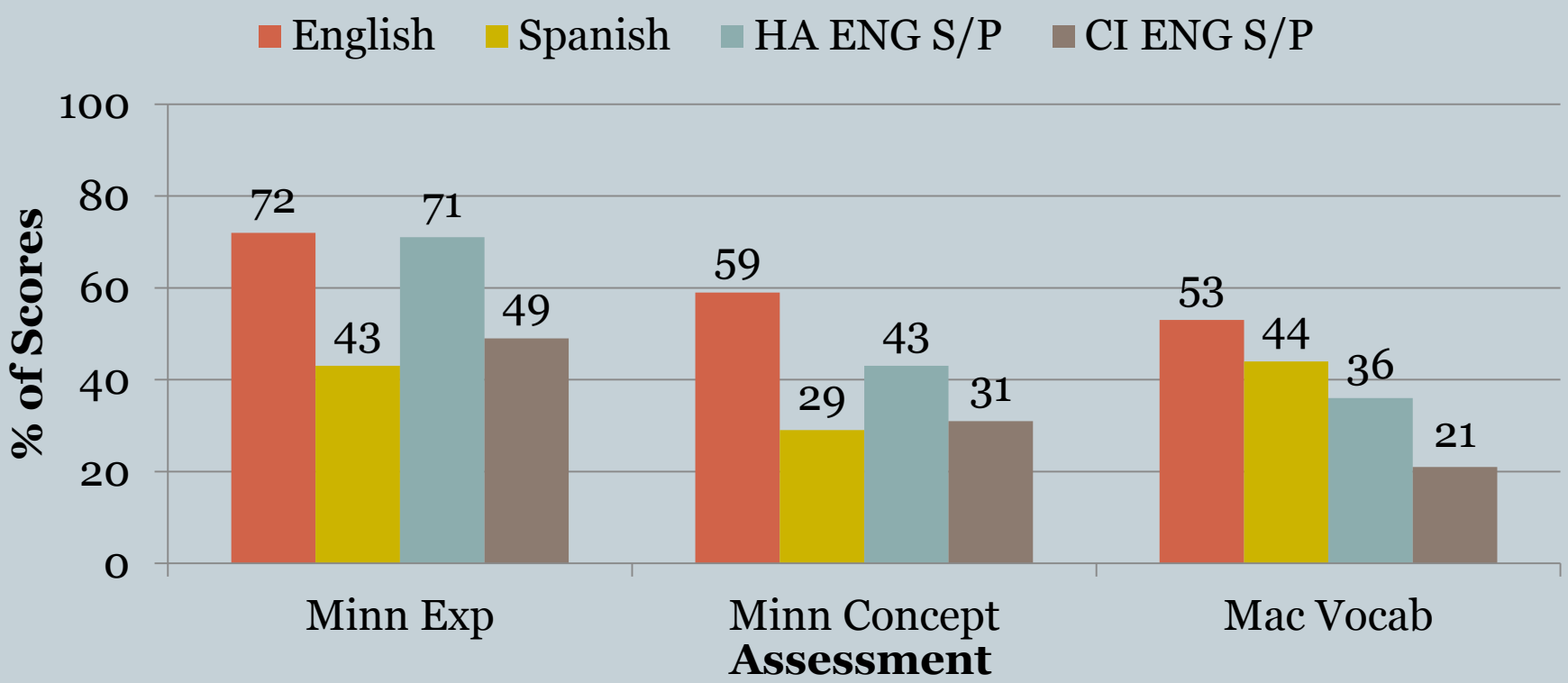
# Determining Language Quotient

- Language Age/Chronological Age x 100
  - If LQ = 100, Language Age = CA
  - If LQ < 100, Language Age < CA
  - If LQ > 100, Language Age > CA
- LQs of 80+ are within the normal range compared to hearing children

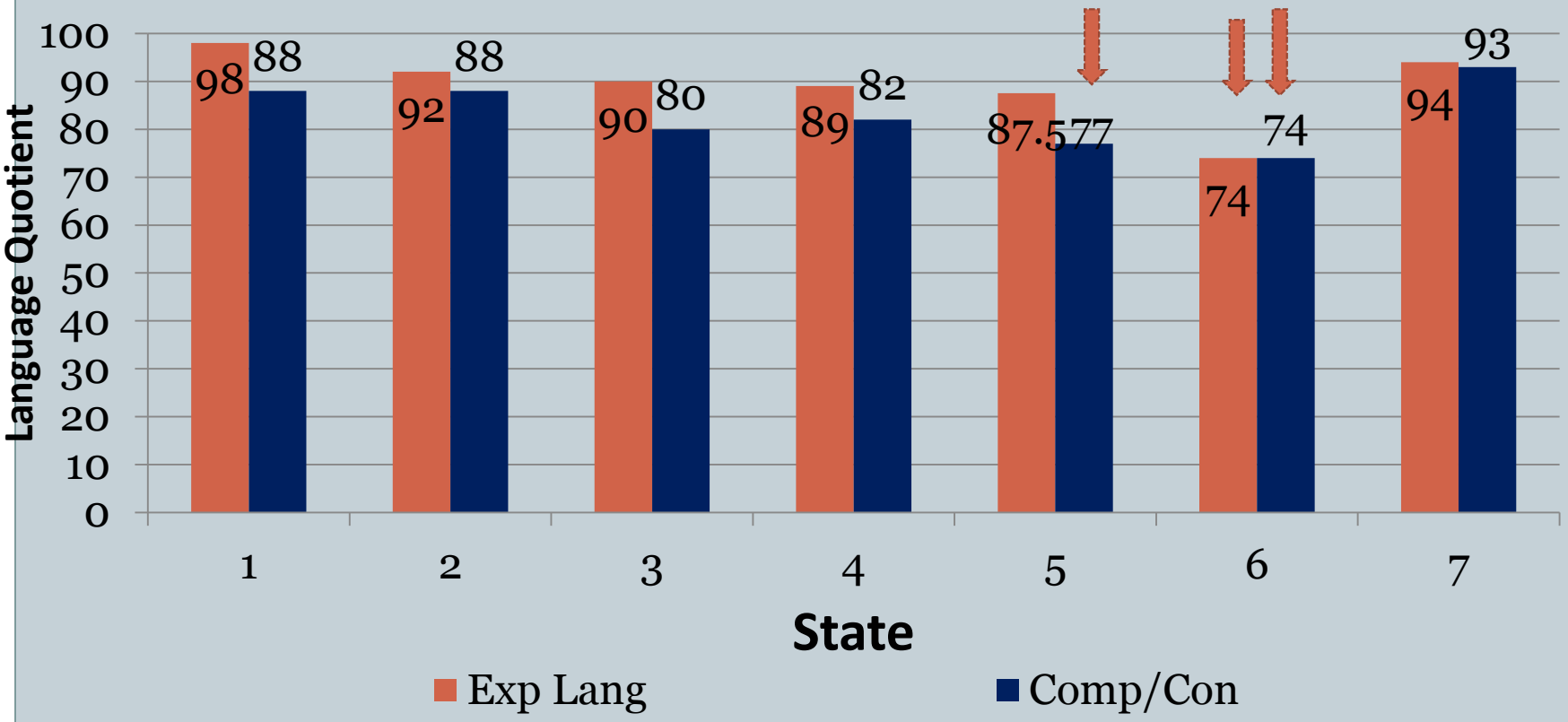
# Median Language Quotients: English vs. Spanish, HA vs. CI



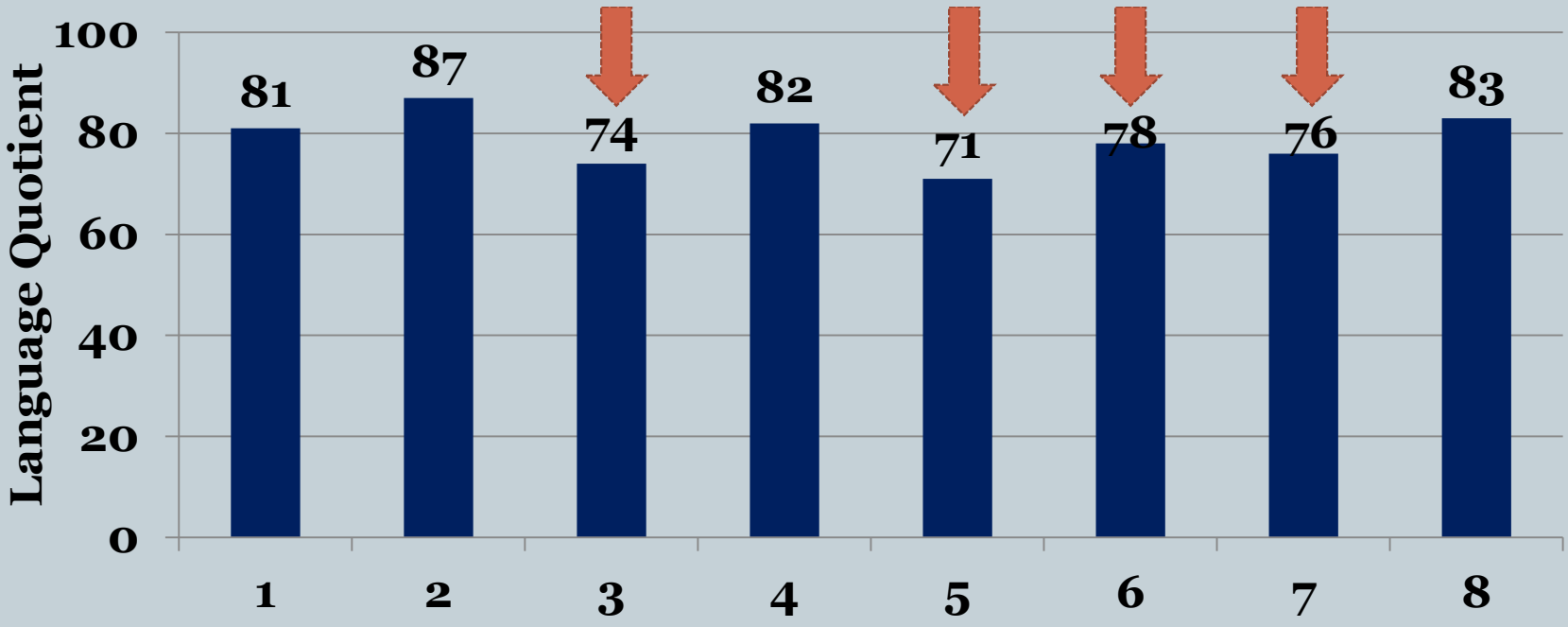
# Percent of Scores in the Average Range (LQ = 80+)



# Minnesota CDI: Median ENG Language Quotients (n = 370)



# MacArthur: Median ENG Vocab Prod. Quotients (n = 560) by State



# Bates-MacArthur Exp Vocabulary: Sub-Group Comparisons

- All group comparisons examine the MacArthur expressive vocabulary LQ
  - Insufficient number of participants with the Minnesota for group comparisons
  - Unilateral vs. Bilateral and Additional Disabilities vs. No Disabilities examined with most recent assessment from all participants (n = 72)
  - Other comparisons made with most recent assessment from children with bilateral loss and no additional disabilities (n = 32 to 42)

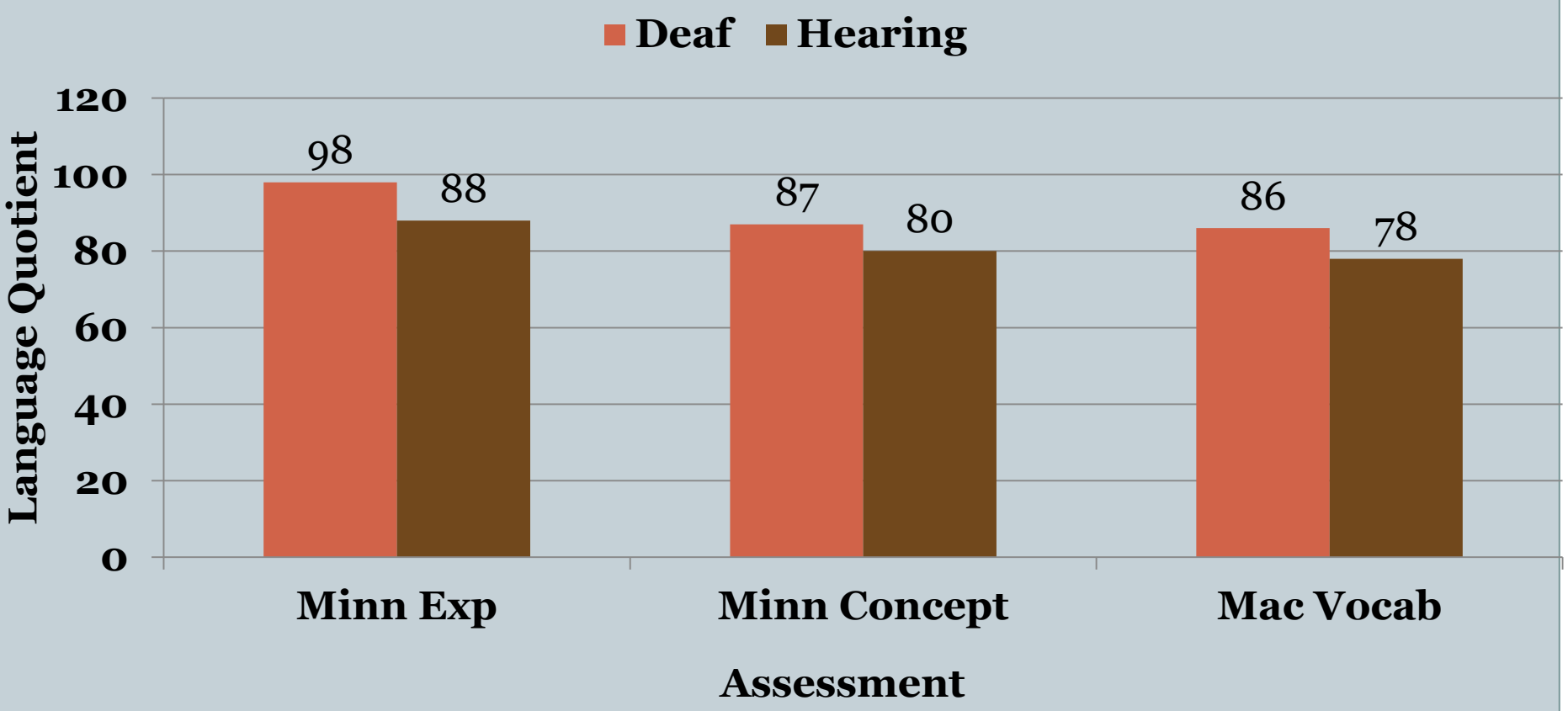
# Bates-MacArthur Exp Vocabulary: Sub-Group Comparisons

