

DEAFNESS AND AUTISM: DIFFERENTIAL DIAGNOSIS WITH ACOUSTICS

Symbolic Gesture

- Children with autism have difficulty with symbolic gesture.
- Current research is investigating the specific symbolic gestures that are difficult.
- Children who are deaf or hard of hearing who have been diagnosed with autism have failed to develop symbolic gestures at the same rate as their non-autistic deaf and hard of hearing peers.

MACARTHUR WORDS AND GESTURES: GESTURE DEVELOPMENT

Subcategories:

First communicative gestures

Games and Routines

Actions with Objects

Pretending to be a Parent

Imitating Other Adult Objects

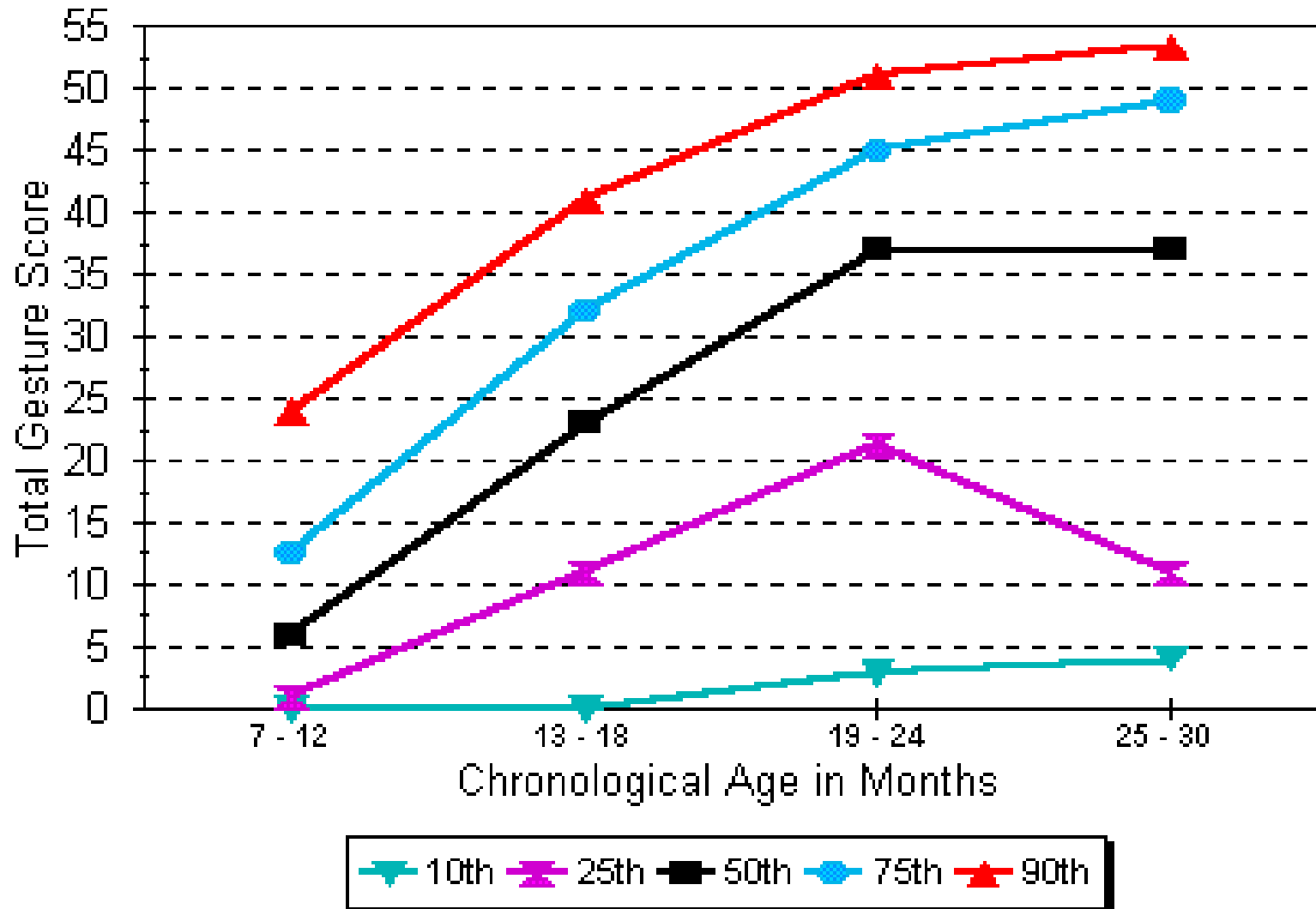
Pretend Objects

use of symbolic gestures

- Children with auditory neuropathy have symbolic gesture that is within the normal range
- Children who are deaf or hard of hearing typically have symbolic gesture development similar to children with normal hearing
- When children fail to develop symbolic gestures at the rate of typical development from 9 to 16 months – this is a risk factor for autism, motor delay, or cognitive delay

