Language underperformance in children who are D/HH: How to recognize it and what to do about it

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Cincinnati Children's
changing the outcome together

Conflict of interest

- No conflicts of interest
- Disclosure: My focus is on **language**.

Learning Objectives

- To describe language underperformance in children who are D/HH
- To identify the impact of language underperformance in children who are D/HH on developmental domains
- To recognize the impact of high-tech augmentative and alternative communication intervention strategies on language learning in children who are D/HH

Outline

- Background
- Research culmination
  - Labels are not predictive
  - Understanding language gaps
  - Impact on functional outcomes
- Motivation to change
- Technology assisted language intervention
- What to consider

Background

- 1-3/1000 infants born with significant hearing loss
  - Can affect language and communication

- Universal Newborn Hearing Screening (UNHS) has decreased the ages of identification and intervention
  - Earlier age of intervention supports language development
  - Many with average language levels

- Motivation for solid language foundation is to promote independent functioning now and later in life

CDC 2016 EHDI Summary; Sininger et al. JAAA. 2009. Uus K, Bamford J. Pediatr. 2006; Meinzen-Derr et al. Am Ann Deaf 2011. Moeller. Pediatr. 2000. Yoshinaga-Itano et al, Pediatr. 1998.; Yoshinaga-Itano, Pediatrics 2017

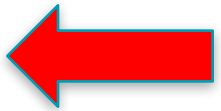
Background

- Despite positive impact of (“hearing-focused”) technology, language levels continue to hover in average to low average range for many
  - Expect 50% have scores >100; and ~15% scores >115

- Language scores are used as a “target”
  - Do not account for an individual’s capability

Culmination of research

Children with Cochlear implants with “additional disabilities”



Clinical characteristics of children who are D/HH

Disparities in access to CI

Early 2000’s **CI and Disability Focus**

2005-2010

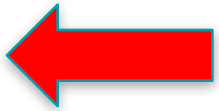
2010-2015

Current

Culmination of research

Multi-site
observational study
of children who are
Deaf-blind with CI's

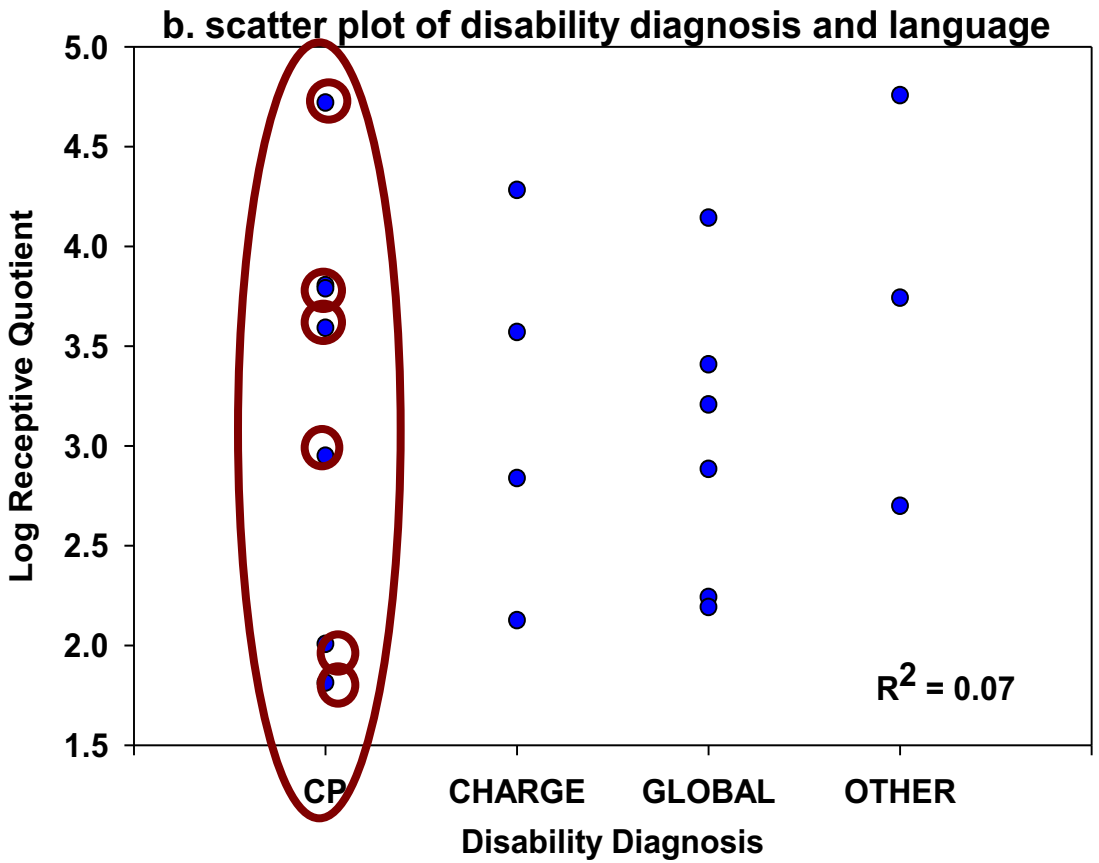
Understanding
language in children
who are D/HH Plus



Early 2000's 2005-2010 2010-2015 Current

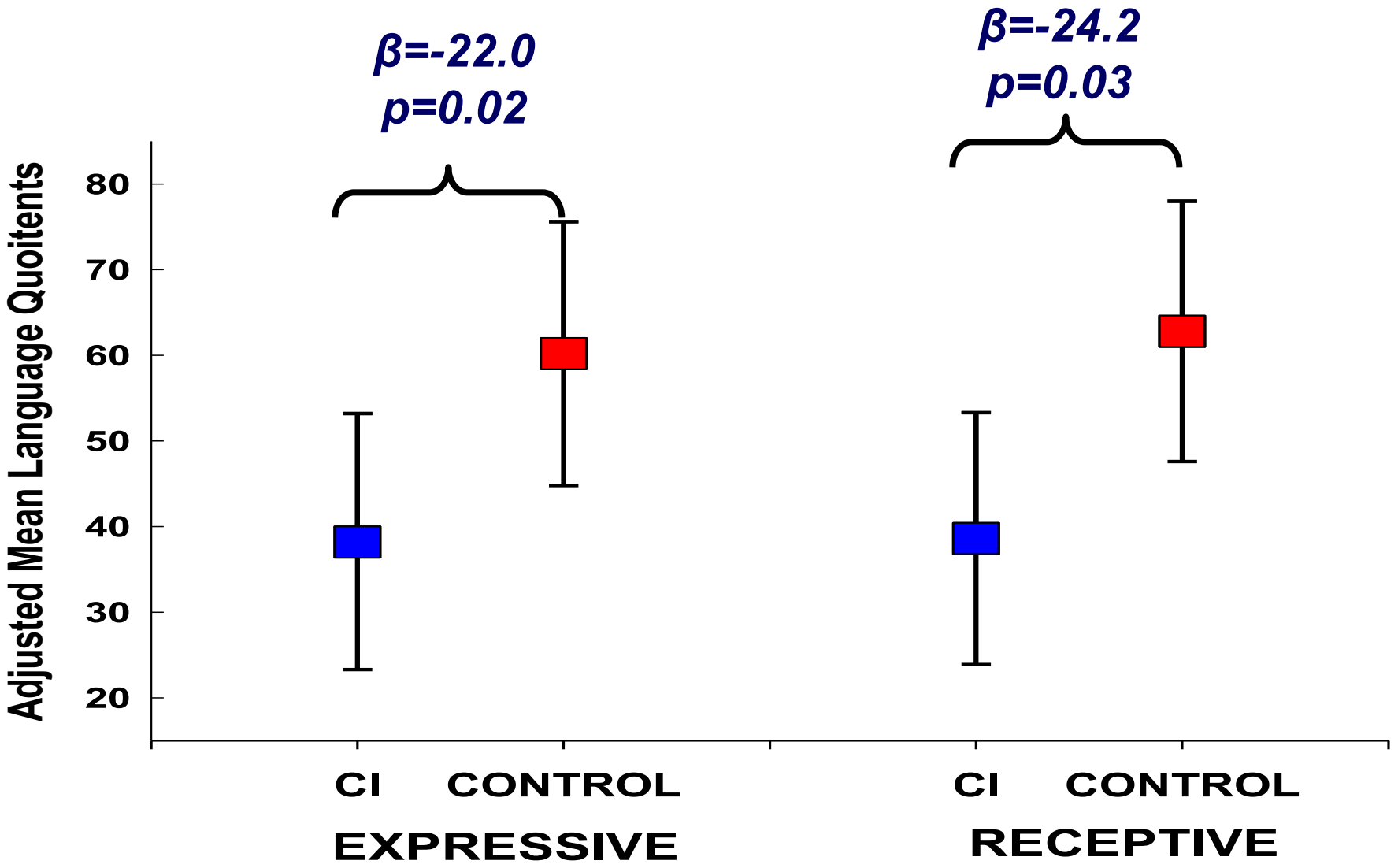
Disability Focus
Recognition of non-verbal IQ as necessary but not sufficient