- No significant difference ($p > .05$) between:
  - Boys vs. girls
  - Mothers with vs. without a high school diploma

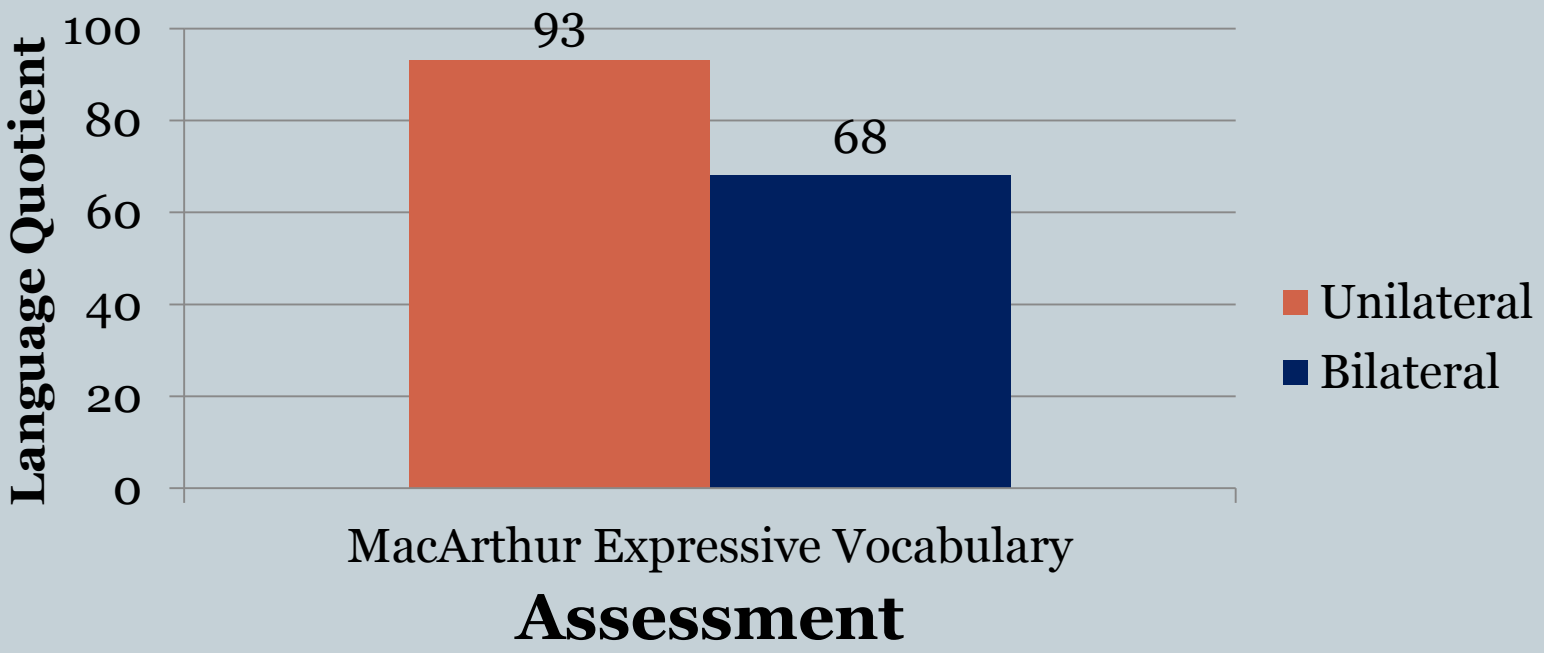
# Bates-MacArthur Exp Vocabulary: Sub-Group Comparisons

- Significant differences ($p < .05$):
  - Unilateral vs. bilateral hearing loss
  - No additional disabilities vs. having additional disabilities
  - Mild/Mod vs. mod-severe to profound hearing loss
  - Identification of hearing loss by vs. after 6 months of age

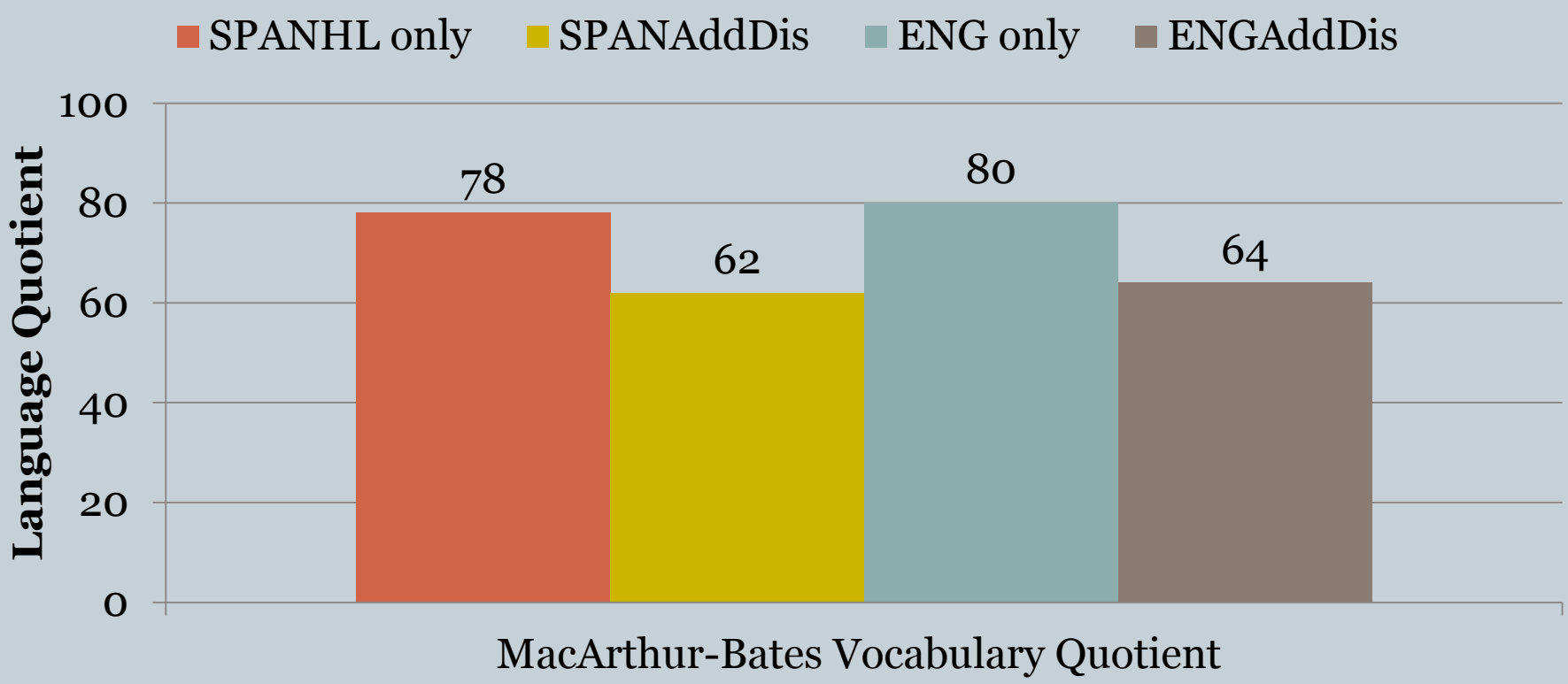
# Deaf vs. Hearing Parent(s)



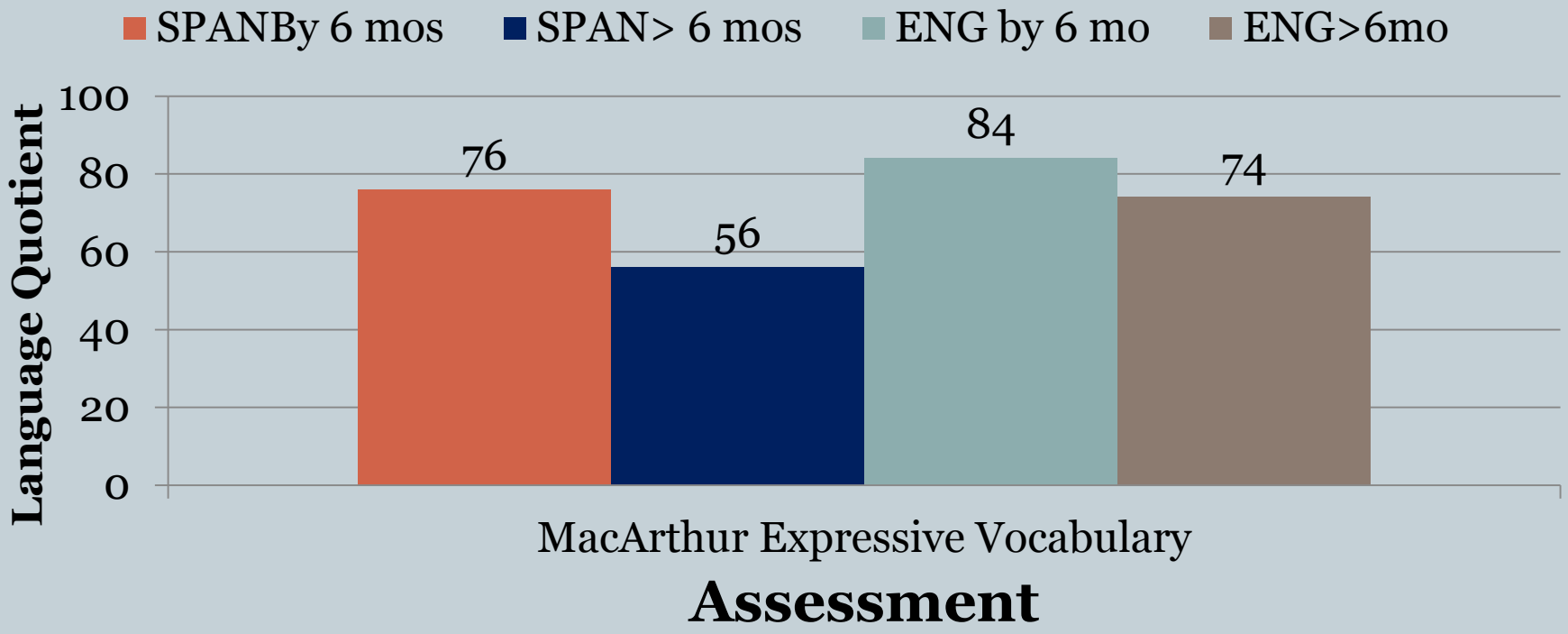
# Unilateral vs. Bilateral Hearing Loss



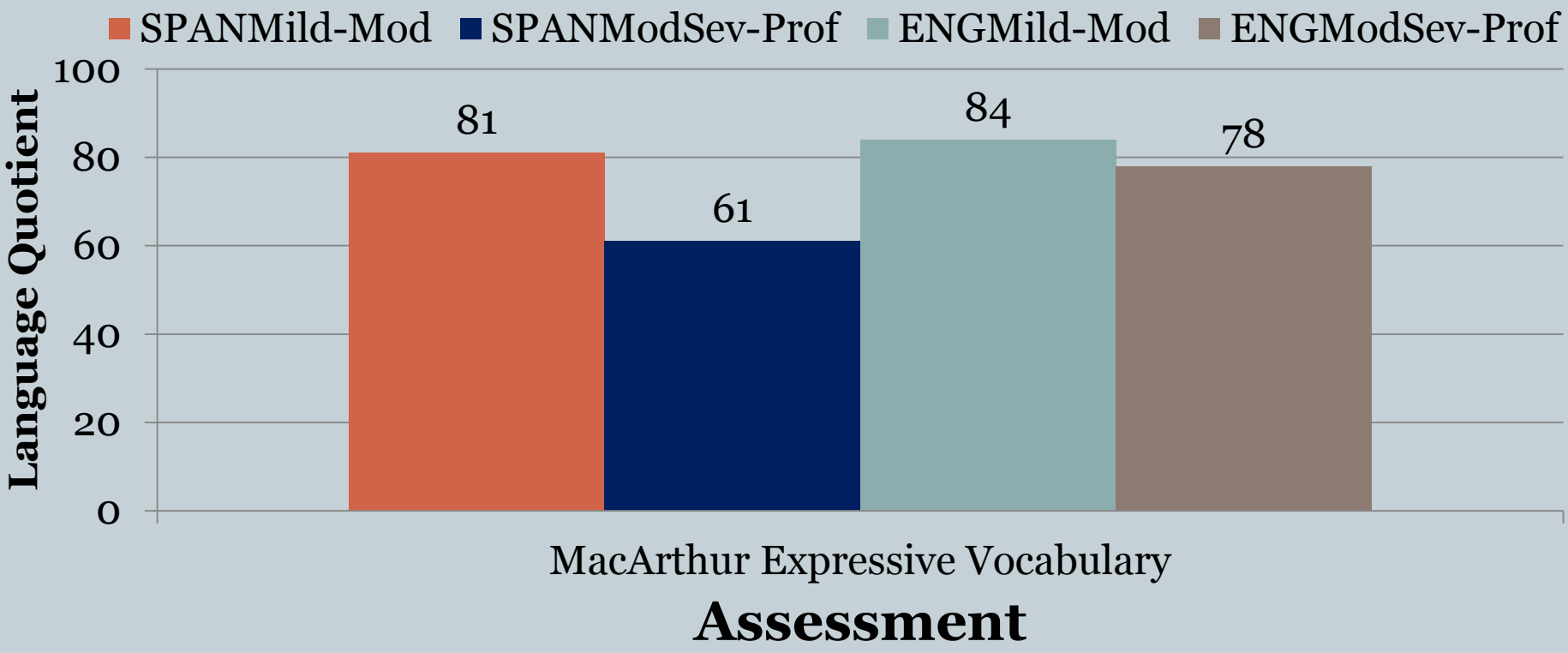
# MacArthur Bates Vocabulary Quotient Additional Disabilities vs. HL Only



# MacArthur-Bates Expressive Vocabulary Identification by 6 months vs. Later



# MacArthur-Bates Expressive Vocabulary
# Mild to Mod HL vs. Mod-Sev to Profound HL



# Conclusions

- More than half of the children demonstrated significant language delays
- Median language quotients were lower for children from Spanish-speaking compared to English-speaking homes
- Typically children scored more poorly on cognitive-linguistic items compared to both vocabulary and more concrete/routine language items

# Conclusions

- Expressive vocabulary quotients were higher (on average by 20-25 points) for children who had:
  - Unilateral hearing loss
  - Intervention by 6 months of age
  - No additional disabilities
  - Mild or moderate hearing loss

# Language Outcomes of Children with Cognitive Delays/Disorders and Hearing Loss

- The conventional method of reporting the language outcomes of children who are Deaf Plus with cognitive delays/disorders is to report their scores by chronological age.

- However, that method does not provide the family and early intervention provider with enough information to know whether or not the children are achieving to their cognitive potential and whether they are maintaining this development.

