

***Understanding the role of communication  
modality in phonological constraints: Insights  
from sign languages***

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May 7, 2019

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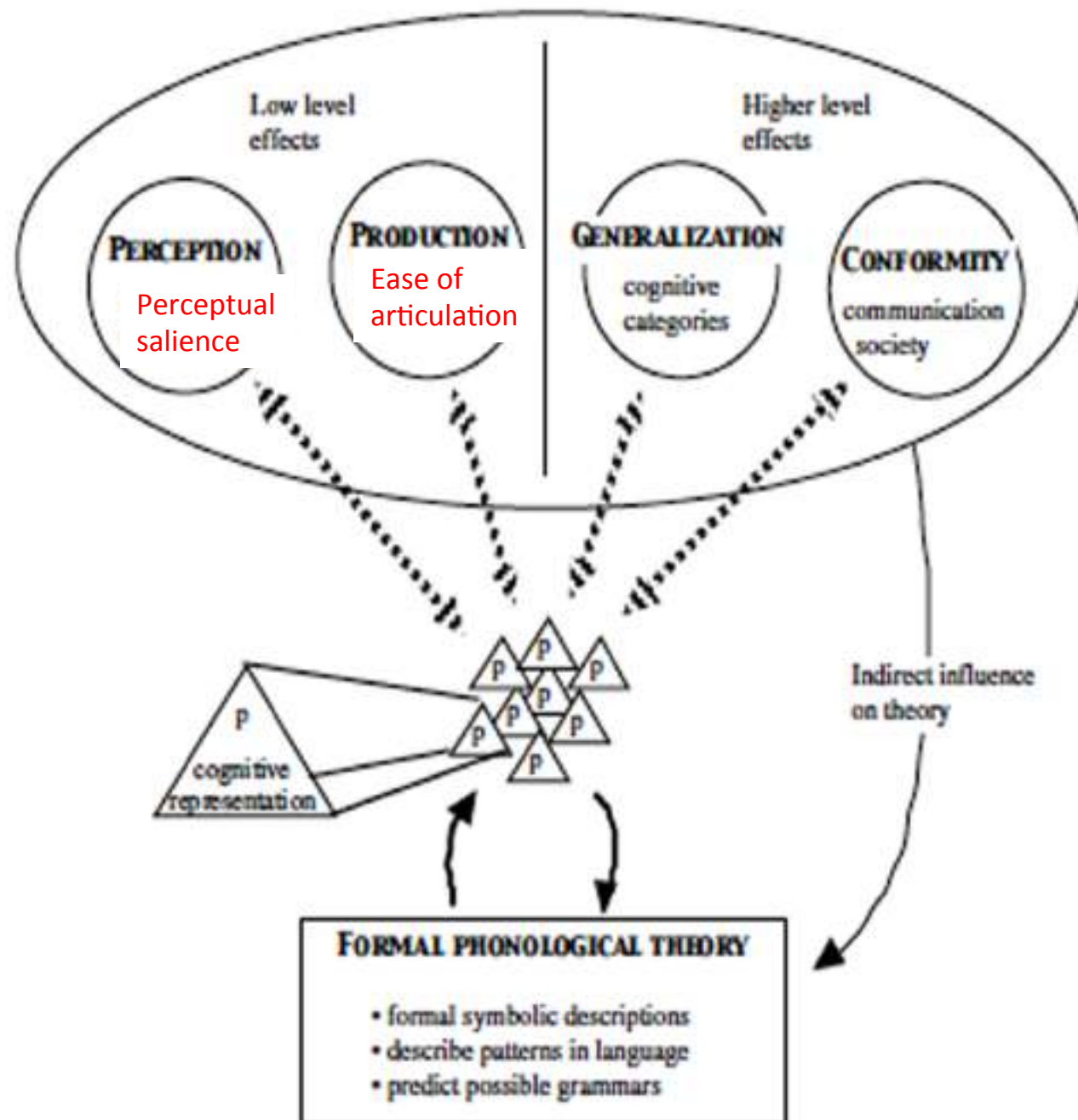
## 2 case studies from sign languages (SLs):

- 1) Sonority
  - a) Syllable construction
  - b) Sonority Sequencing Principle
- 2) Pattern congruity/pattern symmetry

### **To what extent**

**--do they function identically in signed and spoken languages,  
--is their realization tailored to the communication modality  
involved, social, or cognitive pressure, or UG?**

From Johnson  
and Hume  
(2003)



# It possible to tease apart modality-driven from modality-neutral constraints

by the phonetics of vision and the hand

**1) gesturers**: visual perception; hand mechanics;

by cognitive biases

**2) gesturers; homesigners**: iconicity

by social factors

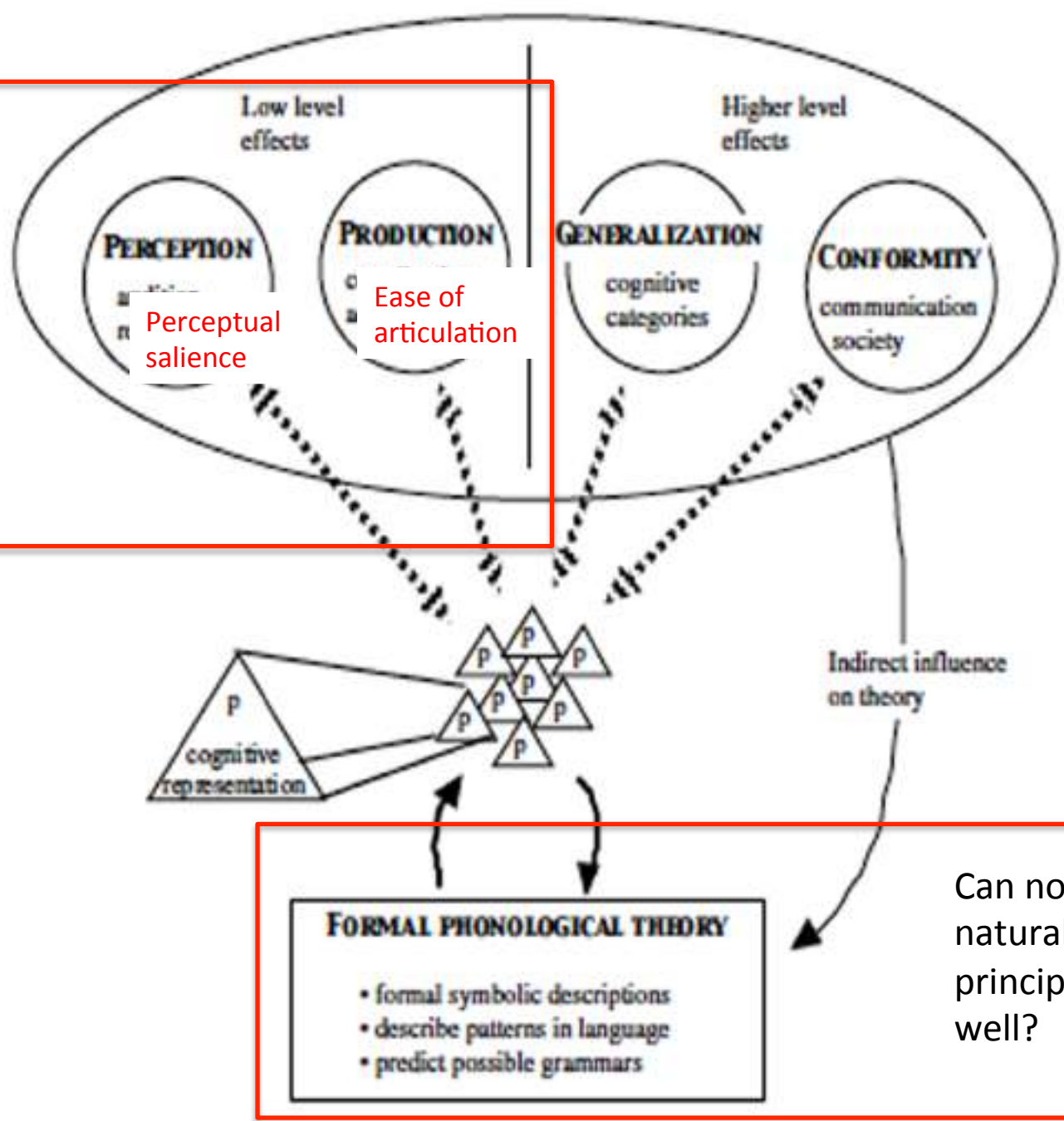
**3) users of emerging systems** at a range of time points

The abstract mechanisms are what remain after the effects of 1,2,3 are isolated.

# Organizational principles for sonority & syllable structure

Oscillators, Sonority & Sonority  
Sequencing

Are the phonetic of sign language too far apart for non-signers to intuitively grasp sign language sonority?



Can non-signers be taught a natural and unnatural principle of sonority equally well?

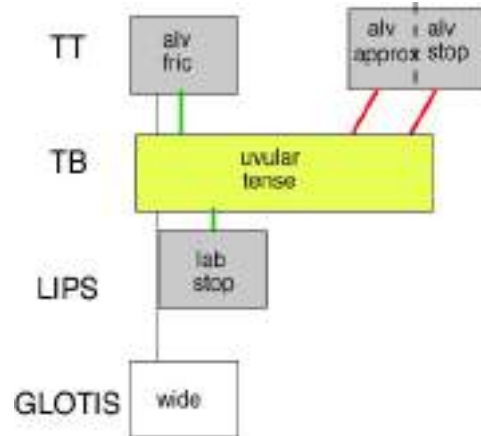
# The argument

- Modality Driven:
  - Modality plays an important syllable timing generally, in SpLs, but not in SLs . Jaw movement, along with the notion of a p-center, capture syllable.
  - The Sonority Sequencing Principle is motivated by interdependence of the articulators of speech, rather than by an abstract phonological mechanism.
- Modality Neutral:
- The abstract notion of sonority and its role in building syllables from the most salient property in the signal – whether it is auditory or visual.
- The use of sonority in syllable construction is amodal, but the SSP is very much modality driven.