MacArthur CDI: Total Gestures

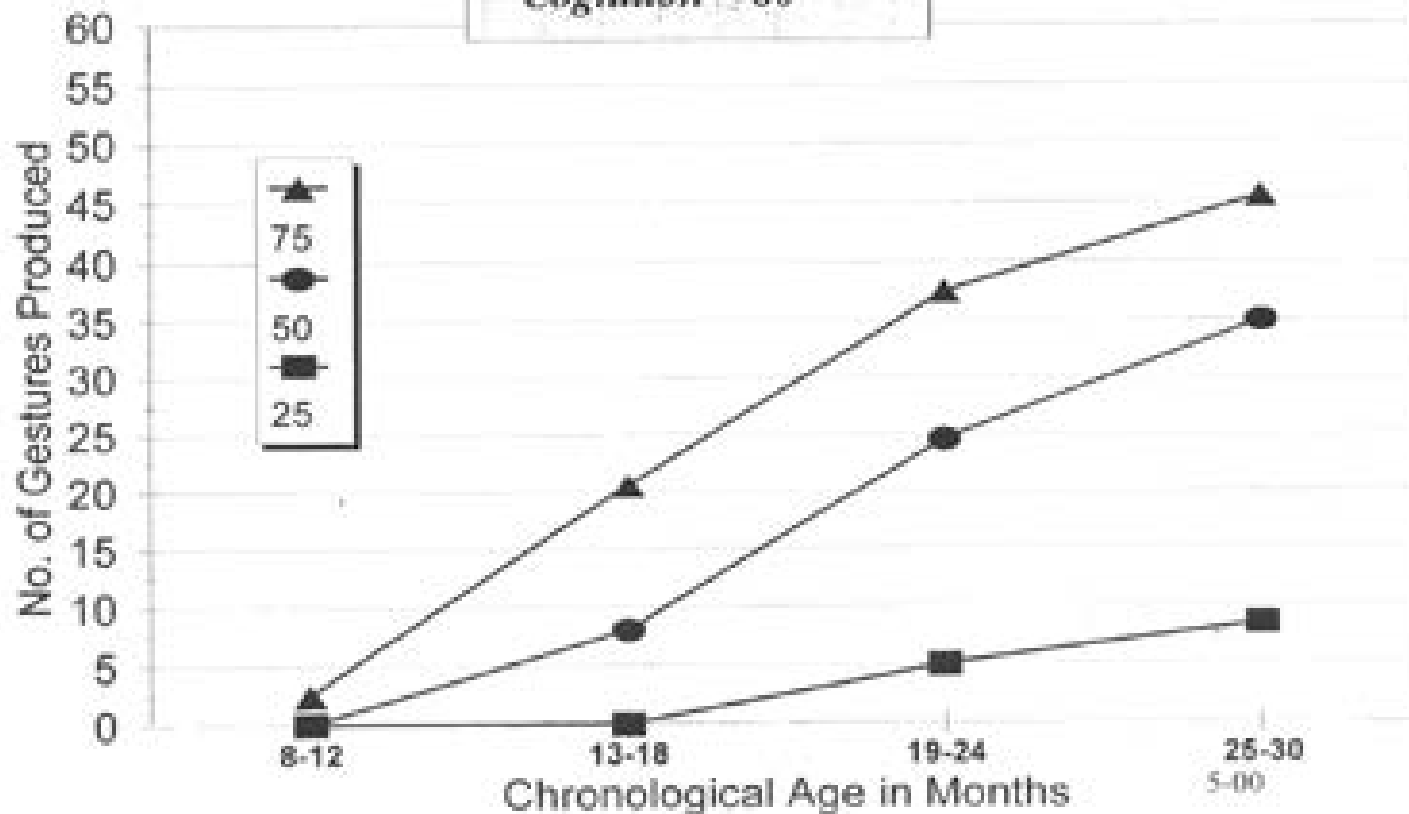
Total Group



Total Gestures

MacArthur Words & Gestures

Cognition < 80



PLAY ASSESSMENT QUESTIONNAIRE

Development of symbolic play

- Children who are deaf or hard of hearing should develop symbolic play at the same rate of development as children with normal hearing.
- Children with auditory neuropathy have symbolic play development within the normal range
- If a children who is deaf or hard of hearing fails to develop symbolic play similar to typical development, this may indicate a secondary disability:
 - Motor delay – significant delays that are comparable to delays in symbolic play
 - Autism - starts out in normal range – becomes increasingly delayed with increasing age and subsequent assessments
 - Cognitive delay – significant delay but it is consistent at each assessment

Children with Autism

- We are examining about 12 children who have been diagnosed with autism and who have varying hearing levels.
- It appears that the gestures developed by 9 months of age for these children can be within the normal range for children who are later identified as autistic.
- However by 18 months of age, a significant feature seems to be that the children have plateaued in their symbolic gesture development and although they may have age level scores at 9 months – the lack of further development results in a significant delay by 15 months of age. It is possible that we may be able to see this plateau in symbolic gesture development if we sampled the children more often than every 6 months.

Symbolic Play Questionnaire

- Some children with autism have been found to have significant delays in their symbolic play development.
- However, as autism is on a spectrum, we have found that some of the children with mild behavioral symptomatology can be developmentally normal on this questionnaire.
- Many of the children with autism, however, are scoring lower on this instrument.
- There may be an indication that children with developmentally age appropriate scores on subscales of self-help, gross and fine motor, but have significant delays in symbolic play could be part of the symptomatology for some children with autism.

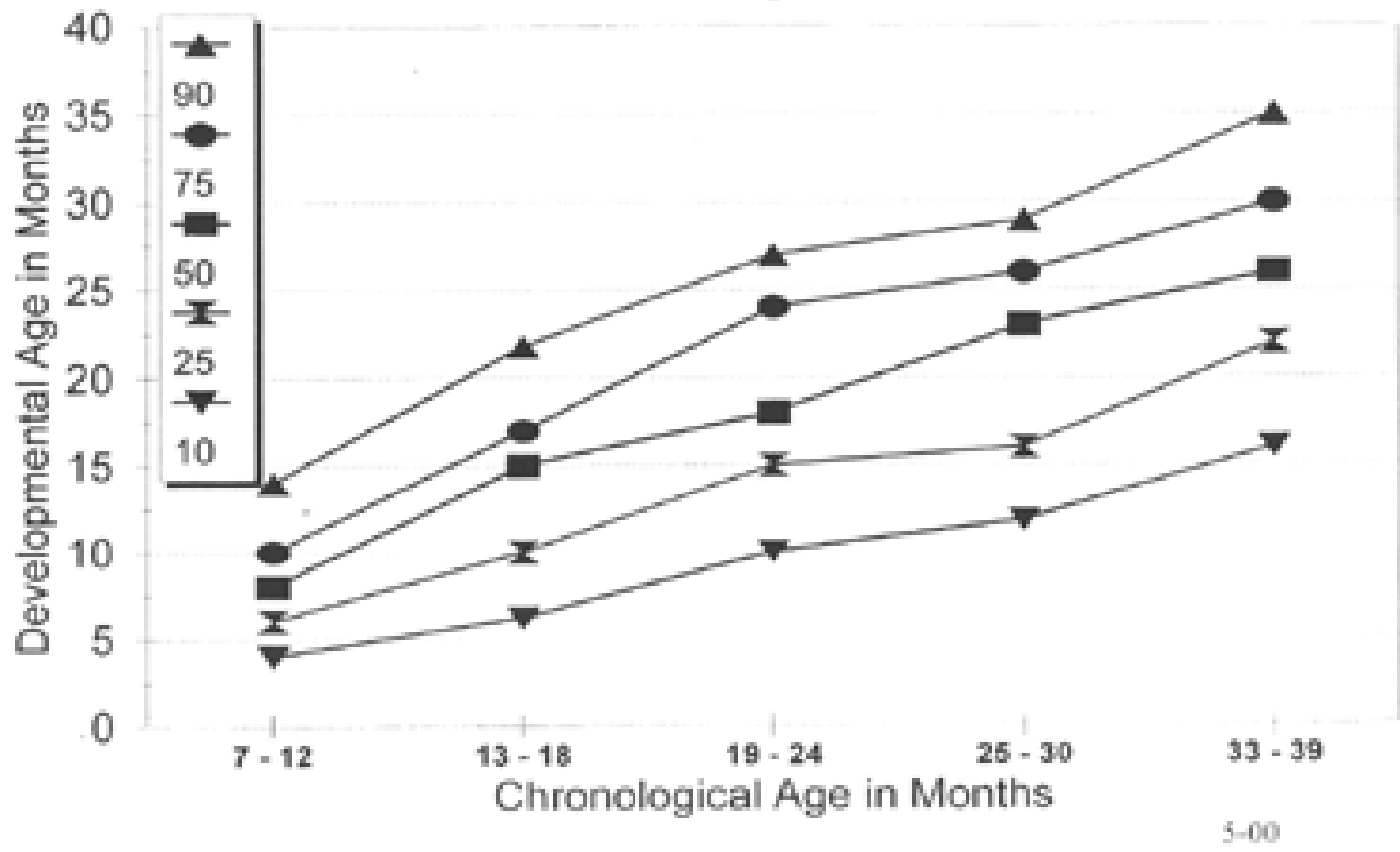
Symbolic Play - Spontaneous
Play Assessment Questionnaire
 Age Norms for Children Who are Deaf or Hard of Hearing