Specific Disability Label Not Very Predictive



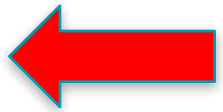
Meinzen-Derr J, et al. 2010 Laryngoscope;
Meinzen-DerrJ, et al. 2011 Res Dev Disabil

Language Differences

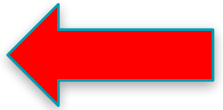


Culmination of research

Recognition of a cognitive-language gap in children who are D/HH plus as compared to DD matched controls



Cross-sectional study on language and cognitive abilities in children who are D/HH (DD and typically developing D/HH)



Negative impact of language gaps on social functioning

Early 2000's | 2005-2010 | 2010-2015 | Current

Expanded focus on impact of language gap in all children who are D/HH

Defined Language “Underperformance”

Language abilities relative to cognitive abilities

$$\frac{\textit{Receptive Language standard score}}{\textit{Nonverbal IQ standard score}}$$

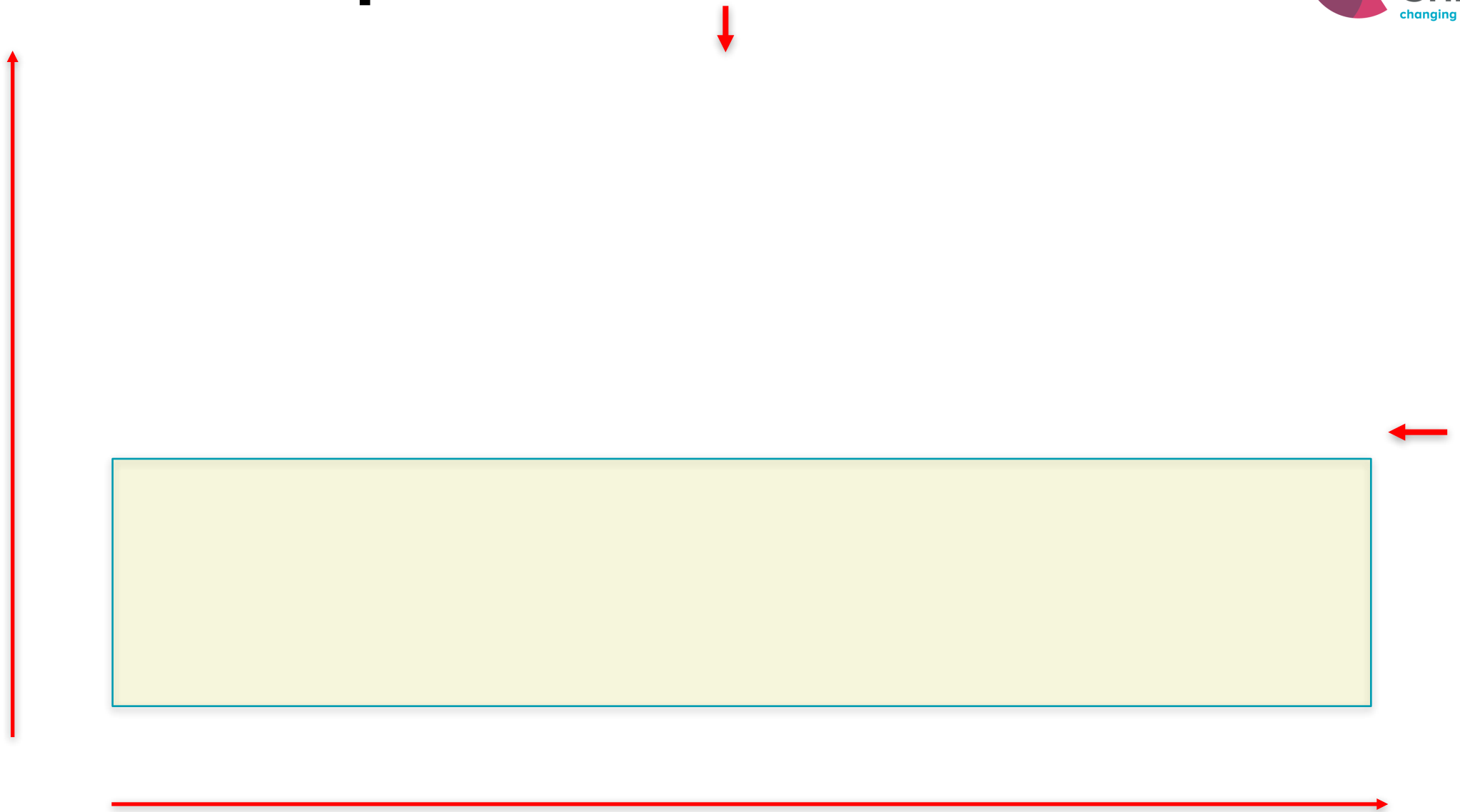
LANGUAGE = 85

IQ = 100

85/100 or 0.85

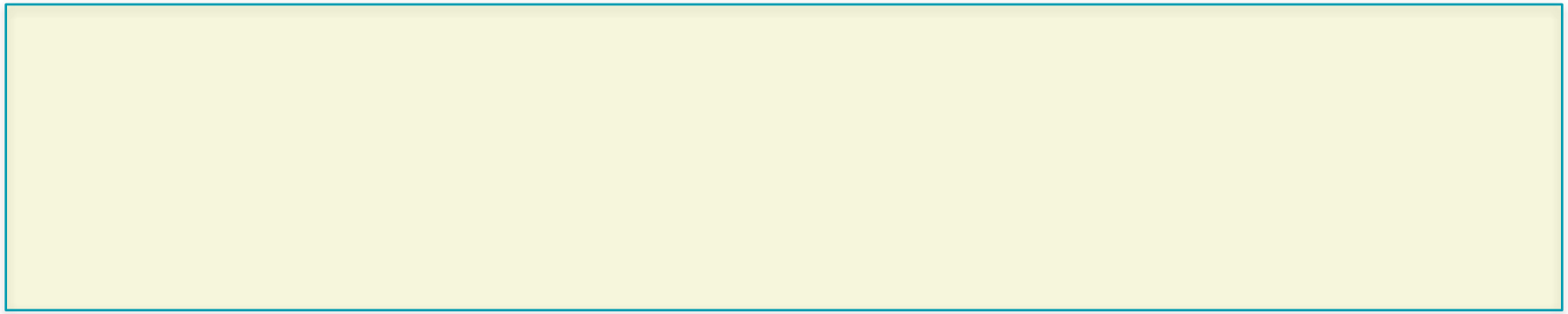
~45% have a language to cognitive ratio <0.85