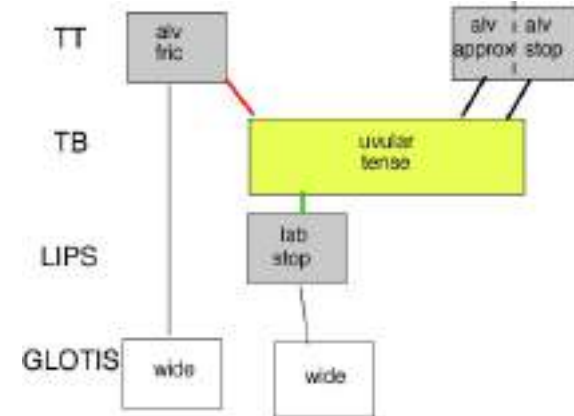


In speech, cases like "sport" vs. "support," the coordination of tongue and lips may be perceived as separate syllables (Saltzman et al. 2008)

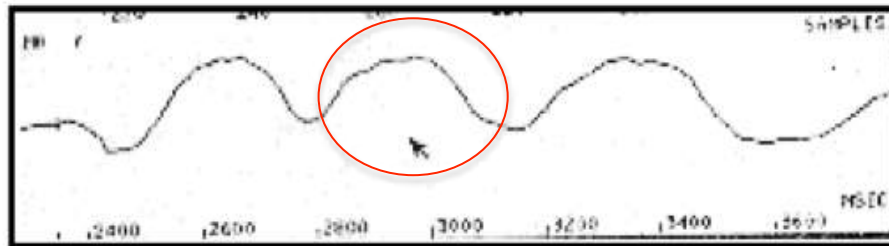
sport



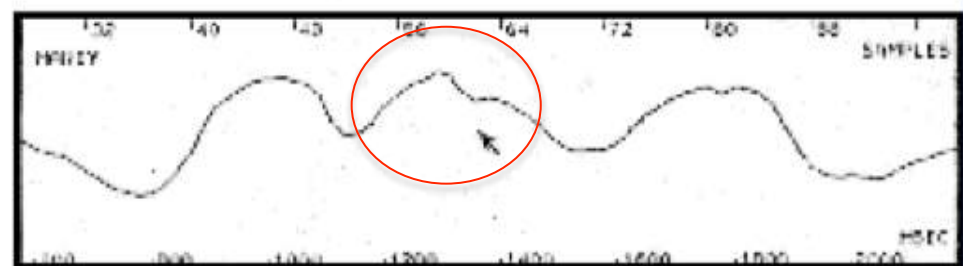
support



Jaw Height



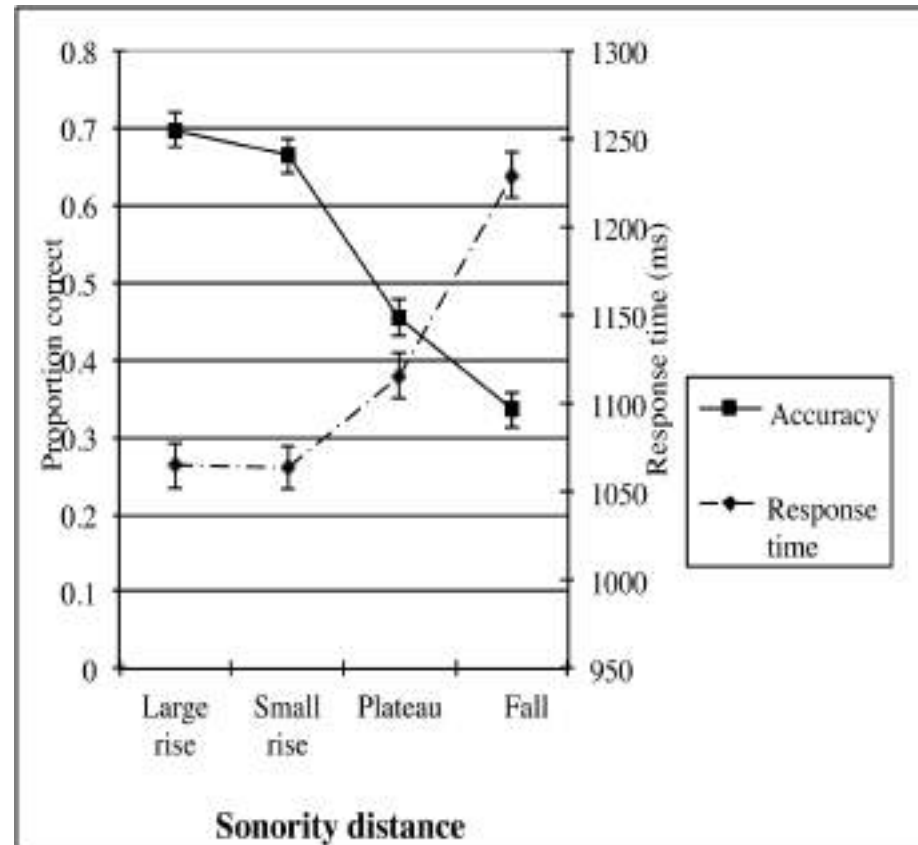
"I say **sport** today"



"I say **support** today"

# Timing: Sonority hierarchy in SpLs (Dell and Elmedlaoui 1985; Berent et al. 2013)

low V > high V > glide > liquid > nasal > voiced fricative > voiceless fricative  
> voice stop > voiceless stop





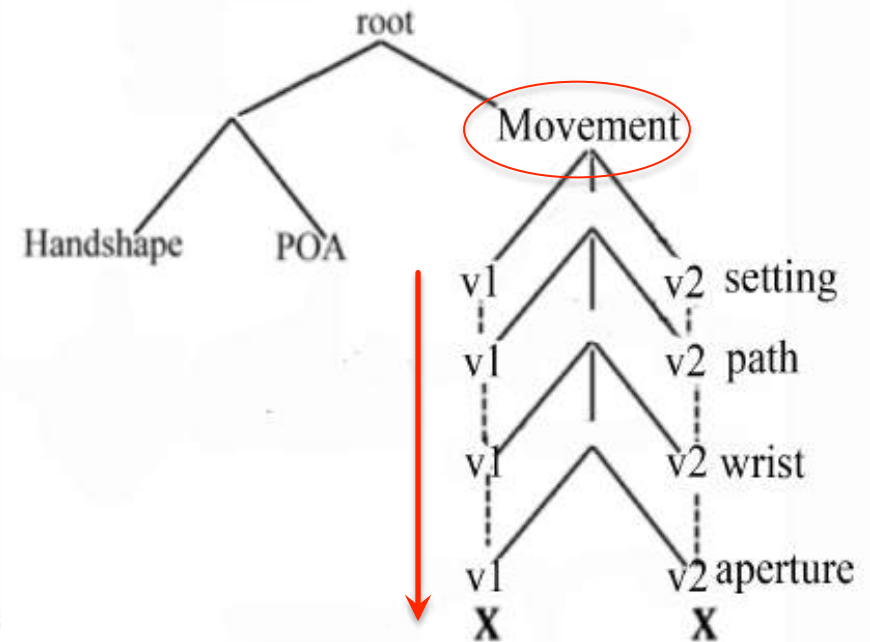
These movements matter for building syllables  
because we observe that:

- they are relevant to syllable count.
- they appear when deaf infants start to babble syllabically
- a sign is not well formed without a movement, and an epenthetic movement will be inserted if it's not there
- when a fingerspelled word becomes reduced, the larger movements are the ones preferred to be maintained.

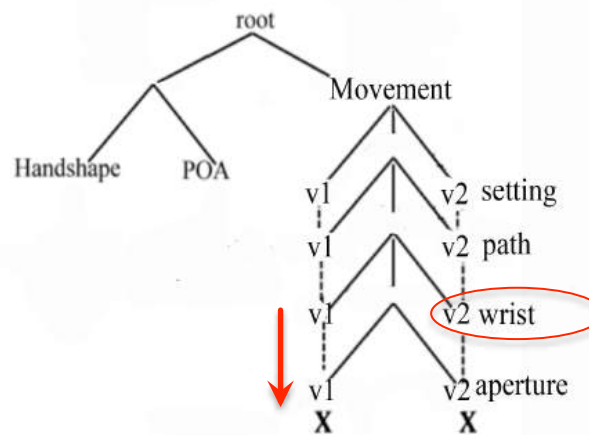
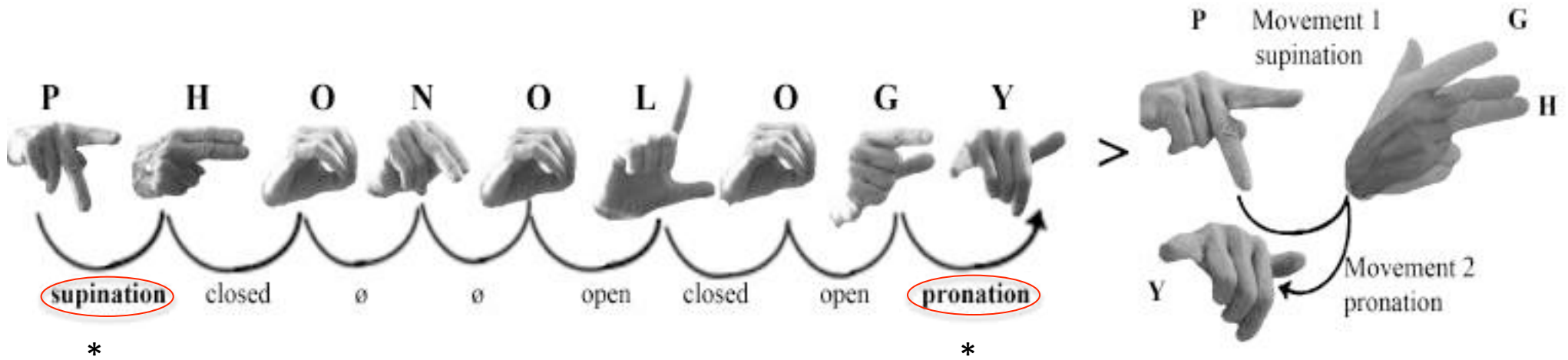
# SL sonority: Sign Language phonology movement components

