Implications of Early and Late Language

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Conference for SLPs using ASL
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UCONN

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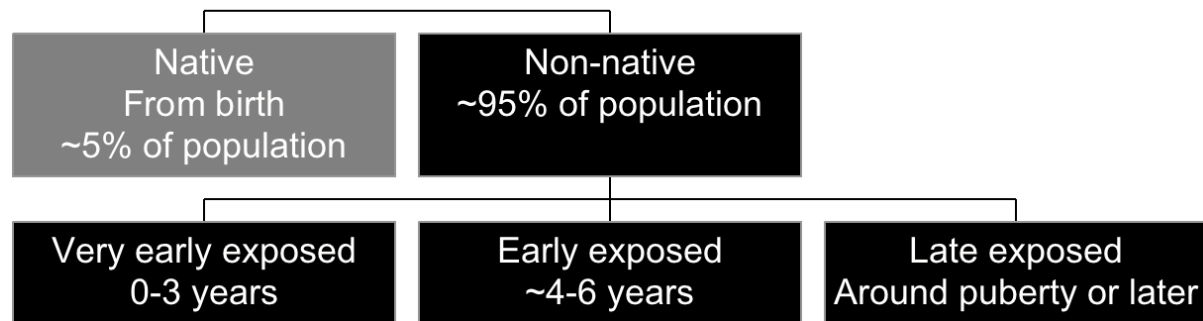@DLilloMartin   @SLLALab

Overview

- Delayed sign language acquisition and critical period effects
- Cognitive consequences of delayed sign language acquisition
- Bimodal bilingualism as an alternative direction
- New study with hearing parents and deaf children

Delayed sign language acquisition and critical period effects

With Stephanie Berk
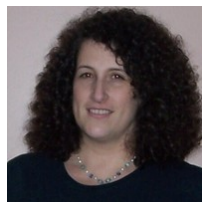
Deaf Children Are First Exposed to Sign Language at Different Ages

Native From birth ~5% of population	Non-native ~95% of population	
Very early exposed 0-3 years	Early exposed ~4-6 years	Late exposed Around puberty or later

Age of Acquisition effects for deaf learners of sign languages

- For many, sign language is learned as a late L1
- Natural experiment:
  - How does late L1 acquisition compare to native?
  - Are particular areas of language affected more than others?
  - How does Late L1 acquisition compare to L2?

Effects of delayed accessible language input: ASL grammatical performance

- Comprehension and production of basic SVO word order but reduced facility with variations related to particular linguistic contexts
  - Adults (Newport 1990)
  - Adolescents (Cheng & Mayberry 2019)
  - Children (Lillo-Martin & Berk 2003; Berk & Lillo-Martin 2012)
- Very recent research suggests even comprehension of SVO order is based on heuristics, not grammar (Mayberry presentations)

Extended study of 2 late learners in school age

- Two deaf children with no accessible linguistic input until approximately 6 years of age (Mei, Cal)

- Comparison deaf children with early input in ASL from deaf parents

Berk 2003; Berk & Lillo-Martin 2012; Lillo-Martin & Berk 2003

Mei

- Initially misdiagnosed as mentally retarded
- By 4 1/2 yrs old diagnosed as profoundly deaf
- 5;9   Intake evaluation
  - "MEI's overall performance indicates that she has some well developed nonverbal cognitive abilities."   (School psychologist)
- 6;1   First exposed to ASL, upon starting school
- 6;7   Observations began

Cal

- By 3 yrs old, diagnosed as profoundly deaf, but lack of appropriate services
- 5;9   Intake evaluation
  - "CAL's performance on the K-ABC Nonverbal Scale suggests he is functioning within average range of nonverbal intelligence." (School psychologist)
- 5;9   First exposed to ASL, upon starting school
  - 2 months to end of academic year; then 3 month summer break
- 6;10 Observations began

Observations

- Both children were observed twice per week during school year for 15-30 minute sessions.

- Each child interacted individually with Deaf signer and a bag of toys.

- Deaf signer regularly worked in dorm with the children as language/ Deaf culture role-model.

- Filmed in child-familiar dorm living area room.

Sessions analyzed

Session	MEI 1	MEI 2	MEI 5	MEI 6	MEI 12	CAL 1	CAL 2	CAL 10
Age	6;6. 26	6;7. 29	6;8. 24	6;9. 01	7;1. 05	6;10. 06	6;11. 06	7;4. 06
Expos	10	11	12	12	16	14	15	20
School	6	7	8	8	10	10	11	14
# Utts	140	83	157	118	55	123	90	94
MLU Words	1.6	1.6	1.85	2.3	2.1	1.6	1.5	1.7
MLU Morph	1.9	1.8	2.1	2.6	2.5	1.7	1.7	2.4

Did Mei and Cal go through a 2-word stage?

⮩Yes, as determined by utterance length
- MLU
- Distribution of multi-word utterances

- **Limited semantic relations**
  - *Mei and Cal express a much wider range of semantic relations than 2-year-olds in the 2-word stage (e.g. intention, attribution).*

- **Missing constituents**
  - *Mei and Cal's utterances are more likely to be missing more complex constituents, leading more often to unacceptable utterances than 2-year-olds'*

Berk & Lillo-Martin (2012)

Canonical and Derived Orders in ASL

- Basic/Underlying Order: S V O

- Used in pragmatically neutral contexts; other orders marked in various ways

- *Not necessarily the most frequently observed!*

- Chen Pichler (2001) observed early accurate use of non-canonical orders by Deaf children

Word Order - Mei & Cal vs. Aby & Sal

- Null Hypothesis:
  - Mei and Cal will not be statistically different from Sal and Jil in usage of canonical vs. derived, and correct vs. incorrect (derived) orders

- Binomial Exact Probability
  - Calculated for Mei and Cal separately

Word order under delayed input

- Cal and Mei are different from Sal and Aby in the overall proportion of canonical orders used
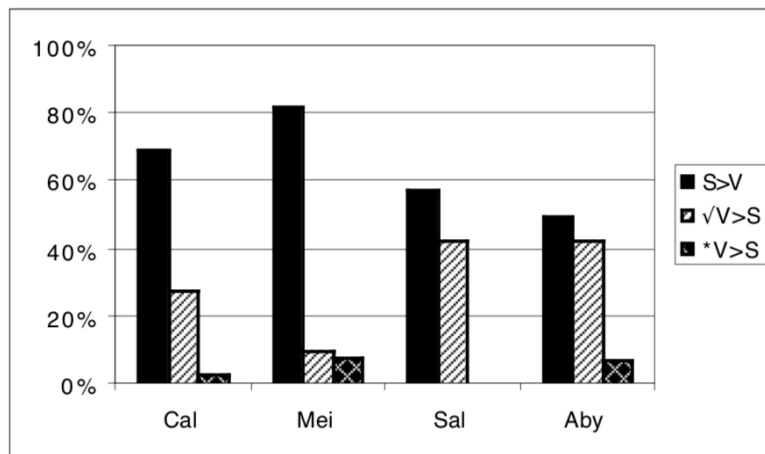
- Mei also makes more errors in her attempts at derived orders
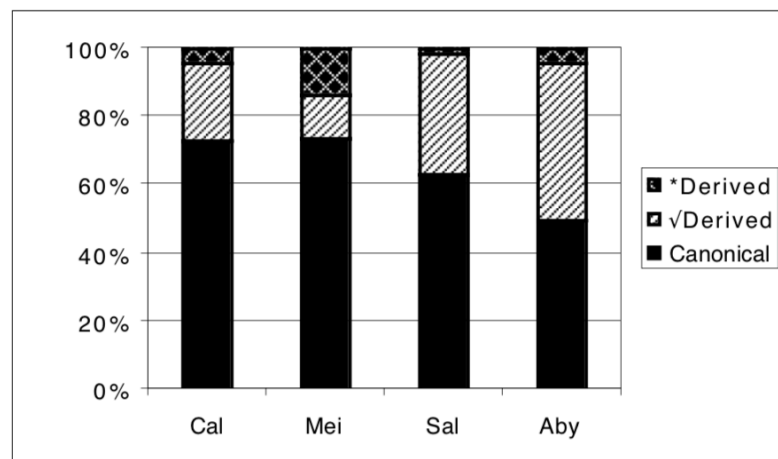
Figure 1. Later vs. Native Learners: Overall Word Order

