Phonological Complexity is Subregular: Evidence from Sign Language

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May 26, 2017

Today's Question

Do the computational properties of phonology hold across modalities?

Two Major Camps

- "Continuity View": phonology depends on/emerges from the properties of the phonetic system (grounded)
  - Hayes et al 2004, Steriade 1997
  - Markedness, Feature geometries, Inductive Learning
- "Algebraic View" : Abstract computational system that gets to peek at the phonetics, but is largely independent
  - Neurological Evidence, Acquisition Evidence, Extensive theoretical commonalities
  - Berent 2013, Sandler 2012, Sandler and Lillo-Martin 2006

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This has not been fruitful

- work has focused on the feature representations
- a lot of theoretical work is based on loose analogies to spoken language

  Handshape is *"like"* tone..." etc.
- Representational issues still abound

  Senquentiality vs Simultaneity
  SLM 2006, Ch.14: "Is there a Syllable in Sign language"

A New Direction

- Adopt a Formal Language Theory Perspective
- Analyze the complexity of signed vs spoken patterns
- Compare them to limits on phonological complexity (Heinz 2016

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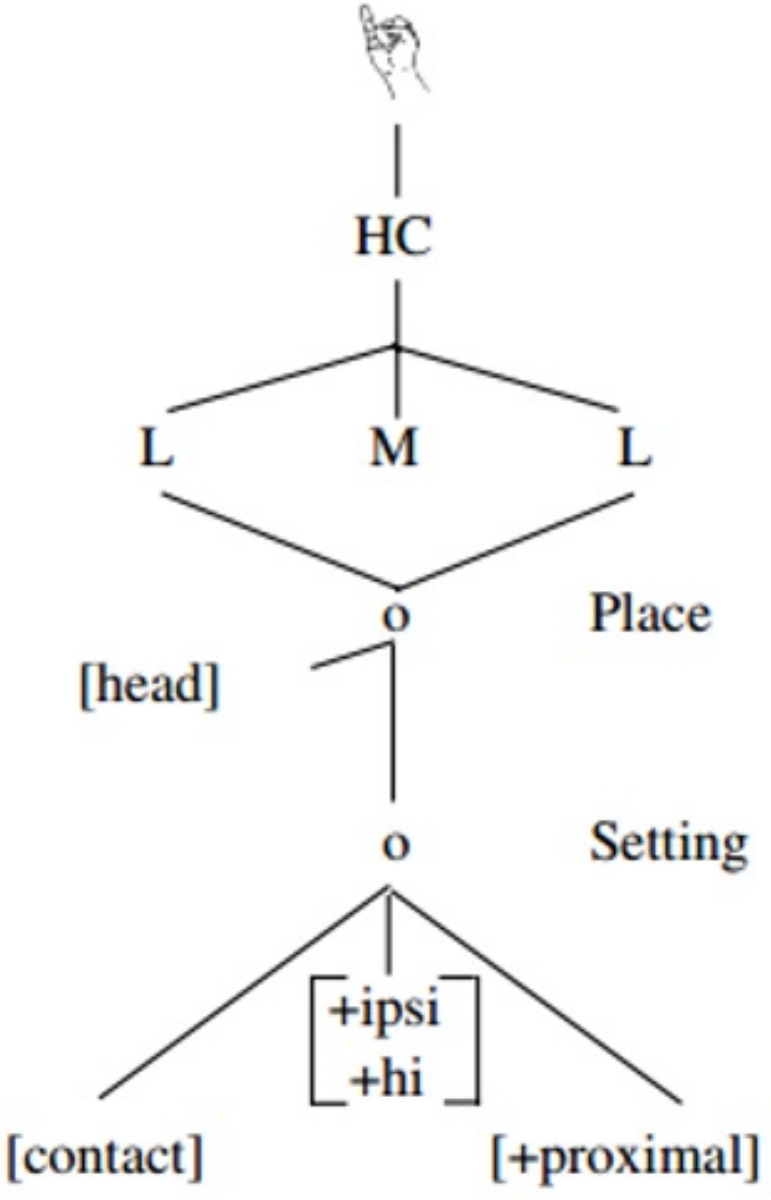
Outline

The Structure of Signed Syllables

IDEA (ASL)



The Subregular Hypothesis

Phonology is **Subregular**: it fits best into the **sub**-classes of the **regular** languages.