| Chronological Age (Mean Age) | N | Developmental Age in Months | | | | |
|------------------------------------|-----|-----------------------------|----|----|----|------|
| | | Percentile Rank | | | | |
| | | 10 | 25 | 50 | 75 | 90 |
| 7 - 12 (9.4) | 77 | 4 | 6 | 8 | 10 | 14 |
| 13 - 18 (15.4) | 101 | 6.2 | 10 | 15 | 17 | 21.8 |
| 19 - 24 (21.4) | 129 | 10 | 15 | 18 | 24 | 27 |
| 25 - 30 (27.2) | 158 | 11.8 | 16 | 23 | 26 | 29 |
| 33 - 39 (35.6) | 139 | 16 | 22 | 26 | 30 | 35 |

Symbolic Play Skills - Spontaneous

Play Assessment Questionnaire

Total Group



**MINNESOTA CHILD
DEVELOPMENT INVENTORY:
PERSONAL SOCIAL
DEVELOPMENT**

Items are not in developmental order

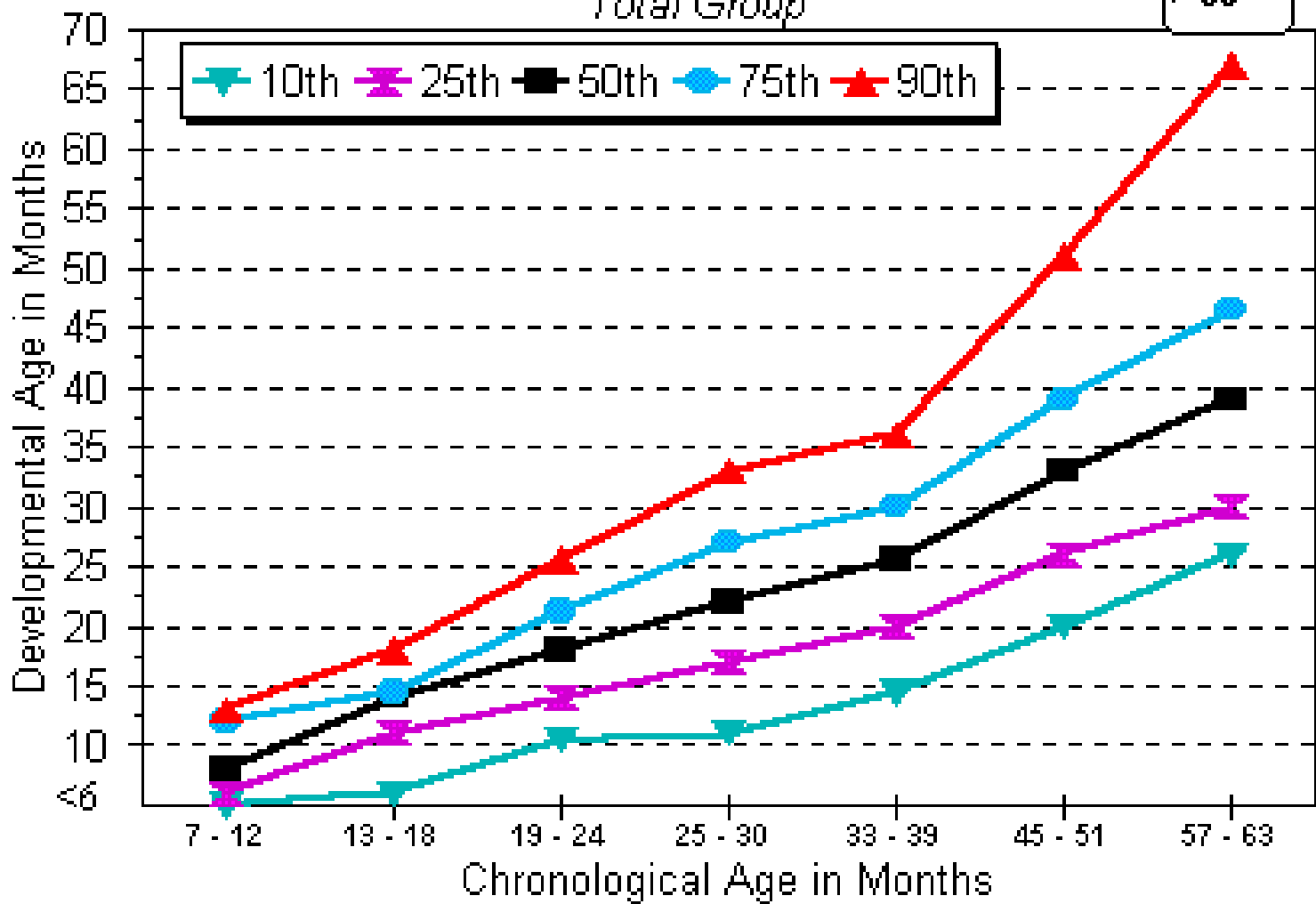
Child Development Inventory: Personal-Social Subscale

- Our preliminary analysis of the developmental trajectory of the children with hearing loss and autism shows some interesting characteristics.
- For most children who are deaf or hard of hearing, their Personal- Social subscale is highly related to the Expressive Language subscale. ($r=.64$)
- With our preliminary analysis of the developmental trajectory of children with autism, the Personal-social subscale quotient decreases with age from borderline or low average to significant delay by about 3-4 years of age– in the first three years of life.

