Multiple metathesis is strictly local: evidence from stress driven metathesis

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Overview

What I would like to show today

- Some attested metathesis mappings: NOT ISL.
- Instead, OSL (or beyond) with a large locality domain.
- Separating the stress pattern from related metathesis
  → 3-ISL

Factorization of the grammar matters!

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Outline

Local Metathesis

Metathesis

Transposition of two segments

a b → **b a**
a b **c** → **c** b **a**

Local Metathesis

Transposition of **two adjacent** segments

(Kwara'ae) /sa**lo**/ → sa**ol**

(Heinz 2004)

Local Metathesis

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Metathesis in Kwara'ae

Kwara'ae

- an Austronesian language spoken in the Solomon Islands
- exhibits synchronic CV-metathesis (Normal Form)

Two speech registers in Kwara'ae (from Heinz 2005, p.1)

Citation	**Normal**	
loʔi	loiʔ	'snake'
buri	buir	'behind'
bore	boer	'although'

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Metathesis is ISL

Chandlee (2015)

Metathesis is Input Strictly Local (ISL)

Rotuman word-final CV metathesis (CV → VC)

ho**sa**	→	ho**as**	‘flower’
hu**la**	→	hu**al**	‘moon’

Input/Output Strictly Local

Strictly Local (SL) functions examine a string from left to right and rewrite the symbol based on the previous *n*-symbols.

Input Strictly Local (ISL) functions:
The output element depends on the previous *n*-symbols in the *input*.

Output Strictly Local (OSL) functions:
The output element depends on the previous *n*-symbols in the *output*.

Input Strictly Local (ISL)