Relationship between score and ratio

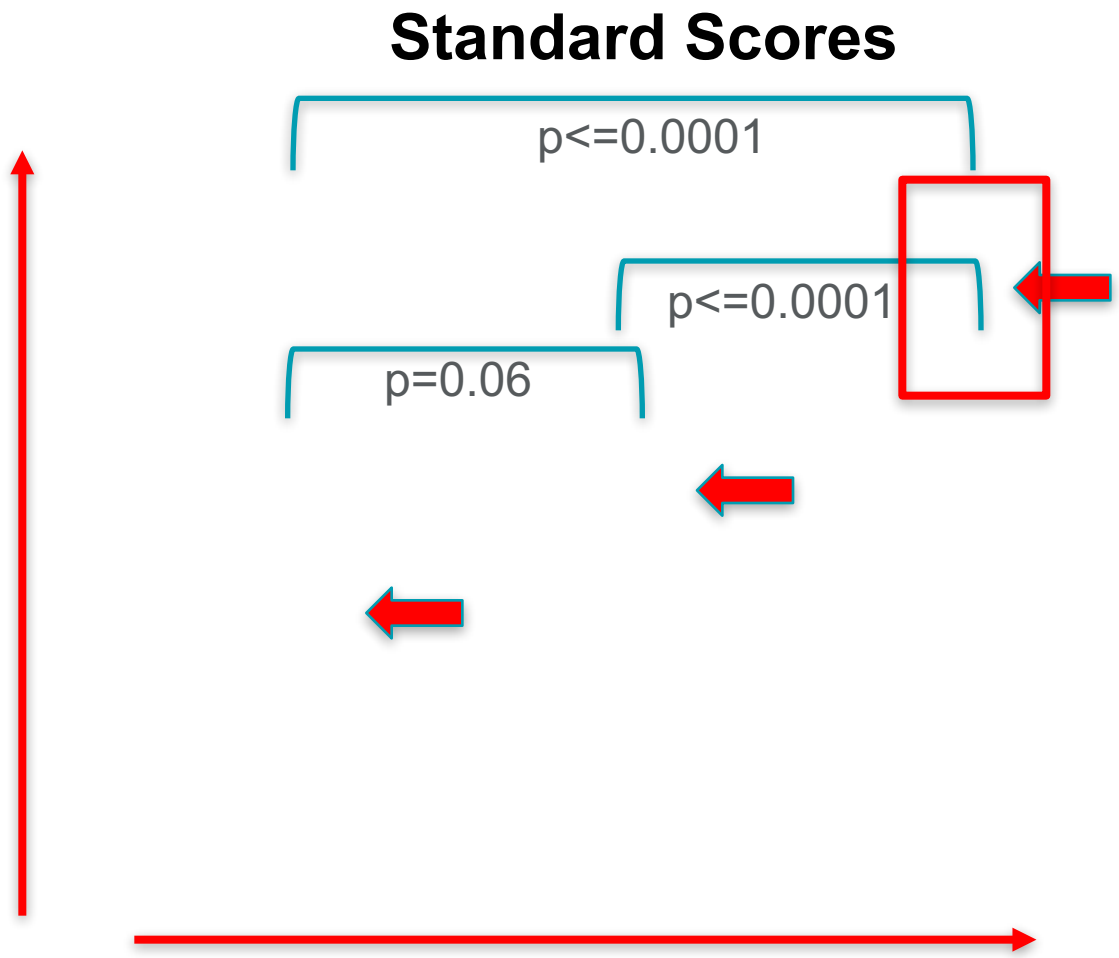


Meinzen-Derr J, et al. 2018 JDBP

Relationship between score and ratio

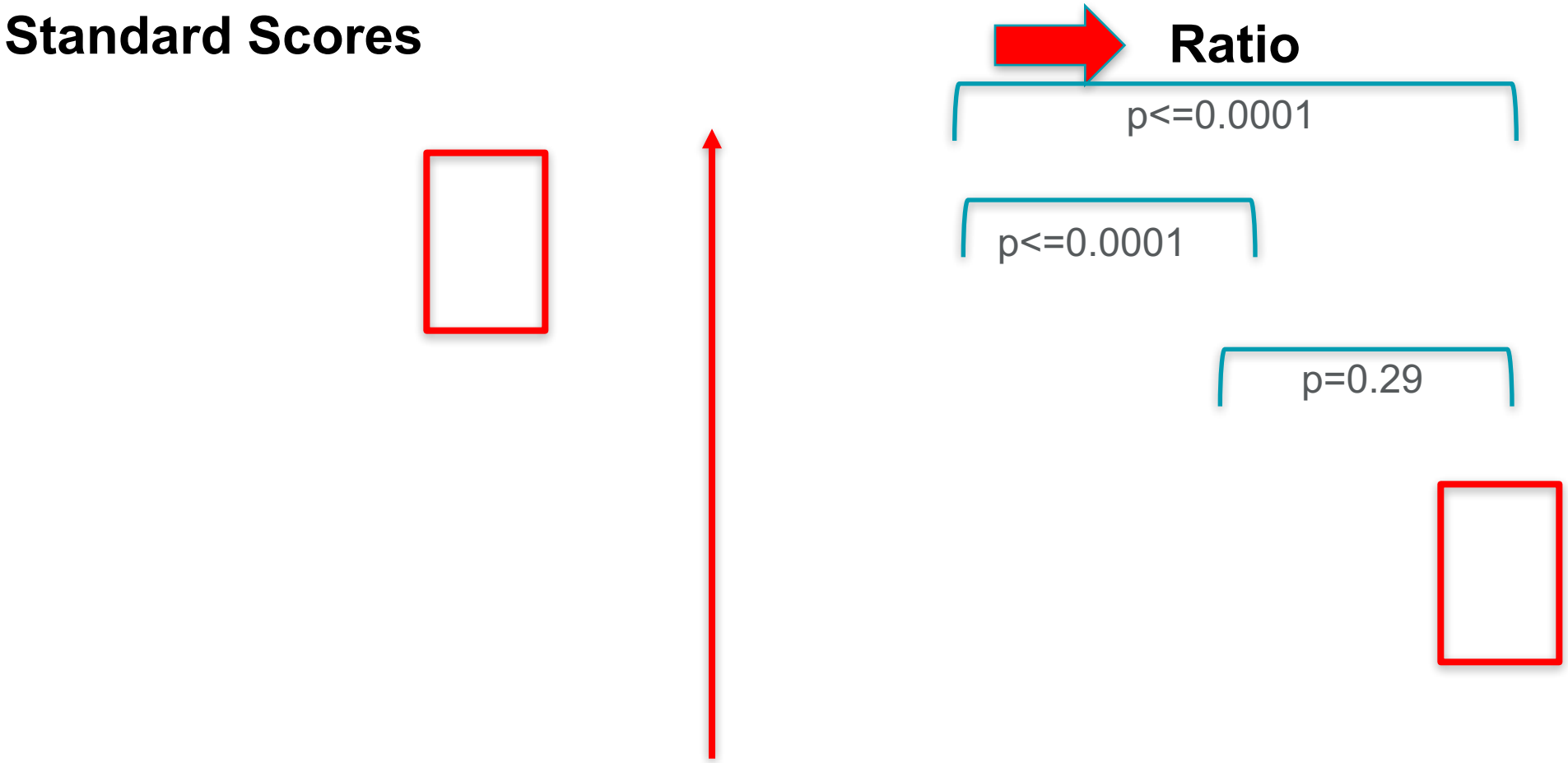


Understanding language levels differently



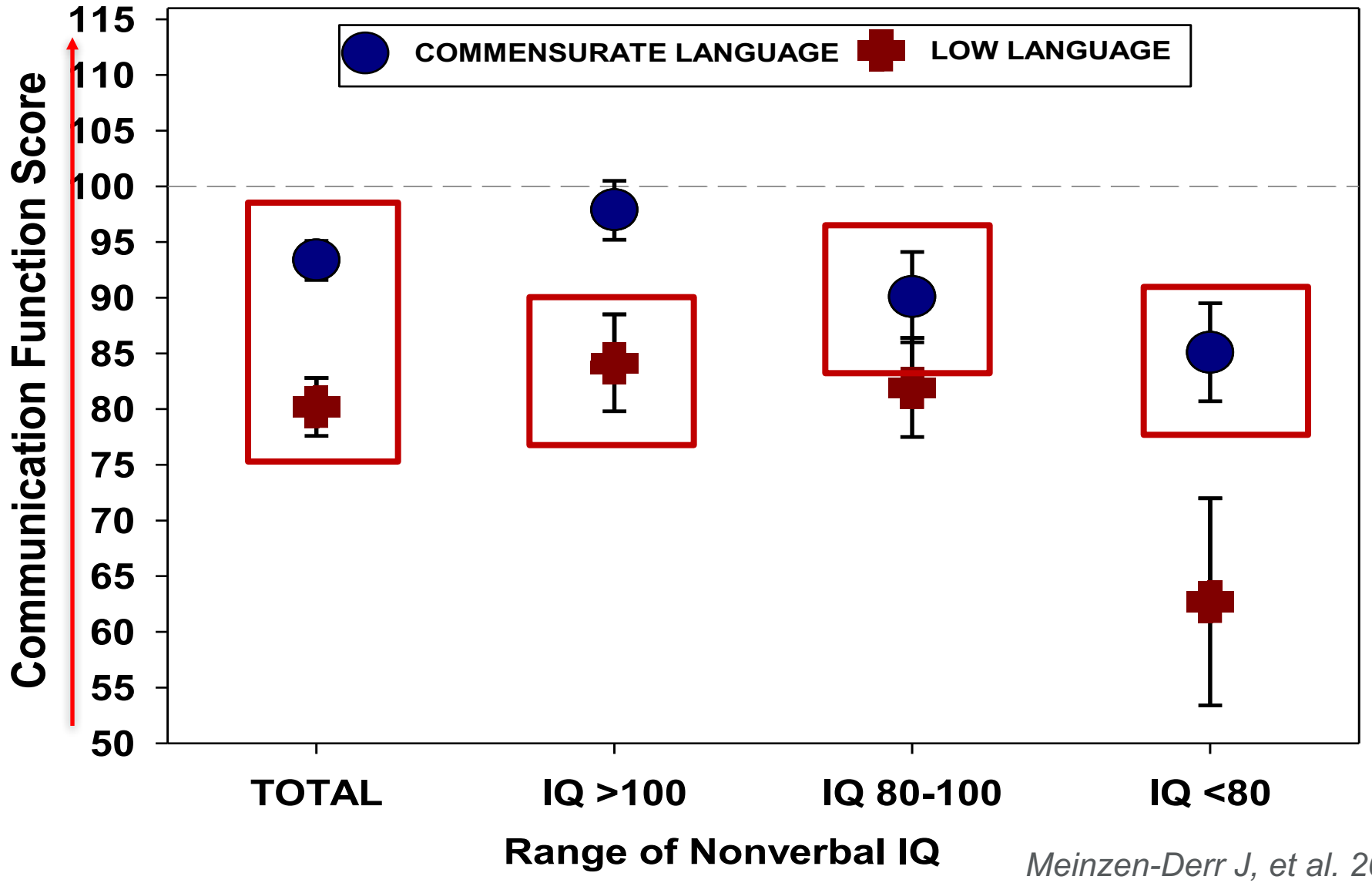
Meinzen-Derr J, et al. 2018 JDBP

Understanding language levels differently



Meinzen-Derr J, et al. 2018 JDBP

Impact on functional outcomes



Meinzen-Derr J, et al. 2014 JDBP

Culmination of research

Implementation of a research advisory committee

Longitudinal study on language and cognitive abilities in children who are D/HH

RCT of novel intervention to improve language in children who are D/HH with a language gap

Data linkage study of EHDI, EI, ODE data for children who are D/HH with focus on long-term outcomes (Broader Public Health Focus)

Early 2000's
CI and Disability Focus

2005-2010
Disability Focus
Recognition of non-verbal IQ as necessary but not sufficient

2010-2015
Expanded Focus on Impact of Language gap in all children who are D/HH

Current
Typical D/HH and Disability Focus, Shift to Intervention

Overall motivation for something different

WHY

- Recognition of a language gap among children who are D/HH
  - language outcomes continue to hover in the average/low average range
- Belief that this gap does not have to persist
  - language levels should be commensurate with cognitive abilities

WHEN

- We should address this gap **early in novel therapeutic ways** when traditional approaches are not sufficient to allow children to meet their cognitive potential

HOW

- Wanted to apply augmentative and alternative communication (AAC) strategies as a **teaching tool** for language learning in children who are D/HH with language underperformance