Lillo-Martin & Berk (2003)

Word order under delayed input
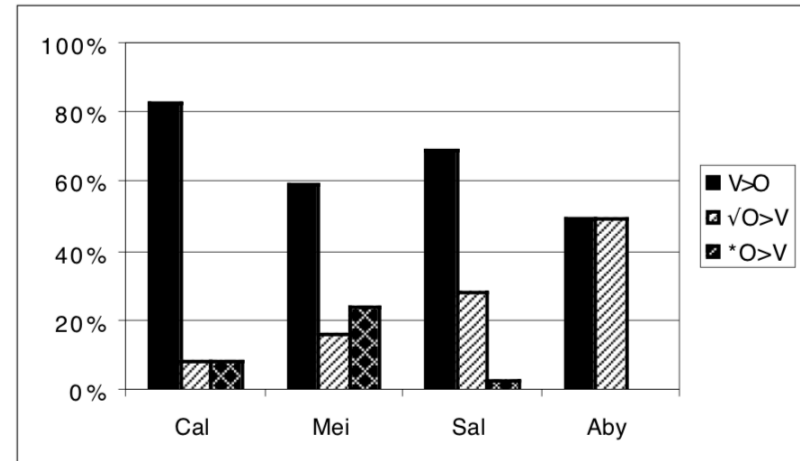
Lillo-Martin & Berk (2003)

Word Order Summary

- Mei and Cal are more restricted in use of non-canonical orders, and make more errors with these orders.

- They are less proficient in using alternate orders than native signers at a comparable level of linguistic development.

Similar results with older learners studied by Cheng & Mayberry (2019)

Effects of delayed accessible language input: ASL complex morphology

- Comprehension and production of complex morphology is affected by age of exposure
  - Adults (Newport 1990)
  - Children (Berk 2003)

Verb Agreement – person marking

- In ASL, some verbs show agreement with their (subject and) object
- These verbs (typically) have [+human] arguments
- Agreement uses spatial loci
- Agreeing verbs generally move from locus of subject to locus of object

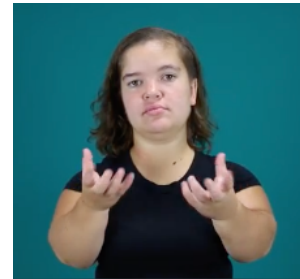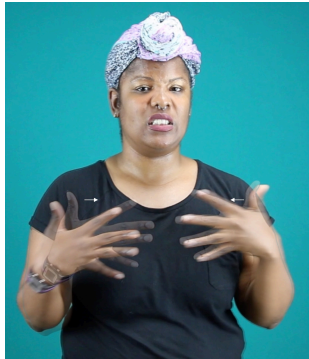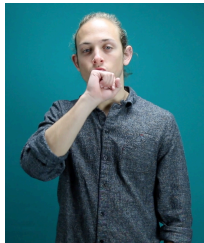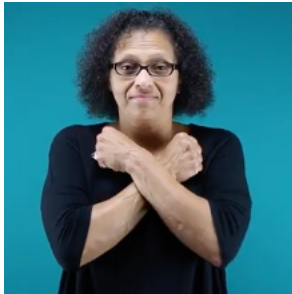# Spatial Verbs – location marking

- Spatial verbs show agreement by moving from their source location to their goal location
- Some spatial verbs only indicate one location
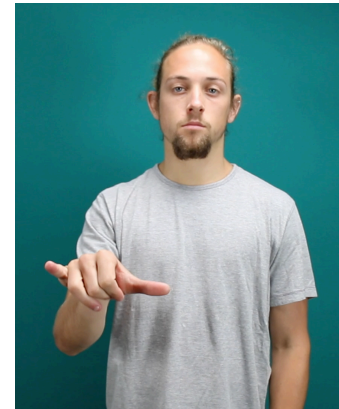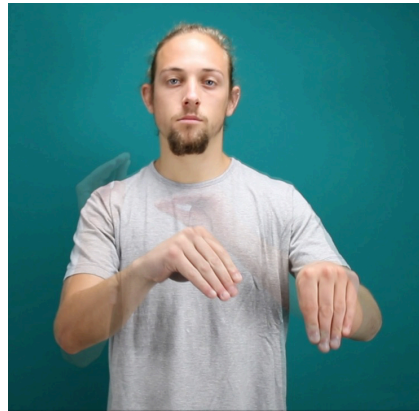
Plain Verbs

- Plain verbs generally do not show agreement
  - Some are 'body-anchored'
  - Some can optionally be signed in a location

# Acquisition of ASL verb agreement under delayed exposure

- Study of spontaneous production data from Mei and Cal
- Comparison of use of directionality for person versus spatial verbs

Table 1: Participant data

Pseudonym	Age at immersion	Age filming began	Age at conclusion of filming	Age range of current analyses
MEI	6;0	6;7	10;0	6;7-9;9
CAL	5;9	6;10	10;1	6;10-10;0
LES	3;6	6;3	10;2	6;3- 8;0
JIL	birth	1;7	3;7	2;0-4;6
NAT	birth	5;11	9;11	7;11- 8;11

Berk (2003); Kwok, Berk & Lillo-Martin (under review)

Verb Agreement Errors
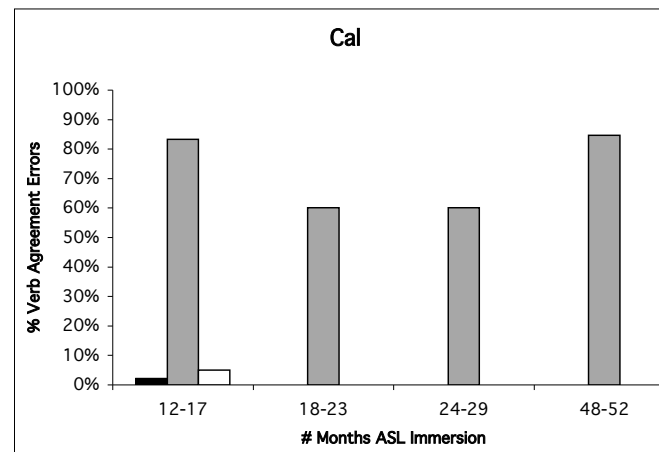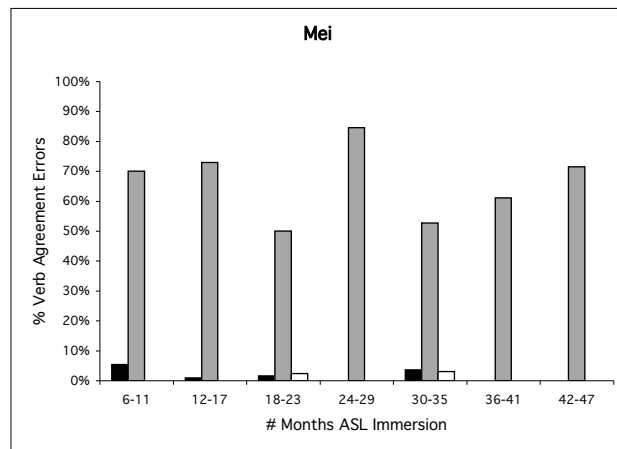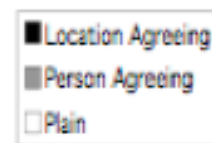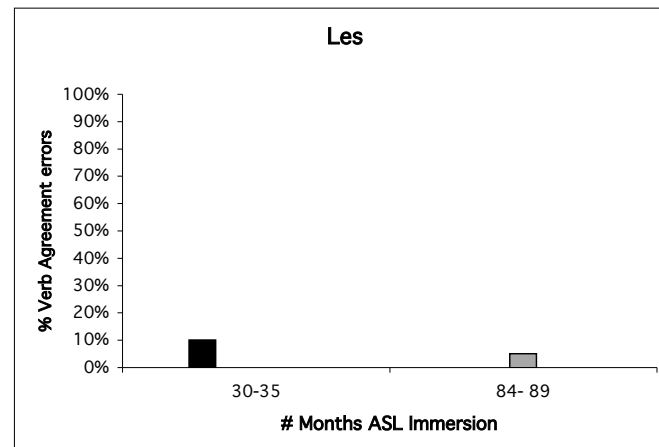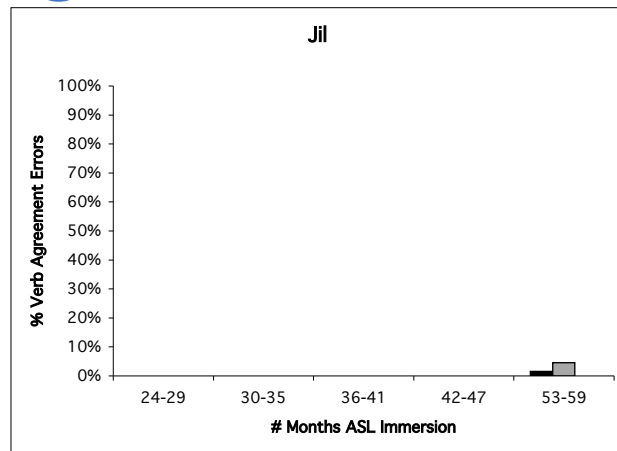
Berk (2003)