Personal Social Development

Total Group

> 66



Assessments that can assist in earlier diagnosis of autism in young children who are deaf or hard of hearing

- MacArthur-Bates Words and Gestures
- Child Development Inventory: Personal Social subscale
- Play Assessment Questionnaire

Developmental Profile for Case Child Deaf of Deaf

- Significant decrease in Social Quotient as the child ages from 16 to 33 months - 20 quotient points decrease or greater.
- Significant decrease in Play Assessment Quotient from 27 to 33 months – 30 quotient point decrease
- Decrease in Gesture Quotient from 16 to 33 months.

- However the Self Help Quotient increases with age as does the Situation Comprehension Quotient

Developmental Profile – Child with Autism – Oral – unable to learn sign language

- Social Quotient significantly decrease between 16 and 33 months – 20 quotient point decrease
- Self Help Quotient significantly decreases between 16 and 33 months – 34 quotient point decrease
- Situation Comprehension Quotient significantly decreases between 16 and 33 months – 20 quotient point decrease
- Play Assessment Quotient – remain stable but extremely low
- Gesture Quotient remains relatively stable but extremely low

Case: Strong signer

- Decreases Social Quotient – greater than 35 quotient point decrease
- Decrease in Self Help Quotient – almost a 50 point decrease
- Situation Comprehension Quotient only slight decreases about 10 quotient points
- Play Assessment Quotient- significant decreases – about 50 quotient points
- Gesture Quotient – increased to 100 at 16 months – age appropriate.

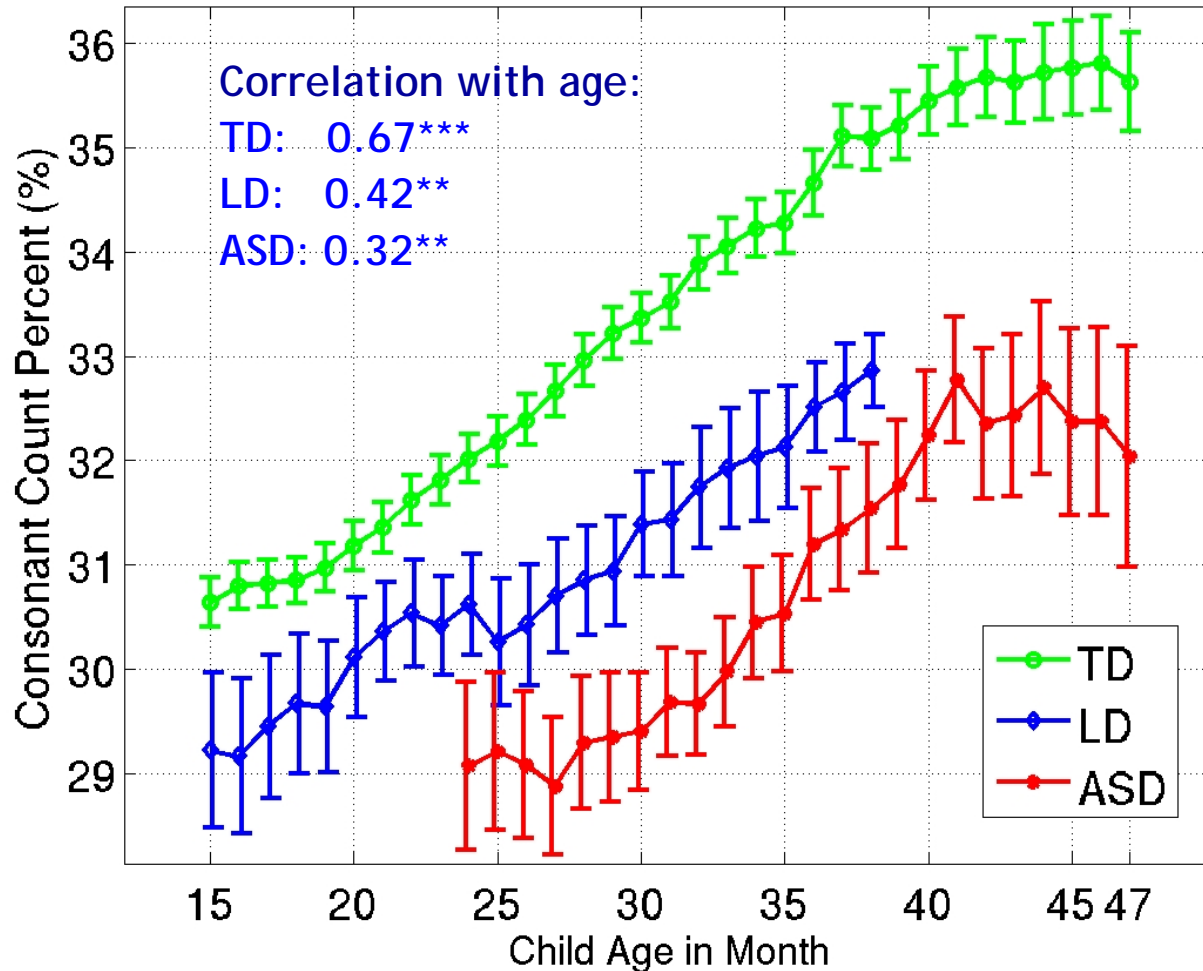
- All 3 cases had significant decreases in the CDI Personal Social Quotient, despite the fact that the symptomatology for all 3 cases is quite different.
- 9/12 autism cases had significant decreases in the Child Development Inventory Personal Social Quotient
- The cases that did not show this decrease either did not have Child Development Personal-Social Quotients or were children who were older when we first have began collecting data, e.g. 48 months+
- .

