

# Unique Modality Hypothesis: A constraint on semantic composition

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# Natural language semantics

## Goals:

- to model meaning composition in natural language
- to identify universal principles and constraints to meaning composition
  - Functional Application, Predicate Modification, etc.
  - LF operations (Quantifier Raising)
  - Type theory

# Natural language semantics

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**This talk:** A restriction against cross-modal composition

- Semantic mechanism sensitive to modality?

# This talk

## Unique Modality Hypothesis

- A constraint on cross-modal composition
- FA and PM can only apply to a single modality

Case study: the use of **pointing** in spoken and signed languages

Implications on:

- composition mechanisms available across and within modalities
- development in cognitive and language acquisition

# Pointing



# Pointing



Appears early in development (9mo; deixis)

[Baker et al. 2008; Bates 1976; Clark 1978; West 2011]



Continues to interact with both modalities of language

[Baker et al. 2008; Marschark 1997]

## in communication

(1) Who cooked yesterday? / WHO COOK WHO

a. 

## in communication

(1) Who cooked yesterday? / WHO COOK WHO

a. 

(2) a. Look !

b. LOOK  

## in communication

(1) Who cooked yesterday? / WHO COOK WHO

a. → 

(2) a. Look !

b. LOOK →  → 

(3) a. She  is sick today.

b. →   SICK TODAY

# This talk

## Pointing

1. Investigate the use of pointing in spoken languages
  - often supplementary, with exceptions
2. Pointing as a predicate restricting location
  - sentential-level composition only
  - DP-internal composition possible with demonstratives
3. Extending to signed languages
  - same locational predicate, but no need for a linker

## Modality differences

4. Restrictions on cross-modal composition (UMH)
5. Extension of pointing and deixis to anaphora

## **Pointing in spoken languages**

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## : Distribution and interpretation

- ubiquitous
  - wide range of meanings
- (4)
- That  is my friend.
  - I have to go there .
  - Maybe it's closed .
  - .

## : Distribution and interpretation

- ubiquitous

- wide range of meanings

- (4)
- a. That  is my friend.
  - b. I have to go there .
  - c. Maybe it's closed .
  - d. .

- (often) supplementary

- (5)
- a. #I like the  singer, but not the  singer.
  - b. I like the first singer, but not the second singer.
  - c. I like the singer on the right, but not the singer on the left.

### pro-speech vs. co-speech

- pro-speech (terminology from Ebert et al. 2020; Schlenker 2018)

(6) Q: Who cooked yesterday?

- a. []  
→ 
- b. Mark cooked yesterday.

(7) Trainer: No one should dance today.

- a. But []  
→ 
- b. But Indira is dancing right now.

- clausal; replaces a full proposition

### pro-speech vs. co-speech

#### - co-speech

(8) [I watered the plants]<sub>→a</sub>

- a. context: plants healthy
- b. context: plants withered

causal  
surprise

(9) a. [I have to go home]<sub>→EAST</sub>

b. [I have to go home]<sub>→</sub>

- resulting inference is highly context-dependent
- information of → can elaborate on any part of the sentence
- meaning depends on what is pointed to

## Co-speech pointing: analyses

Two main discussions:

1. Pointing used with pronouns/demonstratives:

(10) She  is happy but she  is not.

- indices [Heim & Kratzer 1998]
- identity relations [Elbourne 2008; King 2001]
- situations [Grosz 2019; Wolter 2006]

# Co-speech pointing: analyses

Two main discussions:

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- indices [Heim & Kratzer 1998]
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- situations [Grosz 2019; Wolter 2006]

## 2. Pointing used with other expressions:

- co-speech gesture
- weaker/supplementary contribution

# Co-speech pointing gesture

## co-speech gestures

- weaker/secondary contribution
  - supplementary information [Ebert 2017]
  - co-suppositions [Schlenker 2018]
  - same as speech; pragmatically made non-restricting [Esipova 2018]

## co-speech [Ebert & Ebert 2014; Ebert et al. 2020]

- non-at-issue
- inference depends on what it composes with
  - [a linguist]<sub>→</sub>: exemplification
  - [the linguist]<sub>→</sub>: identity



[Ebert et al. 2020] Pointing + *that*: identity (at-issue)