Summary

- Delayed linguistic input affects the course of acquisition – even when input is relatively 'early', long-lasting effects are seen

- Sensitive period effect is not uniform, but particularly impacts certain aspects of grammar

- Possible reason for a distinction between person and locative agreeing verbs: person agreement is purely grammatical, while locative agreement has semantic effects

Cognitive consequences of delayed language exposure

Matthew Hall

Background

- Many studies report cognitive delays in deaf children, in various domains (including 'non-linguistic')

- Controversy regarding the source:
  - Auditory Deprivation?   Language Deprivation?

- Need to test 3 groups to distinguish

- This study: Executive Function, measured by BRIEF (Behavior Rating Inventory of Executive Function)

Non-signing CI users	Hearing controls	Deaf native signers
n=26	n=45	n=44
5;06-12;10 (M=8;09)	5;06-12;11 (M=8;04)	5;01-12;10 (M=8;03)
Implant ave. 17 mo		

Results - BRIEF

- Elevated scores indicate *more problems*

- Hearing controls and Deaf native signers *do not differ*

- Oral CI users show *higher, more problematic scores*

- Auditory deprivation does not necessarily lead to cognitive delays, but language deprivation might

Hall et al. (2017, 2018)

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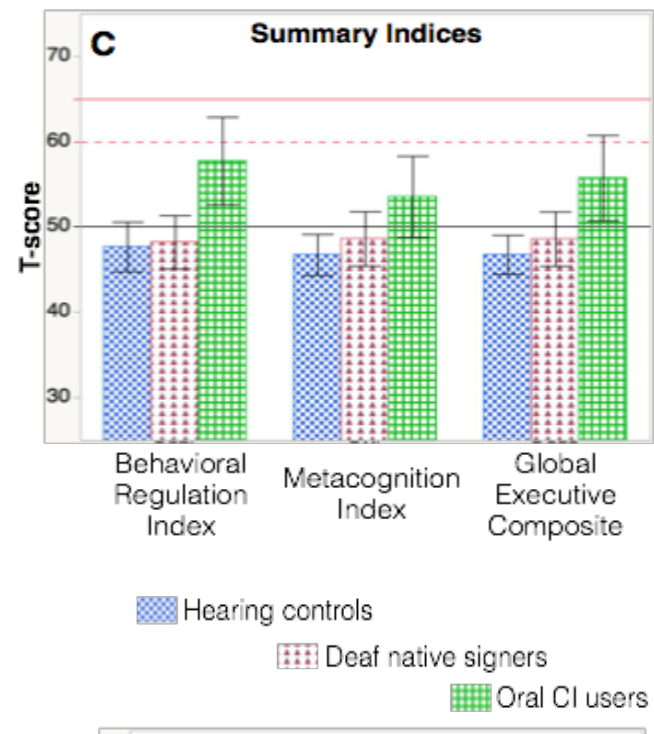
Why is exposure delayed?

Effects of delayed accessible language input

- Well-known, wide-spread, long-lasting effects of delayed accessible language input

- Common phenomenon: only ~5% of deaf children are born into signing families

Effects of delayed accessible language input

- Well-known, wide-spread, long-lasting effects of delayed accessible language input

- Common phenomenon: only ~5% of deaf children are born into signing families

- Even nowadays, with hearing technology, a period without linguistic input is inevitable and outcomes are extremely varied

- Nevertheless, parents are often advised not to sign with their children while awaiting a cochlear implant; they are told the child can learn sign later
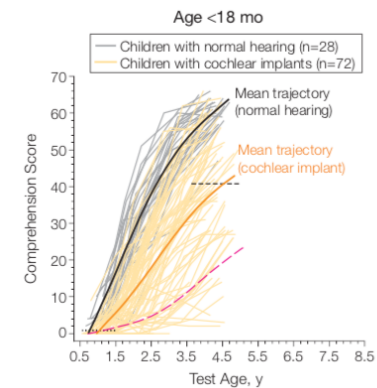
Scores on RDLS comprehension test for hearing (black) and deaf children who received a cochlear implant before 18 months (yellow) (Niparko et al. 2010)

Parents want their children to learn spoken language

- Often, parents are warned that use of a sign language will inhibit their children's acquisition of a spoken language

- Parents might even be told that their child can learn a sign language later, but that the critical period means they must learn speech first
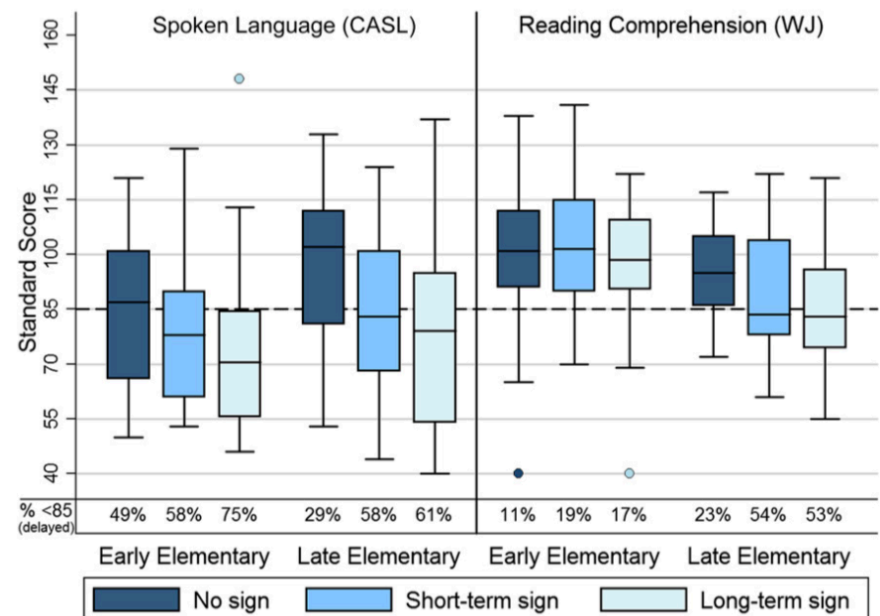

Geers et al. (2017)

Problems with the previous research

- Typically, children in the 'sign' or 'manual' group in such studies
  - Have delayed input in sign
  - Have inconsistent/infrequent input in sign
  - May be using an artificial sign system, not a natural sign language
- Such groups are highly heterogeneous and lags could be due to many different reasons

Caselli, Hall & Lillo-Martin (2017)

Bimodal bilingualism

With Kathryn Davidson, Deborah Chen Pichler, Corina Goodwin, and Viola Kozak
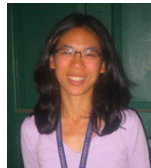
Possibility of bimodal bilingualism: DDCI

- Childhood bilingualism is achieved around the world!
- Given the effects of delayed input on *both* sign and spoken language development,

➢ *What if deaf children begin with a sign language and then start to learn a spoken language after cochlear implantation?*

Three studies

- Study 1: How does English develop in DDCI compared to Kodas overall?
  - Results of standardized tests
- Study 2: Finer-grained analysis of morphosyntactic development
- Study 3: Relations between ASL skills and English phonological awareness