Setting > path > orientation > handshape >  $\emptyset$

WE	SEE	HAPPEN	UNDERSTAND	THINK
<pre> graph TD     root --&gt; IF     root --&gt; PF     PF --&gt; setting     setting --&gt; ipsi["[ipsi]"]     setting --&gt; ipsi["[-ipsi,]"]     ipsi --&gt; X1[X]     ipsi --&gt; X2[X]         </pre>	<pre> graph TD     root --&gt; IF     root --&gt; PF     PF --&gt; path     path --&gt; direction["[direction]"]     direction --&gt; X1[X]     direction --&gt; X2[X]         </pre>	<pre> graph TD     root --&gt; IF     root --&gt; PF     PF --&gt; orientation     orientation --&gt; prone["[-prone][prone]"]     prone --&gt; X1[X]     prone --&gt; X2[X]         </pre>	<pre> graph TD     root --&gt; IF     root --&gt; PF     PF --&gt; aperture     aperture --&gt; open["[-open] [open]"]     open --&gt; X1[X]     open --&gt; X2[X]         </pre>	<pre> graph TD     root --&gt; IF     root --&gt; PF     PF --&gt; empty["∅"]         </pre>



# (locally) Lexicalized fingerspelling



# Timing of handshapes and movement

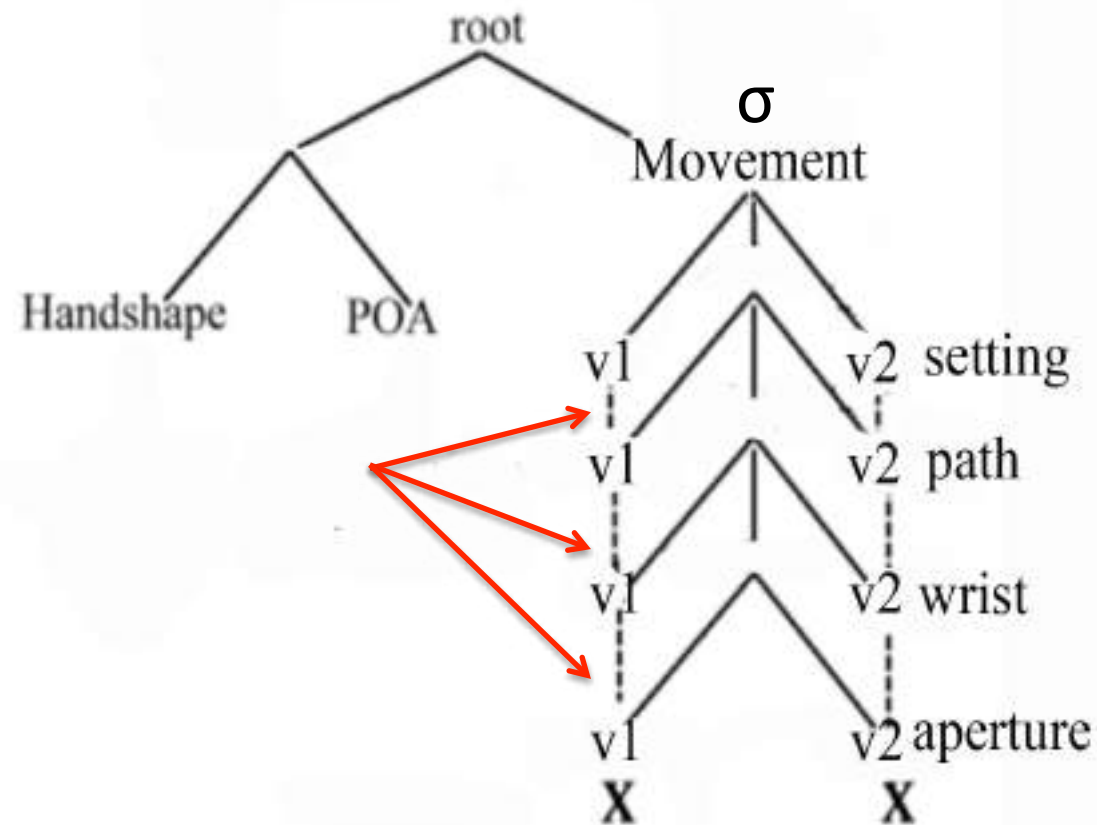
(Brentari et al. 1995)

PICK BOOK  
 $1\sigma$       $1\sigma$

GRAB WATCH  
 $1\sigma$       $2\sigma$







Alignment must be indicated; otherwise the tiers will not be aligned.

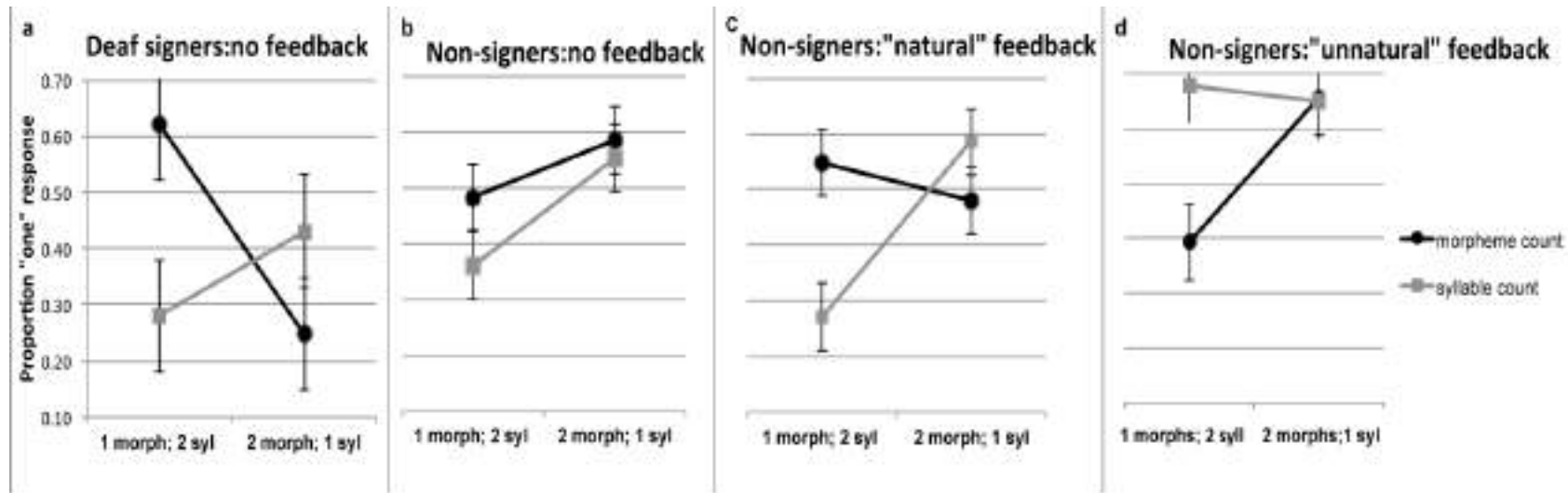




# Gesturers have the “right” intuitions: Berent et al. (2013)

		Syllables	
		One	Two
Morphemes	One	cf. Eng. <i>can</i> 	cf. Eng. <i>candy</i> 
	Two	cf. Eng. <i>cans</i> 	cf. Eng. <i>candies</i> 

# Sensibility for sonority in SLs: “meaning units” (black) vs. “parts” (gray)



Gray movement; black handshape

Gray handshape;  
black movement

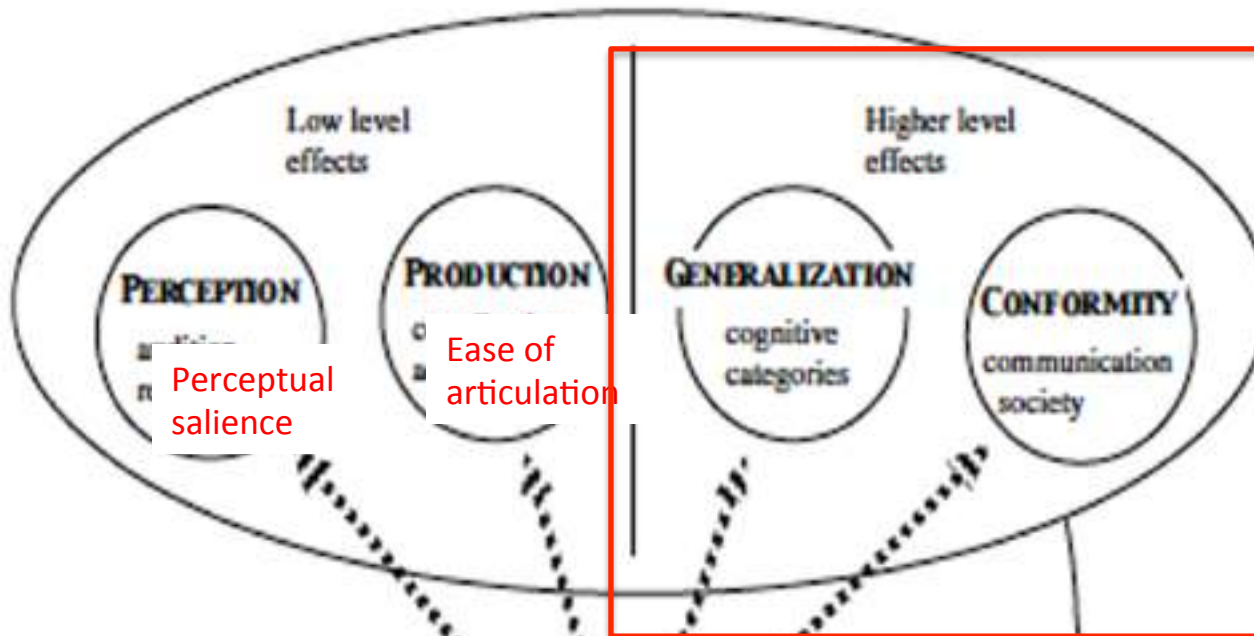
# Conclusions

- Syllable timing and the SSP are modality driven
  - Sign languages do not have a primary articulator so no anchor for sonority
  - Spoken languages have a SSP in part because the need to overlay other oscillators on top of the primary jaw oscillator. Sign languages have \*NO\* Sonority Sequencing Principle because they have a multiple oscillators that can operate independently.
- Non-signers do not intuitively know that they should associate movement with syllables, so the experimental results suggest that sonority is (at least in part) motivated by phonetics (also modality driven).
- However, non-signers can be taught this the natural association of movement to syllables; This suggests that the abstract notion of sonority can be accessed in a new modality. The idea to exploit the most perceptually salient element of the form as a syllable peak amodal.