This case is being pursued by

Jeff Heinz

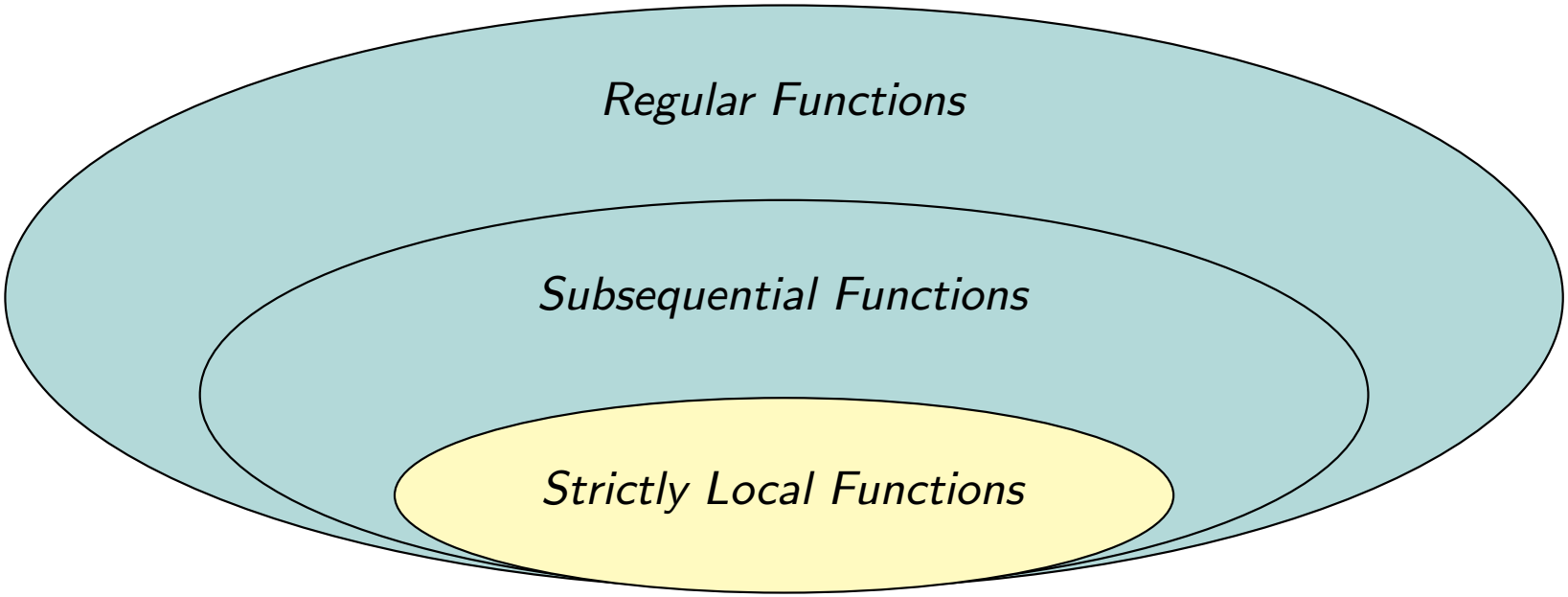
Jane Chandlee

Adam Jardine

Thomas Graf

... and others

Phonological Mappings are Subregular



McNaughton & Papert 1971; Rogers & Pullum 2011; Rogers et al. 2012; Heinz 2016; Mohri 1997 Chandlee 2014

Input Strictly Local Mappings

Strictly Local (SL; Chandlee 2014)

- define a window of segments of length k to map from input to output
  - $k = 2$
  - 'np' $\rightarrow$ 'mp'
- Move through string from left to right.
- Rewrite segment x as y based on previous n symbols in input string
- Mapping never considers both input and output.