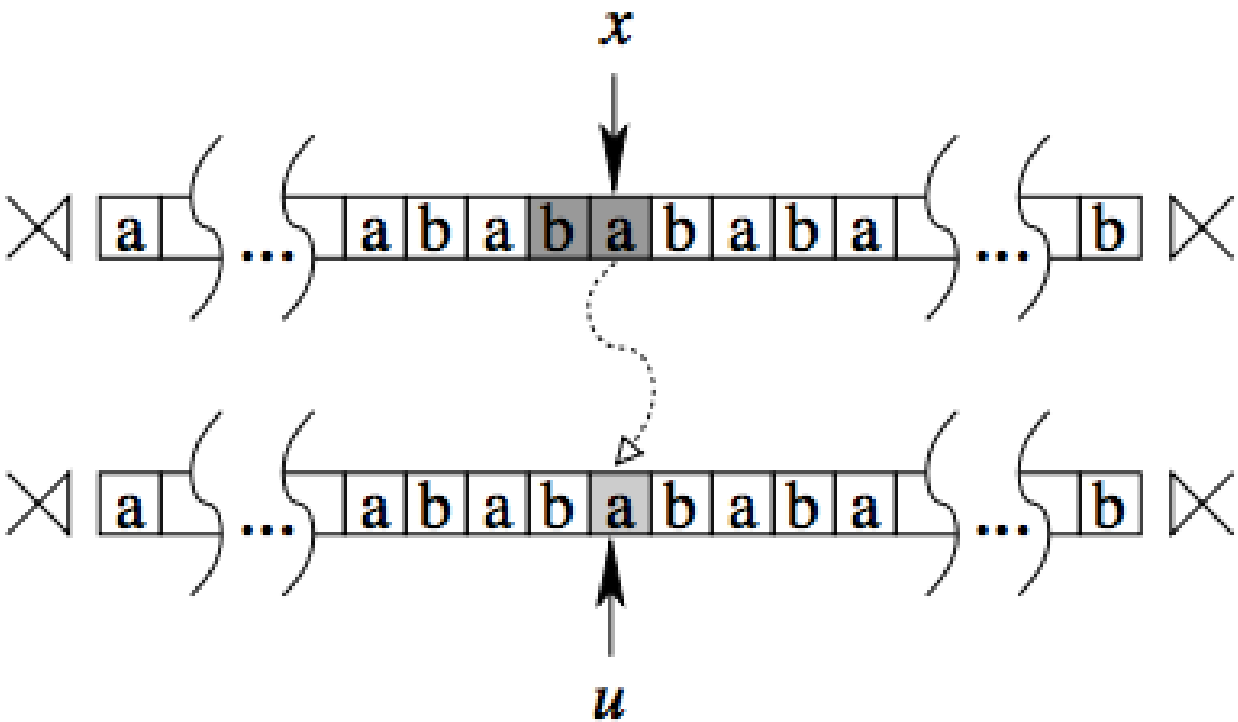

Figure: The element in the lightly shaded cell only depends on the corresponding element in the darkly shaded cells and the its preceding element (Chandlee 2015, Heinz 2016).

Rotuman metathesis is 3-ISL

Chandlee (2015)

Input	⋊	C	V	**C**	**V**	⋉
	⋊	h	o	**s**	**a**	⋉
			↓			
Output	⋊		ho			⋉

Rotuman metathesis is 3-ISL

Chandlee (2015)

Input	⋊	C	V	**C**	**V**	⋉
	⋊	h	o	s	**a**	⋉
Output	⋊		ho			⋉

Rotuman metathesis is 3-ISL

Chandlee (2015)

Input	⋊	C	V	**C**	**V**	⋉
	⋊	h	o	s	a	⋉
Output	⋊		ho			⋉

Rotuman metathesis is 3-ISL

Chandlee (2015)

Input	⋊	C	V	**C**	**V**	⋉
	⋊	h	o	s	a	⋉
						↓
Output	⋊		ho			**as** ⋉

Rotuman metathesis is 3-ISL

Chandlee (2015)

Input	⋊	C	V	**C**	**V**	⋉
	⋊	h	o	s	a	⋉
Output			ho			**as** ⋉

It is 3-ISL because the target sequence is ‘CV⋉’.

Multiple Metathesis cannot be ISL

Kwara'ae exhibits cases of **multiple metathesis** in which more than one occurrence of a metathesized sequence appears in the output.

/lima**ku**/	→	ˈli.ˌma**uk**	'my hands'
/ke**ta**la**ku**/	→	ˈke**at**.ˌla**uk**	'my height'
/bo**le**bolea/	→	ˈboel.bo.ˌlea	'crazy'
/da**ro**ʔani**da**/	→	ˈda**or**.ʔa.ˌni**ɛd**	'to share them'
/ra**ʔe**ra**ʔe**na**ʔe**/	→	ˈra**eʔ**.ˌra**eʔ**.ˌnaˑ**ʔ**	'incline, slope'

Multiple Metathesis is (beyond) OSL

/CV**CV**/	→	CV**VC**
/CVCV**CV**/	→	CVCV**VC**
/CV**CV**CV**CV**/	→	CV**VC**CV**VC**
/CV**CV**CVCV**CV**/	→	CV**VC**CVCV**VC**
/CV**CV**CV**CV**CV**CV**/	→	CV**VC**CV**VC**CV**VC**

Multiple Metathesis is (beyond) OSL

	/CV**CV**/	→	CV**VC**
→	/CVCV**CV**/	→	CVCV**VC**
	/CV**CV**CV**CV**/	→	CV**VC**CV**VC**
	/CV**CV**CVCV**CV**/	→	CV**VC**CVCV**VC**
	/CV**CV**CV**CV**CV**CV**/	→	CV**VC**CV**VC**CV**VC**

Multiple Metathesis is (beyond) OSL

	/CV**CV**/	→	CV**VC**
→	/CVCV**CV**/	→	CVCV**VC**
	/CV**CV**CV**CV**/	→	CV**VC**CV**VC**
→	/CV**CV**CVCV**CV**/	→	CV**VC**CVCV**VC**
	/CV**CV**CV**CV**CV**CV**/	→	CV**VC**CV**VC**CV**VC**

Multiple Metathesis is (beyond) OSL

Multiple Metathesis in Kwara'ae can be described with **Output Strictly Local (OSL) functions** but is a **complicated** pattern that requires a **large locality** domain.