Tomblin, 2015; Nittrouer 2014, 2016; Meinzen-Derr, 2014,2018; Luckner 2005; Traxler, 2000

Why AAC strategies?

Spoken language relies on auditory input channel and vocal output channel
Input is temporally based (sequence in time) and dynamic (rapidly fading nature)

- Language development through augmented means
- Role of graphic symbols in language development
- Importance of visual learning

Romski, 1997; Bedrosian, 1997;Stredler-Brown, 2010; Harris, 2010;Allen, 2014; Sevcik, 1991;Sutton 2008

Why AAC strategies?

Spoken language relies on auditory input channel and vocal output channel
Input is temporally based (**sequence in time**) and dynamic (**rapidly fading nature**)

- Language development through augmented means
- Role of graphic symbols in language development
- Importance of visual learning

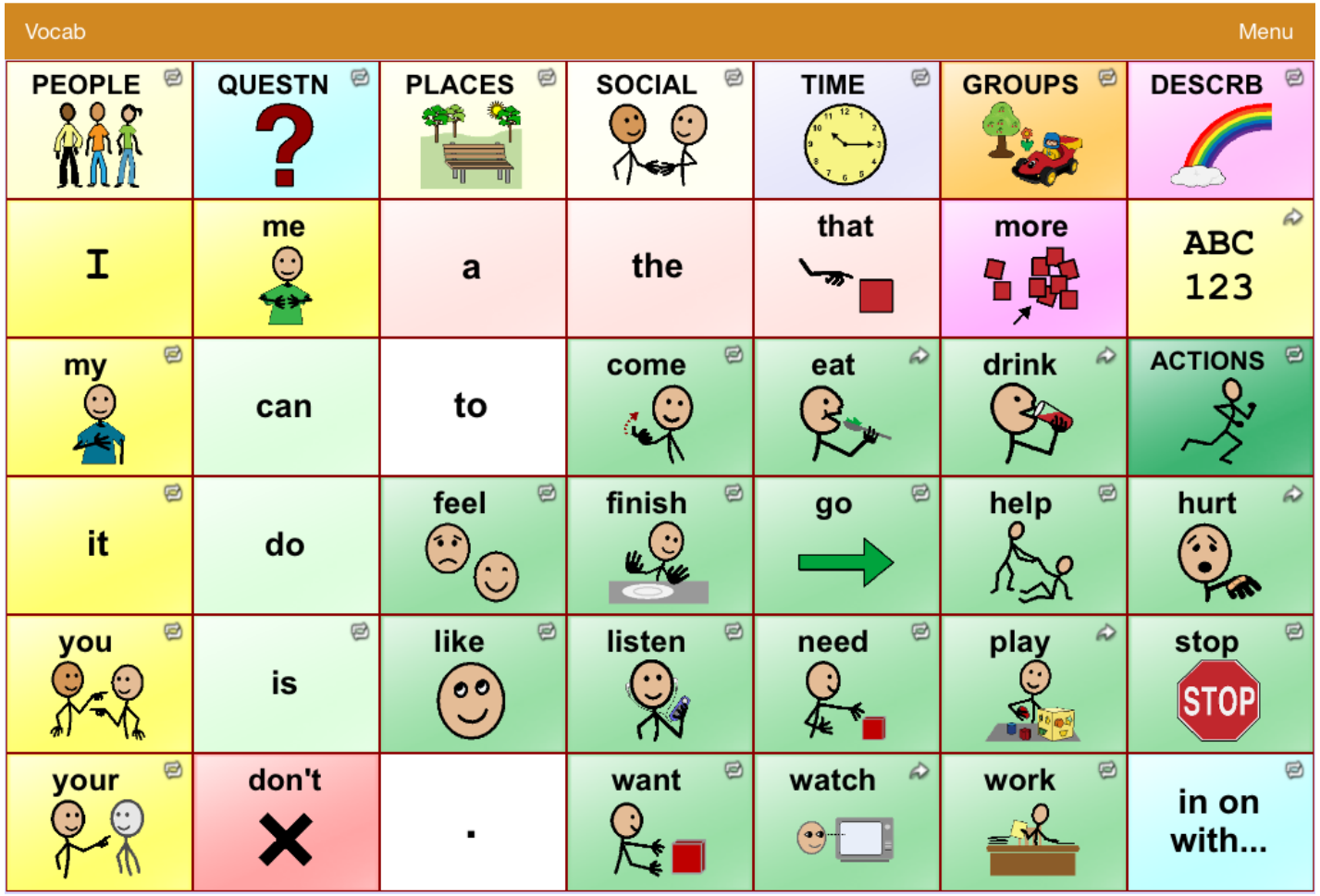
Provides a **stationary visual** (symbolic/iconic) representation of language

Leverages **multi-sensory input** (auditory and visual) to enhance development

Technology-Assisted Language Intervention-TALI

- AAC strategies incorporated into speech-language therapy as a teaching tool for more complex verbal language skills
- Provides static visual representations for abstract linguistic concepts, offers grammatically appropriate options
- Can easily add appropriate morphological word endings
- Consistent model for verbalizations and feedback for self-monitoring
- Children were taught to use their own voice to speak the message after creating it
- Active family participation in using aided language stimulation to model more and encourage more complex language