Study 1: Standardized Tests

|	Participant	Age of first English testing	Age at first implant	Years since CI	Mother's Education
Children with CIs	PAM	4;00	2;11	1;01	BA/BS
	NIK	5;05	1;04	4;01	BA/BS
	GIA	5;07	1;06	4;01	Post-grad
	FIN	5;08	1;07	4;01	Post-grad
	MAX	6;04	1;08	4;08	BA/BS
Koda children (n=20)	Mean	6;00	N/A	N/A	
	Range	4;09-8;02	N/A	N/A	12-21

Davidson, Lillo-Martin & Chen Pichler (2014)

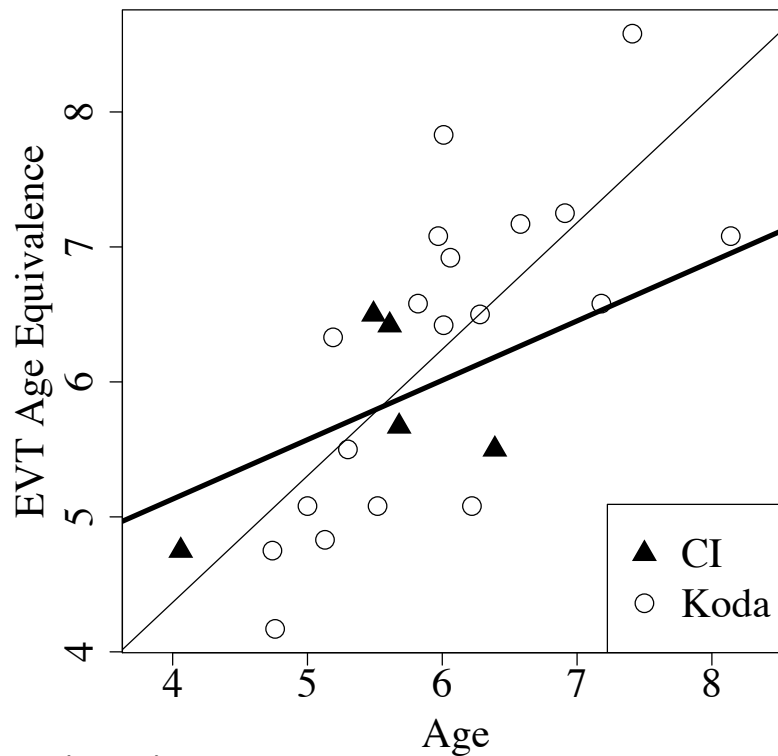# Bimodal Bilinguals – Development of ASL and English

ASL
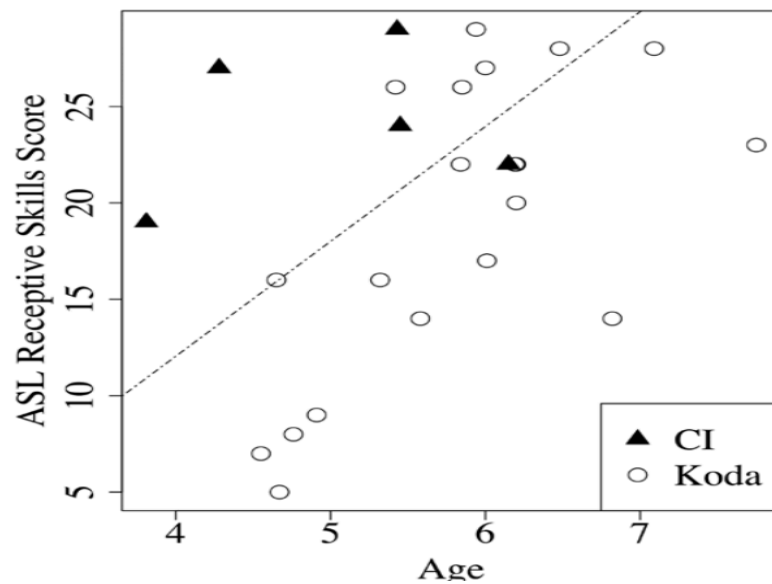
English
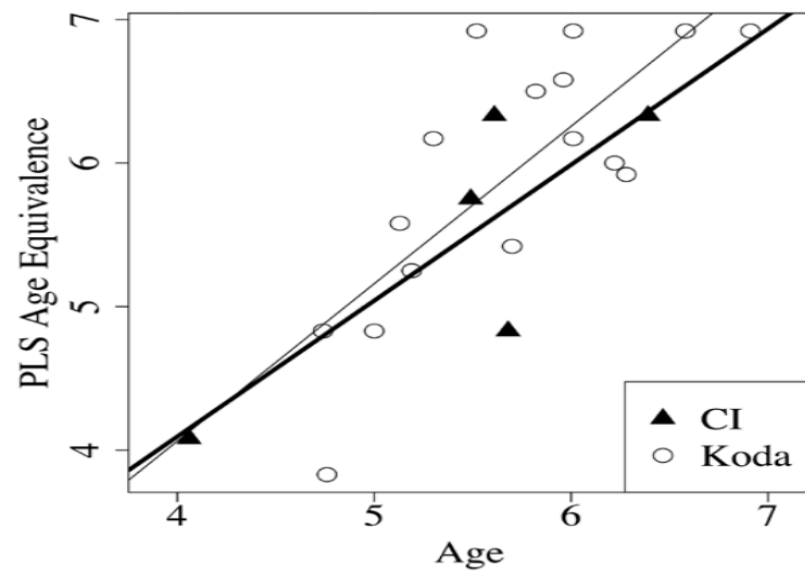
Davidson, Lillo-Martin & Chen Pichler (2014)

Expressive Vocabulary Test

Participant	Age	EVT Standard Score
PAM	4;00	110
NIK	5;05	112
GIA	5;07	108
FIN	5;08	100
MAX	6;04	90

EVT age equivalent scores were not sig. different between CI (6.00) and KODA (6.45) groups ($t(10)=01.4$, p=0.3)

Davidson et al. (2014)

Index of Productive Syntax (IPSyn)

Participant	Age	IPSyn Score
PAM	4;00	93
NIK	5;04	83
GIA	5;07	83
FIN	5;08	76

Points awarded for use of up to 56 syntactic structures (max score 112)

Geers et al. (2003) found of 8/9 yos:

CI w/Speech + Sign:
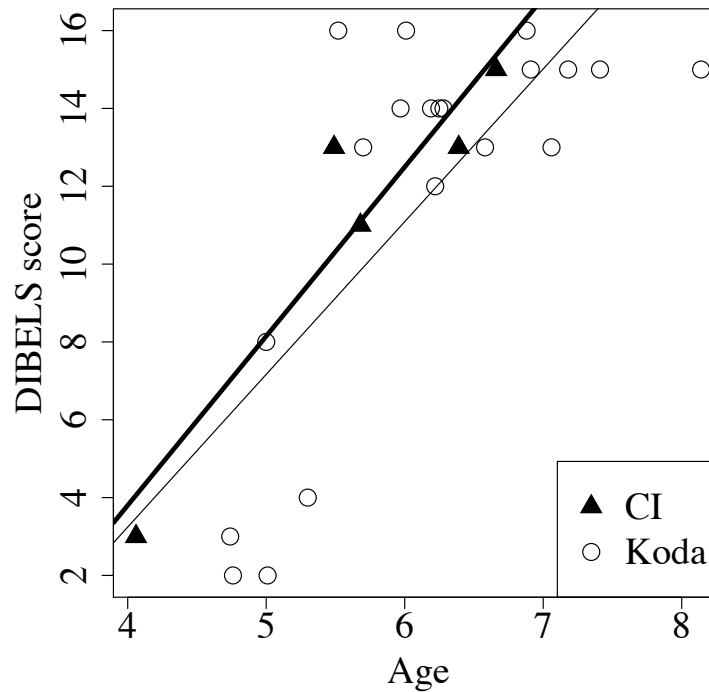   Mean 67.1 (Range 13-93)
CI w/Speech only:
        Mean 64.8 (Range 1-92)
Normal Hearing:
        Mean 81.2 (Range 75-91)

Davidson et al. (2014)

Phonological Awareness: DIBELS

Linear model with age and status shows **age** to be a significant predictor of success, (β=3.60, t=5.04, p<0.001) but not **audiological status** (β=-1.28, t=-0.79, p=0.44)

Davidson et al. (2014)

Articulation: Goldman Fristoe

Participant	Age	GFTA Standard Score
NIK	5;05	109
GIA	5;07	112
FIN	5;08	100
MAX	6;04	102

Kodas: Mean 107.9 (SD 7.5); range 86-116

Davidson et al. (2014)

Study 1 Summary

- 5 case studies: Native signing Deaf children with cochlear implants (< age 3)

- No difference between Deaf children and hearing peers on
  - language scales
  - vocabulary
  - syntax
 - phonological awareness
  - articulation

Study 2: In-depth analysis of English morpho-syntax

- Standardized tests showed no difference b/w DDCI and Kodas, both at chronological age equivalents

- Gross, overall measures – what about more fine-grained analyses?