Example: Word-Final Devoicing

SL_2-Mapping: -son $\rightarrow$ -voice / $\_\ltimes$

Input String: TOD

ISL Output

$\rtimes$ T O D $\ltimes$

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Strictly Local To Sign Language

What Kind of Processes are Strictly Local?

- Substitution
- Deletion
- Epenthesis
- 'Bounded' Metathesis

Strictly Local Processes in Sign Language

- Non-Local Metathesis
- Partial Reduplication
- Compound reduction/Blending

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Metathesis and Reduplication

Chandlee 2014: Spoken Metathesis and Reduplication are Strictly Local processes

Partial reduplication

Marshallese			
ebbok	'to make full'	sulat	'write'
ebbok-bok	'puffy	susulat	'will write'

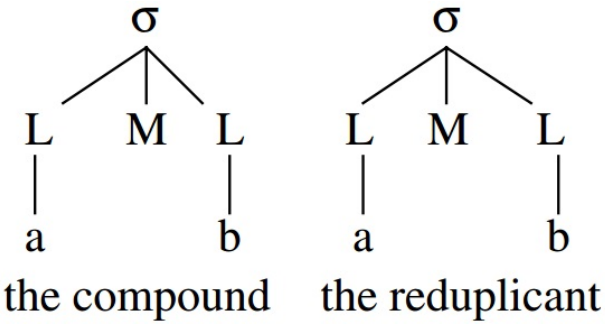
Non-Local Metathesis

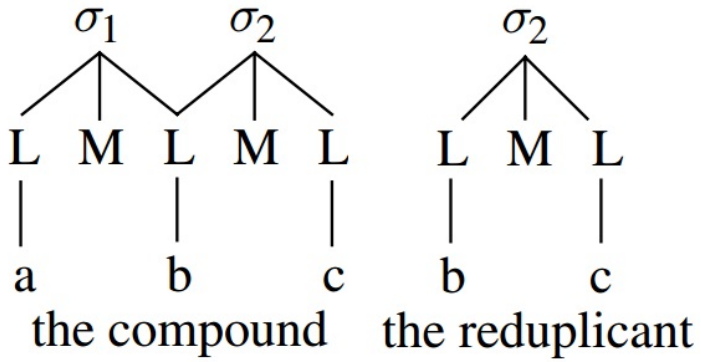
- Metathesis = Delete x Copy
- 'Long Distance Metathesis'
  - Cuzco Quechua (Davidson 1977)
  - yuraq $\rightarrow$ ruyaq, 'white'
  - aBc $\rightarrow$ cBa

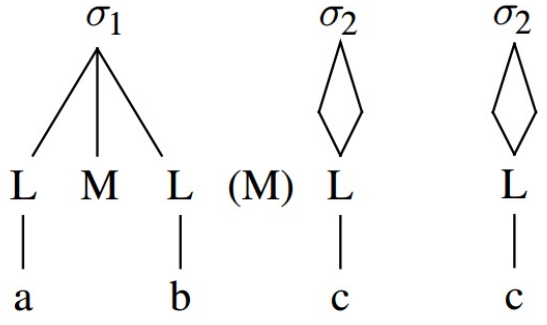
ASL FinalSyllable Reduplication

FAINT (ASL)

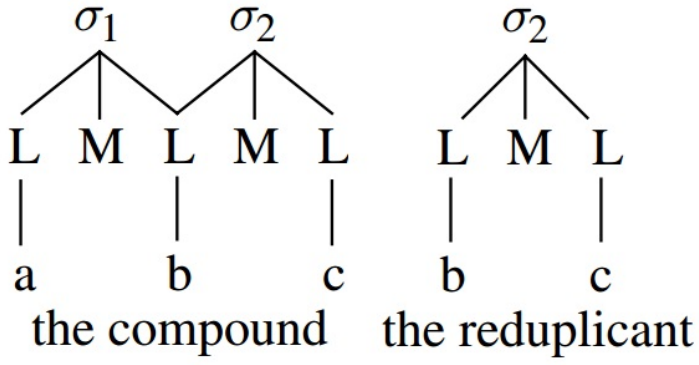
OVERSLEEP (ASL)