# What do we know about children who are Deaf Plus

- Parental stress is highly related to language outcomes (birth through 5 years) but Colorado parents with children who are Deaf Plus with EI support do not report any higher degrees of increased parental stress (Pipp-Siegel, 2000)
  - Immediate support from highly knowledgeable providers is critically important
- Maternal emotional availability (bonding) predicts language gain (Pressman et al., 2000)
- The Symbolic Play Assessment Questionnaire (PAQ) is highly related to productive vocabulary development (Snyder & Yoshinaga-Itano, 1999; Yoshinaga-Itano & Snyder, 1999)

# Intervention targets

- Mastery motivation is highly related to language outcomes particularly for children who are Deaf Plus (birth through 5 years) (Pipp-Siegel, 2005)
  - Mastery motivation of social interactions predicts language outcome
  - Effect is greatest for children who are Deaf Plus

# KENT INVENTORY OF DEVELOPMENTAL SKILLS (KIDS)

- N=25
- CA= 5 months to 33 months
- Mean = 13 months
- 14 children had no additional disabilities
- 11 children had additional disabilities

- Developmental Quotients should be interpreted conservatively. When infants are very young, e.g. 6 months, even a 2 month delay can result in a quotient of 67

# Children without additional disabilities (N=14)

- Mean CA= 6 months (range =5 months to 13 months)
- Median language quotient = 85 (range =12 to 146)
- Language quotients 80 or greater= 50% of children
- Language quotients 70 to 79 = 7% of children
- Language quotients less than 70 = 43% of children

# Children with additional disabilities (N=11)

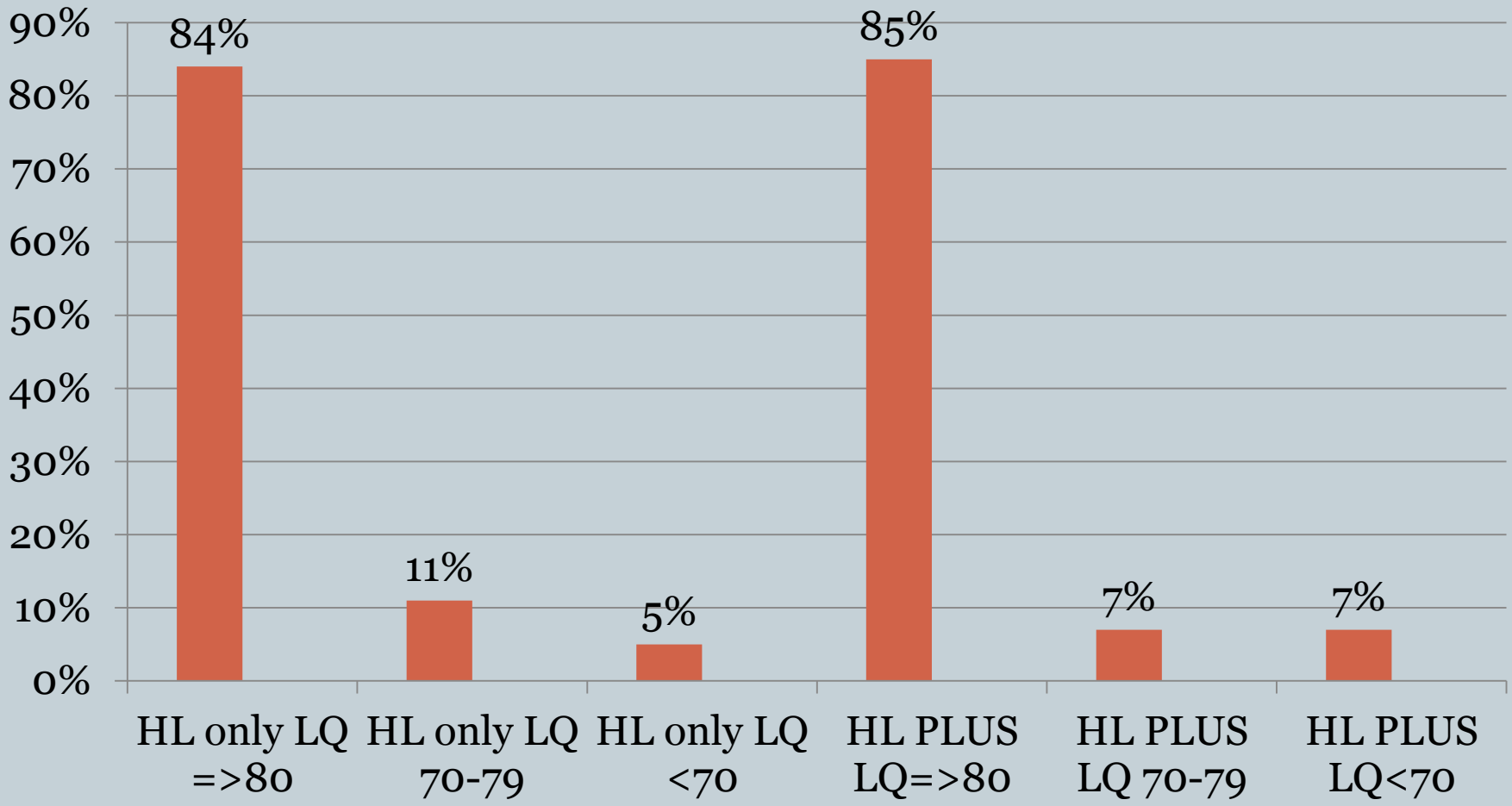
- Median CA= 21 months ( range = 6 months to 33 months)
- Median language quotient (relative to cognitive age) = 103 (range = 37 to 173)
- Language quotient 80 or above = 82% of children
- Language quotient 70 to 79 = 0% of children
- Language quotient less than 70 = 18% of children

# Minnesota Child Development Inventory – Expressive Language Scale

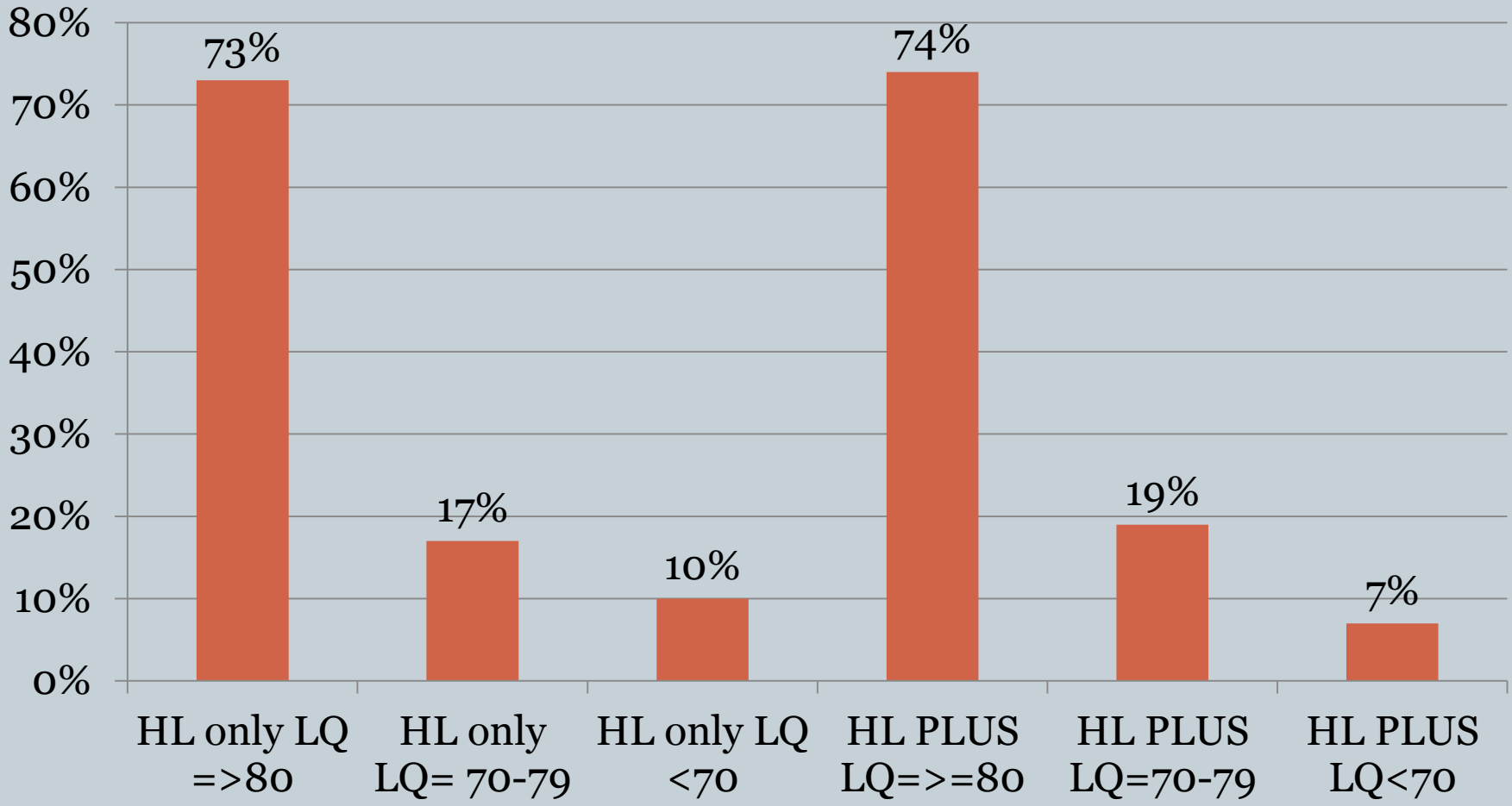
- N=108
- Range 14 to 35 months (mean 27 months)
- 81 children had no additional disabilities
- 27 children had additional disabilities

- The Colorado database has 2200+ children in the database. This data reflects a single year and is representative of past year's analyses.

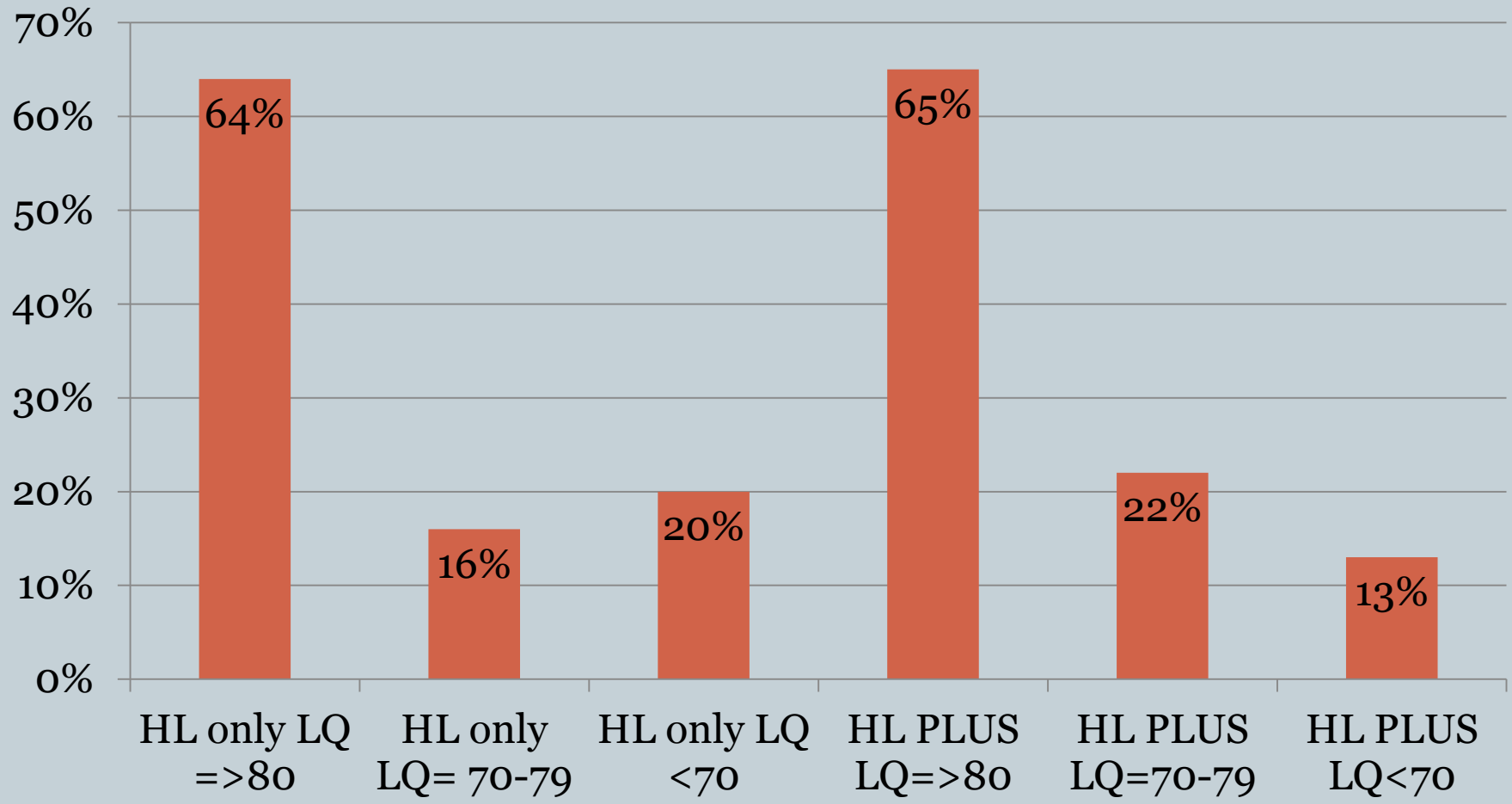
# CDI Expressive Language
# (HL only N=81, Median 94)
# (HL PLUS N=27 relative to cognitive age Median 97 )



# CDI Comprehension-Conceptual
# HL only N=81 Median 93
# HL PLUS N=27 Median 102 relative to cognitive age



# MacArthur Quotients: HL only N=75, Median 83 HL PLUS N=23, Median 95



# Expressive One Word Picture Vocabulary Test

- N= 57
- 36 completed EOWPVT and 21 did not
- Of the 36 who completed the assessment 8 had additional disabilities judged to impact development
- Children without additional disabilities (N=28)
- Mean CA = 33 months (range – 31 to 36 months)
- Median standard score = 100 (range <55 to 116)
- Median percentile score = 50 (range =<1$^{st}$ to 86$^{th}$)