- Bilingual children *usually* are a bit slower than monolingual for norms of each language (e.g., Hoff & Core 2015)

Goodwin & Lillo-Martin (2019)

Specific morphemes

- Do DDCI have difficulty with any specific morphemes of English?
- Analysis of children's responses to tests designed to elicit short sentences and narratives
- DDCI: n=5, ages 4;01-6;05
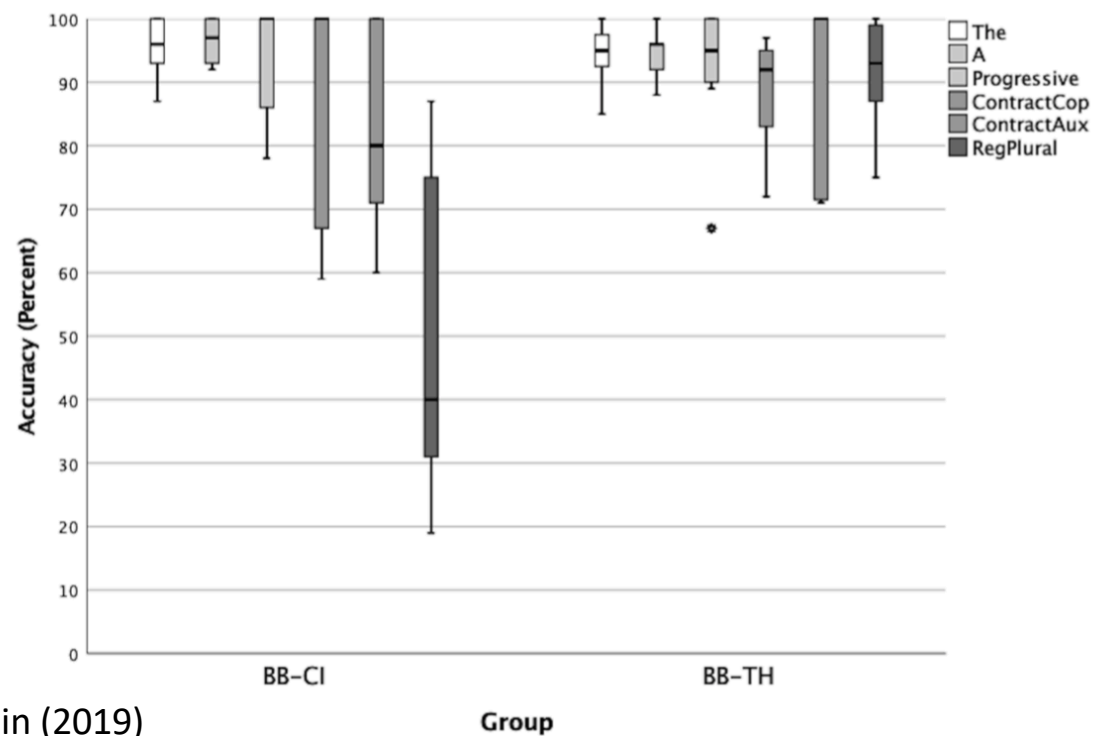- Koda: n=7, ages 5;01-6;03

Goodwin & Lillo-Martin (2019)
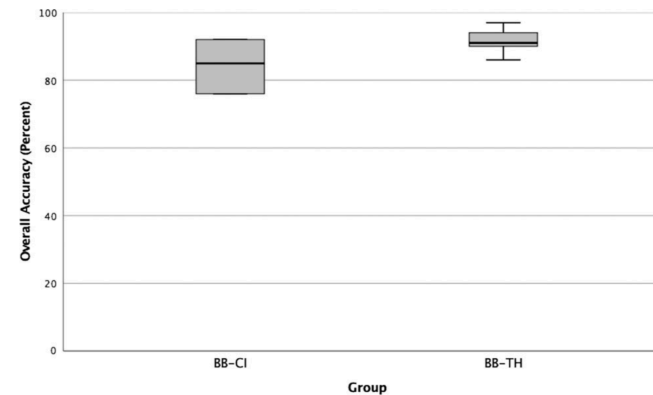
Overall morphological accuracy

Accuracy on individual morphemes (by perceptual salience)

Goodwin & Lillo-Martin (2019)

Study 2 Summary

- DDCI very similar to Koda age-mates in English morpho-syntax
  - Despite differences in hearing age, acoustic vs. electric hearing
- DDCI lower accuracy than Kodas on plurals (perceptual salience)

Related analyses do find:

- DDCI and Kodas show some bilingual effects
  - Overall morphosyntactic development
  - Age of acquisition for specific morphemes measured longitudinally
  (Goodwin & Lillo-Martin in prep)

Study 3: Relationships between ASL and English reading

Lillo-Martin, Chen Pichler, Kozak & Quadros (2018)

Research questions

1. Do young bimodal bilingual children with more developed ASL skills also show greater ability in ASL Phonological Awareness compared to children with less developed ASL skills?

2. Do children show any relationship between ASL skills and English phonological awareness?

Tests of ASL and English

1. **ASL Receptive Skills Test:** overall ASL receptive abilities (Enns & Herman, 2011)
2. **ASL Minimal Pairs (MP):** ASL phonological discrimination
3. **ASL Handshape Test:** ASL phonological awareness
4. **DIBELS Initial Sound Fluency subtest** (Sopris West Ed. Services), English PA.