ASL Final Syllable Reduplication



Window Length:	4 segments
ISL_4 Mapping:	$\emptyset \rightarrow \text{LML} \;/\; \text{LML}\_\_\ltimes$
Input String:	LMLML

$\rtimes$ L M L M L $\ltimes$

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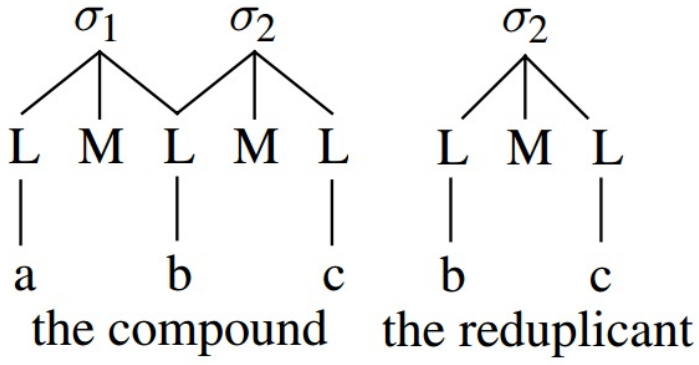

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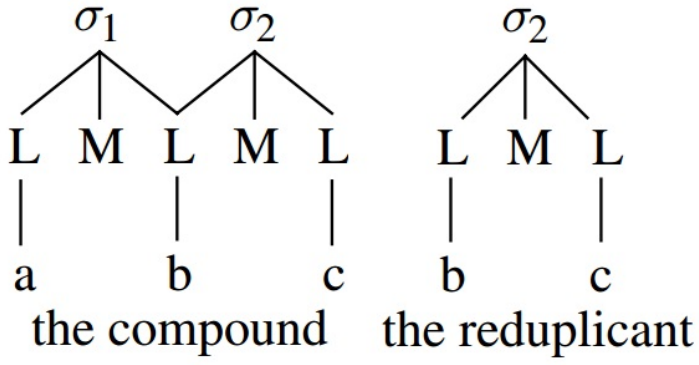

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ISL_4 Mapping: $\emptyset \rightarrow$ LML / LML__⋉

Input String: LMLML

⋊ L M L M L ⋉

L

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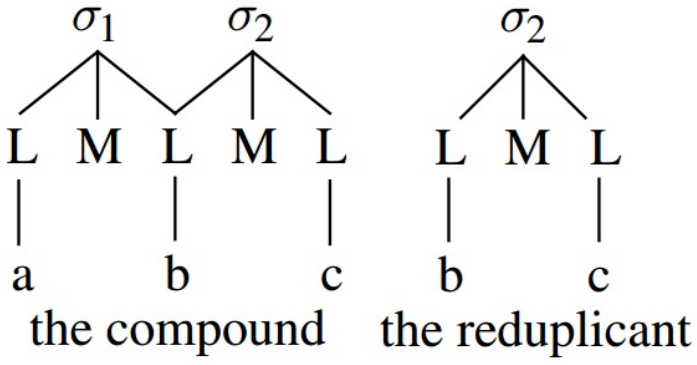

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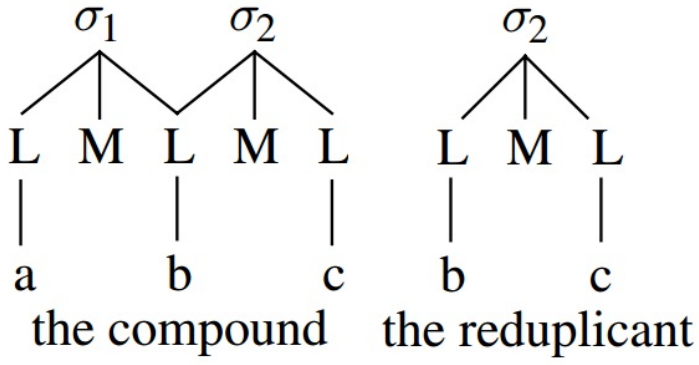