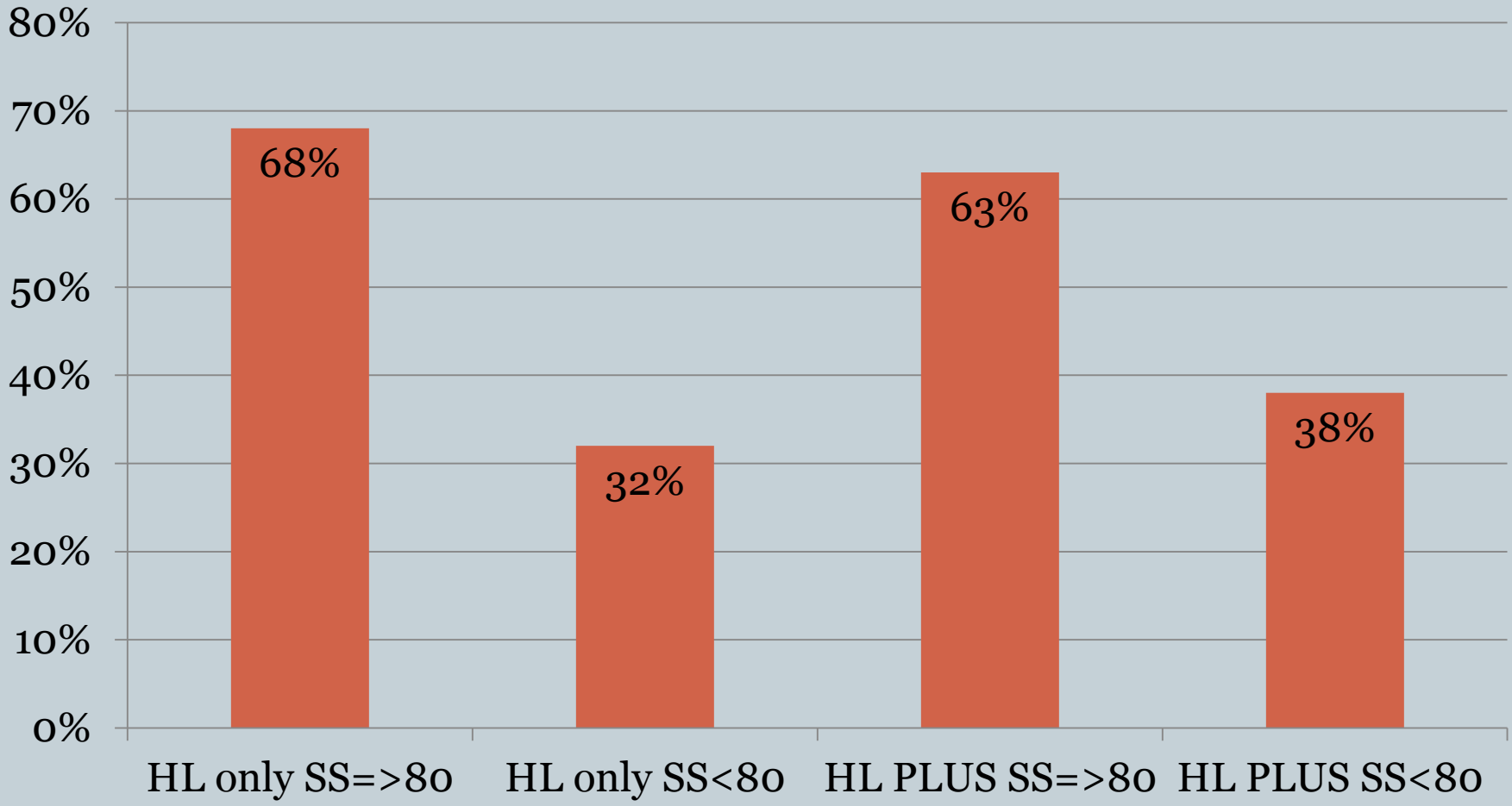
# Demographic data

- Spoken language only = 21%
- Spoken language primarily with occasional signs = 56%
- Spoken + sign language = 21%
- Sign language only = 2% (parents were deaf)

# Children without additional disabilities: EOWPVT – N=28

- Standard scores 80 or above = 68%
- Less than 80 = 32%

# EOWPVT Standard Scores –HL only N=57, Median score 98, HL PLUS N=8, Median score 92 relative to cognitive age

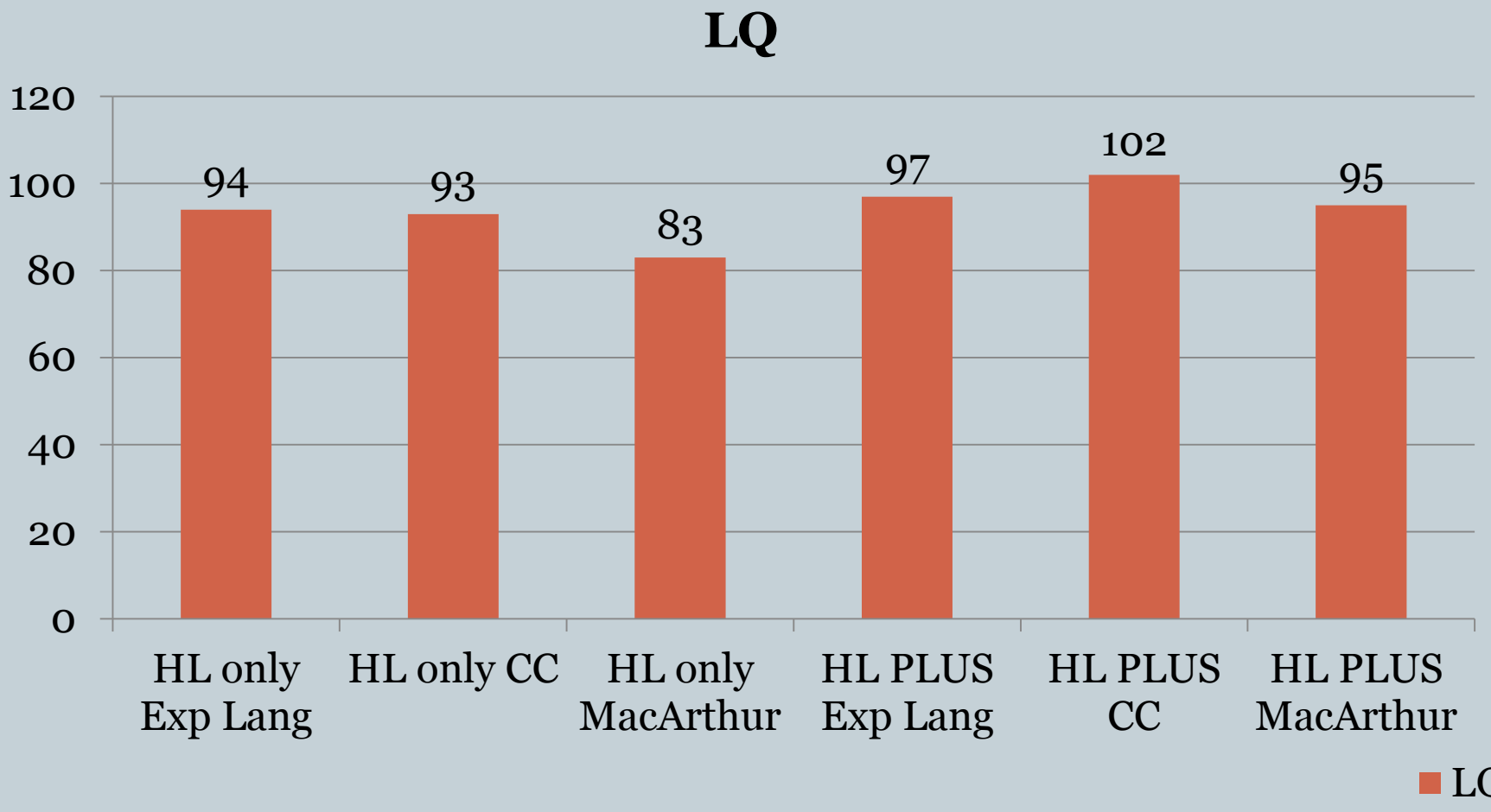


# Parent Sign Checklist

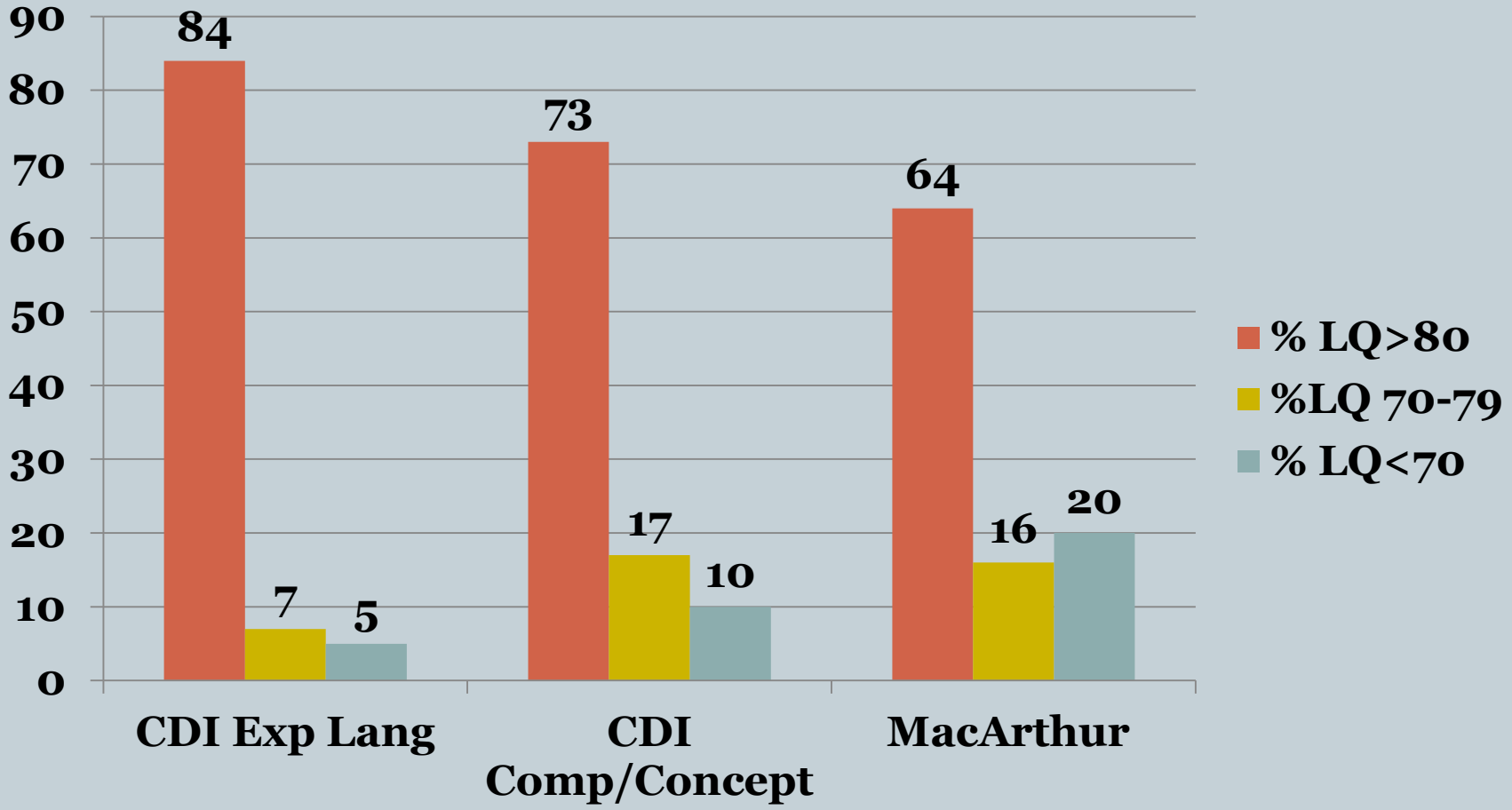
- N=28 of 31 who indicated that they tried to sign all or most of the time when communicating with their child
- Profile of the children
- Mean CA = 27 months (range = 5 to 34 months)
- Parent ability:
- Median percentage of known signs on the inventory = 72% (range – 2 to 100%

- CA 1 to 11 months – Median percentage of signs = 100 (N=2)
- CA 12 to 23 months – median percentage of signs = 62%  (range – 5 to 73%) (N=5)
- CA 24 or more months – Median percentage of signs = 72% (range 2 to 100%) N=21)

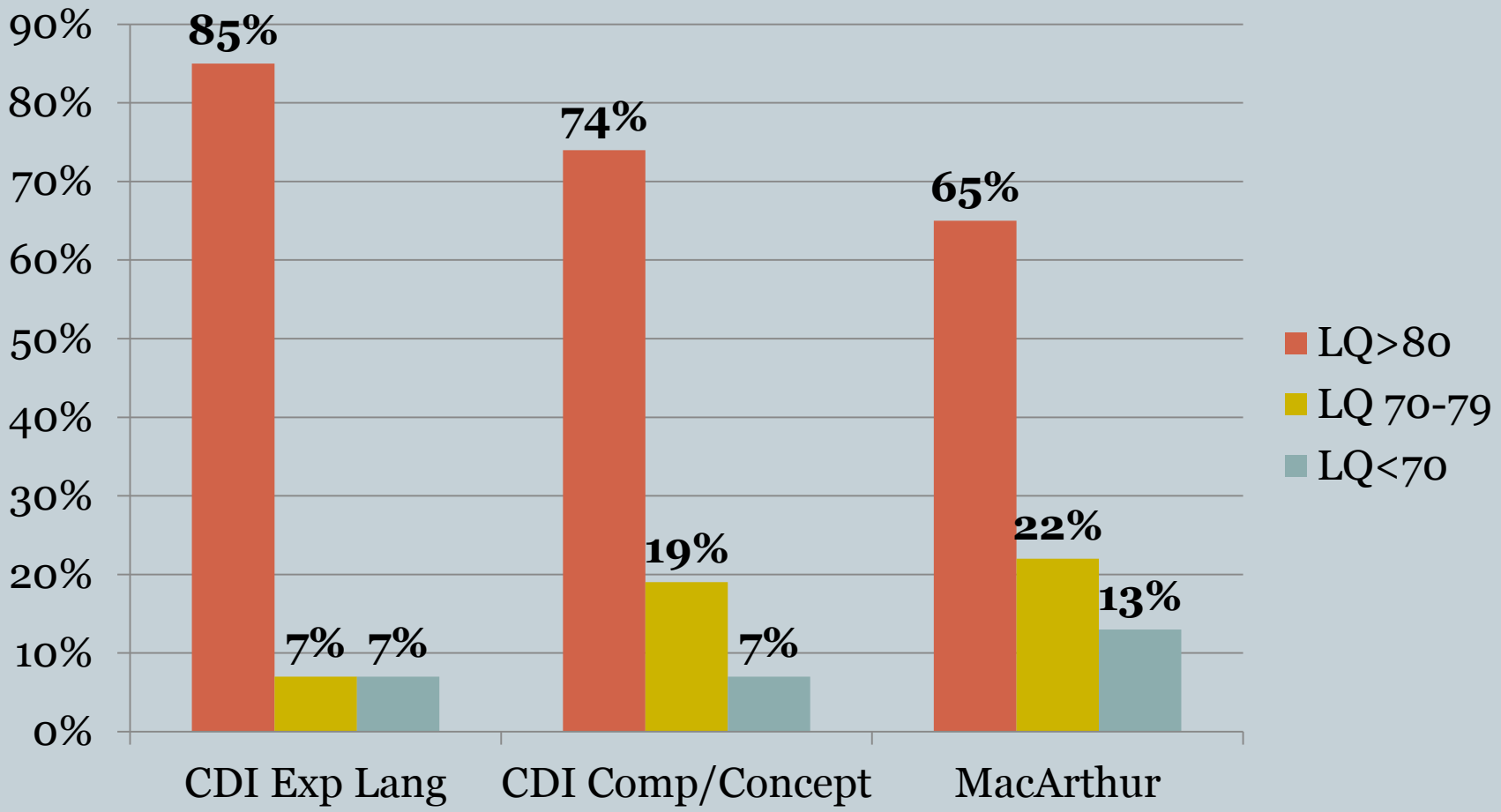
# Language Quotients HL only and HL Plus (relative to cognitive age)