Sample Page-Set – TouchChat HD with Word Power



Study Objectives

To determine if high-tech augmentative and alternative communication (AAC) supports within the context of speech-language therapy are effective **as a teaching tool** to enhance language development among children who are D/HH compared to treatment as usual

We conducted a randomized control trial to determine the efficacy of the intervention

Enrollment is closed and follow up is ongoing

Randomized Control Trial

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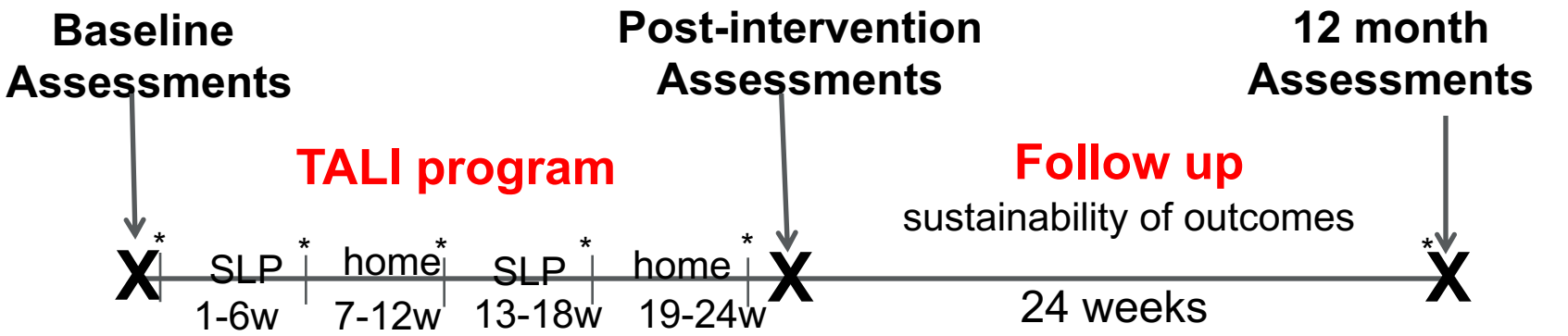
- Intervention (**TALI**)
  - High-tech AAC intervention strategies (TouchChat© on an iPad) within a series of speech-language therapy sessions
- Control (Treatment as usual – **TAU**)
  - Continue with standard care
  - Given option to cross-over into the technology intervention following the 24-week period
- Language goals and interventions based on child's specific language needs and family priorities

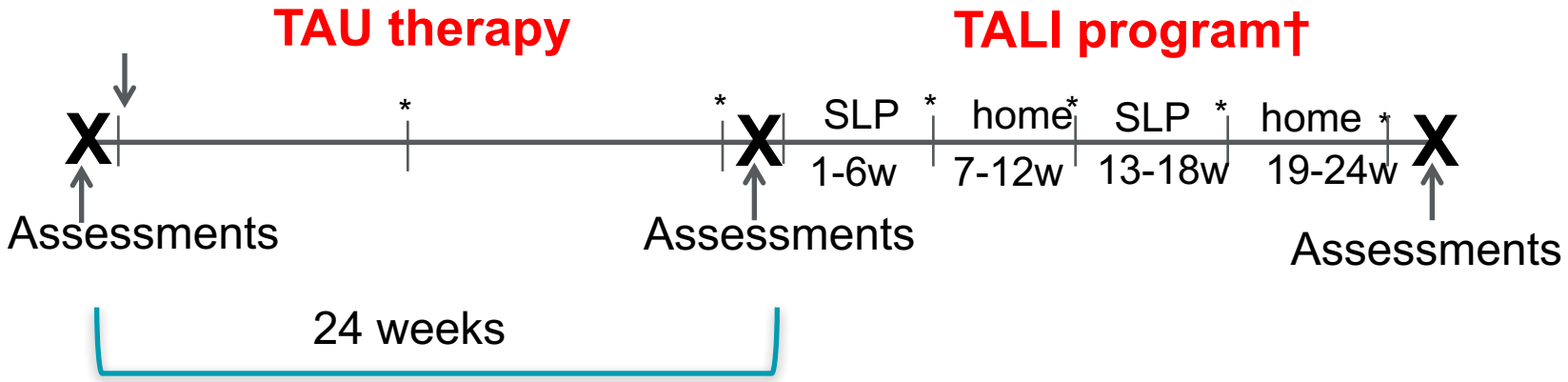
Meinzen-Derr et al, 2017;2019

Inclusion Criteria

- Children ages 3-10 years with bilateral permanent hearing loss
- Non-verbal IQ of ≥ 60
- Language “underperformance”
- *Screening visit occurred and eligibility decision made PRIOR to randomization*

Study timeline





*Language samples obtained

†TAU participants may opt to participate in TALI upon study completion

Primary endpoints (language sample outcomes)

- ~20 minute language samples (100 complete utterances)

- Mean length of utterances in morphemes (MLU) - *syntax*
  - Average number of morphemes per utterance
- Mean turn length (MTL) – *discourse*
  - Length of child's conversational turn that may include more than one sentence/utterance
- Number of different words spoken - *semantics*

Additional outcome data

- **Standardized assessments**
  - Clinical Evaluation of Language Fundamentals -5 or CELF-P & Pragmatics Profile
  - Peabody Picture Vocabulary Test

- **Duration and frequency of use (continuous monitoring)**
  - TouchChat's software for monitoring

Other Outcomes and Measures

- **Neuro-behavioral**
  - Leiter International Performance Scale-3rd edition
  - Behavior Rating Inventory of Executive Function (BRIEF-3)
- **Functional**
  - Vineland Adaptive Behavior Scales
  - Child Behavior Checklist
- **Detailed demographics questionnaire**
- **Health record review**

Characteristics of eligible vs. ineligible

CHARACTERISTIC	Eligible N=40	Ineligible N=19
Mean Age in years	6.2 (2.5)	9.0 (2.4)
3-5 years of age	62.5%	17%
Median Age identification of hearing loss [IQR]	21 [2-48]	52 [21-84]
Gender – Female	50%	61%
Race - nonwhite	30%	11%
Health Insurance - Private	41%	41%
Mom college graduate	47.5%	50%
Household income <$20k	27.5%	6%
Use cochlear implants	30%	13%
Nonverbal IQ	97.8 (17)	93.8 (18)

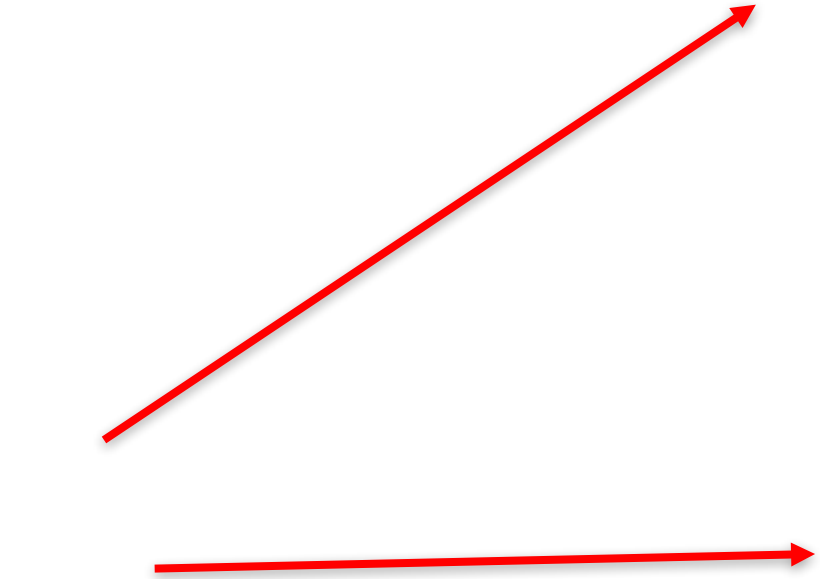
Participant Characteristics

CHARACTERISTIC	TALI N=20	TAU N=20
Mean Age in years	6.3 (2.6)	6.5 (2.5)
3-5 years of age	65%	60%
Median age ident of hearing loss	36.5 [iqr 2-55]	17 [iqr 2-37]
Among 3-5 yr olds	4.5 [4.2-47.1]	3 [1-17]
Gender – Female	45%	55%
Race – Non-White	25%	35%
Health Insurance – Private only	37%	45%
Mom college graduate	40%	55%
Household income <$20k	35%	20%
Use cochlear implants	30%	30%
Median aided thresholds*	20 [iqr 15-26]	15 [iqr 12.5-20]
Nonverbal IQ	96.2 (19.7)	97.7 (17.6)