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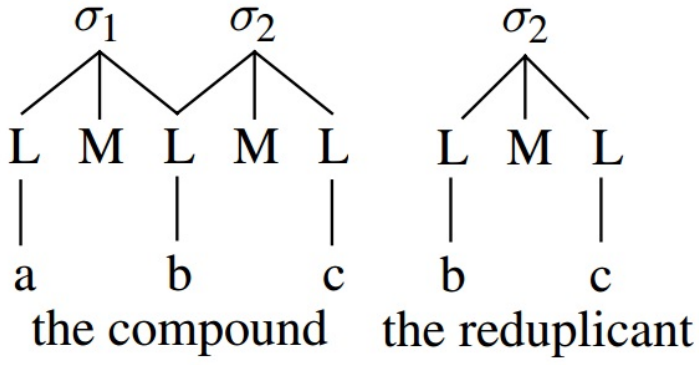

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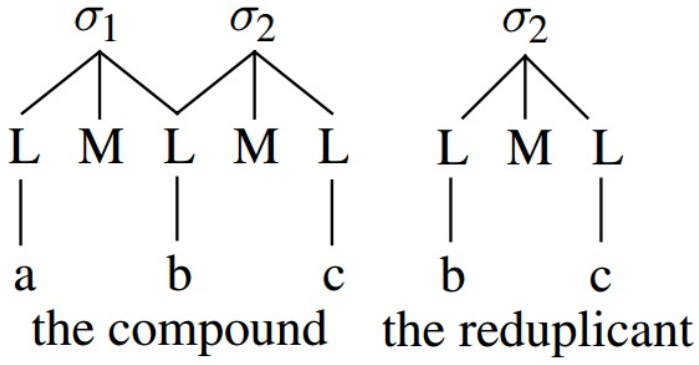

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$$\begin{array}{ccccccc} \rtimes & L & M & L & M & L & \ltimes \\ & L & M & L & M & & \end{array}$$

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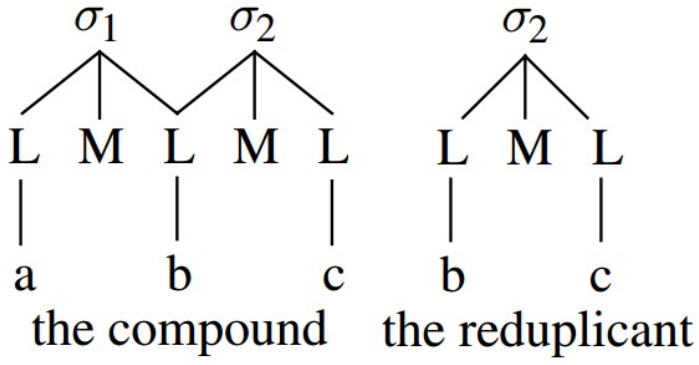

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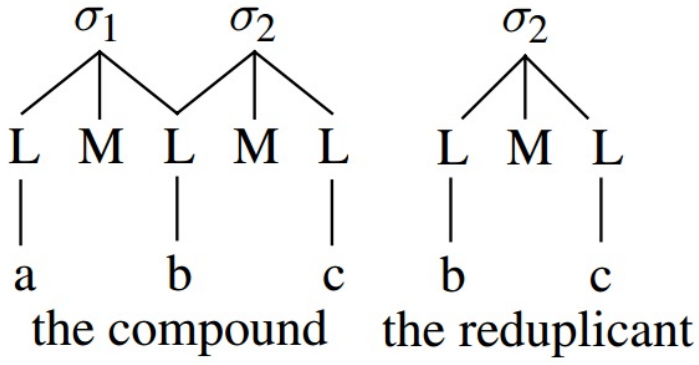