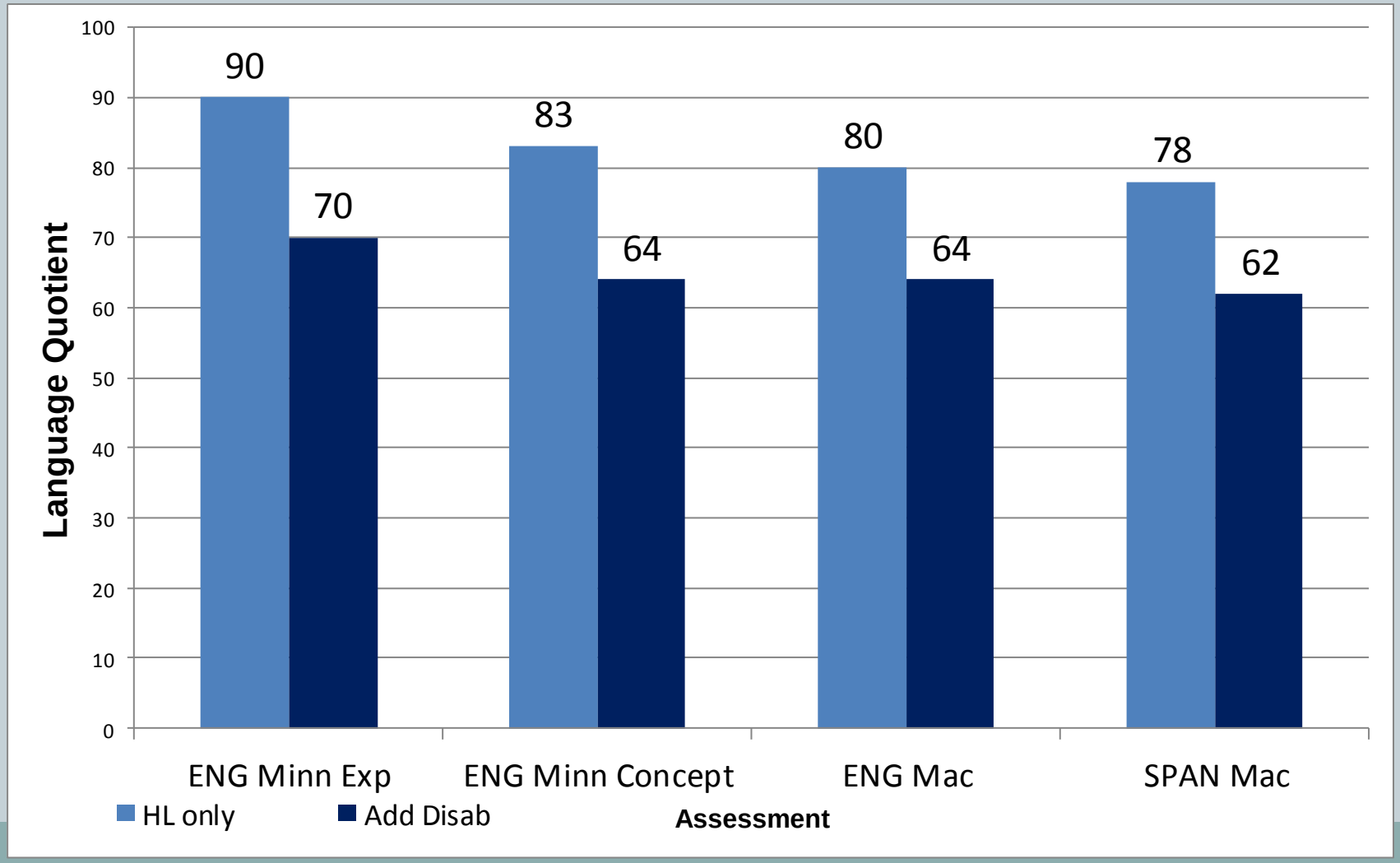
# % Colorado children with LQs in the normal, borderline and delayed range – no additional disabilities



# % Colorado children with additional disabilities: LQ relative to Cognitive Age



# NECAP (8 states excluding CO) Hearing Loss only versus additional disabilities (relative to chronological age)



# Early screening and identification of autism in children who are deaf or hard of hearing

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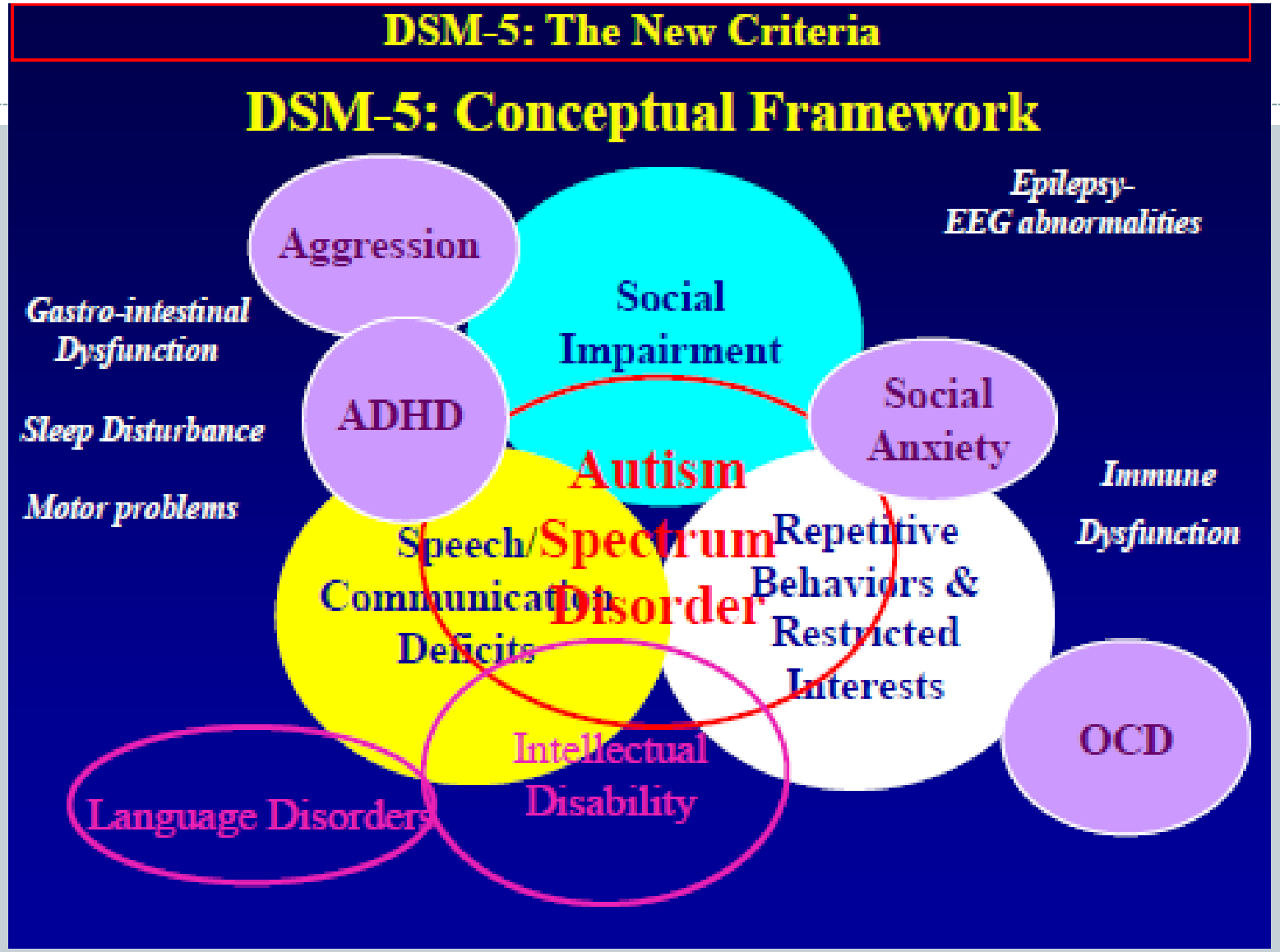
From Walter E Kaufmann, MD, Boston Children's Hospital




http://autismconsortium.org/symposium-files/WalterKaufmannAC2012Symposium.pdf

# LENA DATA COMPARING CHILDREN WHO ARE HARD OF HEARING WITH CHILDREN WITH TYPICAL DEVELOPMENT, ASD, AND LANGUAGE DISORDERS

# Unique Acoustic Characteristics of Children with Autism and Their Caregivers:

Dongxin Xu [1,2]

Jill Gilkerson [1,2], Jeffrey Richards [1], Steve Rosenberg [3]

[1] LENA Research Foundation, Boulder, Colorado, USA

[2] University of Colorado, Boulder, Colorado, USA

[3] University of Colorado, Denver, Colorado, USA

www.lenafoundation.org

# Different Technologies & Instruments in Autism Research:

- Questionnaire & Human Observation
- Video, Eye Tracking, EEG, fMRI, ……
- **Audio Recording**

# Advantage of Audio Recording:

- Convenient Operation
- Large Sample Size
- Naturalistic Setting
- Automatic Processing
- Objective Measurement

# Cost Effective Way of Studying:

- Child
- Caregiver
- Their Interaction

In Natural Environment

# Rich Information:

- **Not just Child Vocal Behavior**

**AND**

- **Child Social-Emotional Behavior**
- **Language and Communication Development**
- **Articulatory Motor & Stereo-type Behavior**

# Demonstrate the Potential:

- Naturalistic Audio Recording
- Automatic Processing

- **Study Objective Features & Measurements:**
  - Child Interaction with Environment
  - Child Vocal & Phonetic Development
  - Developmental Trajectories
  - Unique Characteristics

    **(compared with children of Typical Development & Language Delay)**
  - Caregivers of Children with Autism

## LENA: Language ENvironment Analysis

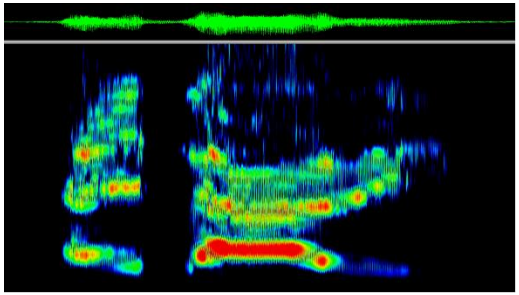


# Automatic Processing

Audio Stream of Child Voice
& Environment Sound

Identification of Different Sounds (Segmentation)

Sequence of
Key Child,
Adult,
Environment Noise
Overlapped Sounds
.....



Human Voice
(Child or Adult)

Phone Recognition

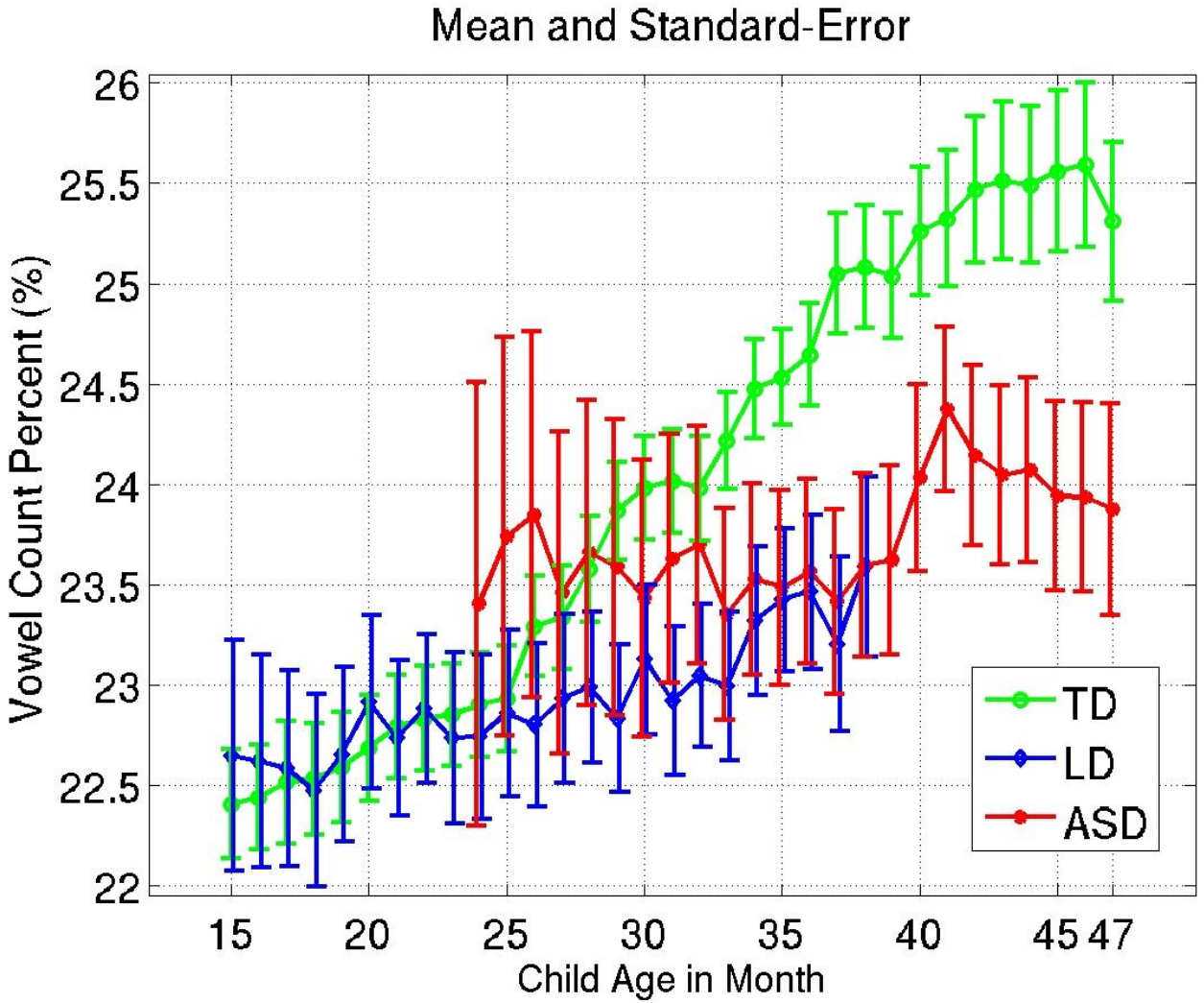
Consonant-like Sound,
Vowel-like Sound,
Non-Speech Sound,
Pause