Data Collection and Processing

- Digital recorder children wear
- Records continuously for 16 hours
- Audio transferred to computer
- Speech recognition software processes file, automatically analyzing audio stream



Mean and Standard-Error



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

TD versus ASD:
 $t(90) = 7.95^{***}$

TD versus LD:
 $t(68) = 5.52^{***}$

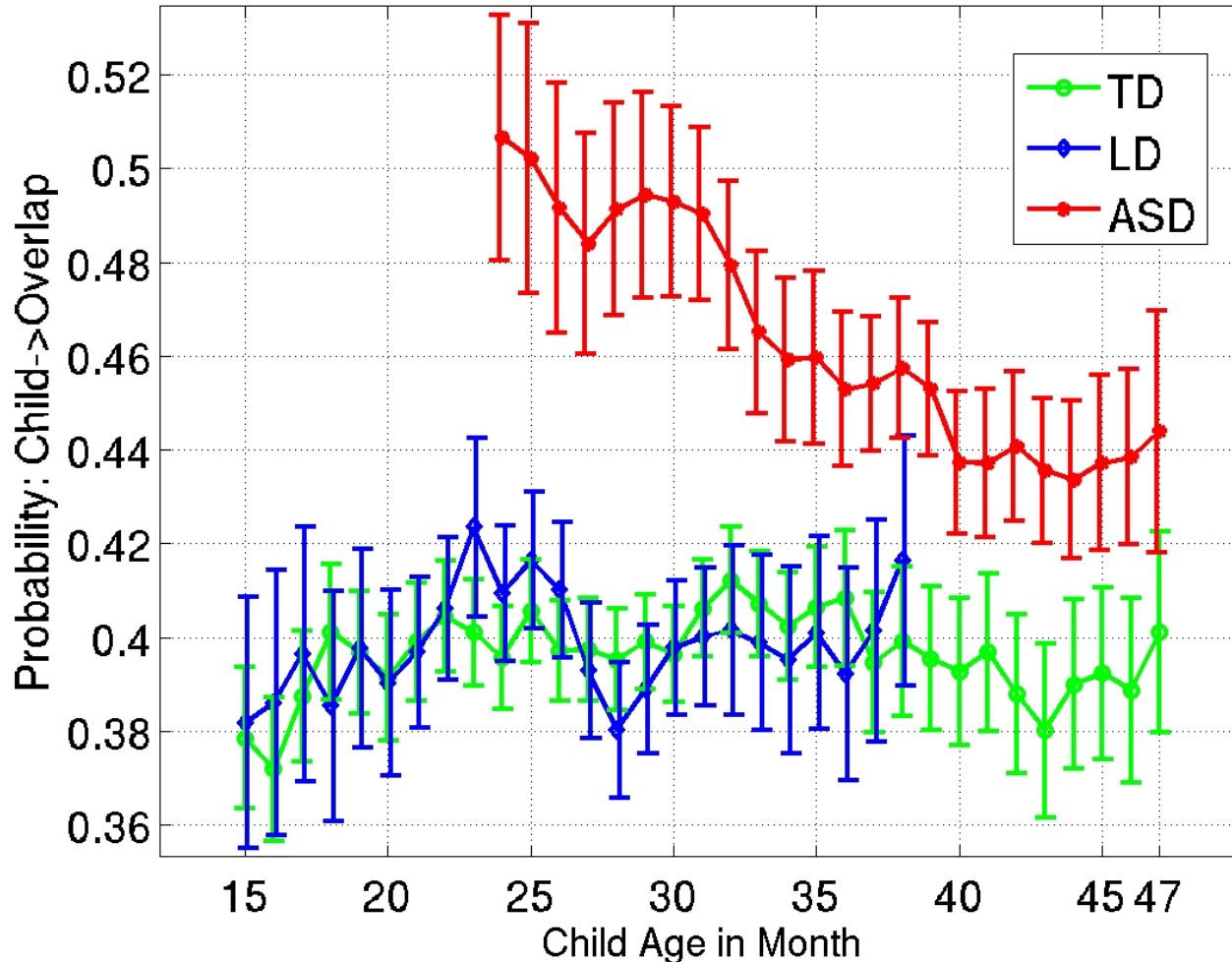
LD versus ASD:
 $t(118) = 2.62^{**}$

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Mean and Standard-Error



t-test

(Welch 2-sample 2-side)