- (13) Cornelia brought [this bottle] .
- presupposition:** there is a unique (contextually salient) bottle
  - at-issue:** Cornelia brought that bottle and the gesture referent is that bottle
  - non-at-issue:** the gesture referent itself a bottle
- (14) Cornelia brought [this bottle] .
- $[x] \wedge \text{bottle}_p(x) \wedge [z] \wedge z = I_B \wedge \underline{x =_p z} \wedge \text{bottle}_{p^*}(z) \wedge \text{bring}_p(\text{cornelia}, x)$

### What we know already

- co-speech gestures have secondary meaning contributions
- co-speech pointing is non-at-issue until it meets a demonstrative

### This talk

- co-speech pointing allows a wider range of meaning
- an alternative analysis of pointing as a locational restriction

## Pointing: wide range of meaning

(15) a. Cornelia brought [the bottle] 

identity

## Pointing: wide range of meaning

- (15) a. Cornelia brought [the bottle] 
- b. Cornelia brought [the bottle] 

identity

relevance

## Pointing: wide range of meaning

- (15) a. Cornelia brought [the bottle] 
- b. Cornelia brought [the bottle] 
- c. Cornelia brought [the bottle] 

identity

relevance

logical link

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- c. Cornelia brought [the bottle] 

identity  
relevance  
logical link

→<sub>A</sub> (what I said) has something to do with A

## One possible analysis

$\llbracket \rightarrow a \rrbracket = \lambda \phi. \phi$  is located at  $a$

## One possible analysis

$\llbracket \rightarrow a \rrbracket = \lambda \phi. \phi$  is located at a

- previously: index, situation variable, identity function
- proposal: one-place predicate that restricts the location of the argument (it's a regular adjective!)

## One possible analysis

$[\rightarrow a] = \lambda\phi. \phi$  is located at a

- previously: index, situation variable, identity function
- proposal: one-place predicate that restricts the location of the argument (it's a regular adjective!)

evidence: similarities to other one-place predicate like *on your right*

(16) Q: Who cooked yesterday?

A1:  $[\ ]$  

A2: On your right 

A3: Ziling  (cooked yesterday).

A4: Ziling, on your right,  (cooked yesterday).

## vs. other adjectives

BUT  ≠ spoken modifiers

- (17) a. #I like the  singer, but not the  singer.  
b. I like the singer on the right, but not the singer on the left.

## 👉 vs. other adjectives

BUT 👉 ≠ spoken modifiers

- (17) a. #I like the 👉 singer, but not the 👉 singer.  
b. I like the singer on the right, but not the singer on the left.

→ channel in which it composes

- (18) a. The linguist **over there** talked to me.  
b. The linguist talked to me **over there**.

(19) [The linguist talked to me]<sub>→a</sub>.

- (can)not be linearized into a sequence
- syntactic (adjunction) or semantic (PM) restriction

Broader restriction against cross-modal semantic composition

## non-linearized adjective

- (20) a. The **difficult** linguist cold-called on me.  
b. A: The linguist cold-called on me.  
B: Difficult!

- (20b) *roughly put!*

[[A]] = cold-call(e)  $\wedge$  AGENT(e,  $\iota x$ .linguist(x))  $\wedge$  PATIENT(e, sp) ...

[[B]] = ...  $\wedge$  difficult( $\iota x$ .linguist(x))

*or*

= ...  $\wedge$  difficult(e)

- explains the flexibility in reference

- (21) [[The linguist talked to me] $_{\rightarrow a}$ ]]  
= [[The linguist talked to me]]  $\wedge$  [[ $\rightarrow$ ]](a)( $\phi$ )  
= *The linguist talked to me, and  $\phi$  is at a*

$\phi$ : the linguist, event of talking, some relevant conversation participant, ...

## 👉 in spoken languages

### co-speech 👉 summary

- meaning: locational restriction
  - similar to other one-place predicates
- restriction against cross-modal sentence-internal composition

→ derives:

- secondary, supplementary, non-restrictive use of pointing
- flexible inference on what it can modify

[Q] What happens when a demonstrative is used?

## + *that*

### + *that* in speech

restricted to DP-internal position; requires referential inference

(22) a. I watered [the plants]<sub>→a</sub>.

b. I watered [the plants]<sub>→</sub>

a=plants

 relevant

(23) a. I watered [those plants]<sub>→a</sub>.

b. **??**I watered [those plants]<sub>→</sub>

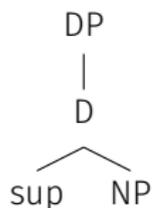
a=plants

=plants

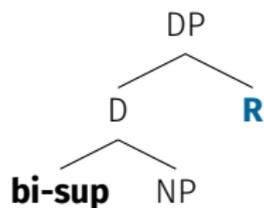
- dimension shifted to at-issue [Ebert et al. 2020]
  - no longer clausal; DP-internal restriction
  - no longer flexible in meaning
- We need an analysis that captures all three properties!