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

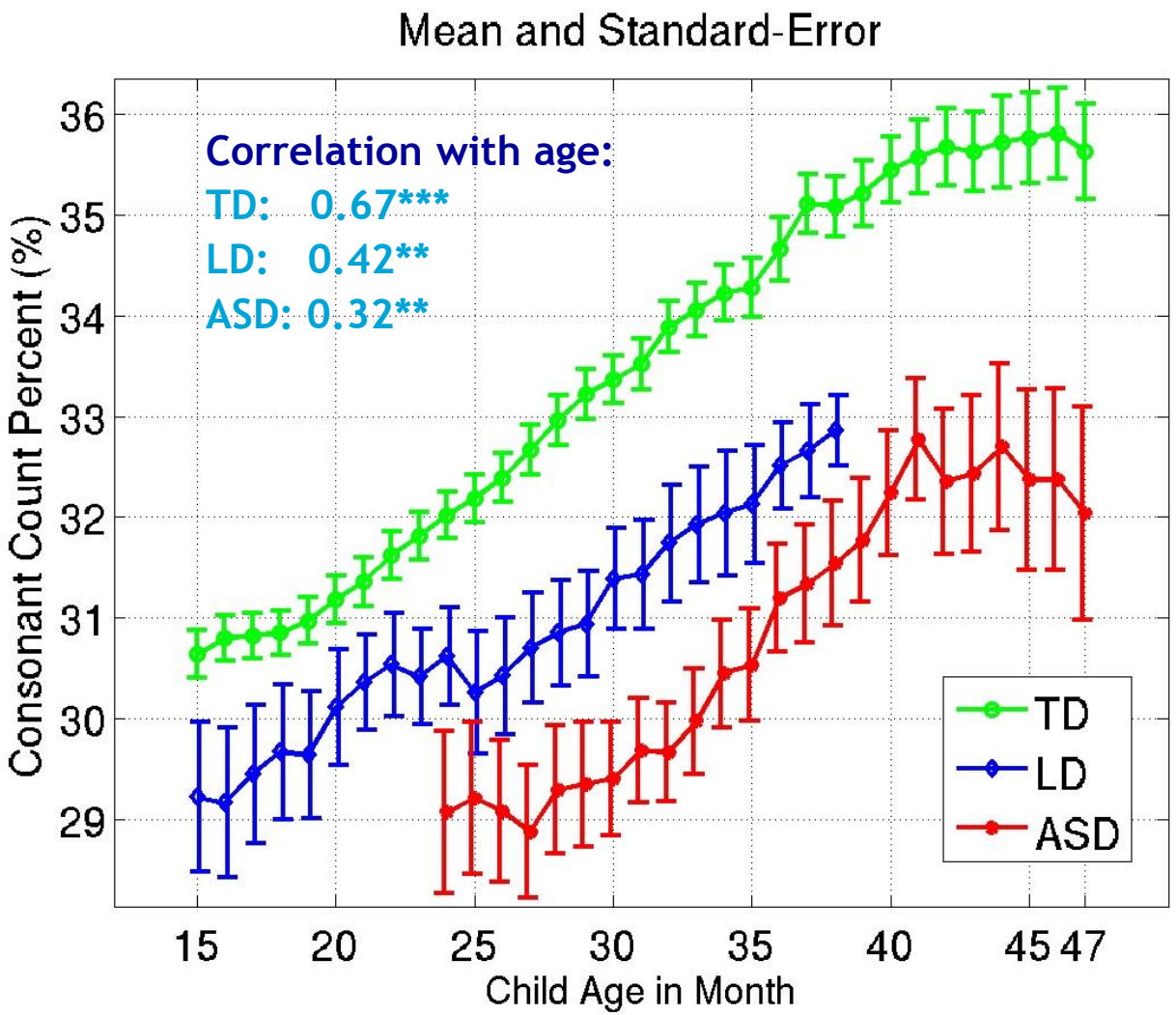
In the following slides of results of findings

- Green: Typical Development (TD)
- Blue: Language Delay not Related to Autism (LD)
- Red: Autism (ASD)

# Frequency of Vowel-like Sound



# Frequency of Consonant-like Sound




**t-test**

(Welch 2-sample 2-side)

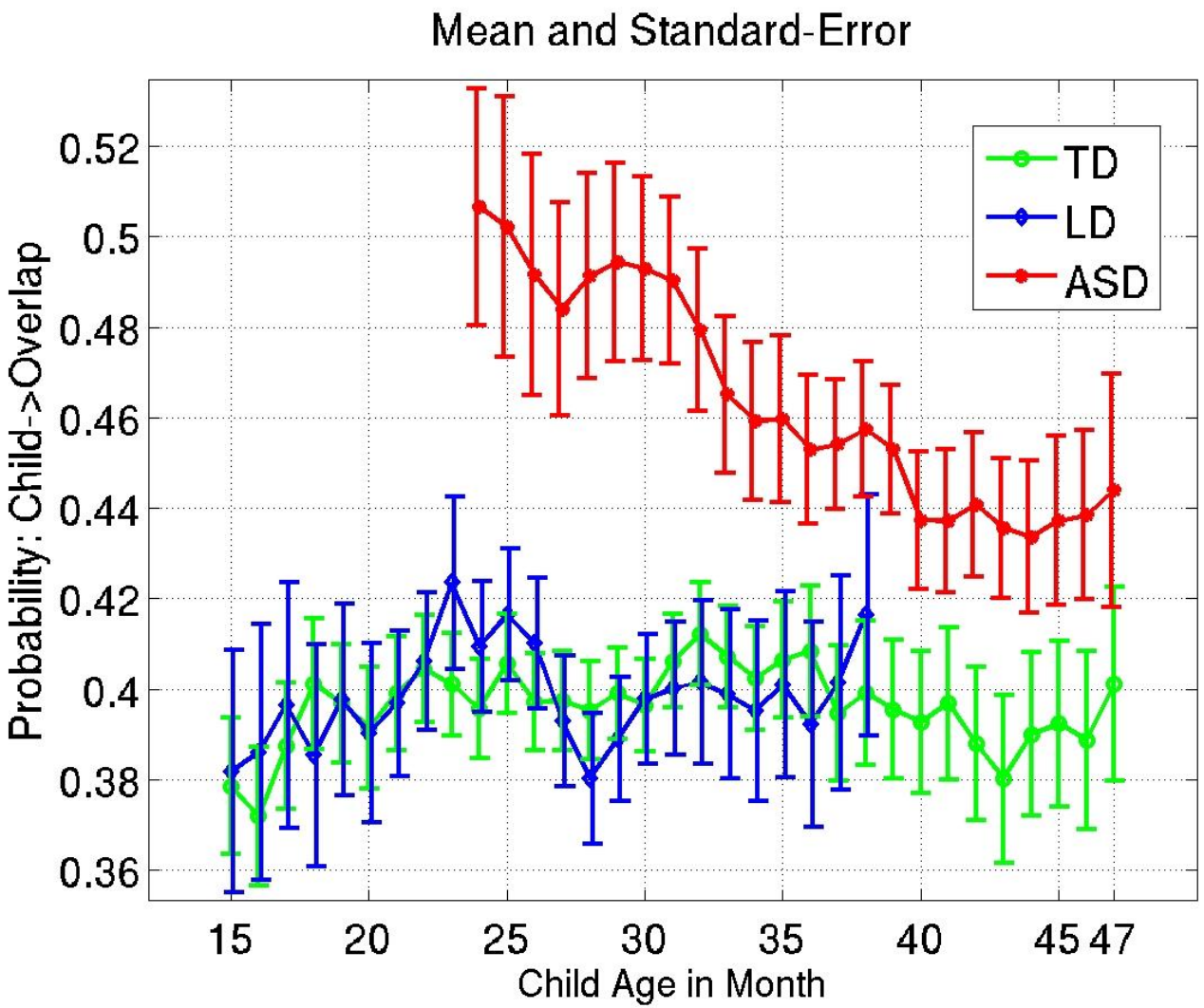
TD versus ASD:
t(90) = 7.95***

TD versus LD:
t(68) = 5.52***

LD versus ASD:
t(118) = 2.62**

*p<0.05
**p<0.01
***p<0.001

# Probability of Sound Collision




**t-test**

(Welch 2-sample 2-side)

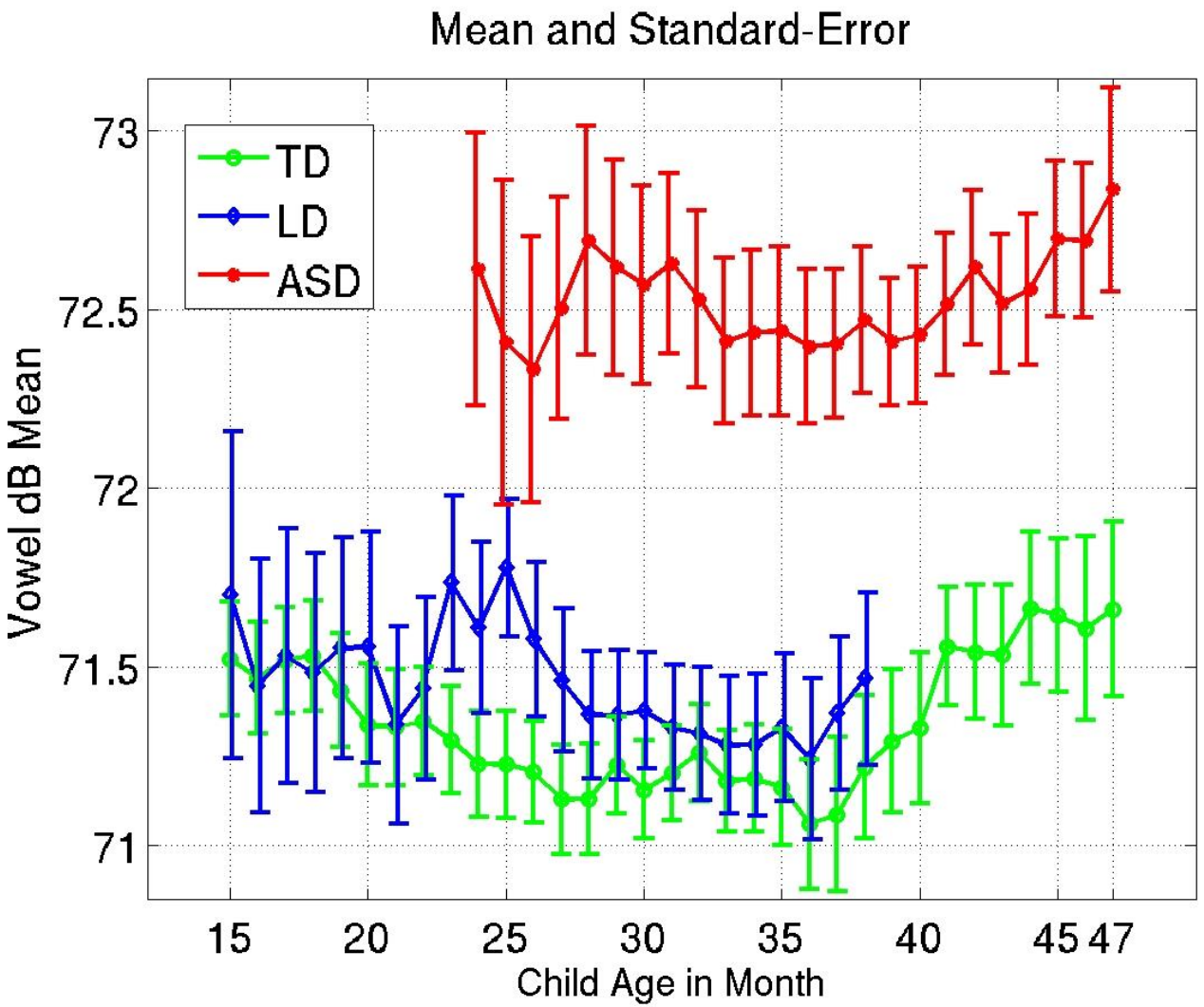
**ASD versus TD:**
**t(132) = 3.66*****

**ASD versus LD:**
**t(111) = 2.94****

**TD versus LD:**
**t(90) = 0.13**

*p<0.05
**p<0.01
***p<0.001

# Child Vowel Volume (dB)




**t-test**

(Welch 2-sample 2-side)