TALI = technology-assisted language intervention
TAU = treatment as usual

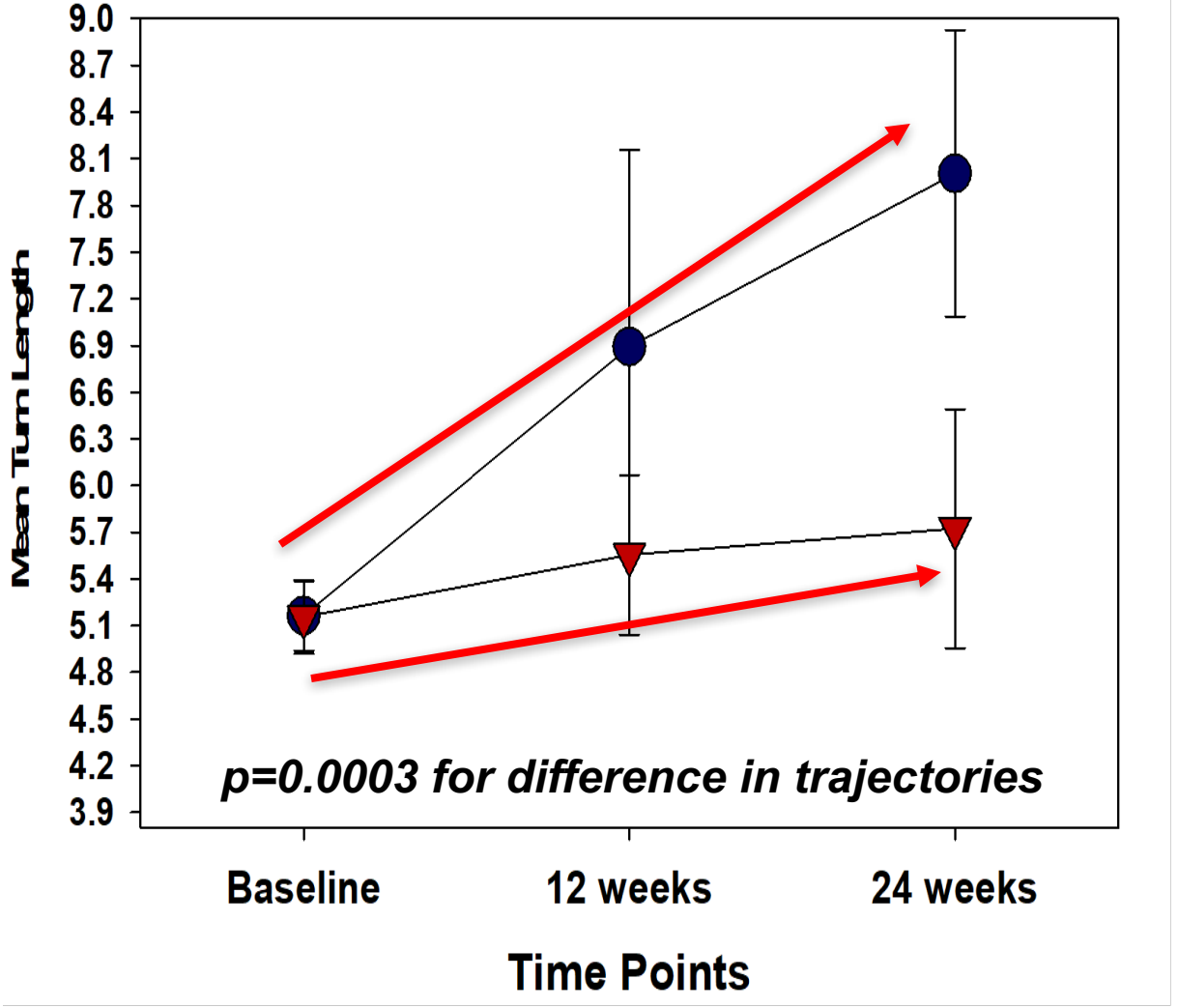
Language Sample Outcomes

MLUm

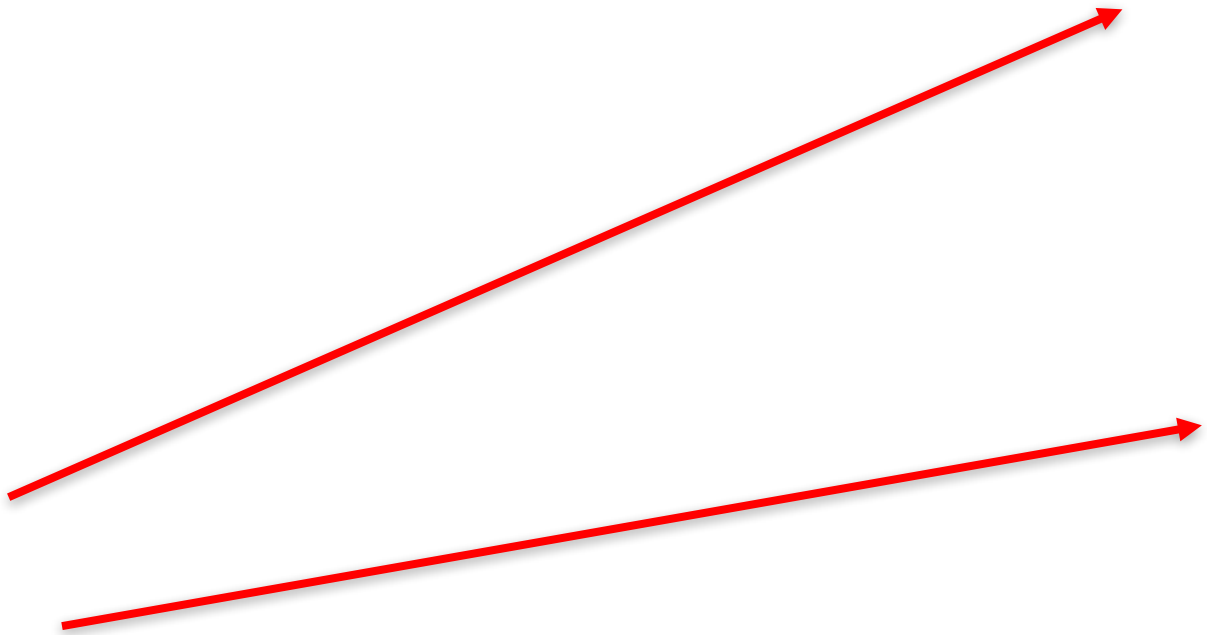


p<0.0001 for difference in trajectories

MTL

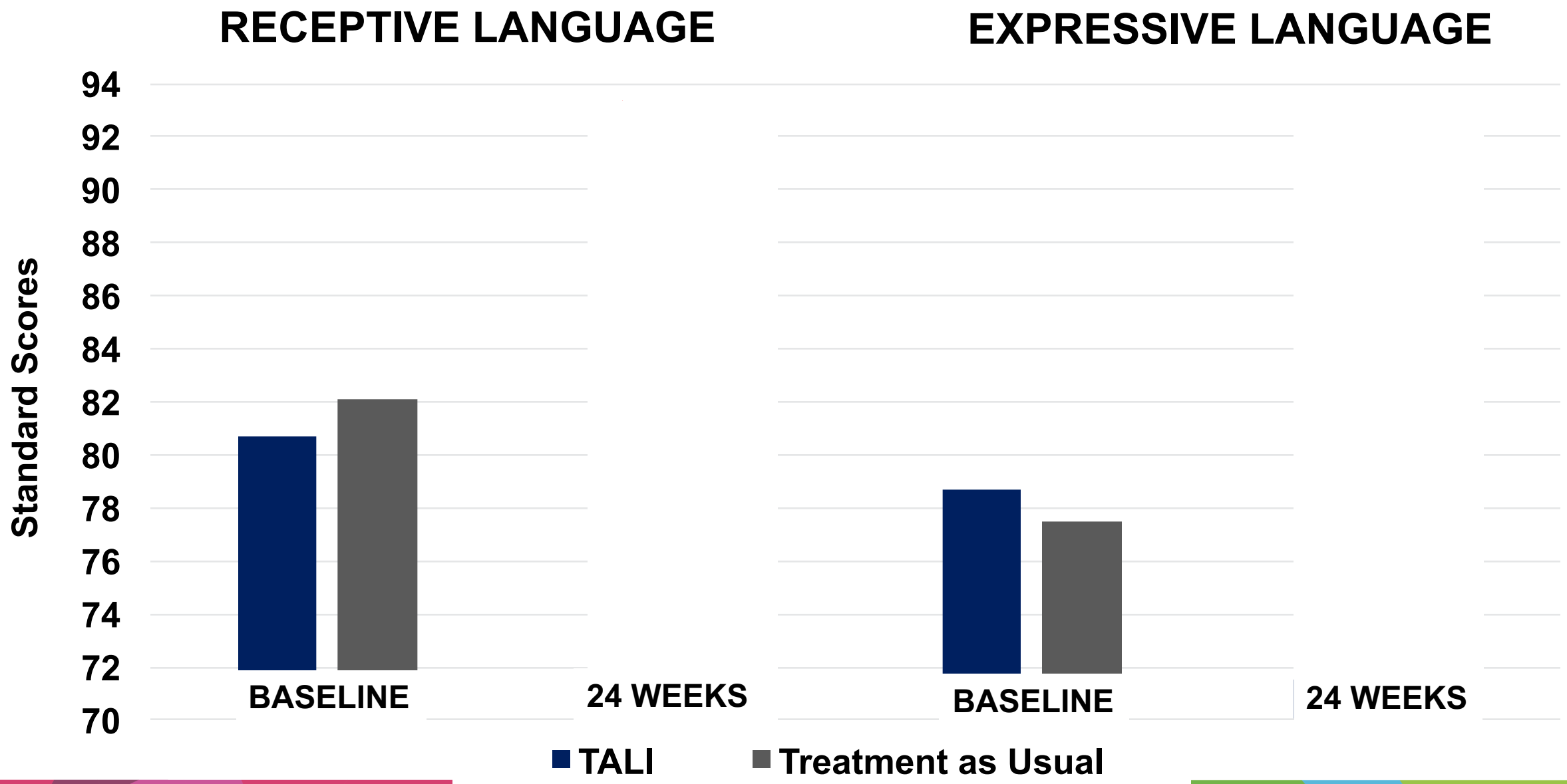


Language Sample Outcomes-NDW



P=0.03 for difference in trajectories

Average assessment standard scores pre to post



Factors impacting effect size of outcomes

- Based on individual data review, no child lost skills in TALI
  - All children gained skills
- Age and IQ will impact expected growth of language

- What **did not** confound the relationship
  - Age of Identification
  - Degree of Hearing loss
  - Maternal education level
  - Private insurance vs Public insurance status

Why we think it is so effective

- Visual component and message construction make auditory message more permanent and accessible
- Consistent verbal models are paired with visual supports
- Highlights low-emphasis language features that are commonly missed
- Children develop skills at an appropriate time developmentally, instead of playing catch up
- Independent means to initiate and self-monitor communication (buy-in, control over environment, social engagement, etc...)

Next Steps and Challenges

- Reproduce in a larger multi-site trial (current pathway)
- Understand the roles of adherence, dose response, and family engagement
- Use in natural settings/other settings (e.g., schools)
  - Tested feasibility in preschool setting
- Understand who would benefit most from treatment
- Evaluate optimal treatment cycles
- Sustainability of results (currently assessing)
- Effects on early literacy skills

What to consider *within EI* to prepare children who may benefit from this therapeutic approach