# Demonstratives

[Ahn 2019] Demonstratives lexicalize a binary maximality operator.



definite



demonstrative

(24)  $\llbracket \text{the linguist} \rrbracket = \text{sup } [\lambda x. \text{entity}(x) \wedge \text{linguist}(x)]$

a.  $\llbracket \text{sup} \rrbracket = \lambda P \iota x: \forall y [P(y) \leftrightarrow y \sqsubseteq x]$

(25)  $\llbracket \text{that linguist} \rrbracket = \text{bi-sup } [\lambda x. \text{entity}(x) \wedge \llbracket \text{linguist} \rrbracket(x)] [\lambda x. R(x)]$

a.  $\llbracket \text{bi-sup} \rrbracket = \lambda P \lambda R \iota x: \forall y [P(y) \wedge R(y) \leftrightarrow y \sqsubseteq x]$

# Demonstratives

- Hidden Argument Theories [King 2001; Elbourne 2008; Nowak 2019; Blumberg 2020]

(26)  $\llbracket \text{the linguist} \rrbracket = \iota x. [\text{linguist}(x)]$

(27)  $\llbracket \text{that linguist} \rrbracket = \iota x. [\text{linguist}(x) \wedge G(x)]$

- Ebert et al. 2020: Definite descriptions only allow one restriction (NP) to be at-issue, while demonstratives allow both NP and  $\rightarrow$  to be at-issue

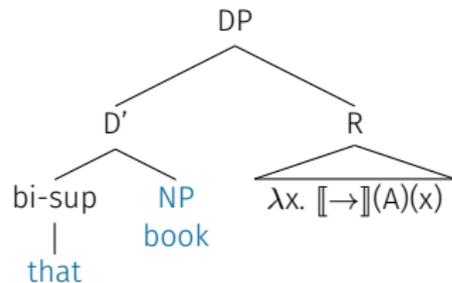
Combining the two intuitions:

## **Demonstrative as an operator used to compose with gestural content**

- Predicate Modification not available across modalities
- Demonstratives provide a semantic argument slot for gestural content

## That book<sub>→</sub>

$\llbracket \text{that book}_{\rightarrow A} \rrbracket =$

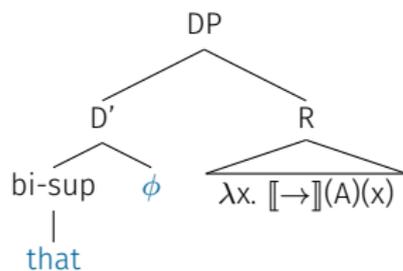


bi-sup  $[\lambda x. \text{entity}(x) \wedge \llbracket \text{book} \rrbracket(x)]$   $[\lambda x. \llbracket \rightarrow \rrbracket(A)(x)]$

'the maximal entity  $x$  that is a book and at  $A$ '

# That<sub>→</sub>

$\llbracket \text{that}_{\rightarrow A} \rrbracket =$



bi-sup  $[\lambda x. \text{entity}(x)] [\lambda x. \llbracket \rightarrow \rrbracket (A)(x)]$

'the maximal entity  $x$  that is at  $A$ '

## in spoken languages: summary

### Main observations:

-  usually has secondary contributions in speech.
  - supplementary, non-at-issue
- With a demonstrative,  becomes at-issue, DP-restricting.

### Proposal:

-  as an  $\langle e,t \rangle$  predicate that provides a locational restriction
- general restriction against cross-modal sentence-internal composition
- demonstratives as unique linkers of two modalities: binary operator that takes gestural content as an additional argument
  - allows  $\rightarrow$  to compose with the rest of the linguistic content

## **IX in signed languages**

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# IX



IX<sub>1</sub>



IX<sub>LOC</sub>

**IX:** pointing handshape used to refer to entities

## IX analyzed as:

- Definite determiner [Irani 2016; MacLaughlin 1997; Neidle et al. 2000]
- Demonstrative [Koulidobrova & Lillo-Martin 2016]
- Pronoun [Lillo-Martin & Klima 1990; Sandler & Lillo-Martin 2006]
- Adverbial [MacLaughlin 1997]

# IX

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What are some semantic properties of IX?