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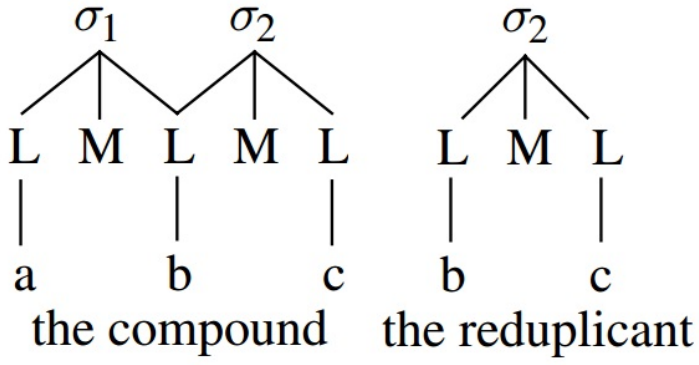

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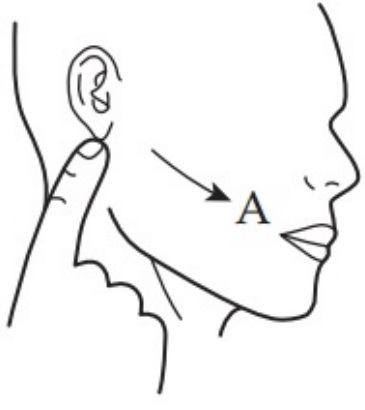
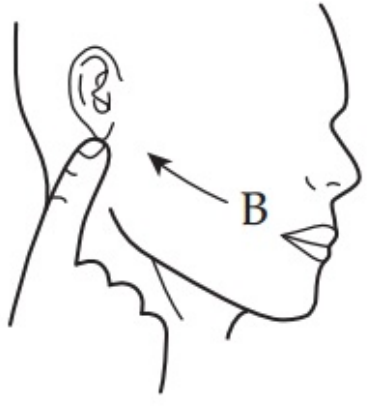
Metathesis

a. FATHER DEAF (ASL)

b. MOTHER DEAF (ASL)





Metathesis

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b. MOTHER DEAF (ASL)

ISL4 Mapping: $aBc \rightarrow cBa$

Window: 4 segments

Input String: $L_1ML_2L_3ML_2$

$\rtimes \quad L_1 \quad M \quad L_2 \quad L_3 \quad M \quad L_2 \quad \ltimes$

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$$\rtimes \quad L_1 \quad M \quad L_2 \quad L_3 \quad M \quad L_2 \quad \ltimes$$
$$L_1 \quad M \quad L_2$$

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ISL4 Mapping: aBc $\rightarrow$ cBa

Window: 4 segments

Input String: $L_1ML_2L_3ML_2$

$\rtimes$	L_1	M	L_2	L_3	M	L_2	$\ltimes$
	L_1	M	L_2	L_2	M	L_3	

Compound Reduction

a. MIND

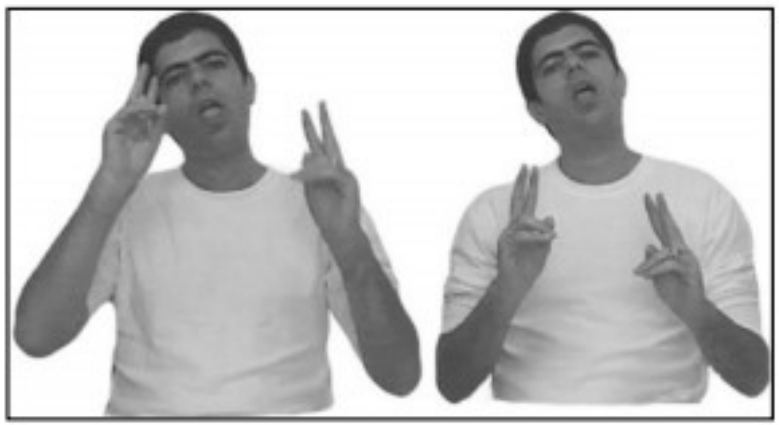
b. DROP

c. FAINT (ASL)

Compound Reduction

a. MIND

b. STOP (suspend)