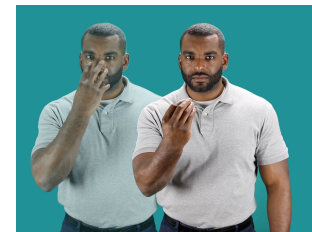# Method: ASL Phonological Discrimination
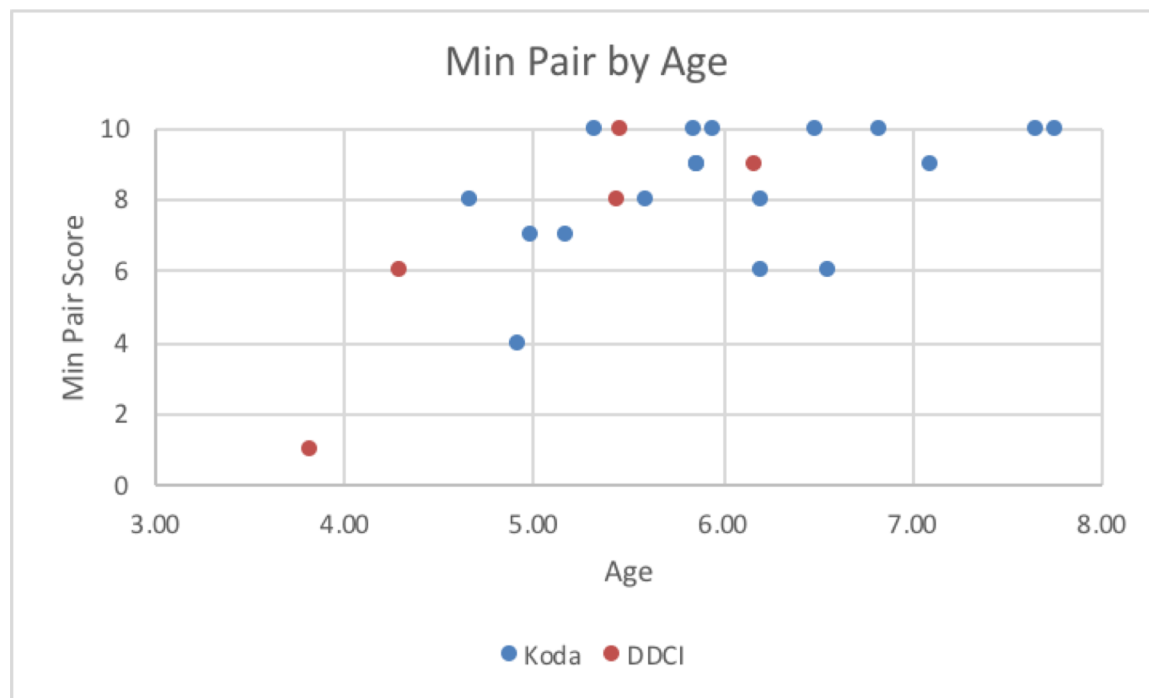Minimal pairs test sample
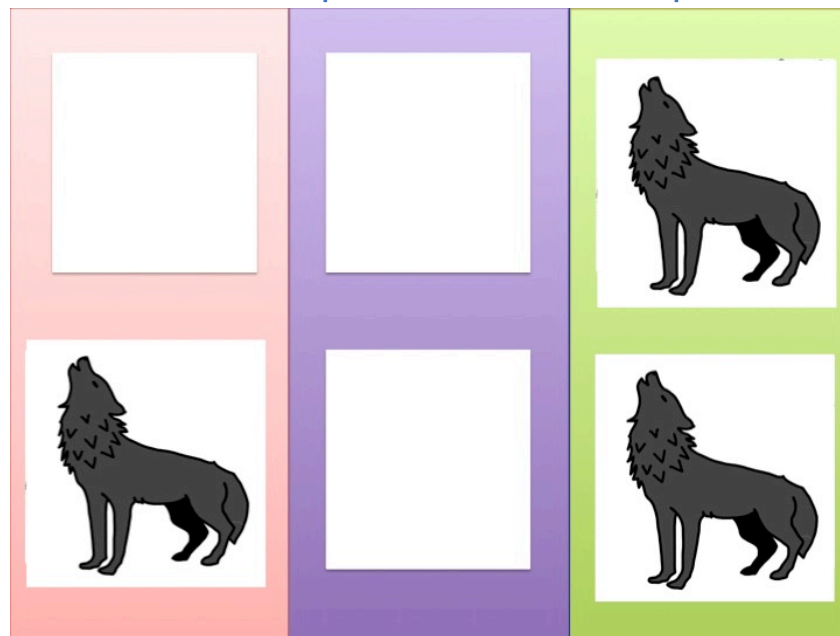
"Which panel shows WHITE and WOLF?"

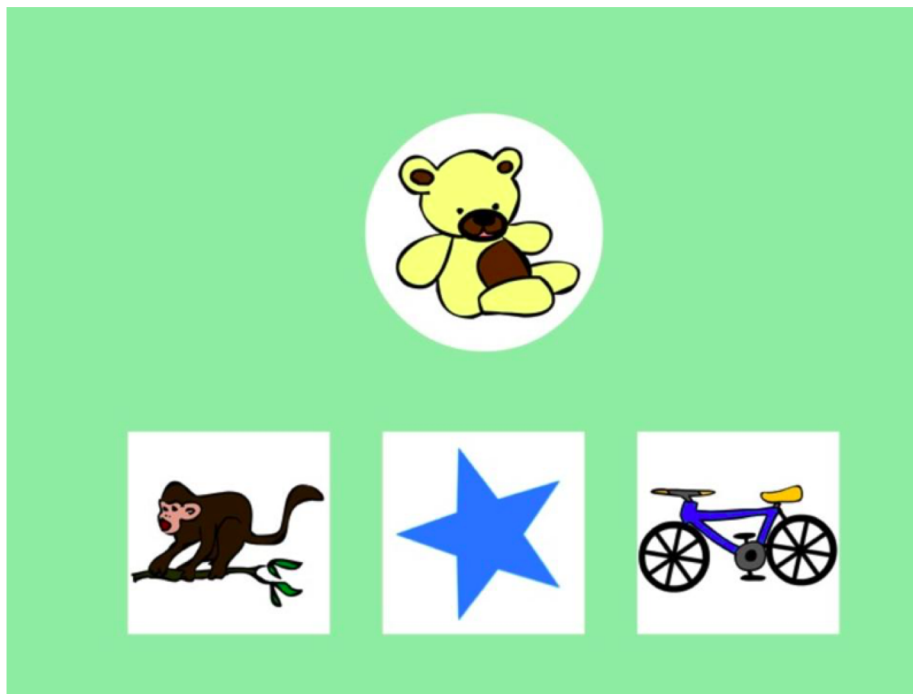WHITE   WOLF

Results: ASL Phon. Discrimination and Age

ASL Phonological Discrimination (Minimal Pairs) improved with age

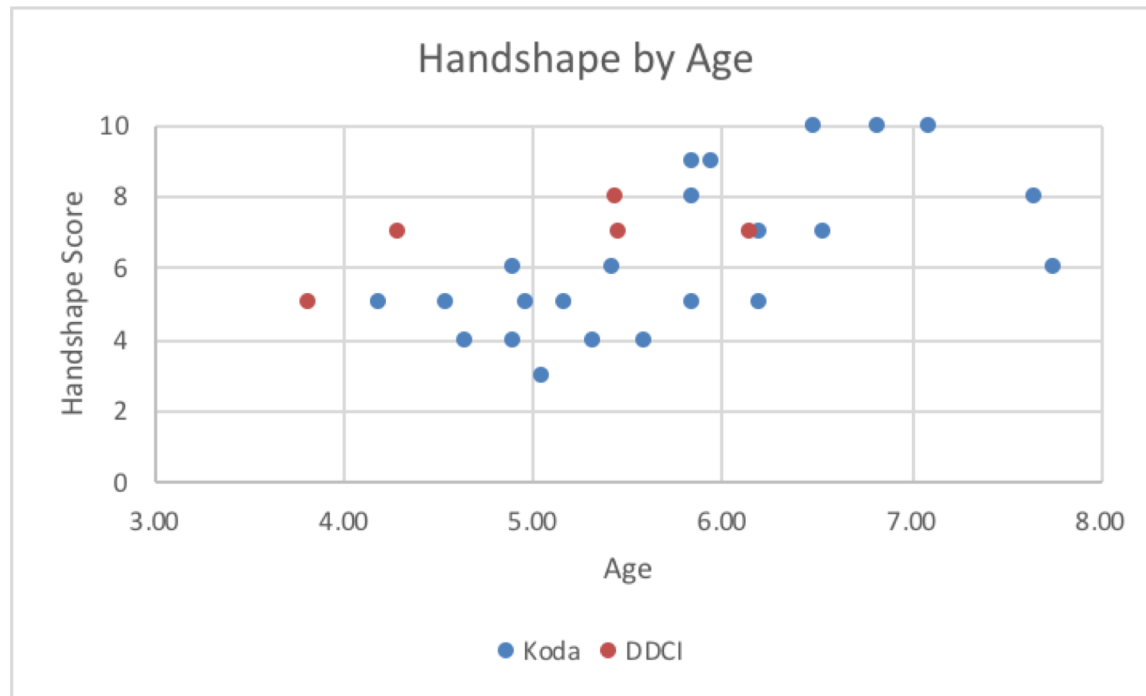$r^2 = .3951, \ p < .001)$

Method: ASL Phonological Awareness
Handshape test sample

"Which sign at the bottom of the screen has the same handshape as BEAR?"