## IX as an deictic reference

IX can point to an actual entity in the context

(28) LOOK STAR IX<sub>A</sub>.  
'Look at that star!'

[ASL]

## IX as an anaphoric reference

IX can refer to entities not present in the context ( $IX_{LOC}$ )

[Friedman 1975]

(29) YESTERDAY JOHN  $IX_A$  MEET  $IX_B$  DOCTOR.  $IX_B$  BUSY.

'Yesterday John met a doctor. The doctor was busy.'

[ASL]



## Setting up referents in space

[Lillo-Martin & Klima 1990]:

loci: overt instantiations of **indices** that occur with pronouns

[Barberà & Zwets 2013; Schlenker 2011; Schlenker et al. 2013; Steinbach & Onea 2015]

(30) Jin<sub>1</sub> met Sol<sub>2</sub>. She<sub>1</sub> helped her<sub>2</sub>.

- $g = \{ \langle 1, jin \rangle, \langle 2, sol \rangle \}$
- $\llbracket she_1 \rrbracket^g = \llbracket x_1 \rrbracket^g = g(1) = jin$

IX<sub>A</sub> is like *she*<sub>1</sub>



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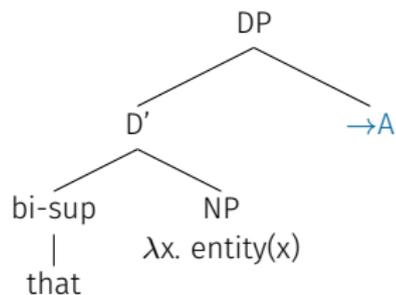
[Ahn et al. 2019]

- loci are optional, indices are not
- loci used only when more than one possible antecedent is present

## Extending locational analysis to IX

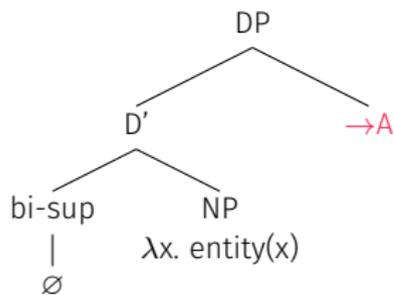
[Ahn 2019]: IX is a locational restriction

$\llbracket \text{that}_{\rightarrow A} \rrbracket =$



'the maximal entity  $x$  that is at A'

$\llbracket IX_A \rrbracket =$



'the maximal entity  $x$  that is at A'

## **IX<sub>LOC</sub> as a modifier**

Recall:

- loci are optional, indices are not
- loci used only when more than one possible antecedent is present

## $IX_{LOC}$ as a modifier

Recall:

- loci are optional, indices are not
- loci used only when more than one possible antecedent is present

$\llbracket IX_{LOC} \rrbracket = \lambda a. \lambda x. x \text{ is at } a$

marked ✓



modifiers are optional



modifier added when referent not salient

(a) *the tall singer vs. the singer*

(b) *this<sub>→</sub> singer talked to that<sub>→</sub> singer*

## Introductory use

Another advantage: **introductory use** captured

[‘anchoring use’ Barberà & Zwets 2013; Sandler & Lillo-Martin 2006]

- (31) SOL  $IX_A$  SIT-IN CLASS.  $IX_A$  DANCE.  
‘Sol<sub>i</sub> was sitting in class. He<sub>i</sub> danced.’
- (32) SOL SIT-IN CLASS.  $?IX_A$  DANCE.

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(32) SOL SIT-IN CLASS.  $?IX_A$  DANCE.

- previous accounts:  $IX_{LOC}$  as a definite expression
  - not compatible with newly introduced,  $e$  entity like Sol
  - introductory use would need a separate account.



$$[[IX_A]] = [[\emptyset IX_A]]$$

A modifier with a null head noun?

- We have them in English: *the rich and the poor*
- Relative clauses with null heads (and no determiner) possible

(33) **Wo mai-de** hen gui.

**I buy-DE** very expensive

'The one **I bought** was expensive.'

[Mandarin; Yuyin He, pc.]