- **Nonverbally connect:** stay physically matched on child's level, show interest
- **Focus:** use actions and words consistently to facilitate new learning (visuals if possible)
- **Imitate and turn-take**: build in time for a response or imitation during interactions
- **Build:** add to what has already been said or done (action/sound/word)

What to consider, cont.

- **Model** and **honor** all types of communication
- Use **pictures/visual supports** of motivating objects, model pointing to picture or giving it to someone to communicate new messages
- Encourage and differentially **reinforce verbal attempts**
- **Read books together**, look at pictures and encourage talking about them
- Model language as a **shared learning experience** while using visuals

Final thoughts

- Recognize when language development does not match a child's ability (understanding potential)
  - Often satisfied with low-average to average language levels
- Even subtle "deficits" (perhaps unobvious altogether) can significantly impact functional outcomes
  - Occurs across the range of IQ and hearing levels
  - Does not have to be "sub-normal" to have an effect
- Novel therapeutic techniques that incorporate AAC strategies can provide children with additional tools in the toolbox
  - We should provide them with all of the tools possible to maximize chance for success

Thank You!

Thank you to participating families and Deaf/Hard-of-Hearing Research Advisory Board

Also big thanks to:
Susan Wiley – Developmental Pediatirician
Rosie Sheldon – SLP (interventionist)
Laura Smith -research coordinator
Sandi Grether - SLP
Cory Pfefferman – research coordinator
Jeni Anderson – SLP (interventionist)
Ilka Riddle – Co-I/dissemination
Lindsay Mays – psychologist
Mekibib Altaye – biostatistician