**ASD versus TD:**
**t(125) = 5.84*****

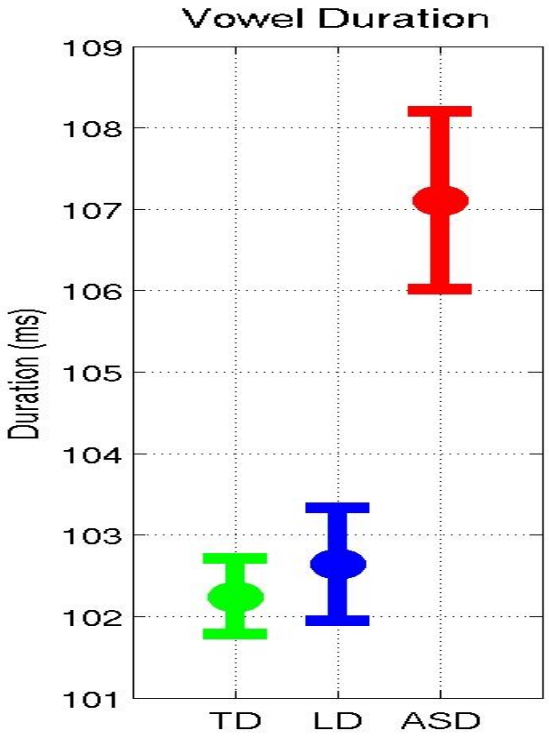
**ASD versus LD:**
**t(117) = 4.78*****

**TD versus LD:**
**t(97) = 0.45**

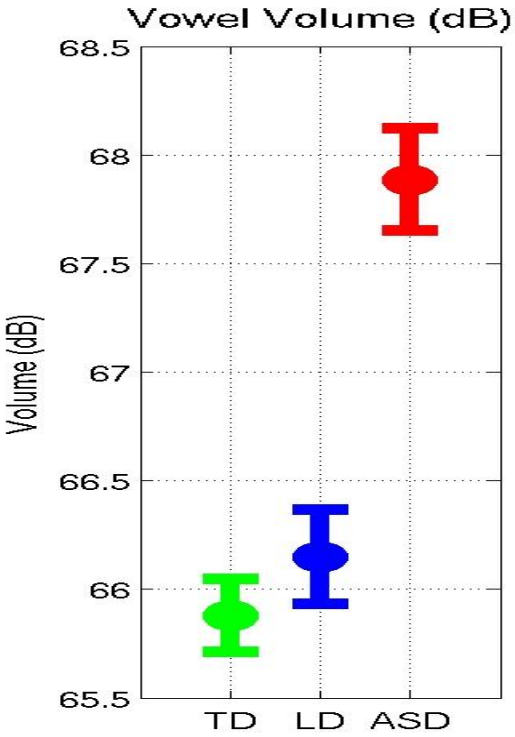
*p<0.05
**p<0.01
***p<0.001

# Characteristics of Female Caregiver (Vowels inside "Child-directed" Voice)

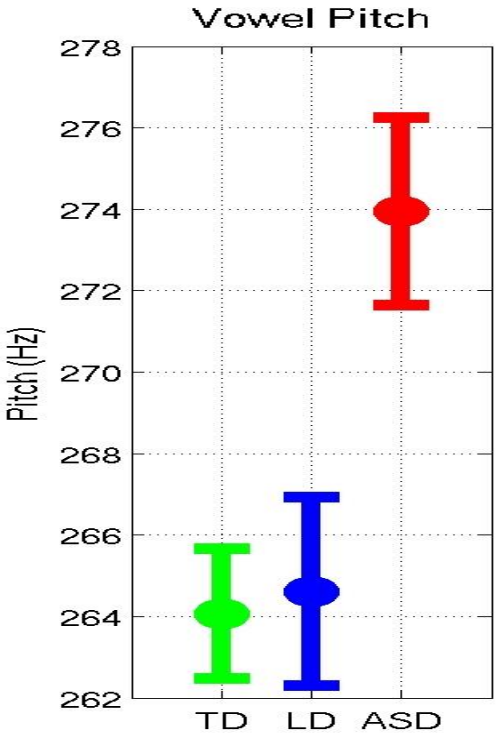
## Mean, Standard Error and t-Statistics




ASD-vs-TD: 4.63***
ASD-vs-LD: 3.58***
TD-vs-LD: 0.91




ASD-vs-TD: 8.58***
ASD-vs-LD: 6.09***
TD-vs-LD: 1.72

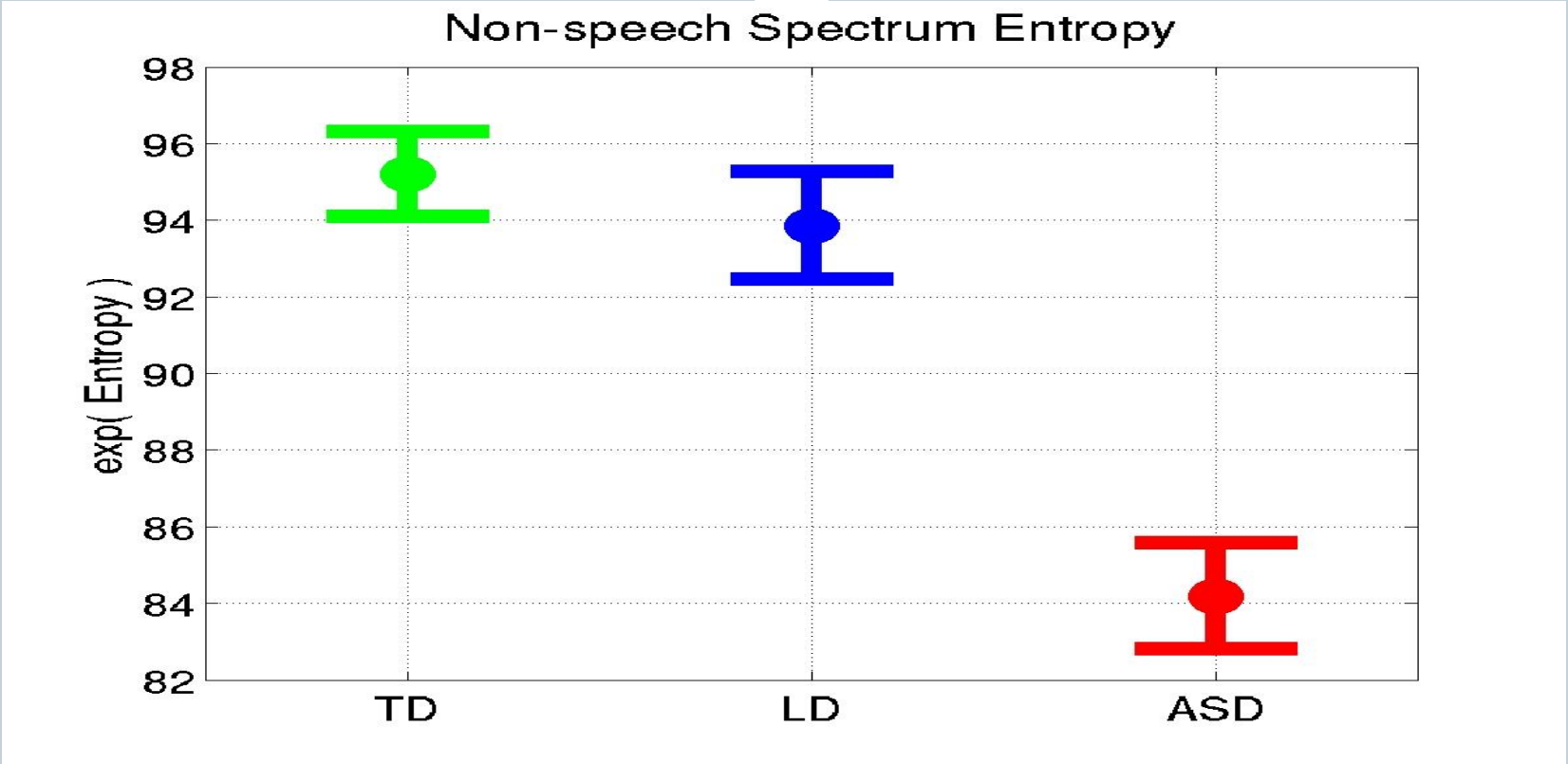



ASD-vs-TD: 3.37***
ASD-vs-LD: 2.25**
TD-vs-LD: 0.16

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

# Characteristics of Female Caregiver ("Child-directed" Non-Speech Voice)

## Mean, Standard Error and t-Statistics




**ASD-vs-TD: 7.02***; ASD-vs-LD: 5.44***; TD-vs-LD: 1.01**

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

# Conclusion: Unique Characteristics of Children with Autism:

- Less Frequent Consonant-like Sounds
- Higher Chance of Sound Collision
- Louder Vowel-like Sounds
- Lower Spectrum Entropy of Unvoiced Consonant Sounds (how noise-like versus tone-like a sound is)
- Discriminant Analysis: 94% (6% Equal-Error-Rate)

# Conclusion: Female caregivers of children with autism

- **Unique Characteristics of "Child-directed" Voice of Female Caregivers of Children with Autism:**
  - **Longer Vowel Duration**
  - **Louder Vowel Volume (dB)**
  - **Higher Vowel Pitch**
  - **Lower Spectrum Entropy of Non-Speech Sounds**

# Phonetic Development Analysis Using Automated Approach

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# Prosodic Features: Correlation with Phonetic Development Score (AVA)

| Child Group | N | C-Dr-SD | N-Dr-M | V-dB-M | V-f0-M | V-f0-SD |
|---|---|---|---|---|---|---|
| TD | 100 | -0.44*** | -0.64*** | -0.53*** | -0.54*** | -0.58*** |
| LD | 46 | -0.39** | -0.59*** | -0.14 | -0.13 | -0.04 |
| ASD | 67 | -0.43*** | -0.47*** | -0.09 | -0.41*** | -0.34** |
| HH | 39 | -0.62*** | -0.77*** | -0.55*** | -0.34* | -0.78*** |

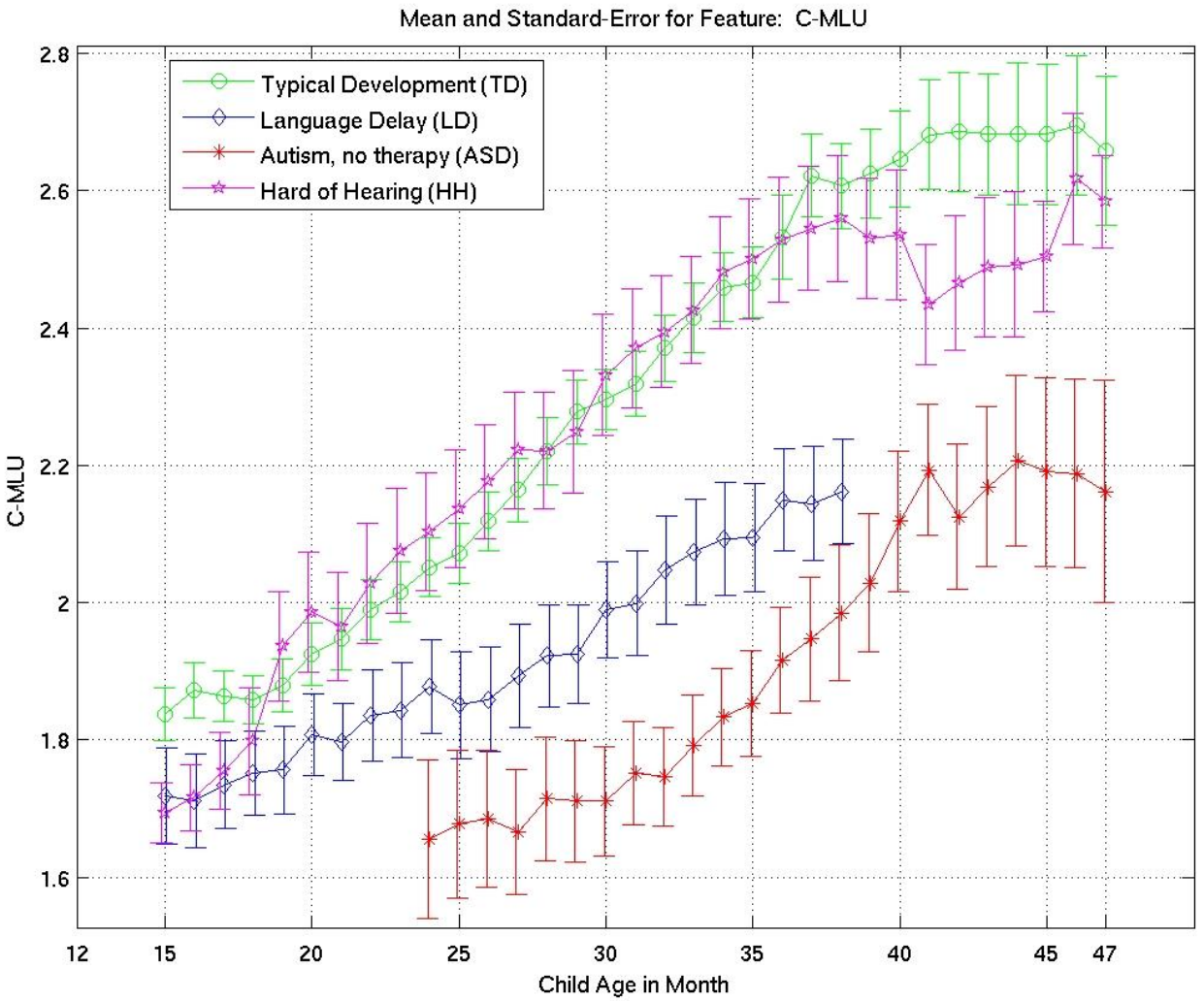
p-value: *: $p<0.05$, **: $p<0.01$, ***: $p<0.001$

# Result of C-MLU: Trajectories & Correlation with Chronological Age

**Correlation with chronological-age:**

HH: 0.51 ***
TD: 0.63 ***
LD: 0.32 *
ASD: 0.32 *

*: $p < 0.05$
**: $p < 0.01$
***: $p < 0.001$



# LENA and all children who are deaf or hard of hearing

- Including severe-profound/profound hearing loss
- Children with additional disabilities
- Holds promise
- Needs additional research
- Over-refers of children with severe-profound/profound hearing loss, late-identified children and children with HL and additional disabilities other than autism

# Question 1: Children with autism

- A. Have good conversational turn-taking skills
- B. Have a high proportion of sound collision when compared to children with typical development
- C. Have no differences in their vowel volume from typically developing children.