- Deverbal anaphors in Nicaraguan Sign Language

[Senghas 1995]

## Deverbal anaphors

[Senghas 1995] Nicaraguan Sign Language (NSL)

'a reduced, truncated form of a recently-signed verb... to refer back to the referent in the narrative that last served as the most salient argument of that verb' (p.139).

- (34) MAN FALL-DOWN-[iterative].  
'The man falls down head-over-heels.'

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'Feathers float down and the man collects them.'  
BIRD LAUGH.  
'The bird laughs.'  
**[COLLECT]<sub>N</sub>** LOOK UP.  
'**The collector** looks up.'

[NSL]

## IX<sub>LOC</sub> as a modifier

$\llbracket IX_{LOC} \rrbracket = \lambda a. \lambda x. x \text{ is at } a$

marked ✓



modifiers are optional



modifier added when referent not salient

*the tall singer vs. the singer*

*this* → *singer talked to that* → *singer*

intro. ✓



modifier can attach to definite/indefinite  
(familiar, new) nouns



modifier can be restrictive or supplementary

# IX in sign languages: summary

## Initial focus

- Analyzing IX as a grammatical element different from 🖐️ in spoken languages
- loci as an index

## Proposal

- Analyzing IX<sub>LOC</sub> as a locational restriction
  - accounts for its markedness
  - accounts for introductory uses
  - captures similarities with deverbal anaphors
- No sign language-specific mechanism necessary!
  - same locational restriction
  - we also point to keep track of referents in spoken languages!

## **Pointing: spoken vs. signed**

---

## Are they identical?



in spoken languages

locational restriction

**IX**

in sign languages

locational restriction

## Are they identical?



in spoken languages

locational restriction

- Often supplementary
- Highly context-dependent

**IX**

in sign languages

locational restriction

- Seldom supplementary
- Systematic function

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in spoken languages

locational restriction

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**IX**

in sign languages

locational restriction

- Seldom supplementary
- Systematic function

Where do these differences come from?

## Empirical differences

[Fenlon et al. 2019]

IX shows more signs of communicative forms than 🖐️

- conventionalized (consistent, stable)
- reduced
- integrated

[Zlogar 2019; Zlogar & Davidson 2018]

Gestural information enters restrictive content in ASL, but not English

[Petitto 1987; Lillo-Martin 2021]

Development of pointing looks different between ASL and English-learners

# Accounting for the differences

## 1. Restriction against cross-modal composition

- Stronger (syntactic/semantic) than pragmatic blocking [Esipova 2018]
- Only a lexical operator (demonstratives) can combine the two channels

## 2. Extension of deixis to anaphora

- Use of  to establish joint attention
- Integrated into language as locational restriction
- Deixis → Anaphora

## 1. Restriction against cross-modal composition

### **Unique Modality Hypothesis** (UMH):

Semantic compositional mechanisms such as Functional Application and Predicate Modification are not available for cross-modal composition

- Lexical item that serves as a modality linker: **demonstratives**

## Modality linkers

most often **demonstratives** (proximal or distal):

- English: *that, those* and animate pronouns
- Korean: one demonstrative *ce* (but not *ku*)
- Romanian: long demonstratives
- Russian: proximal demonstratives
- Lugwere: demonstratives I, II

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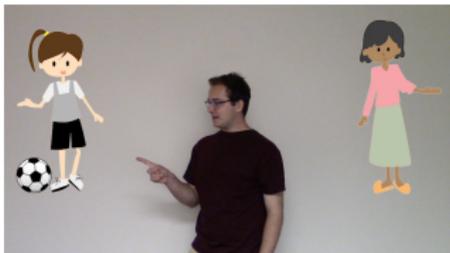
cross-linguistic variation on signalling cross-modal composition:

English *that* vs. Korean *ce*

## English vs. Korean

[Ahn & Davidson 2018]:

the use of *that* does not always signal composition with →,  
but the use of *ce* does.



One woman is my friend.

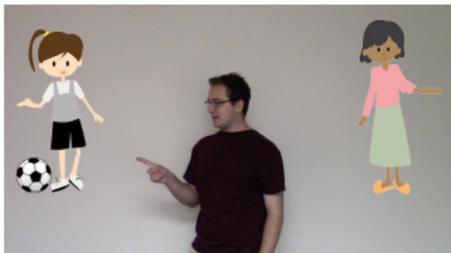


One umbrella is broken.

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One woman is my friend.

She

She→

That woman      plays soccer.