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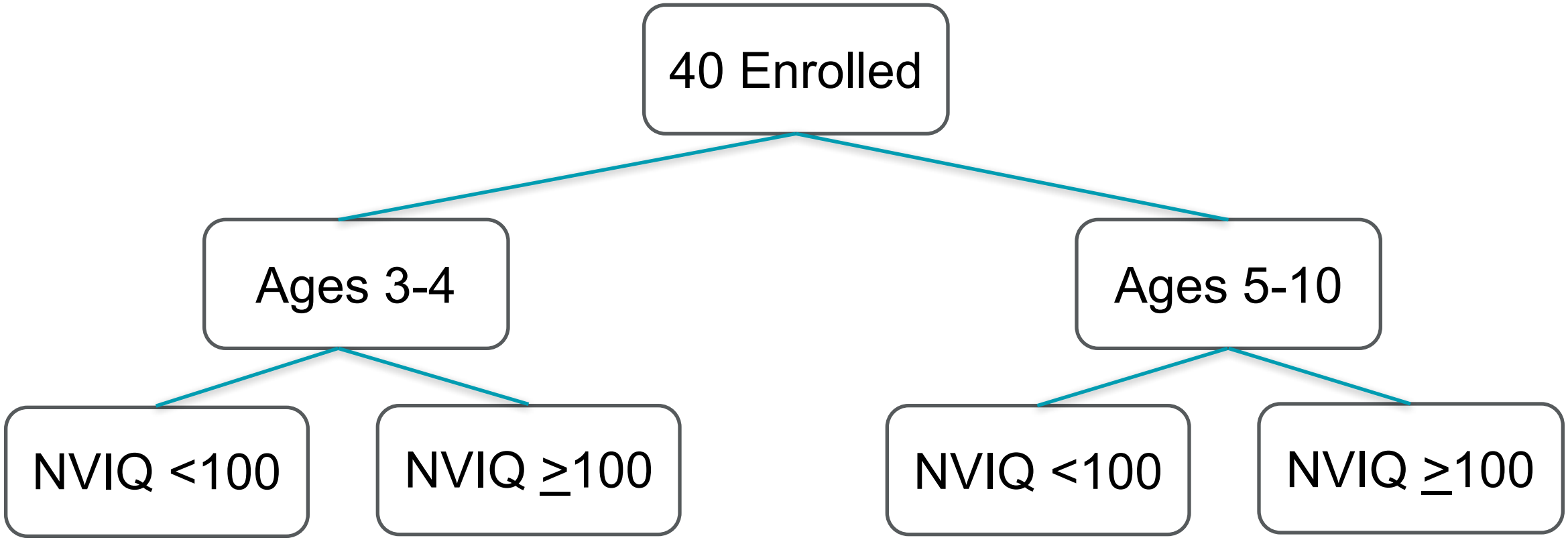
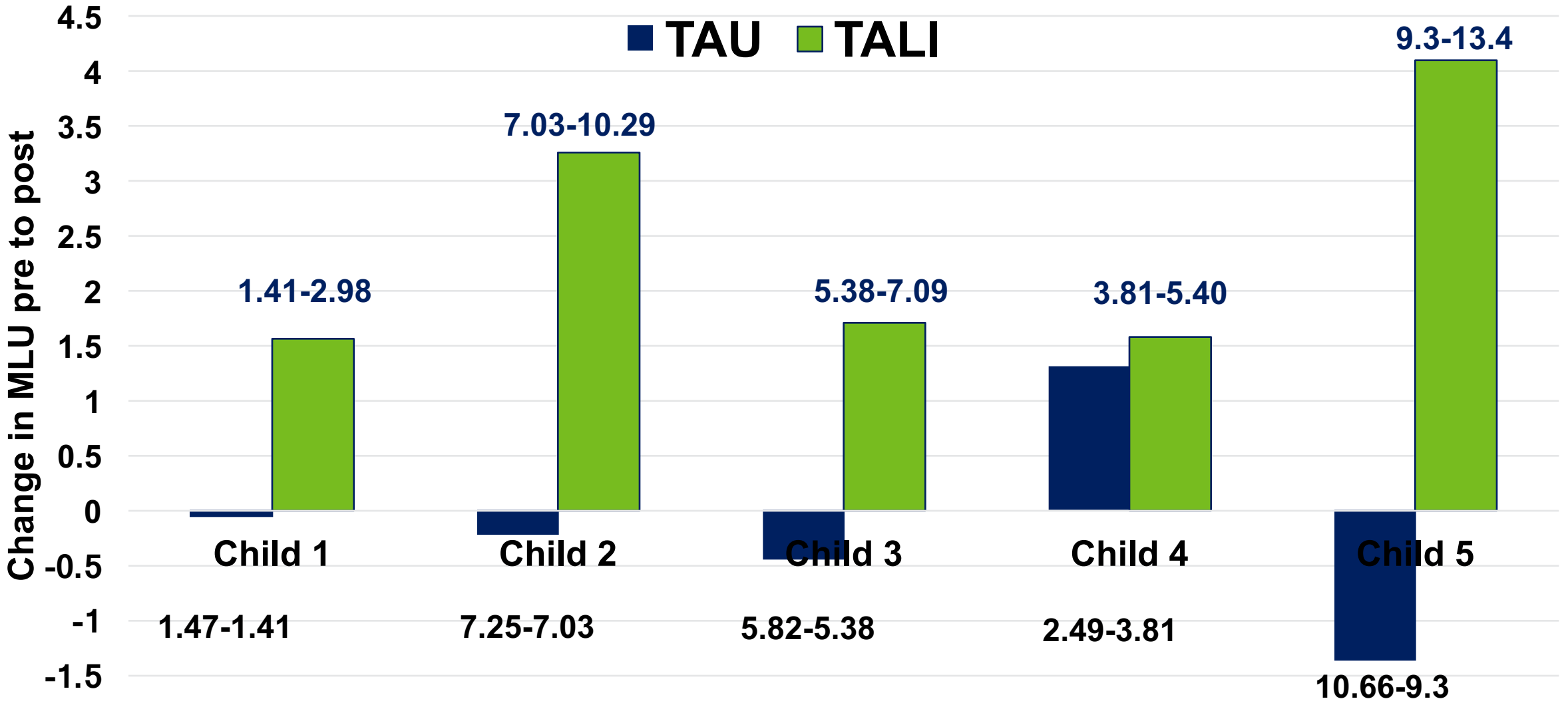
- EXTRA SLIDES

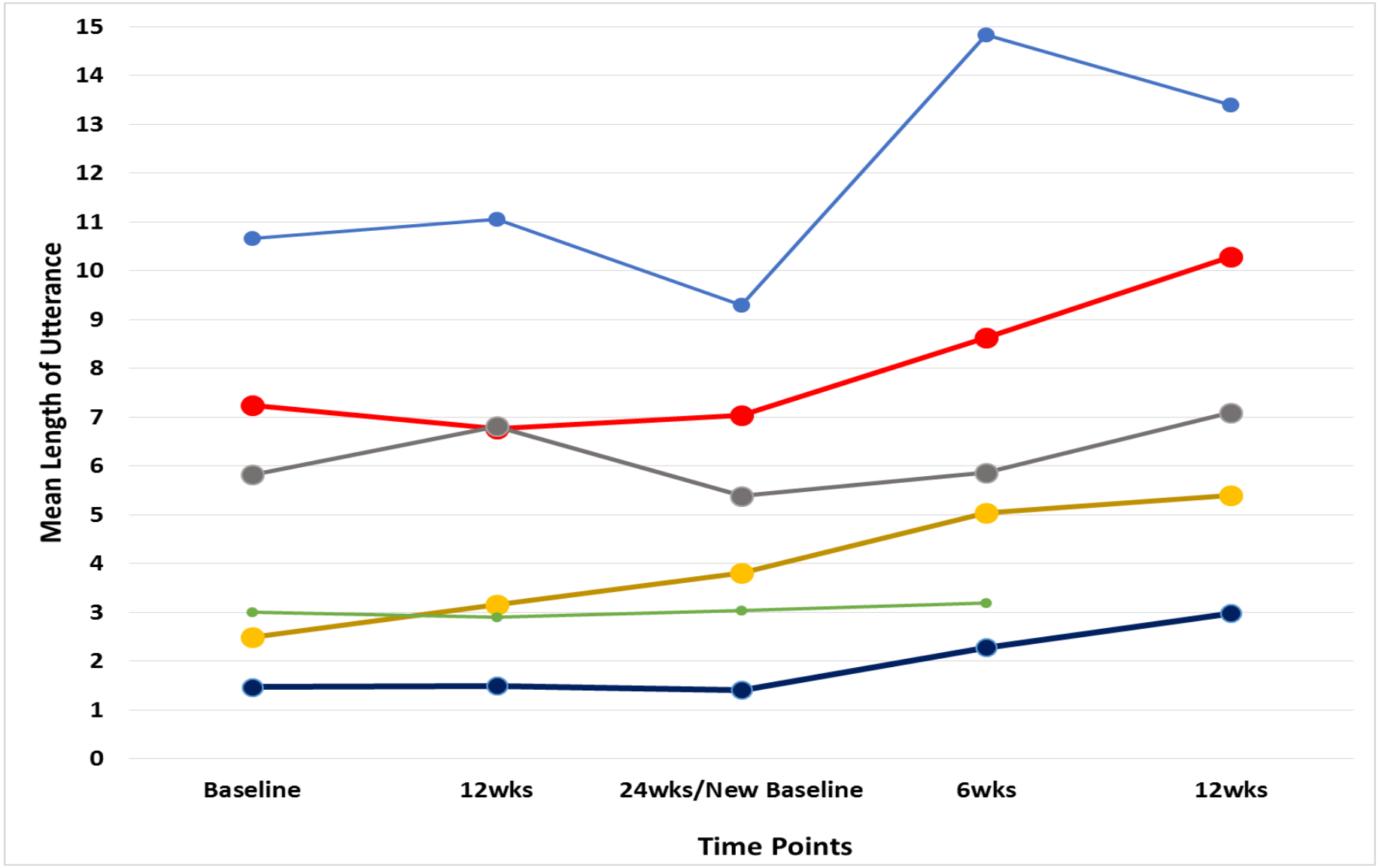
Stratified randomization



Results of Crossing Over to TALI



Cross-over data



Individual Impact Pilot study: Standardized Testing, quality of life

PLS on 7/10/15

	Raw Score	Standard Score	Percentile Rank	Age Equivalent
Auditory Comprehension	42	73	4	3 years 7 months
Expressive Communication	35	64	1	2 years 10 months
Total Language	77	67	1	3 years 3 months

PLS on 1/19/16

	Raw Score	Standard Score	Percentile Rank	Age Equivalent
Auditory Comprehension	56	93	32	5 years, 3 months
Expressive Communication	54	91	27	5 years, 0 months
Total Language	110	91	27	5 years, 2 months

- We enrolled a child in out pilot study with mild sensorineural hearing loss who had long-standing apraxia and global developmental delays (mild intellectual disability) due to progressive neurologic cerebellar atrophy
- She had initially been enrolled in a signing program which had a program for hearing children with apraxia with minimal improvements in speech
- She transitioned to her public school and had various clinicians and educators encourage augmentative communication, none of which were effective and her mother felt that people were asking her what she thought we should do
- Following trial: school story