Results: ASL Phonological Awareness and Age

Handshape by Age

ASL Phonological
Awareness
(Handshape) improved
with age

$r^2 = .3198, \quad p < .001$

Results: ASL-RST and ASL PA

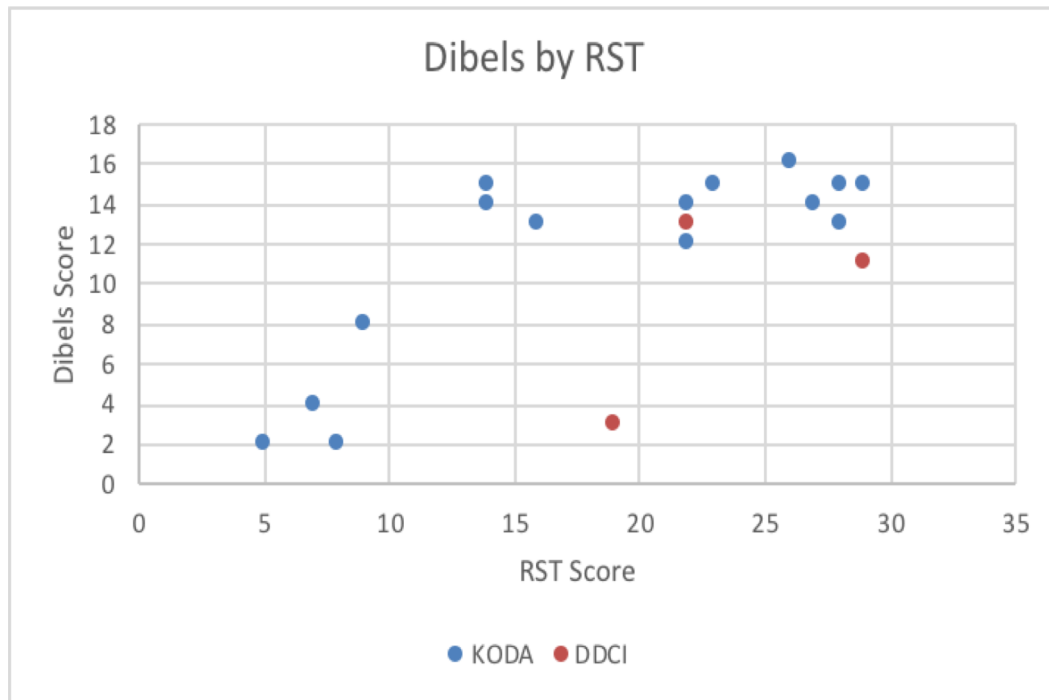### HANDSHAPE BY RST

Handshape Score (y-axis: 0 to 10)
RST Score (x-axis: 0 to 35)

● KODA ● DDCI
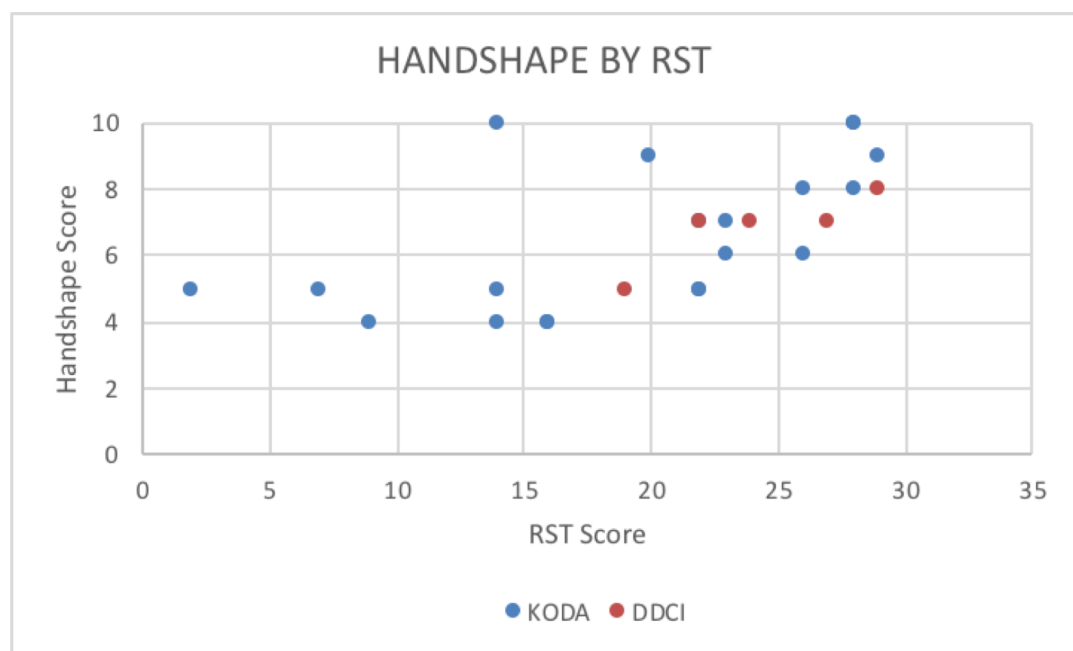
$r^2 = .3566, p < .0001$

ASL-RST significantly predicted scores on ASL PA test (shown), but not on the ASL Phonological Discrimination (Minimal Pair) test.

Results: English PA predicted by ASL tests

All three ASL tests significantly predicted English Phon. Awareness.

(RST shown here)
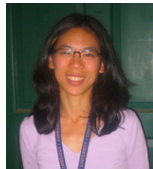
$r^2 = .5007$, $p < .0001$

Conclusions

- Consistent with previous studies, we find a positive relationship in young bimodal bilinguals between:
  - overall ASL knowledge and ASL PA
  - overall ASL knowledge and English PA
- These findings also consistent with conclusions of Kozak (2018)

What about hearing parents of deaf children?

With Deborah Chen Pichler and Elaine Gale

General Summary

- Remarkable similarity in performance between DDCI and Kodas in most areas

- Some bilingual effects, but no more than for speech bilinguals

- HOWEVER…
  - Very small, select sample
  - Same results for other DDCI??
  - What about deaf children with hearing families?

Unknowns

- Can hearing parents who choose to sign learn enough?

- How can parents best learn a natural sign language?

- What resources do parents need?

- Can children learn enough sign language if their parents are beginners?

- Would that be enough language base for subsequent learning of a spoken language?

Current situation for deaf children and their hearing parents looks discouraging.

- "Significantly delayed first language acquisition is likely to be a hallmark of L1 [sign language] learning by all deaf children whose hearing parents have no prior experience of deafness." (Mayer & Leigh 2010: 179).

- "But successful second language learning by adults (including learning a sign language by hearing parents) cannot be taken for granted." (Knoors & Marshark 2012: 295).

How proficiently do hearing parents have to sign to benefit their deaf children, especially those with a CI?
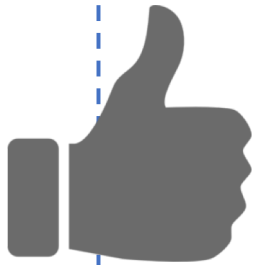
Successful development of ASL and English with Deaf signing parents (Davidson et al. 2014)
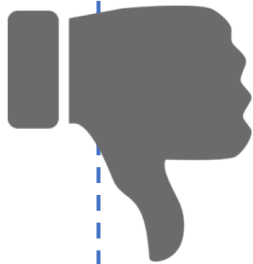
Will less proficient ASL input from hearing parents still benefit children's development, or will it hurt more than help? (Knoors & Marschark 2012)

Preliminary study with hearing parents who are learning ASL with their deaf children

- Questionnaire and semi-structured interviews with hearing parents of deaf children who are including ASL as a home language.
- Topics in the interview include:
  - motivations for signing
  - separation between ASL and other signed systems
  - experiences as L2 ASL learners

Chen Pichler & Lillo-Martin (2018)

Family Interviews – Participants (subset)

Child Pseudonym	Child Gender	Age at interview	Hearing technology	Interviewed	Self Evaluation of ASL
ELLA	F	1 year	hearing aid (HoH)	Mother	beginner
HANA	F	1 year	hearing aid; CI scheduled for 15 mo	Mother	beginner
ÅSA	F	16 months	none (rarely uses hearing aid)	Mother	advanced
CHUCK	M	2 -1/2 years	hearing aids	Mother	beginner
NANCY	F	2 -1/2 years	bilateral CI	Father Mother	beginner
SEBASTIÁN	M	2 -1/2 years	BAHA	Mother	beginner
LUCÍA	F	3 years	hearing aid	Mother Grandmother Godmother	beginner
KAI	M	3 -1/2 years	hearing aid	Mother Father	intermediate advanced
SIENNA	F	5 years	hearing aid	Mother	intermediate
CLARA	F	6 years	bilateral CI	Mother	intermediate

Main research questions for hearing parents who have committed to ASL

1. What made you choose ASL, despite pressure against signing with deaf children?

2. What are your goals for learning ASL for themselves? for your deaf children?

3. What aspects of ASL have been the hardest to learn? the most intuitive to learn?

4. What methods are the most effective for learning ASL?

5. What resources do you still need to support their family's development of ASL?

Q1 What made you **choose ASL**, despite pressure against signing with deaf children?