That woman→

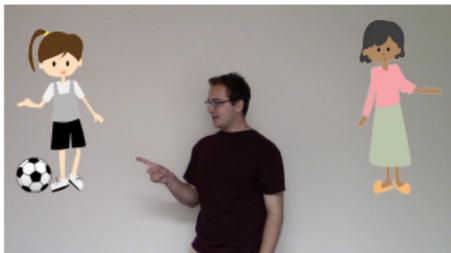


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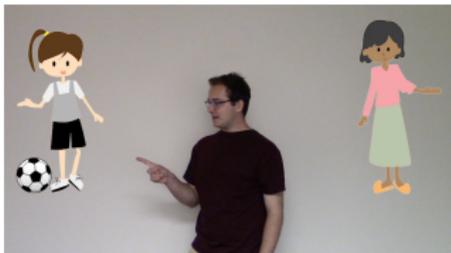
Which woman is my friend?



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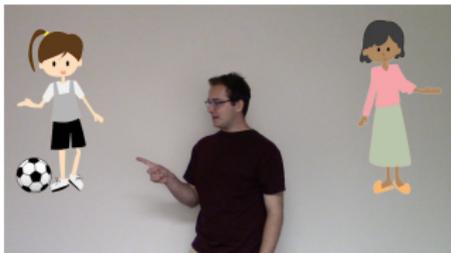
One umbrella is broken.

	ku usan	
	ku usan→	is mine.
	ce usan	
	ce usan→	

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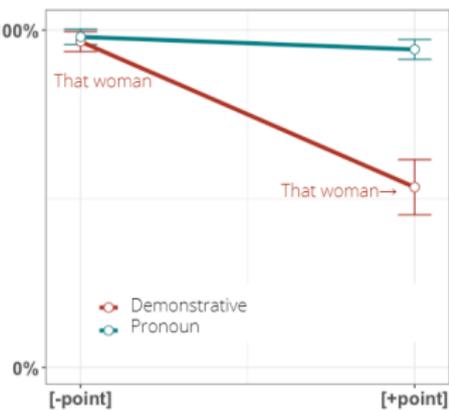


One umbrella is broken.

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	ce usan	
	ce usan→	

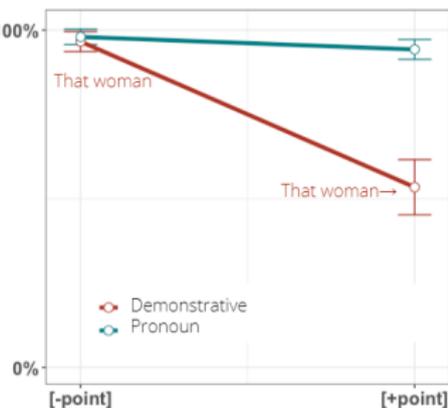
Which umbrella is mine?

# [DP] plays soccer.

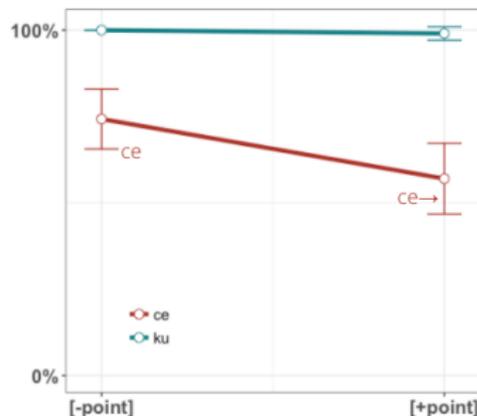


(n=50, 14 items, 4 fillers, GLMM)

# [DP] plays soccer.



(n=50, 14 items, 4 fillers, GLMM)



(n = 37, 13 items, 5 fillers, GLMM)

- English *that* optionally composes with →
- Korean *ce* lexically signals composition with a gestural element (similar effect predicted from Romanian long demonstrative)

## 1. Restriction against cross-modal composition: summary

- Semantic compositional mechanism is not available across modalities
- The only option available is supplementary, sentential-level contribution of non-at-issue content
- A lexical linker like a demonstrative uniquely creates a slot that can host a gestural element
  - Languages vary on the syntactic, lexical nature of the linker

## 1. Restriction against cross-modal composition: summary

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  - Languages vary on the syntactic, lexical nature of the linker

→ Need for a linker in spoken, but not signed languages

- pointing composes with the rest of the grammatical content much more readily in signed languages [Zlogar 2019; Zlogar & Davidson 2018]