# Organizational principles for features

Pattern Symmetry

Feature Economy

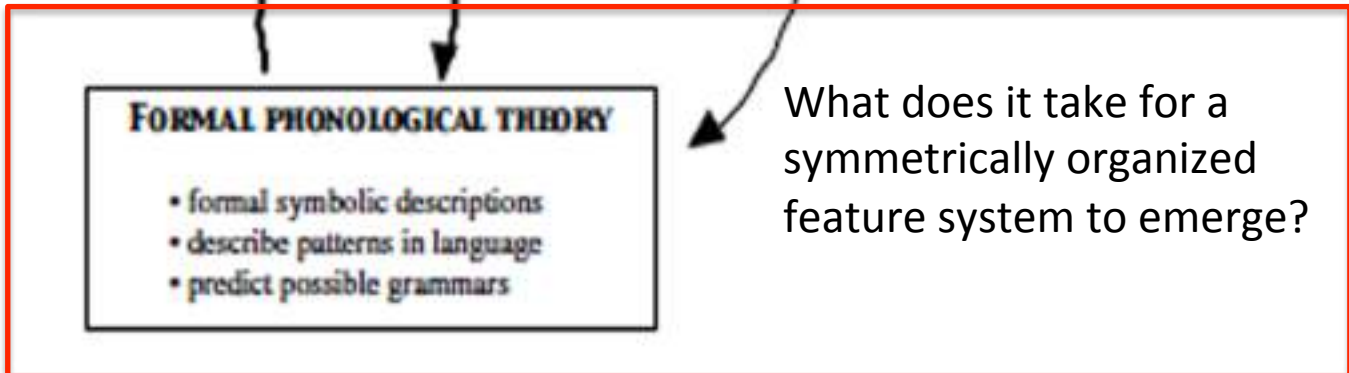


Perceptual salience

Ease of articulation

Can gesturers and users of emerging languages create symmetrically organized patterns in Handshapes?

Indirect influence on theory



What does it take for a symmetrically organized feature system to emerge?

# The argument

- Despite the radical difference in phonetic raw material, the overall pressures on phonological architecture are the same in signed and spoken languages.
- Sign languages exploit to its advantage an existing tendency in 2 dimensions of handshape to build SYMMETRY and FEATURE ECONOMY into phonology and morphology.
- This kind of balance might seem intuitive, even iconic, and experiential (social) factors contribute, but this is an abstract pressure to organize the system.

....I'll conclude that modality makes no difference in preferring a balanced, symmetrical system.

# Hypothetical symmetrical system

	bilabial		dental	alveolar		posto-	retrofle	alveolar	x	velar
<b>stop [-vc]</b>	p		t̪	t		c		t̠		k
<b>stop [+vc]</b>	b		d̪	d				d̠		g
<b>nasal</b>	m		n̪	n		ɲ		ɳ		ŋ
<b>fricative</b>	ɸ		θ	s		ʃ		ʂ		x

# Hypothetical asymmetrical system (1)

	bilabial dental		posto- alveolar alveolar x		retrofle velar
stop [-vc]	p	t̚		c	k
stop [+vc]	b		d		ɖ
nasal		ɱ	n		ŋ
fricative	ɸ		s	ʃ	x



# Hypothetical asymmetrical system (2)

	bilabial dental		alveolar alveolar x		postro-	retrofle	velar
stop [-vc]	p	t̪	t	c	t		k
stop [+vc]	b		d		d̪		g
nasal			n				
fricative	ɸ		s		ʃ		

# Principles of phonological architecture are essential in language creation, because ...

- No minimal pairs
- In looking for evidence of the system we have to look more globally at the system. How does the system come to look like a system, and not just a collection of forms.
- Abstract Principles such as Dispersion, Feature Economy, Symmetry capture these global properties.

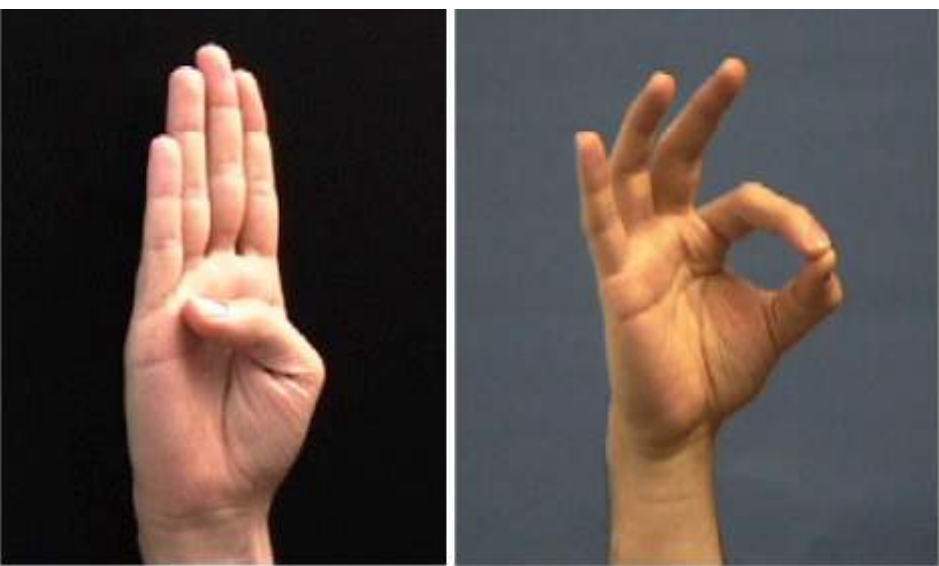
# Sign language (SL) parameters

Japanese SL: *Did he tell her?*

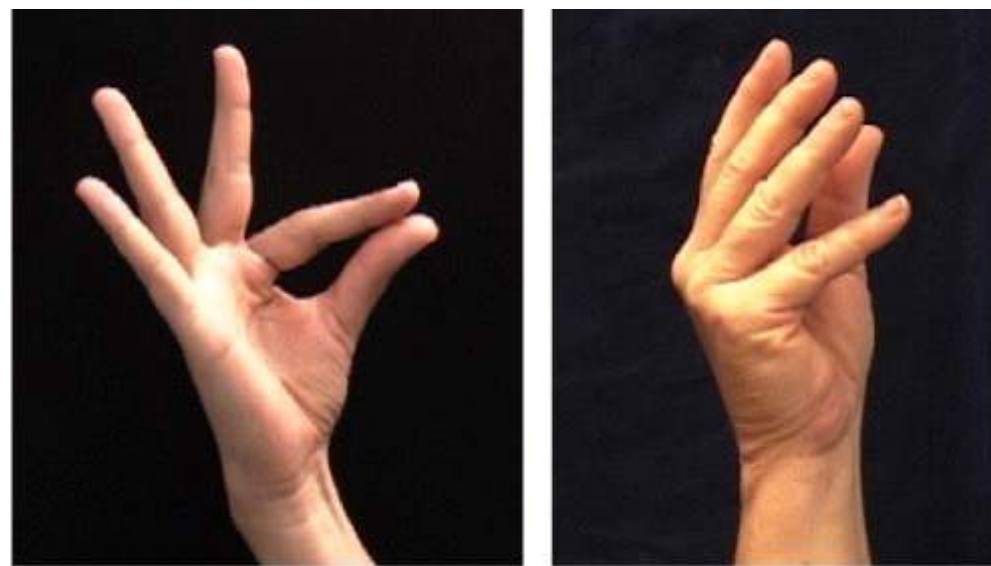
- **Handshape** (& orientation)
- Movement
- Place of Articulation
- Non-manuals (NMM)



Data come from two classes of handshapes  
(Brentari et al., 2012, 2013, 2016)