ASD versus TD:
 $t(132) = 3.66^{***}$

ASD versus LD:
 $t(111) = 2.94^{**}$

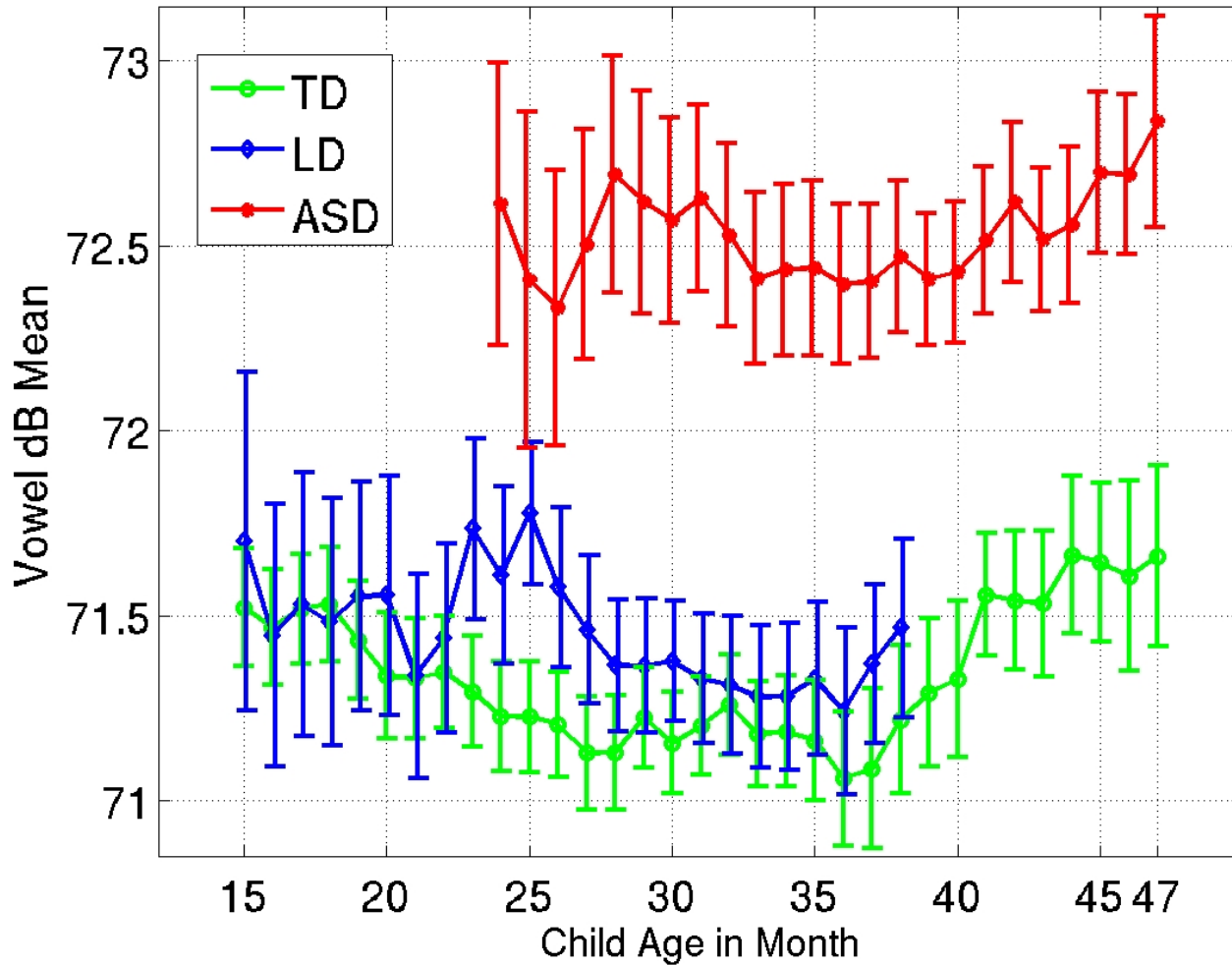
TD versus LD:
 $t(90) = 0.13$

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Mean and Standard-Error



t-test

(Welch 2-sample 2-side)

ASD versus TD:
 $t(125) = 5.84^{***}$

ASD versus LD:
 $t(117) = 4.78^{***}$

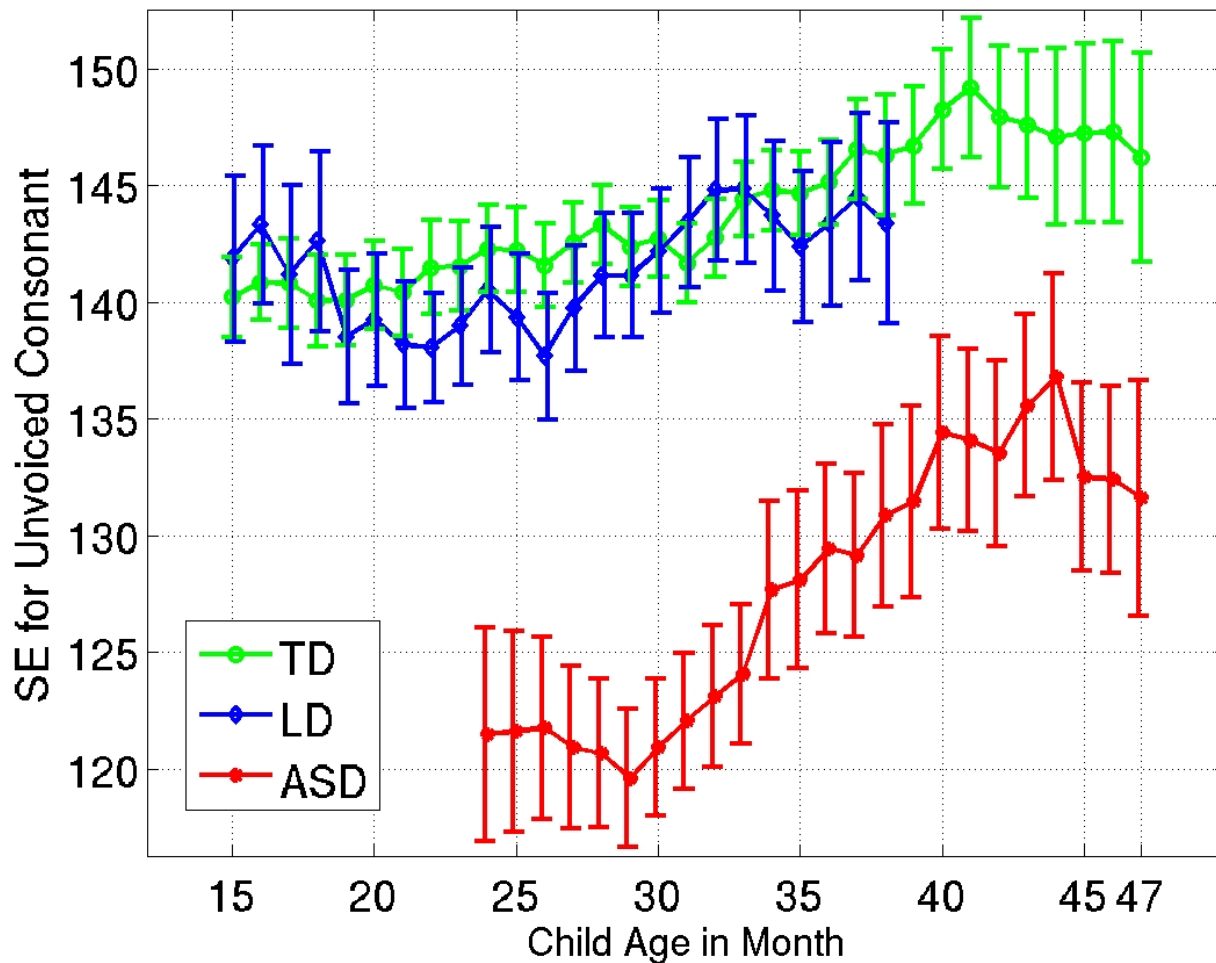
TD versus LD:
 $t(97) = 0.45$

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Mean and Standard-Error



t-test

(Welch 2-sample 2-side)