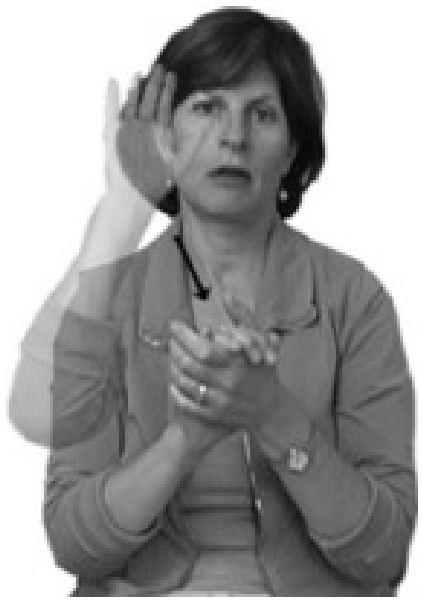


c. MIND^STOP=DAYDREAM

Compound Reduction

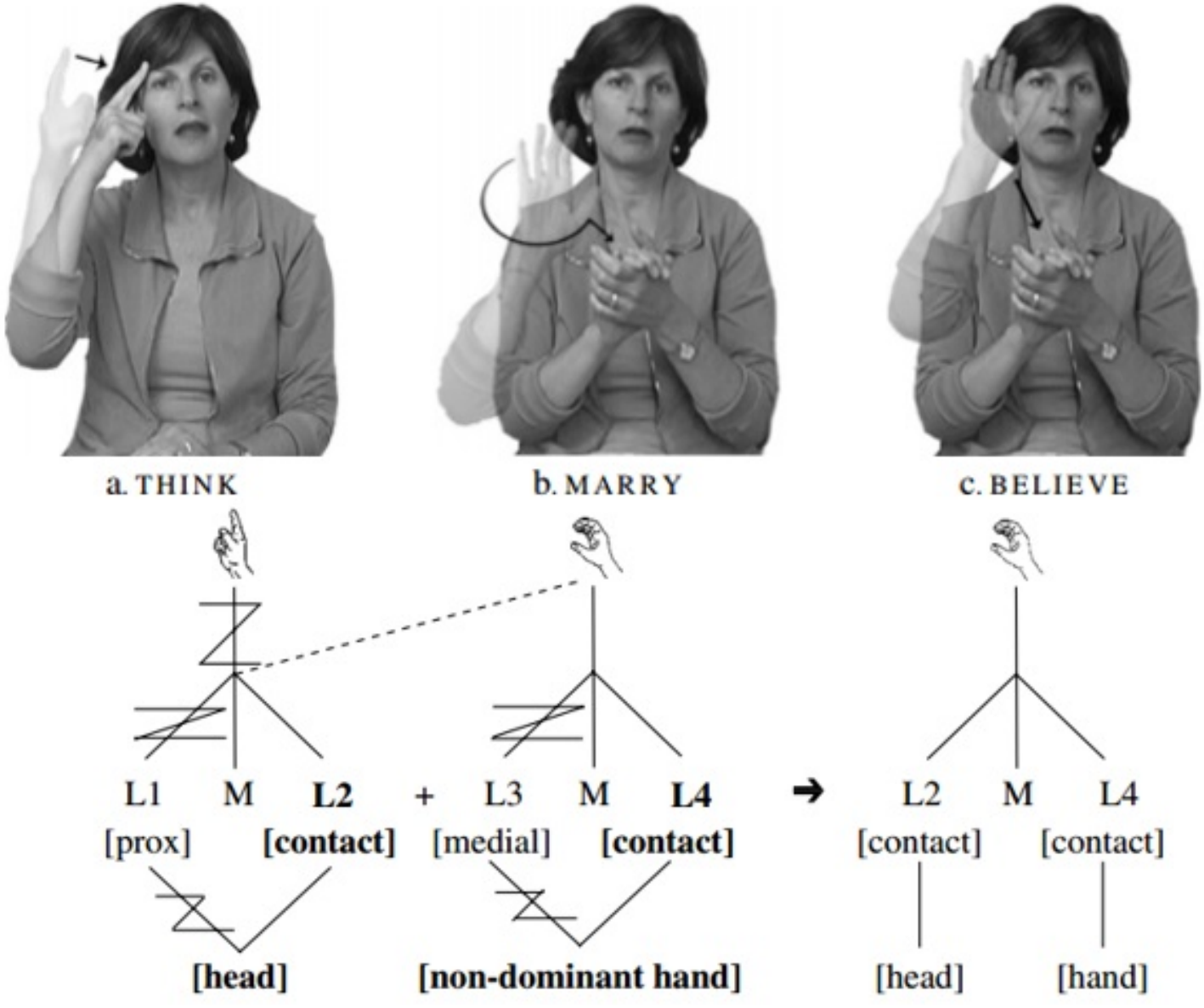
a. THINK

b. MARRY

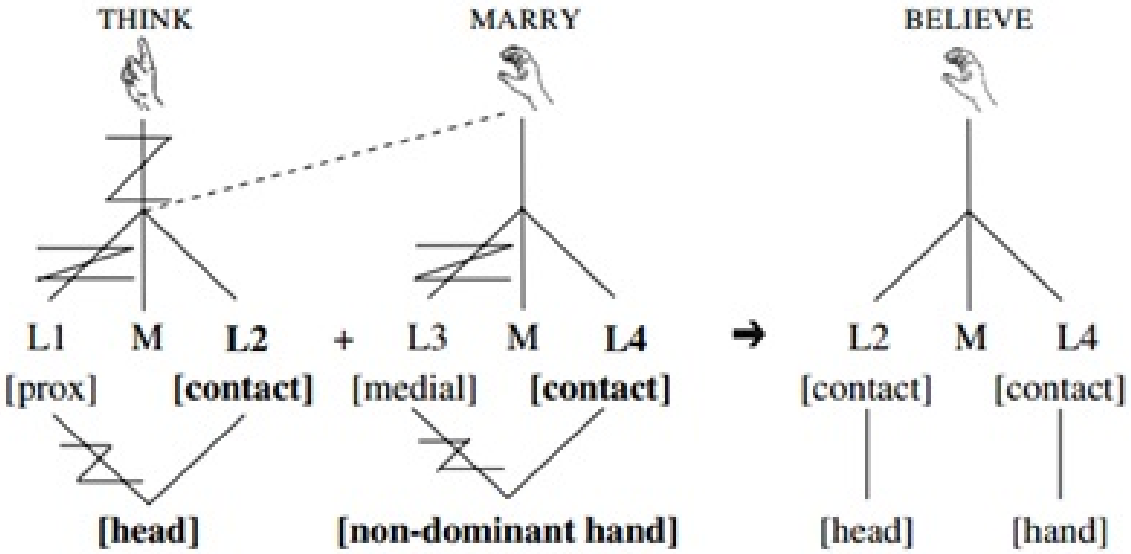


c. BELIEVE

Compound Reduction



Compound Reduction



Window Size: 4

ISL$_4$ Mapping: $\rtimes\ \mathsf{L}_1^1\ \mathsf{M}^1\ \mathsf{L}_2^1\ \mathsf{L}_3^2\ \mathsf{M}^2\ \mathsf{L}_4^2 \ltimes$
$\mathsf{L}_2^2\ \mathsf{M}^2\ \mathsf{L}_4^2$

Conclusion

Today's Results

- Strict Locality Across Modalities for:
  - Bounded Metathesis
  - Partial Reduplication
  - Compound Reduction
- The Subregular Hypothesis seems to hold regardless of the phonetic system
- Some phonological processes are "algebraic", and some part of phonology is independent

Conclusion

Predictions

- Any (morpho)phonological process/structure in sign should have the same subregular complexity class as its spoken counterpart
- If not, or any part of Sign phonology is more than subregular, then either:
  - the subregular hierarchy is not expressive enough
  - the signed modality imposes a different complexity than the oral modality
  - the "algebraic" view is wrong

Conclusion

Future Directions

- Suprasegmental vs segmental dichotomy (Jardine 2015)
- Handshape Configuration
  - Eccarius OT Dissertation
- Typological similarities
- Why stop at phonology?

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> - Richard Feynman, *Six Easy Pieces*

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