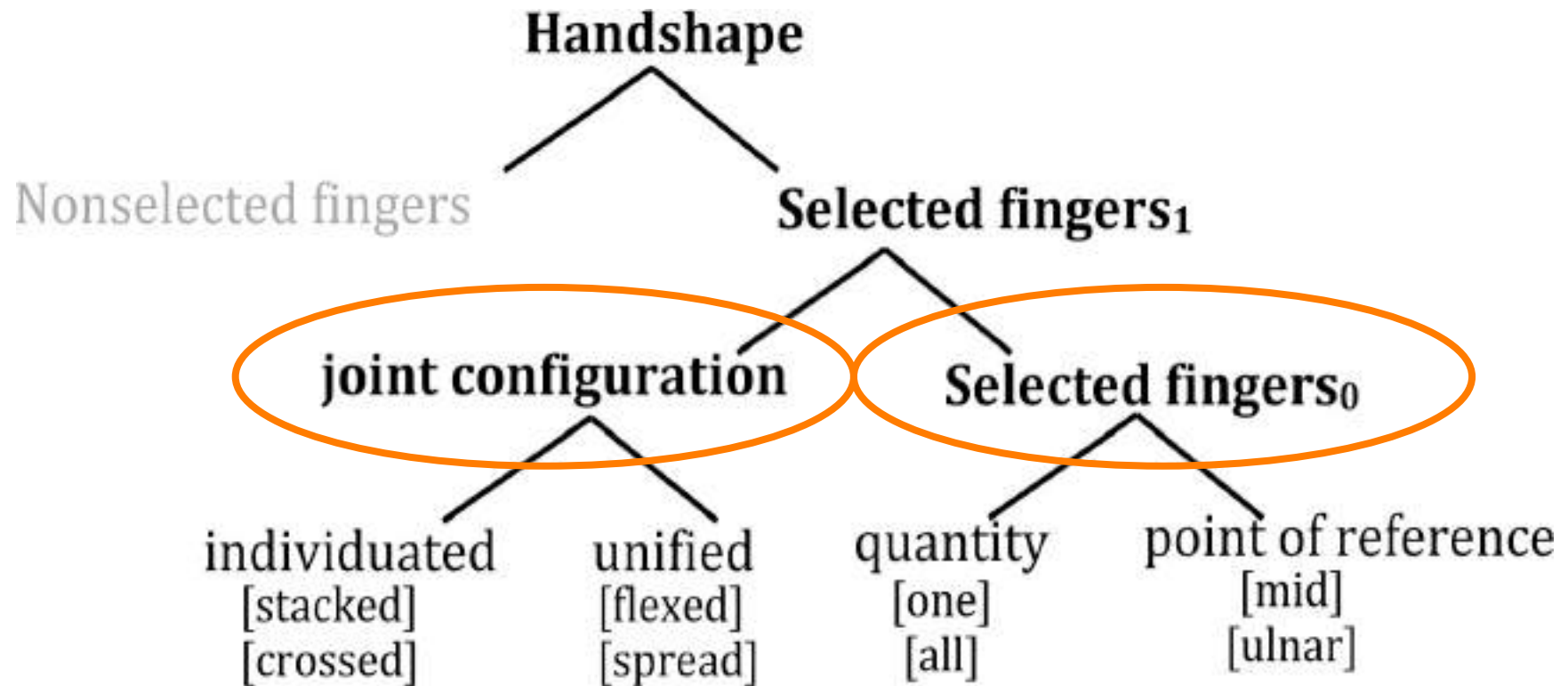
Object handshapes



Handling handshape

# Feature Tree for Handshape in sign languages

(Brentari 1998; revised slightly following Geraci et al. in prep)



**LOW (1)**

**joint configuration**



unified  
[flexed]

**MEDIUM (2)**

**joint configuration**



unified  
[flexed]  
[spread]

**HIGH (3)**

**joint configuration**



individuated  
[crossed]

LOW (1)

MEDIUM (2)

HIGH (3)

Selected fingers



quantity  
[one]

Selected fingers



quantity  
[one]  
[all]

Selected fingers<sub>0</sub>

quantity  
[one]  
[all]

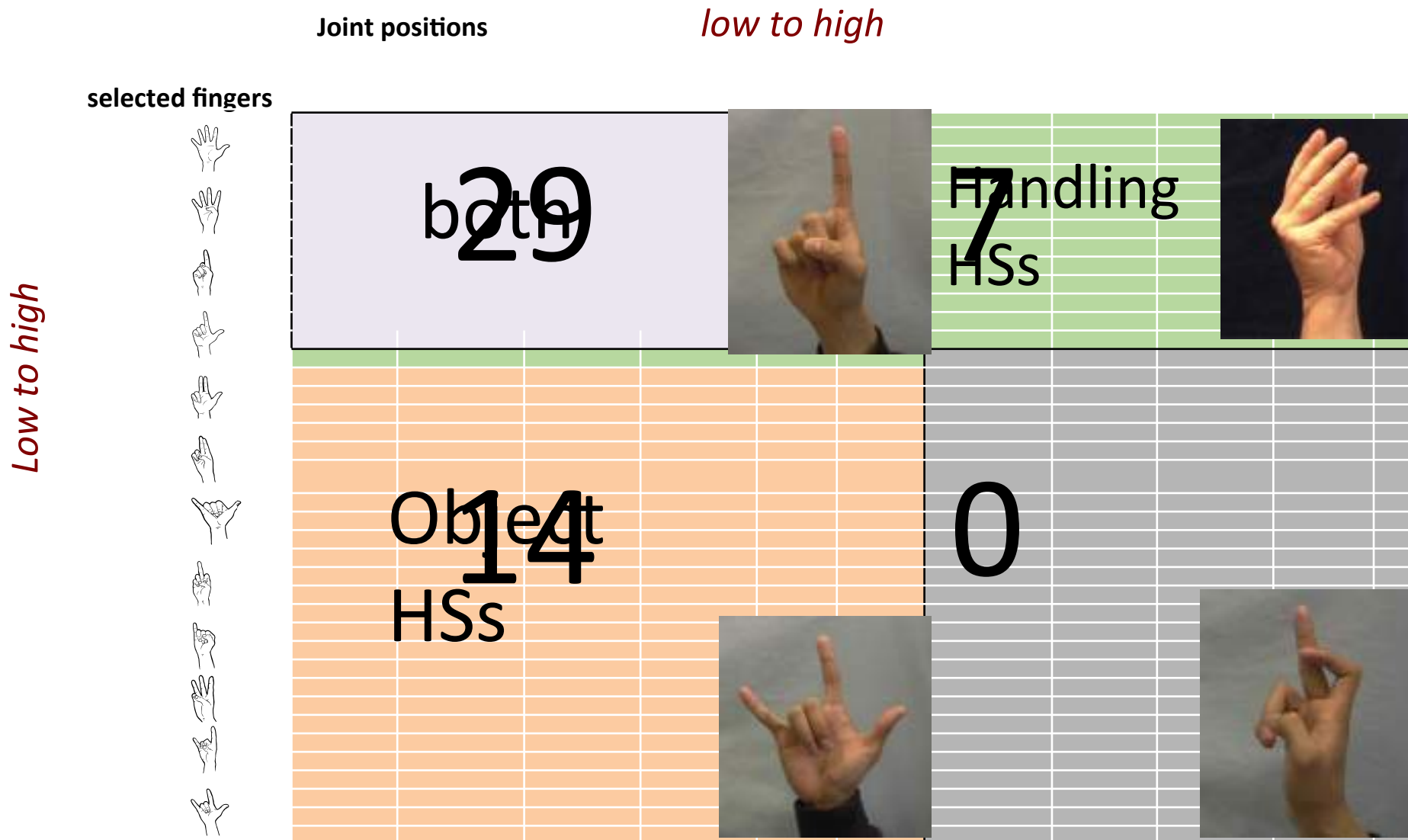


point of reference  
[ulnar]





# In French, American, Italian, and British SLs there is a trade-off between finger & joint possibilities



# Participants' Levels of Linguistic Experience

		<u>Hearing</u> people	-horizontal contact -vertical contact	+horizontal  +horizontal +vertical	Multiple generations of +H, +V
		Silent Gesture	Homesign	Emerging SI	
		Time 0	Time 0	C1: 15 yrs. Time 1	C2: 30 yr. Time 2
					~500 years Time "n"
Linguistic Experience	Language Model (oral modality)	✓			?
	Language Model (visual modality)				✓
	Community of Users			✓	✓
	Modality Experience		✓	✓	✓

---

**Scenes without an agent**

1. [object] on table
2. [object] on table upside down
3. *Multiple [objects] on table  
(regular arrangement in row/s)*
4. Multiple [objects] on table  
(random arrangement)
5. [object] falling

---

**Scenes with an agent**

6. Put [object] on table
  7. Put [object] on table upside down
  8. *Put multiple [objects] on table  
(regular arrangement in row/s)*
  9. Put multiple [objects] on table  
(random arrangement)
  10. Demonstrate function of [object]
- 



*Condition 3: Airplanes in a row*

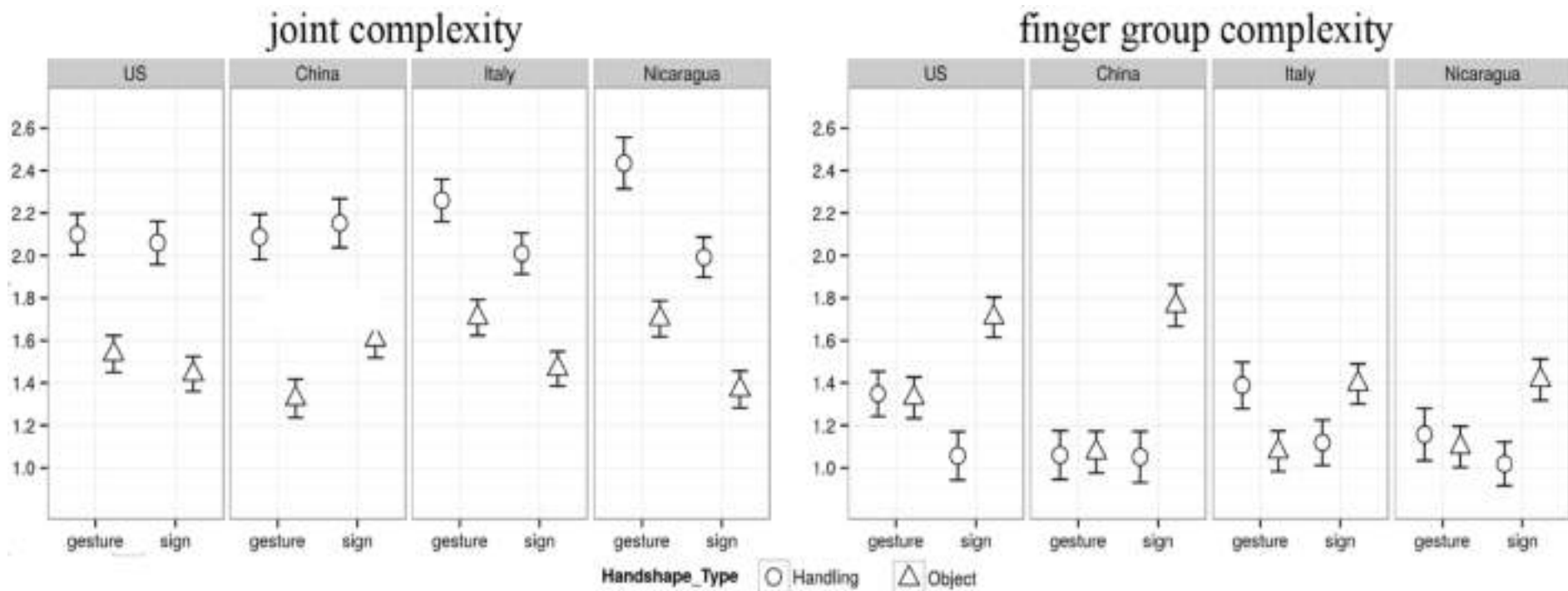


*Condition 8: Put airplanes in a row*

# ADULT EXAMPLES

Joint & Finger Group Complexity

Gestures & signers have different patterns  
Explanation: SLs show reorganization of the system  
towards symmetry (Brentari et al. 2016)