❑I felt ASL would help me to bond and communicate better with my deaf child.

❑I realized that ASL is a rich language and I want my child to have access to it.

❑Reports that baby signs are beneficial for language development.

- "My Deaf child has a right to fully accessible language and to be fully included in all family activities." (as many options as possible)
- "It was a logical choice" (previous knowledge)
- "I'm not easily impressionable" (independence from others' opinions)

Q2 What are your **goals** for learning ASL? goals for your deaf children?

❑To learn enough ASL to support my speech when my child has trouble understanding me.

❑To become an ASL-English bilingual person, actively using both languages.

❑To adopt ASL a family language, used by more than just my deaf child and me.

- For the child: To develop Deaf identity
- For the parent: To be able to communicate with their child in the child's chosen language

Q3 What aspects of ASL have been the **hardest** to learn? the most intuitive to learn?

	Very easy	Not difficult	Quite difficult	Near impossible
Accurate form		6	3	1
Vocabulary	1.5	4.5	5	
Fingerspelling	1	3.5	5.5	1
Nonmanuals	2	5.5	2.5	
Storytelling skills	1	1	6.5	2.5
Word order		2	8	1
Classifiers		1.5	8.5	
Eye gaze	2	5	3.5	0.5
Child-directed sign	3	4.5	3.5	

fewer responses →←← more responses

Q3 How **important** is each aspect of ASL for hearing parents of deaf children?

	Critical	Useful but not required	Not that important
Accurate form	5	3	2
Vocabulary	7	4	
Fingerspelling	8	3	
Nonmanuals	9.5	1.5	
Storytelling skills	10	1	
Word order	5	5.5	0.5
Classifiers	5.5	4.5	
Eye gaze	9	1	
Child-directed sign	8	2	1

fewer responses ← → more responses

Q4 What **methods** are the most effective for learning ASL?

- One-on-one contact (Deaf mentor, online options)
- Corrective feedback
- General online materials (for parents, children, siblings)
- Early childhood educational program at the school
- Deaf community
- Classes at a local college/university

"Patience"   "Keep trying!"

Q5 What **resources** do you still need to support their family's development of ASL?

- More contact with Deaf signers, one-to-one

- Combination of in-person and e-meetings

- Continuity of resources provided across the different periods of child's life

- Recurring theme: Lack of support to use signs or sign language.
  - parents left on their own to locate resources for signing
  - need more advanced sign language classes that go beyond just vocabulary

Lack of support for more in-depth ASL learning after first few years.

"Vocabulary is not enough. I don't want SimCom, I want ASL!"

"We're worried that [as his ASL expands,] family communication won't be spontaneous because of our own limitations in ASL."

"I'm worried what I'll do after she turns 5 and our ASL services get cut off."

"We are stuck at intermediate level. We're already in the last ASL class offered in our area, but we still don't feel fluent."

Looking forward

- Hearing parents have an urgent need to learn to sign basics quickly, and then to go beyond survival level to real conversation.

- Deaf children and their parents need the Deaf community to foster continual language growth.

- Creating a new and unique heritage language context; consequences remain to be studied.

- We have just started a new project to track parent ASL development and its relationship with the development of their deaf children [Lillo-Martin, Chen Pichler & Gale]

CONCLUSIONS

Conclusions

- The study of acquisition of sign languages provides a rich source of data for better understanding the nature of language

- Bimodal bilingualism allows us to study how languages can be separated and how they interact in ways not possible for unimodal bilinguals

- The natural contexts in which sign languages are acquired allow for experiments of nature confirming the early years as a sensitive period for acquisition of language in any modality

- Sign languages may provide families with another option when considering the best choices for their deaf children

Sign Language Acquisition by Deaf and Hearing Children
https://signlanguageacquisition.com

SLAAASh Project Website
https://slla.lab.uconn.edu/slaaash/
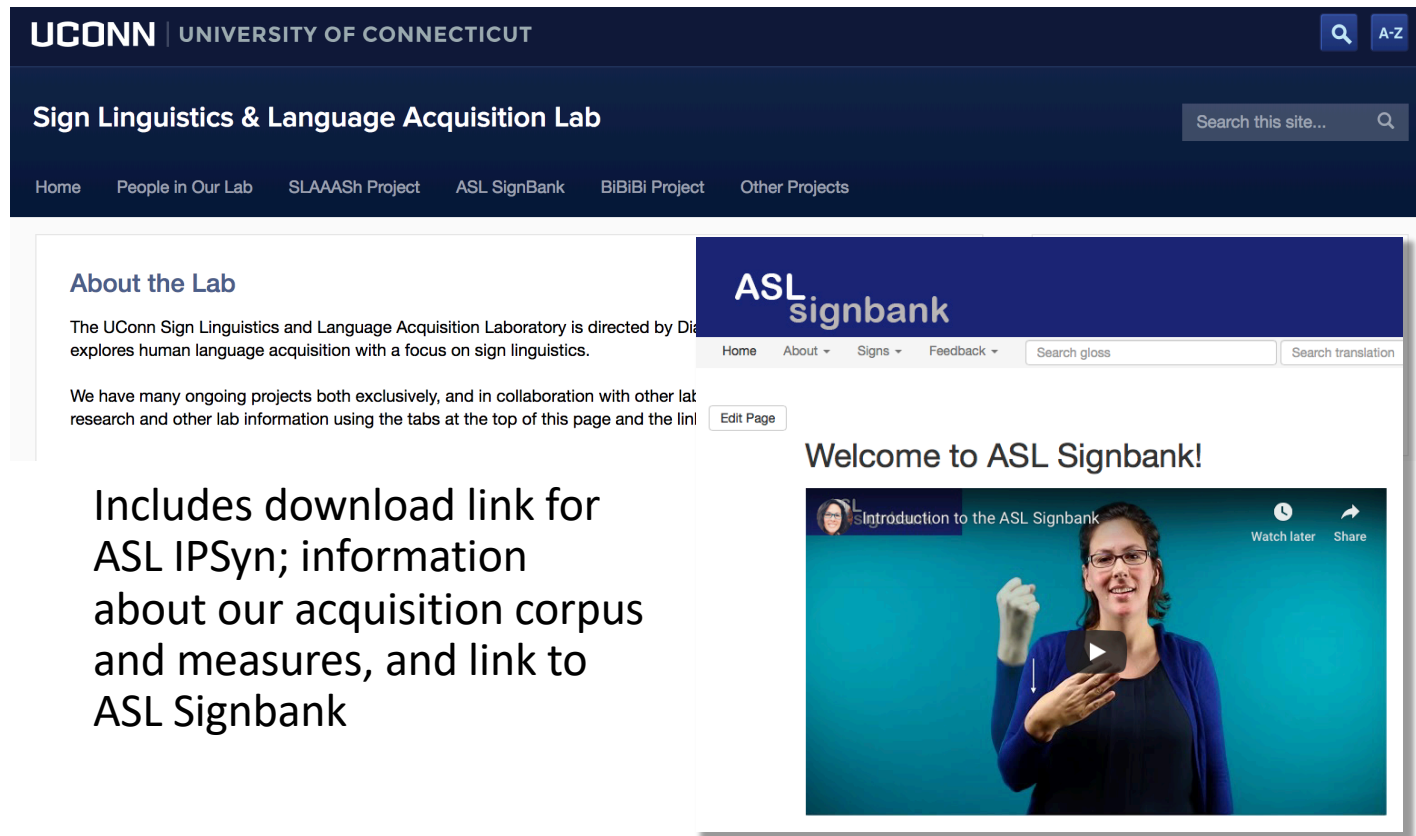
Includes download link for ASL IPSyn; information about our acquisition corpus and measures, and link to ASL Signbank

Acknowledgments