ASD versus TD:
 $t(113) = 5.70^{***}$

ASD versus LD:
 $t(118) = 4.41^{***}$

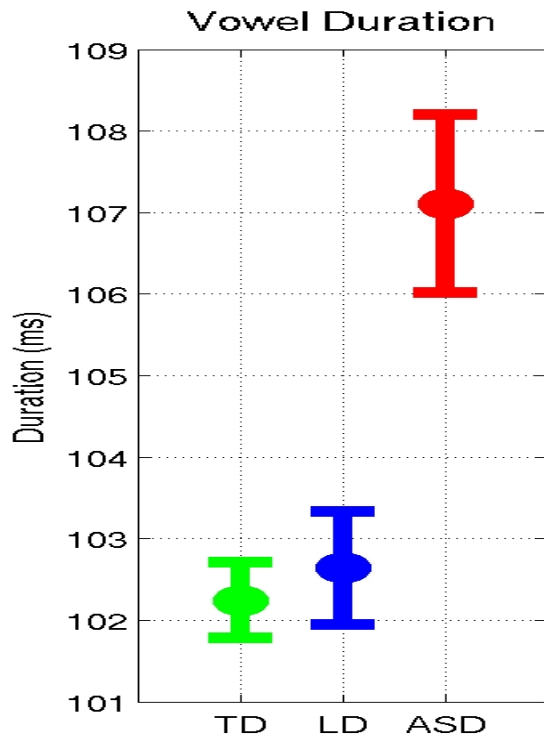
TD versus LD:
 $t(96) = 0.91$

* $p < 0.05$

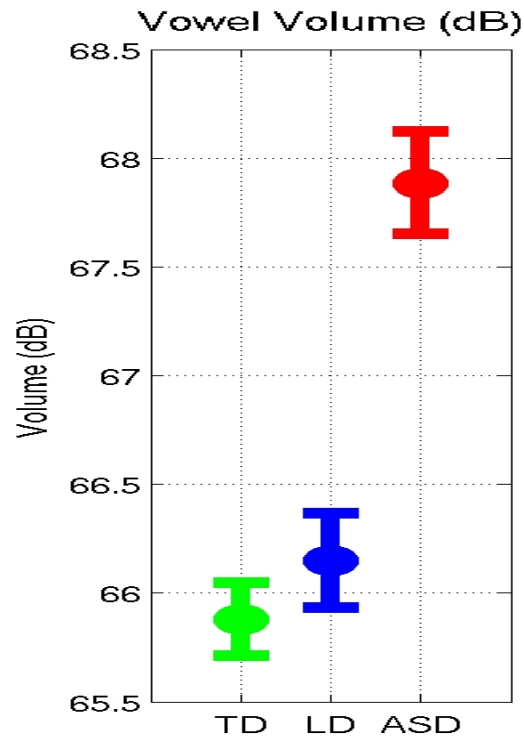
** $p < 0.01$

*** $p < 0.001$

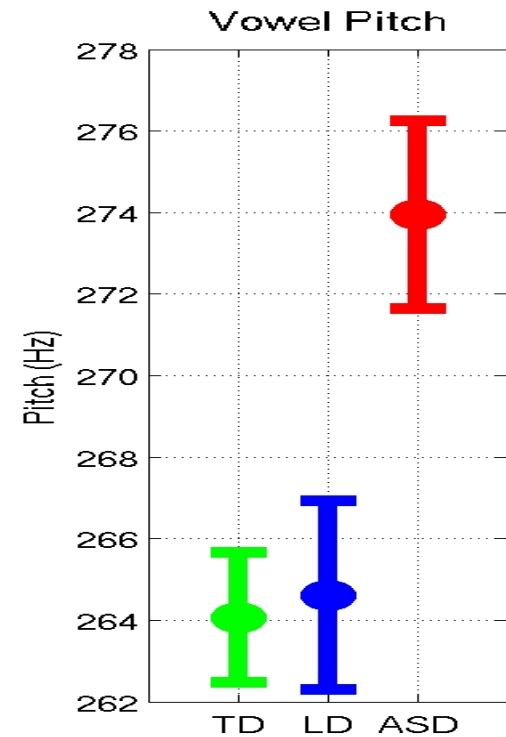
Mean, Standard Error and t-Statistics



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

Method: Automatic Objective Measures

- Number of Phonetic Units per Utterance (mean length of utterance in terms of number of phonetic units – MLU)
- 4 Objective Measures
 - **C-MLU**: number of consonant-like units per utterance
 - **V-MLU**: number of vowel-like units per utterance
 - **N-MLU**: number of non-speech-like units per utterance
 - **PS-MLU**: number of short pauses per utterance

Study Samples

| 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 | 228 | 0.53 M | 1.82 M |
| Hard of Hearing (HH) | 42 | 423 | 1.33 M | 9.33 M |

Color Notation:

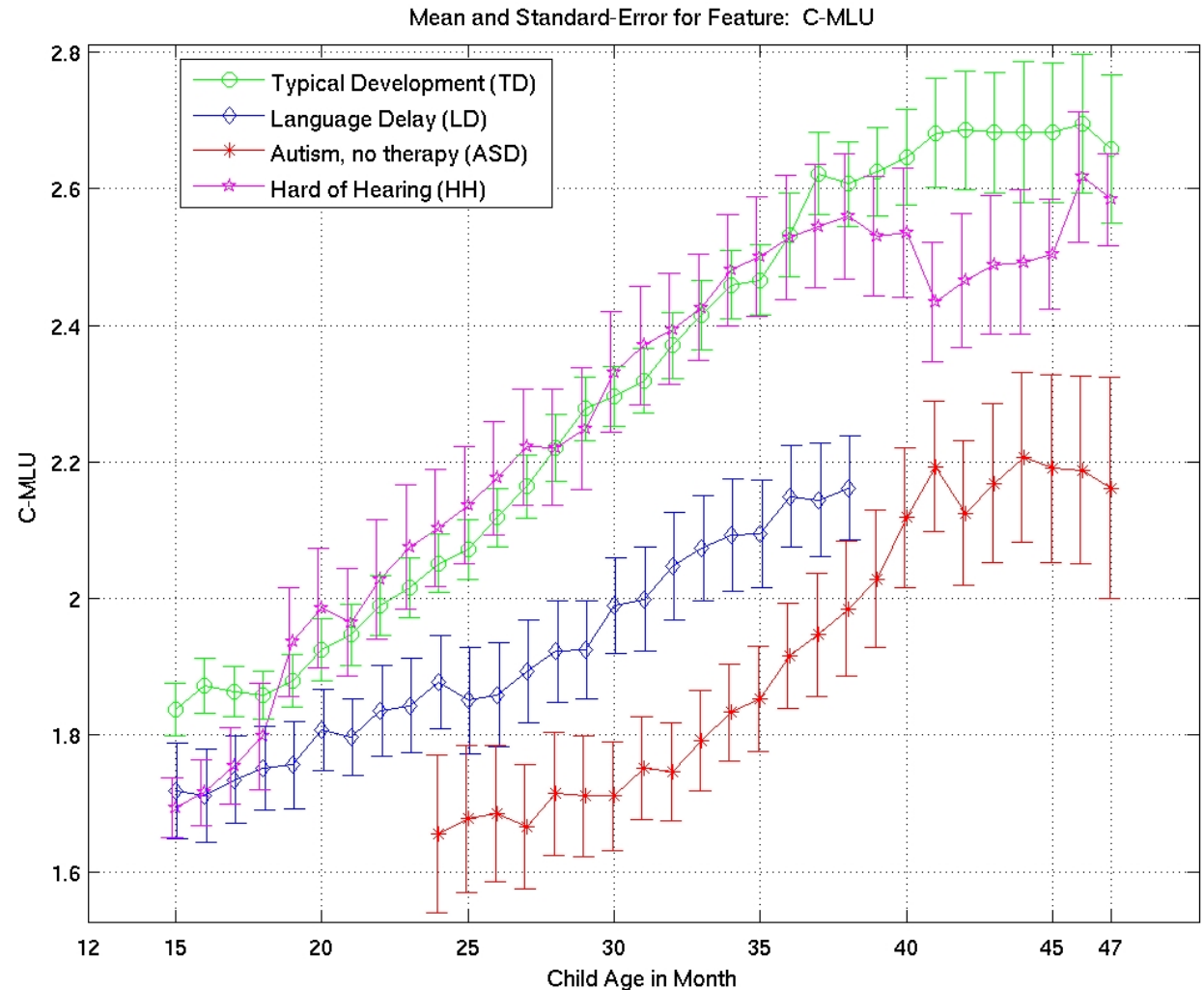
- **Green:** Typical Development (TD)
- **Blue:** Language Delay not Related to Autism (LD)
- **Red:** Autism (ASD)
- **Purple:** Hard of Hearing (HH)

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 *

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

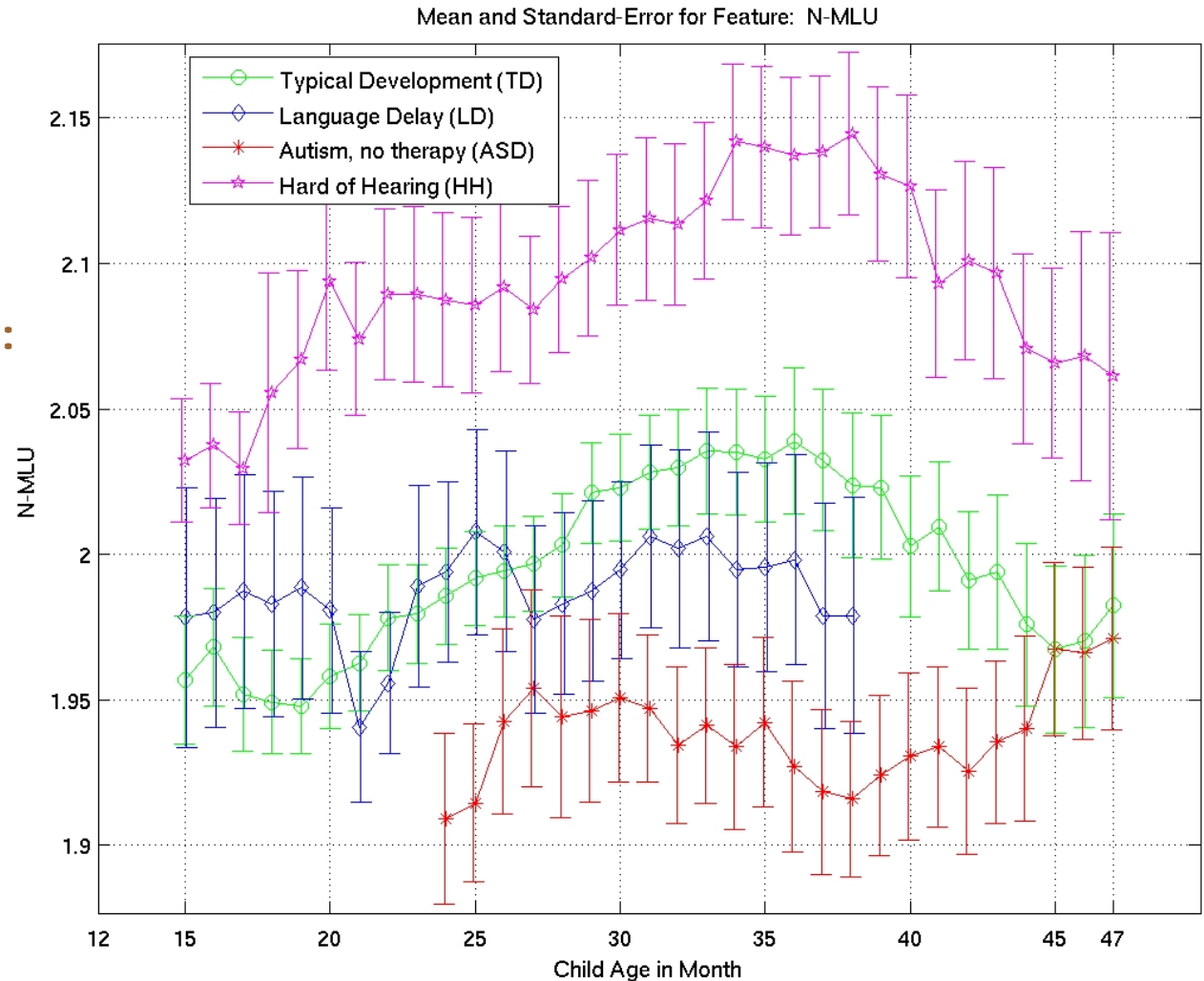


Result of N-MLU: Trajectories & Correlation with Chronological Age

Correlation with chronological-age:

HH: 0.14
 TD: 0.12
 LD: -0.10
 ASD: -0.07

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



Prosodic Feature V-dB-M: Trajectories & Correlation with Chronological Age

Correlation with chronological-age:

HH: 0.02
TD: -0.05
LD: -0.02
ASD: 0.05

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