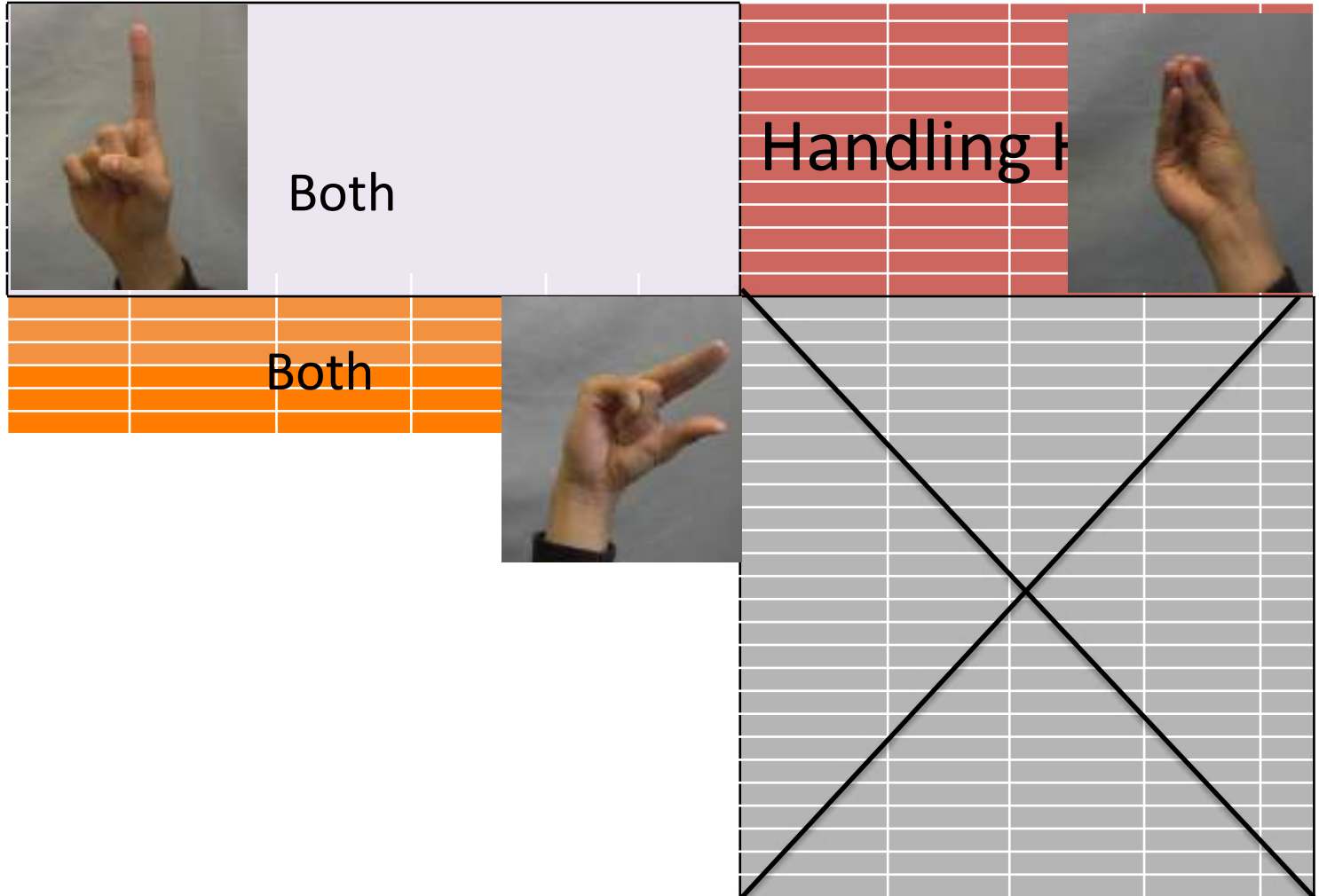
# GESTURERS

Joint positions

*low to high*

selected fingers

*Low to high*



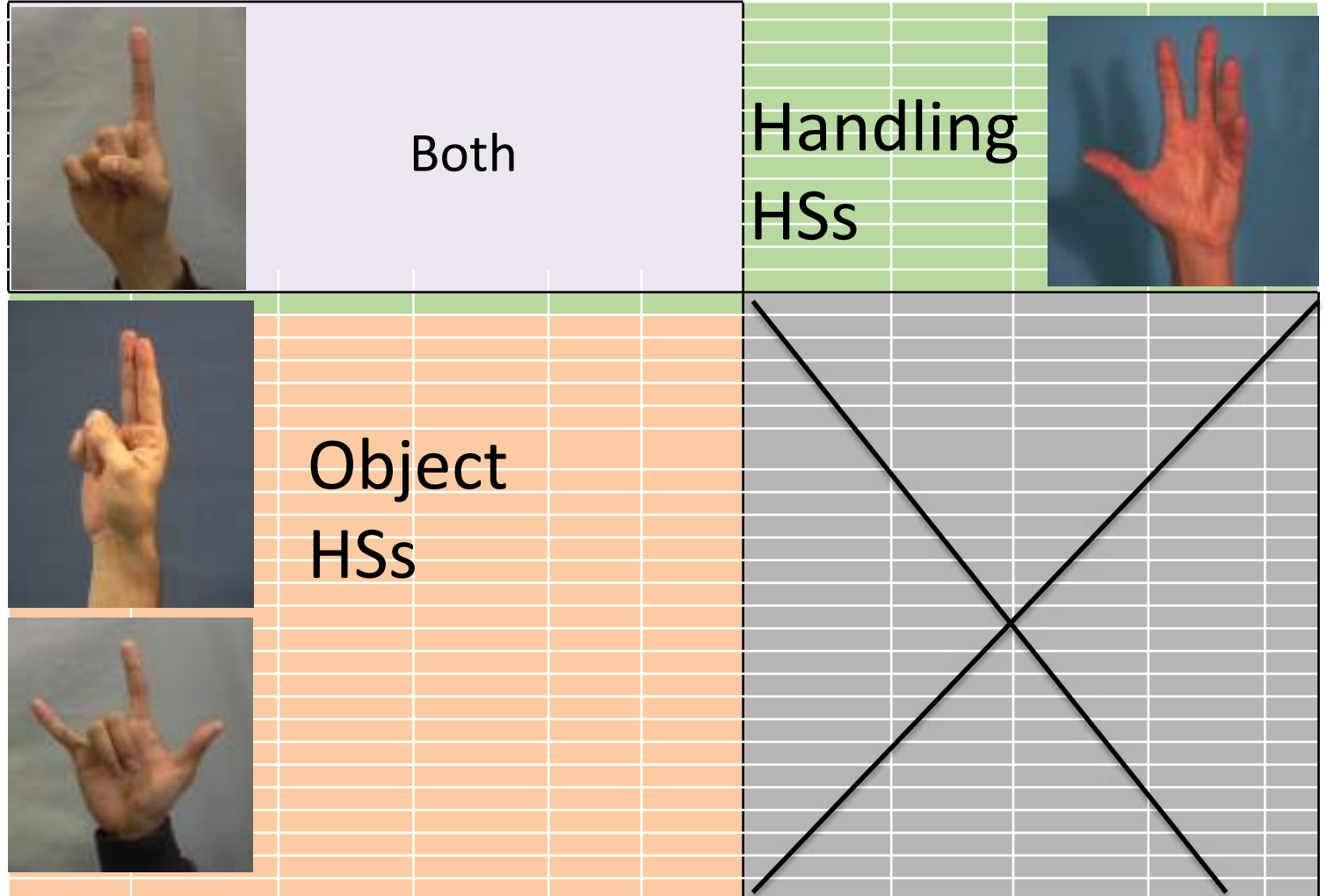
# SIGNERS

Joint positions

*low to high*

selected fingers

*Low to high*



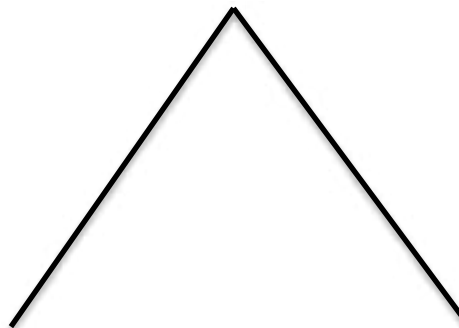
gesturers



object  
handling

±joint complexity

Signers & homesigners



handling

object

±Selected fingers



# Participants Levels of Linguistic Experience

		Hearing people	-horizontal contact -vertical contact	+horizontal	+horizontal +vertical	Multiple generations of +H, +V
		Silent Gesture	Homesign	Emerging SI		ASL Signers
		Time 0	Time 0	C1: 15 yrs. Time 1	C2: 30 yr. Time 2	~500 years Time "n"
Linguistic Experience	Language Model (oral modality)	✓				
	Language Model (visual modality)				✓	✓
	Community of Users			✓	✓	✓
	Modality Experience		✓	✓	✓	✓

**+ horizontal contact:** a community that uses the system as a primary means of communication

**+ vertical contact:** having a proficient user of the system present from a previous group to learn from

**community size:** how large is the group of users?

# Central Taurus Sign Language (CTSL) and Nicaraguan Sign Language (NSL)

- **CTSL**: A village SL has a mix of hearing and deaf members, and the number of deaf members of CTSL community is comparatively small (maximum 25-30). In contrast, a community SL is composed largely of deaf members; there are few, if any, hearing members.
- **NSL**: a community SL is composed largely of deaf members; there are few, if any, hearing members. The NSL community is comparatively large (approximately 3500).