## 2. Deixis to anaphora

- One core property of language: **displacement**
- BUT displacement does not come right away in development
  - deictic uses of demonstratives occur before anaphoric uses
  - Anaphoric expressions like definites diachronically develop from deictic expressions
- Spoken and signed languages differ on how deixis is extended to anaphoric uses

# Demonstrative development in spoken languages

Stage 1: 🖐️ ⇒ DEM

- starts out as a joint-attention device
- gets integrated into language through demonstratives

[12-18mo]

# Demonstrative development in spoken languages

Stage 1: 🖐️ ⇒ DEM

- starts out as a joint-attention device
- gets integrated into language through demonstratives [12-18mo]

Stage 2: Exophoric DEM ⇒ Anaphoric DEM

- Replacing gesture with covert anaphoric index (*losing the pointing*)
- Happens much later [Ahn & Arunachalam 2019] [4-5yrs]

# Acquisition of anaphoric *that*

[Ahn & Arunachalam 2019]



One baby is my friend. | She  
That baby is playing.

# Acquisition of anaphoric *that*

[Ahn & Arunachalam 2019]



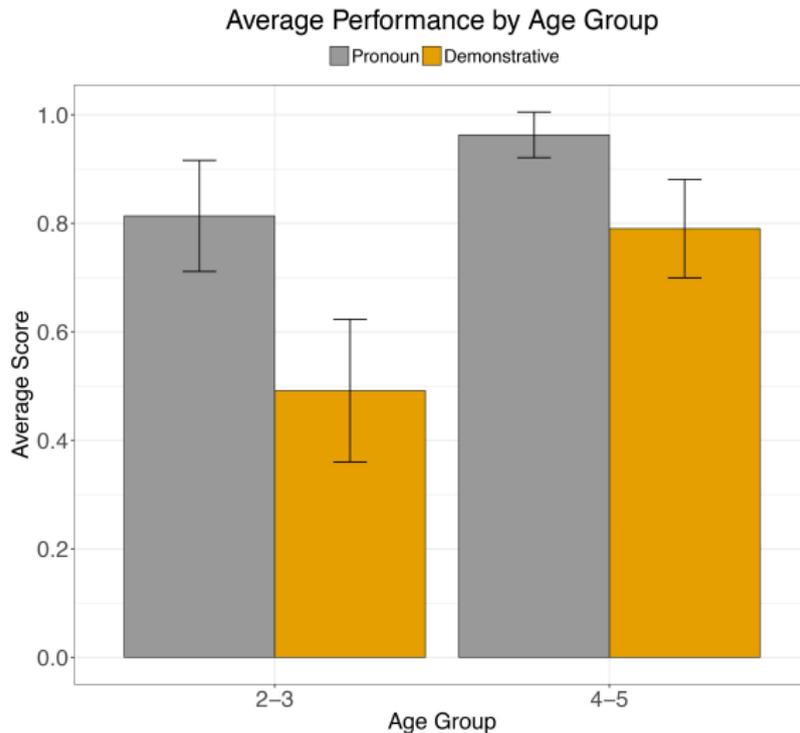
One baby is my friend. | **She**  
**That** baby is playing.

Which baby is my friend?