# Child Development Inventory: Social Quotient

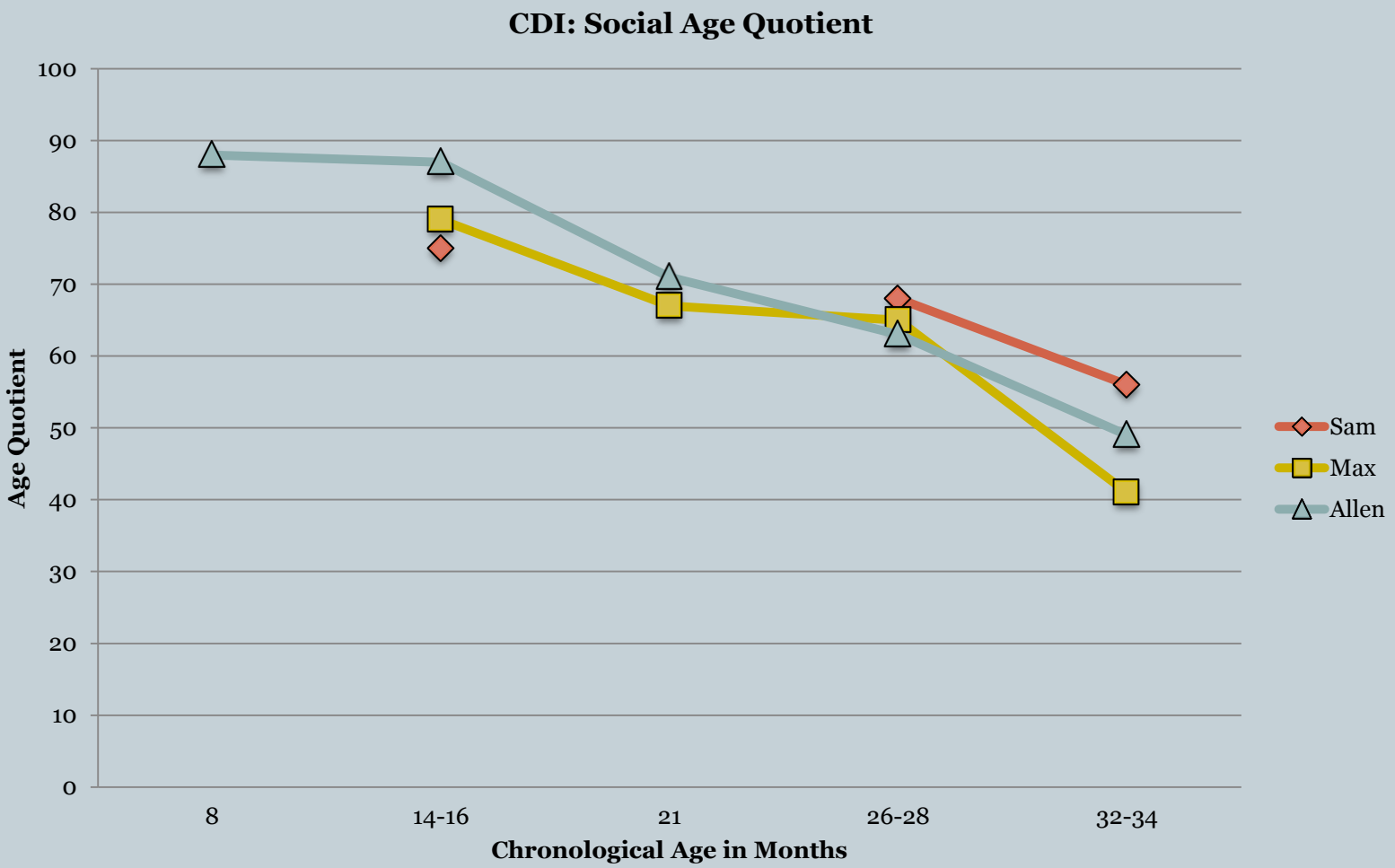
CHILDREN WITH AUTISM AND HEARING LOSS

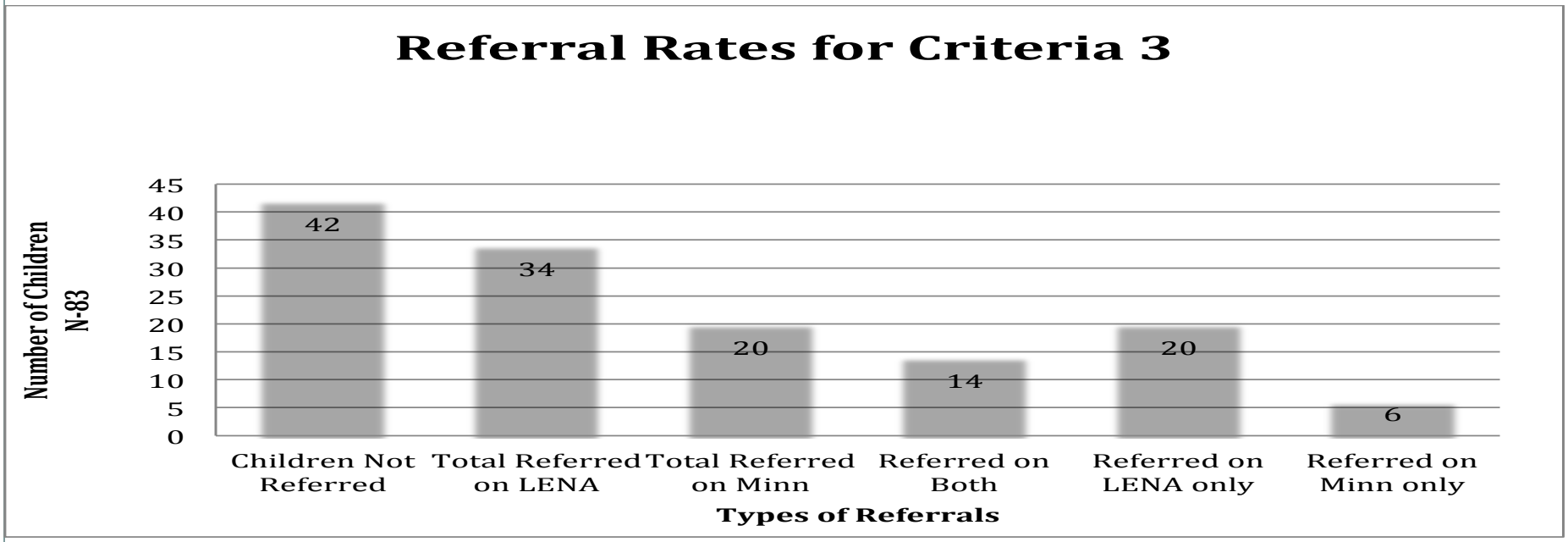
# Development Quotient

- (Development Age/ Chronological Age) x 100

- Decreases with time
- Both loss of skills and
- Failure to gain new skills – interaction with peers

# Personal-Social Quotient: CDI




Referral Rates for Criteria 3
Number of Children
N-83
45
40
35
30
25
20
15
10
5
0
42
34
20
14
20
6
Children Not Referred
Total Referred on LENA
Total Referred on Minn
Referred on Both
Referred on LENA only
Referred on Minn only
Types of Referrals

# Results

- LLAS is a robust measure resulting in the most accurate need for referral.
- Using a double screen (LENA and CDI) the refer rate for the LLAS and M-CDI is 16.87%
  - Those that referred on LLAS but not the M-CDI was 24.10%
  - Those that referred on the MINN-CDI Social but not the LLAS were 7.23%
- Therefore, using a double screen relying on LLAS is the most appropriate for determining who warrants referral for further evaluation
- The sensitivity for referral is robust for all types of hearing loss, except  for bilateral severe/profound hearing loss

# Results: Other Findings

- Among 20 children in the study flagged on the LLAS alone (not the social subscale on the MINN-CDI Social) did not have suspicions of ASD by their CHIP provider, suggesting further diagnostic evaluation may not be needed.
- 6 children were classified not at risk by the LLAS, yet had scores below the cut-off concern on the CDI Social (<0.8 quotient), one of whom has mild ASD (false negative on LLAS)
- 3 children in the study have been diagnosed with a form of ASD (2 with severe to profound HL), one of which was a false negative (did not screen positive) and the other two were noted as risk by LLAS
- The LLAS may not be sensitive enough to pick out minute vocal qualities of children with milder forms of ASD

# Implications

- CDI: WG Gestures
  - Gestures delayed for children with ASD*
  - Delays in gesture may be among earliest signs of ASD**
  - Compared to D/HH norms, Sam and Max between 25th and 50th percentile
    - Compared to children with hearing loss and ≥80 cognition, well below 25th percentile
    - Need to compare to peers

*(Charman, Drew, Baird, & Baird, 2003; Luyster, Lopez, & Lord, 2007; Miniscalo, Fränberg, Schachinger-Lorentzon, & Gillberg, 2012; Mitchell et al. 2006; Veness et al., 2012)
**(Mitchell et al. 2006)

# Implications

- Three profiles for children with hearing loss and ASD
  - Max
    - Very low, often zeroes at 9 and 14 months
    - Children with ASD: Impaired/delayed communication
  - Sam
    - Lost skills, especially between 21 and 32 months
    - Regression of skills in 10-50% of children with ASD*
      - Average onset of regression: 15 and 21 months**
    - Important to screen over time
  - Allen
    - Strong in raw numbers
    - Age quotient for expressive language steadily decreased

*(Landa, 2008)

**( Barton, Dumont-Mathieu, & Fein, 2012)

# Future Research

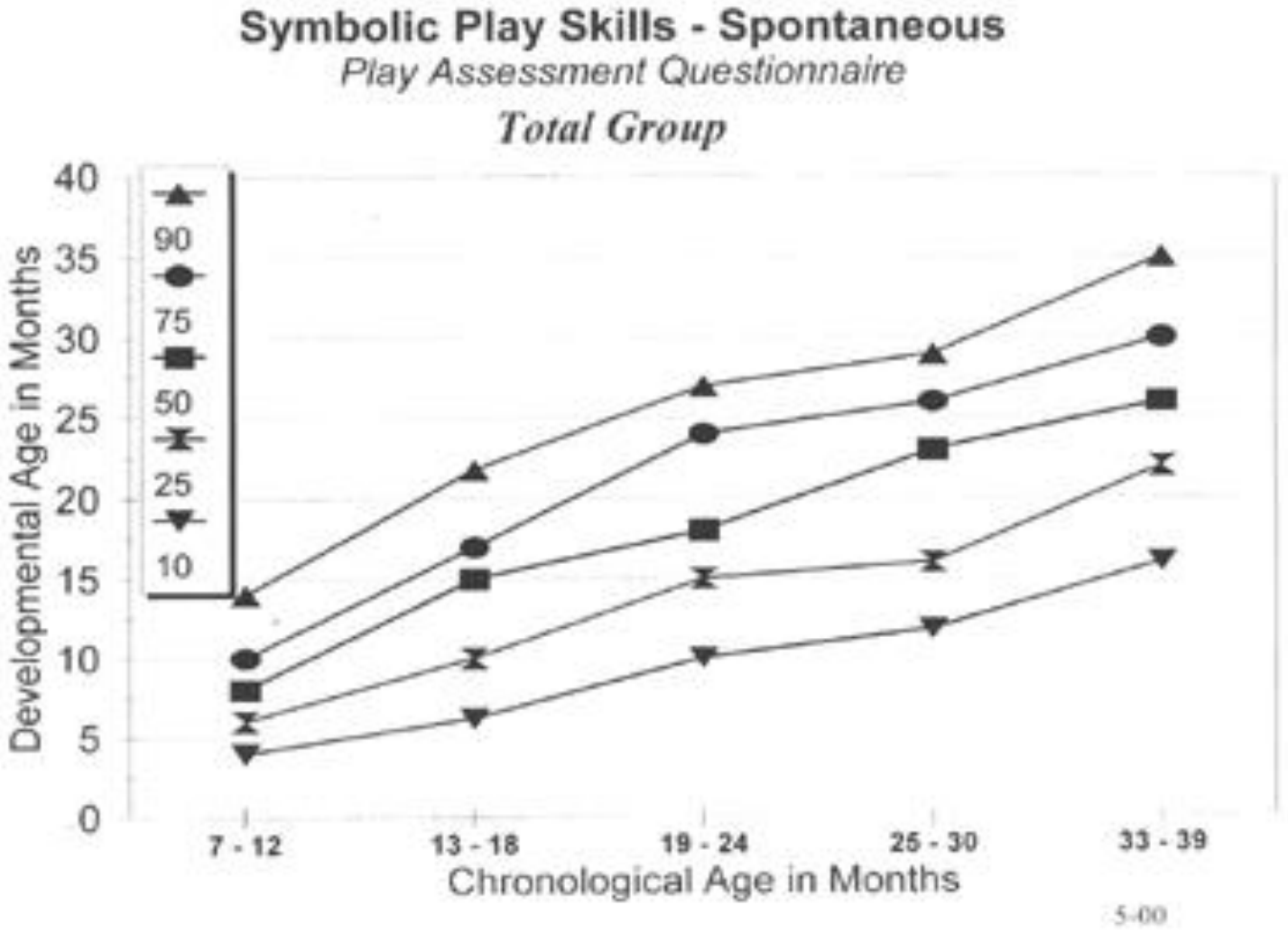
- *Pretending to be a Parent*
  - Compare subscale results for children with ASD to:
    - Children who are D/HH
    - Children with DD and are TD
  - Monitor gesture development (particularly *Pretending to be a Parent*) longitudinally
    - Do children (males) who are TD ever acquire?
    - Do children with ASD ever acquire?
    - Do girls with ASD acquire?
  - Does intervention targeting parent play bridge to later language comprehension or increased imaginative play?

# Future Research

- CDI: WG Gestures normed data passed 16 months
- Increase sample size
  - Compare children with ASD and hearing loss to children with/out hearing loss
- Investigate possibility of MacArthur-Bates CDI: WG as a screener for ASD, over time
- Analyze more of Allen's data to look for anomalies

# PLAY ASSESSMENT QUESTIONNAIRE

- Use this with total population.
- Has greatest benefit for children with cognitive delays or children with large gaps between cognition and language from later-identification or lack of early intervention.
- Parents have been extremely positive about this instrument.
- It serves as both an assessment and as a teaching tool for parents
- Highly related at over .9 relationship with MacArthur Communicative Development Inventories


Symbolic Play Skills - Spontaneous
Play Assessment Questionnaire
Total Group
Developmental Age in Months
40
35
30
25
20
15
10
5
0
90
75
50
25
10
7 - 12
13 - 18
19 - 24
25 - 30
33 - 39
Chronological Age in Months
5-00

# COMMUNICATION MATRIX

- Used with population that have significant developmental delays when Kent Infant Development Scales and Child Development Inventory are not related to intervention goals for the child because of the large developmental changes for children who are Deaf Plus.
- See handout

# Seminars in Speech and Language (in press)

- **Screening, Diagnosing and Implementing Interventions for Children who are deaf or hard of hearing with autism spectrum disorder**
- Co-Editors:  Christine Yoshinaga-Itano, Ph.D. & Amy Thrasher, M.A.

- Szarkowski, A., Mood, D., Shield, A., Wiley, S. & Yoshinaga-Itano, C. A Summary of Current Understanding Regarding Children with Autism Spectrum Disorder who are Deaf or Hard of Hearing
- Wiley, S., Innes, H. Supporting Families of Children who are Deaf/Hard of Hearing with an Autism Spectrum Disorder
- Carr, J, Xu, D. & Yoshinaga-Itano, C. Language ENvironment Analysis (LENA) Language and Autism Screen (LLAS) and the Child Development Inventory Social Subscale as a possible autism screen for children who are deaf or hard of hearing
- Kellogg, K.C., Thrasher, A., Yoshinaga-Itano, C. Early predictors of autism in young children who are deaf or hard of hearing:  three longitudinal case studies.
- Mood, D. & Shield, A. Clinical Use of the Autism Diagnostic Observation Schedule-Second Edition with Deaf Children

- Szarkowski, A., Flynn, S. & Clark, T. Dually Diagnosed: A retrospective study of the process of diagnosing autism spectrum disorders in children who are deaf and hard of hearing
- Shield, A., Preliminary findings of similarities and differences in the signed and spoken language of children with autism
- Thompson, N. & Yoshinaga-Itano, C. Enhancing the development of infants and toddlers with dual diagnosis of autism spectrum disorder and deafness
- Thrasher, A. Video modeling for children with dual diagnosis of D/HH and ASD to promote peer-interaction

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Veness, C., Prior, M., Bavin, E., Eadie, P., Cini, E., & Reilly, S. (2012). Early indicators of autism spectrum disorders at 12 and 24 months of age: A prospective, longitudinal comparative study. *Autism : The International Journal of Research and Practice*, *16*(2), 163–77. doi:10.1177/1362361311399936