In both CTSL and NSL we can analyze forms along these dimensions

	-horizontal	+horizontal
-vertical	homesigners (NSL)	NSL1; CTSL1
+vertical		NSL2; CTSL2, CTSL3

Social Factors: horizontal contact, vertical contact, community size

Phonological factors: three kinds of complexity (joint, SF, total) & handshape type (H-HS, O-HS)

stimulus



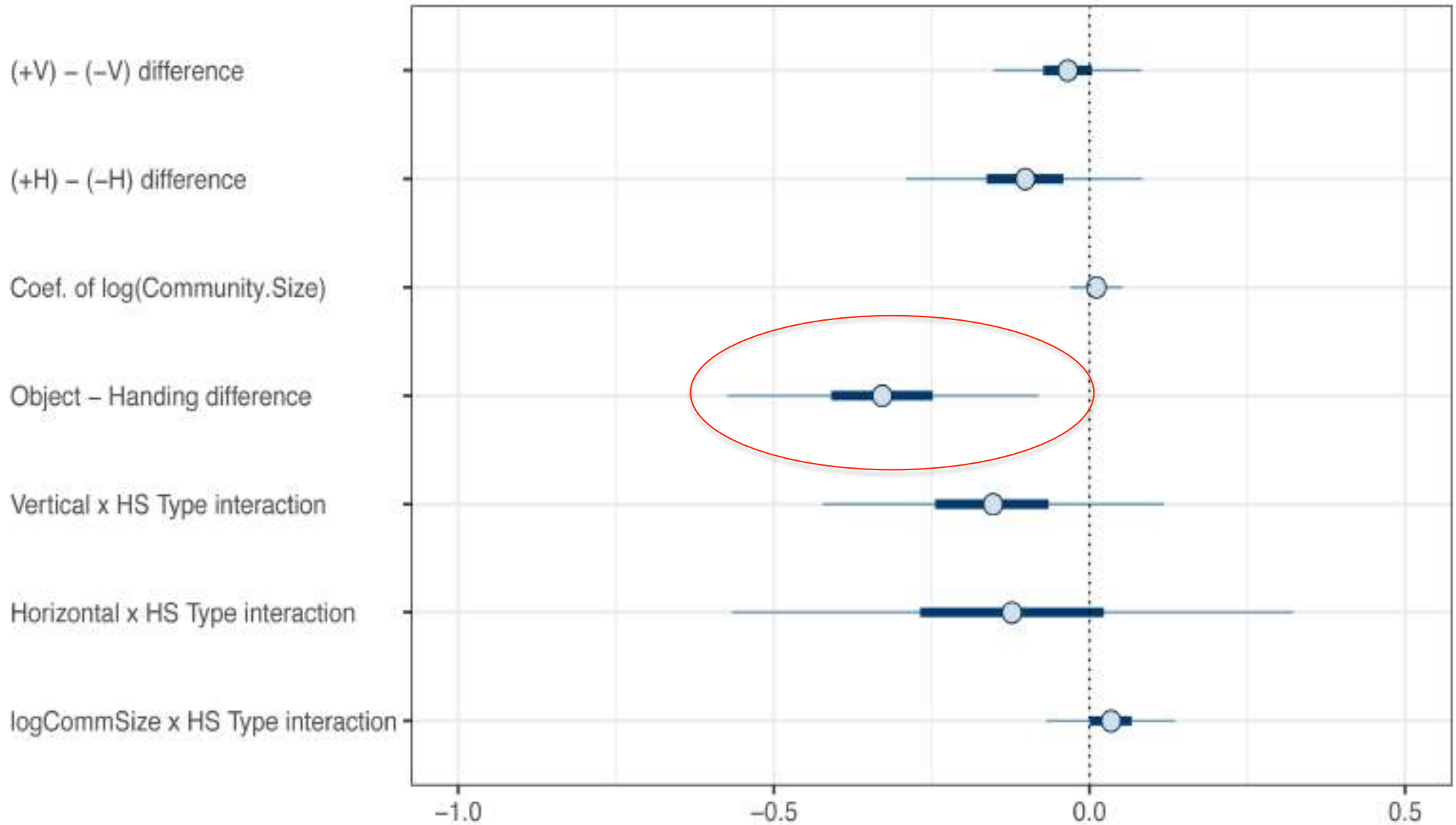
Nicaraguan homesigner -H, -V



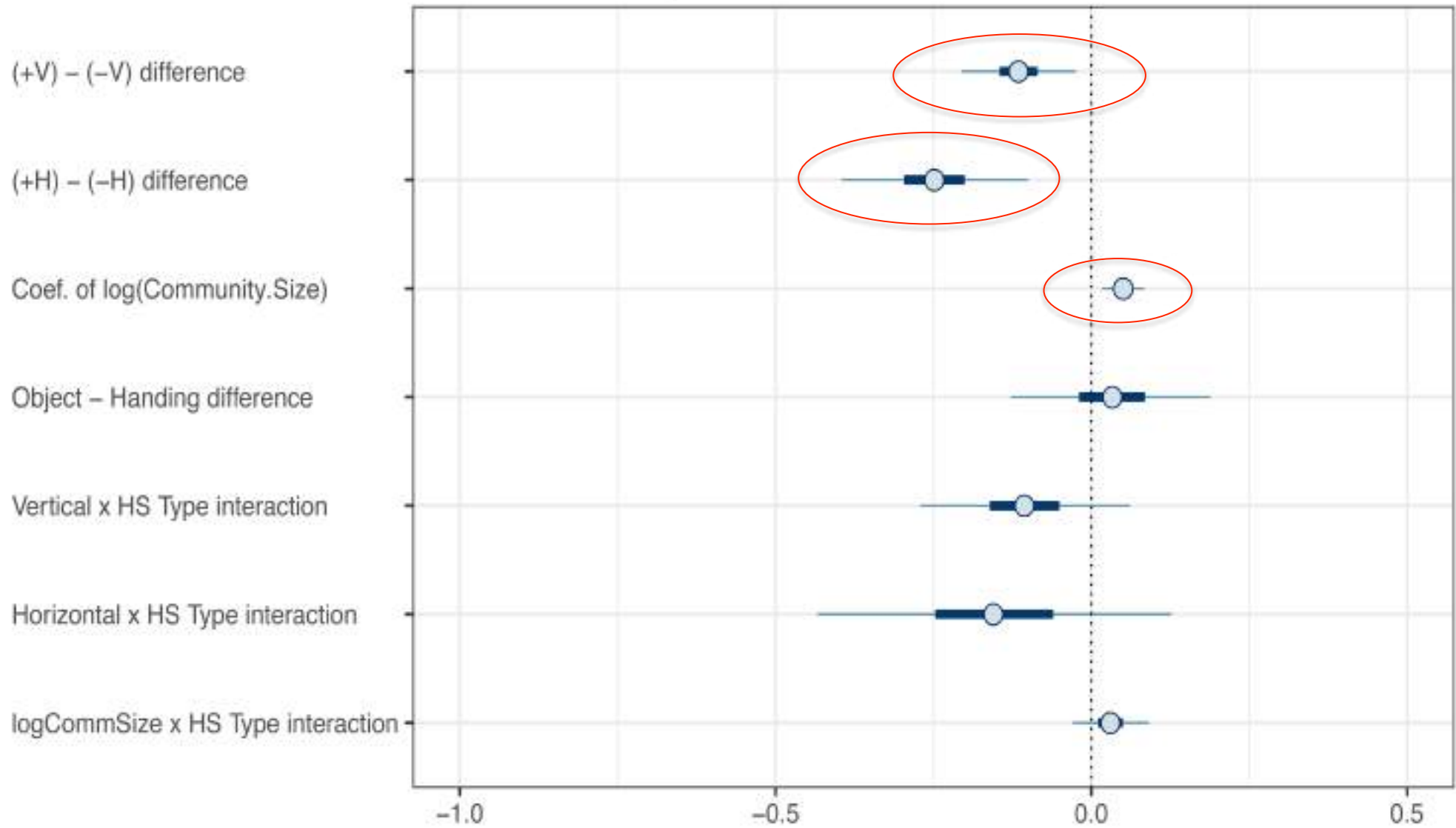
CTSL signer +H, -V



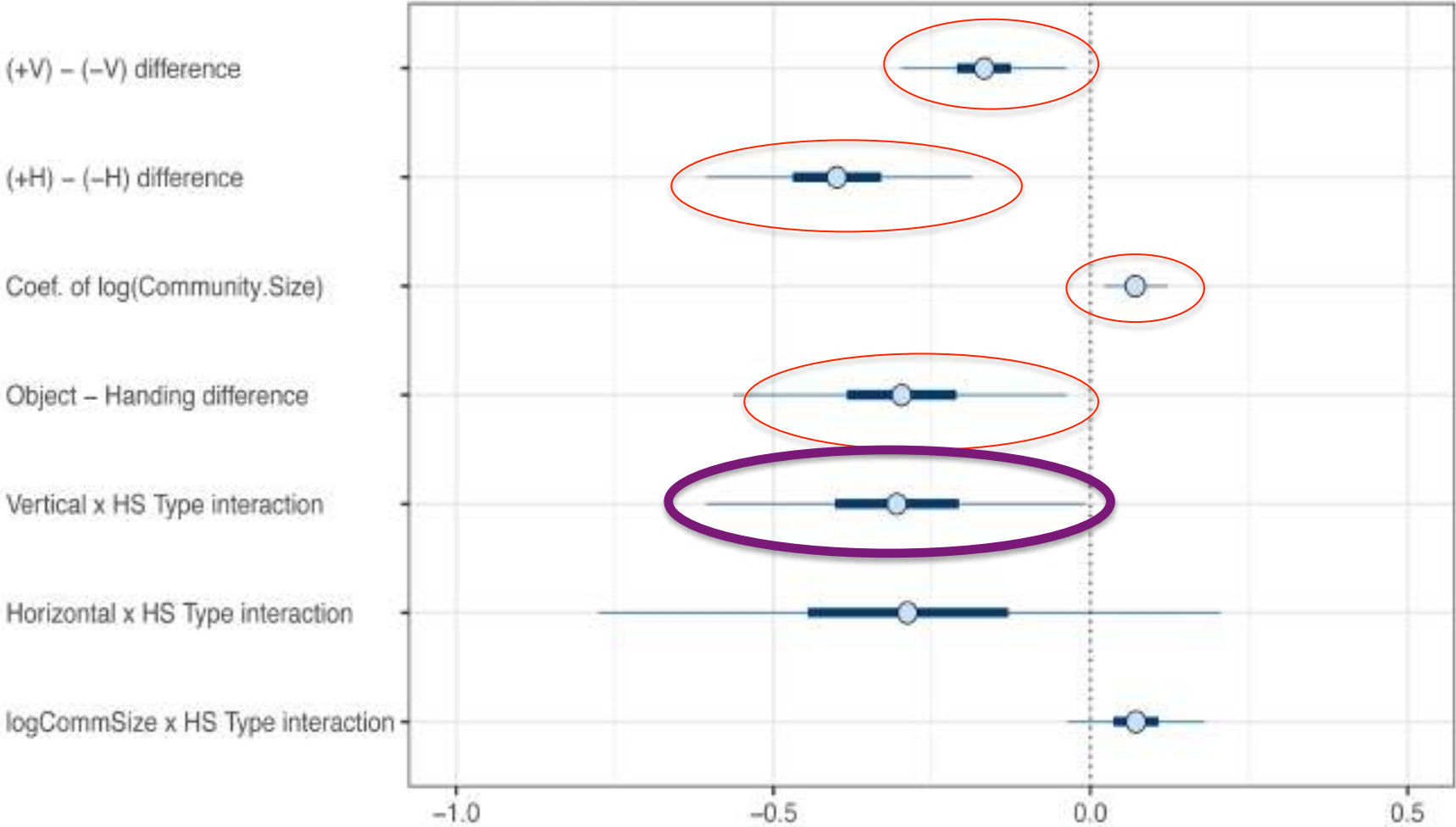
## Coefficients (joint complexity)