[Ahn & Davidson 2018] English-speaking adults: 100%



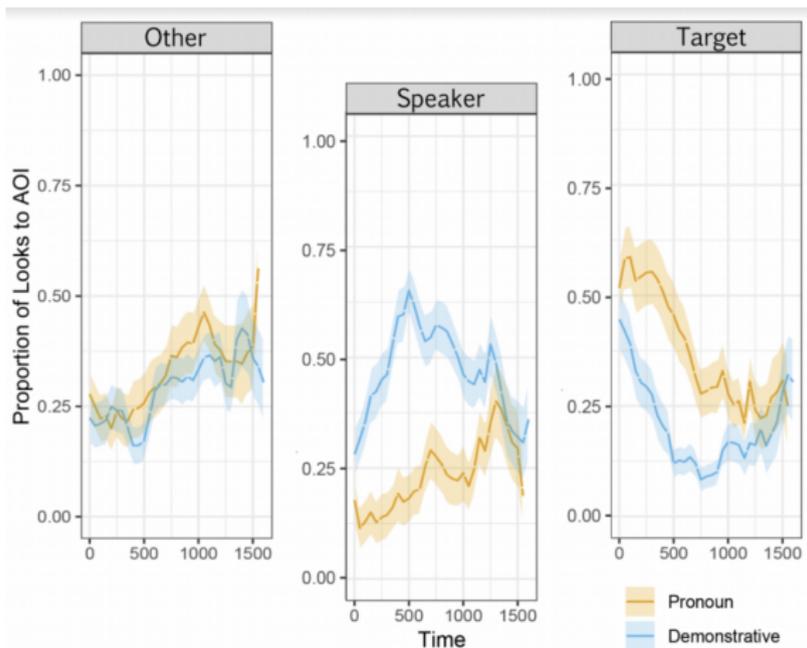
# Acquisition of anaphoric *that*



[n=47 (20 in 2-3, 27 in 4-5); 12 trials + 2 warm-ups]

## Acquisition of anaphoric *that*

One baby is my friend. {She/That baby} is playing. Which baby is my friend?



## IX development in sign languages

Stage 1: 🖐️ ⇒ IX

- Deixis integrated to language as an IX
- Gap in pointing to people

[12-15mo]

Stage 2: Exophoric IX ⇒ Anaphoric IX

- Points to abstract locations
- Occurs around the same time as hearing children

[HOFFMEISTER 1978, Diane Lillo-Martin pc]

[45-51mo]

## Two changes

**Deixis**



**Exophoric**



**Anaphoric extension**

## Two changes

**Deixis**



**Exophoric**



**Anaphoric extension**

## Two changes

**Deixis**



**Exophoric**



**Anaphoric extension**



DEM<sub>→</sub> / IX

## Two changes

**Deixis**



**Exophoric**



**Anaphoric extension**



DEM<sub>→</sub> / IX



DEM / IX<sub>LOC</sub>

## 2. Deixis to anaphora: summary

- Two stages in development of 🖐️:
  1. Deixis to a locational predicate
  2. Exophoric to anaphoric uses
- Two language modalities differ on how deixis is extended to anaphora:
  - spoken: 🖐️ lost; DEM maintained
  - signed: IX maintained, but to abstract loci

→ accounts for the more systematic, integrated use of pointing in signed languages [Fenlon et al. 2019]

- 🖐️ stays a gesture in spoken language, just linked to a demonstrative
- 🖐️ becomes a grammatical morpheme IX in signed languages

## Final question: Why demonstratives?

Why do spoken languages only have one or two modality linkers?

1. Economy: No other compositional mechanism is necessary
2. Part of language acquisition
  - categorical perception in sound acquisition
  - DEM one of the first words learned by children, so easily composes with 
  - but soon the child learns that they are learning a spoken language, thus does not expect the words they are learning to compose with gestures easily

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Research Questions:

1. Do children more readily accept/produce cross-modal composition earlier in their development?
2. Do bi-modal bilingual language users allow cross-modal composition more readily?
  - (if economy): no
  - (if modality limitation): possibly

## **Conclusion**

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# Summary

## Pointing

1. Pointing is supplementary in spoken languages except when it combines with a demonstrative
2. Pointing as a predicate restricting location
  - sentential-level composition only
  - demonstratives as a unique modality linker
3. IX in signed languages can be analyzed on par with pointing, as locational restriction
  - accounts for its markedness as well as introductory uses

## Modality differences

4. Restrictions on cross-modal composition (UMH)
5. Extension of pointing and deixis to anaphora

# Implications

## 1. Unified analysis of pointing $\llbracket !X_{\text{LOC}} \rrbracket = \llbracket \rightarrow \rrbracket$

- Pointing in both modalities analyzed as a locational restriction

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## 2. No sign language-specific stipulation

- [Davidson 2018]: Sign languages do not make meaning more visible than other spoken languages
- Difference due to how  is integrated into language (continues to be gestural vs. becomes a morpheme)

# Implications

## 1. Unified analysis of pointing $[[IX_{LOC}]] = [[\rightarrow]]$

- Pointing in both modalities analyzed as a locational restriction

## 2. No sign language-specific stipulation

- [Davidson 2018]: Sign languages do not make meaning more visible than other spoken languages
- Difference due to how  is integrated into language (continues to be gestural vs. becomes a morpheme)

## 3. Need for more cross-modal semantic studies

- Allows us to identify what is common across modalities ( $\rightarrow$  as a locational restriction)
- While delineating the influence of modalities in semantic composition

# Thank you!

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