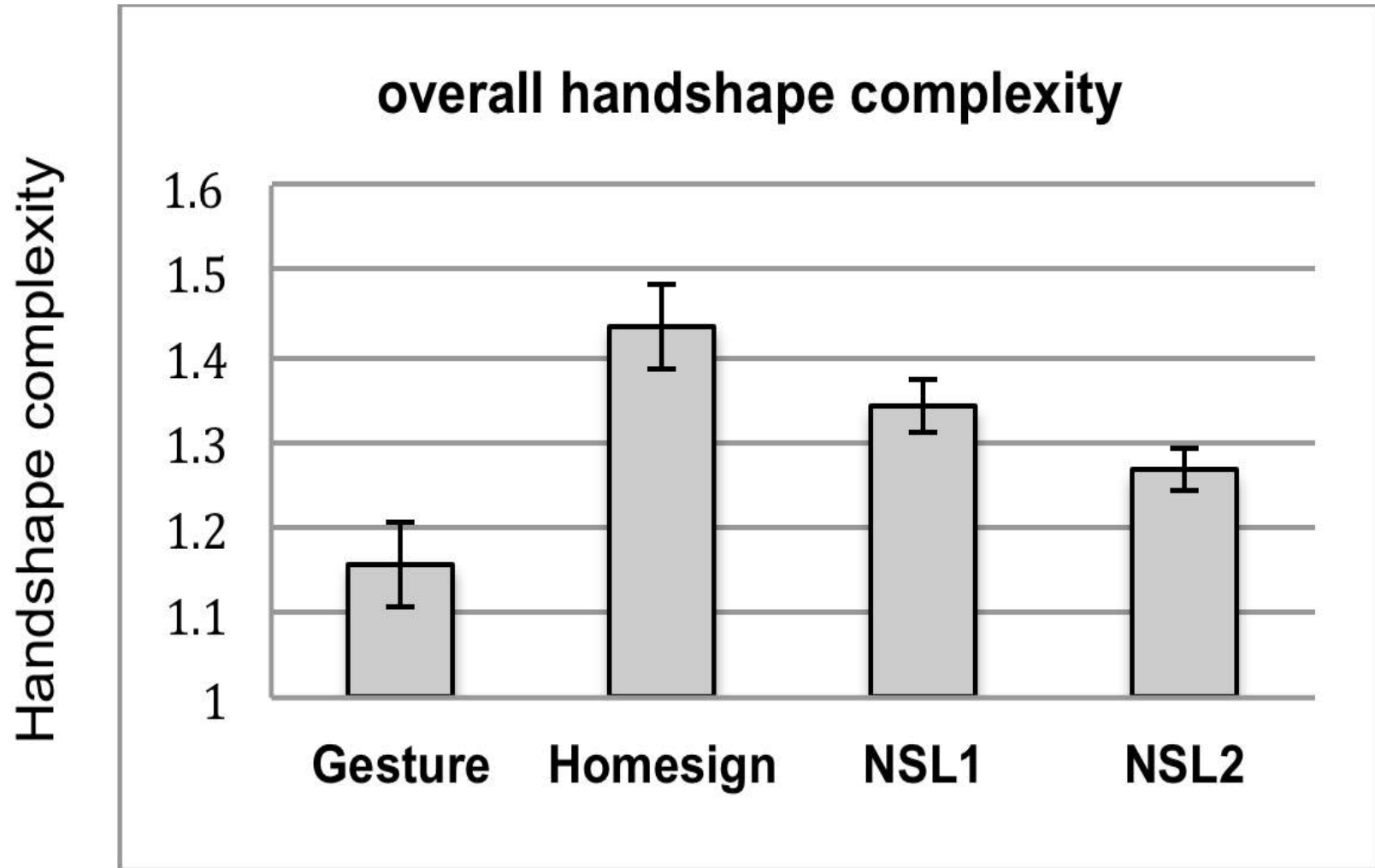
## Coefficients (sf complexity)



### Coefficients (total complexity)



Increases in total complexity is not linear





# Form

# Distribution

+vertical  
contact



+horizontal  
contact



homesign

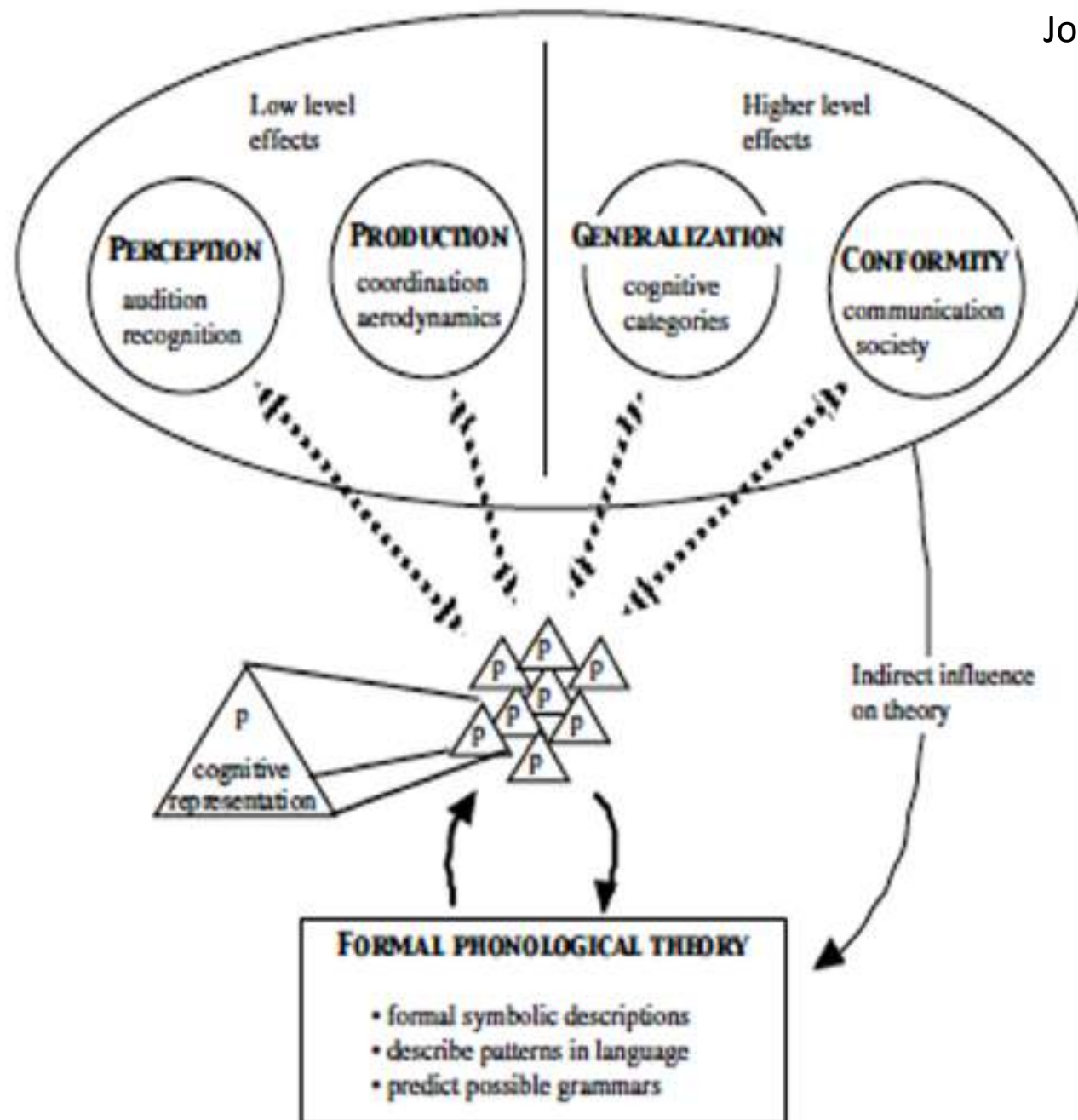
**Align & Re-organize**  
morphological &  
Phonological units  
HandlingHS –  
joints  
ObjectHS—SFs

**Create** multiple  
ways of  
expressing a  
concept  
Hand-as-hand  
Hand-as-object

**SYMMETRY &  
FEATURE  
ECONOMY:**  
organize the  
contrasts in a  
balanced way

**DISPERSION:**  
create the  
greatest  
number of  
contrasts  
possible

From  
Johnson and Hume (2003)



**THANK YOU!**