Multiple Metathesis is OSL

- ⋊⋊⋊⋊ in the output and C in the input: C
- ⋊⋊⋊C in the output and V in the input: V
- ⋊⋊CV in the output and x in the input: λ
- ⋊CVλ in the output and x in the input: λ
- CVλλ in the output and x in the input: λ
- Vλλλ in the output and x in the input : λ
- λλλλ in the output and ⋉ (or C) in the input: CVVC

Input	⋊	C	V	C	V	**C**	**V**	⋉
Output								

Multiple Metathesis is OSL

- ⋊⋊⋊⋊ in the output and C in the input: C
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- CVλλ in the output and x in the input: λ
- Vλλλ in the output and x in the input : λ
- λλλλ in the output and ⋉ (or C) in the input: CVVC

Input	⋊	C	V	C	V	**C**	**V**	⋉
		↓						
Output	⋊	C						

Multiple Metathesis is OSL

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- ⋊⋊⋊C in the output and V in the input: V
- ⋊⋊CV in the output and x in the input: λ
- ⋊CVλ in the output and x in the input: λ
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- Vλλλ in the output and x in the input : λ
- λλλλ in the output and ⋉ (or C) in the input: CVVC

Input	⋊	C	V	C	V	**C**	**V**	⋉
			↓					
Output	⋊	C	V					

Multiple Metathesis is OSL

- ⋊⋊⋊⋊ in the output and C in the input: C
- ⋊⋊⋊C in the output and V in the input: V
- ⋊⋊CV in the output and x in the input: λ
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Input	⋊	C	V	C	V	**C**	**V**	⋉
				↓				
Output	⋊	C	V	λ				

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- ⋊⋊⋊⋊ in the output and C in the input: C
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Input	⋊	C	V	C	V	**C**	**V**	⋉
					↓			
Output	⋊	C	V	λ	λ			

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- ⋊⋊⋊⋊ in the output and C in the input: C
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Input	⋊	C	V	C	V	**C**	**V**	⋉
						↓		
Output	⋊	C	V	λ	λ	λ		

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- ⋊⋊⋊⋊ in the output and C in the input: C
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- ⋊⋊CV in the output and x in the input: λ
- ⋊CVλ in the output and x in the input: λ
- CVλλ in the output and x in the input: λ
- Vλλλ in the output and x in the input : λ
- λλλλ in the output and ⋉ (or C) in the input: CVVC

Input	⋊	C	V	C	V	**C**	**V**	⋉
							↓	
Output	⋊	C	V	λ	λ	λ	λ	

Multiple Metathesis is OSL

- ⋊⋊⋊⋊ in the output and C in the input: C
- ⋊⋊⋊C in the output and V in the input: V
- ⋊⋊CV in the output and x in the input: λ
- ⋊CVλ in the output and x in the input: λ
- CVλλ in the output and x in the input: λ
- Vλλλ in the output and x in the input : λ
- λλλλ in the output and ⋉ (or C) in the input: CVVC

Input	⋊	C	V	C	V	**C**	**V**	⋉
								↓
Output	⋊	C	V	λ	λ	λ	λ	CV**VC**⋉

Multiple Metathesis is OSL

Problem

OSL functions can characterize multiple metathesis patterns in Kwara'ae but are **complex**, and even simple CV sequences require **a large locality domain**.

Stress Pattern

Stress Pattern of Kwara'ae

Metathesized surface forms exhibit systematic stress patterns.

- The initial mora takes the primary stress.
- The syllable containing the penultimate mora bears the secondary stress.
- Additional secondary stress falls on an alternating mora leftward from the rightmost stressed mora.

Stress Pattern

/CVCV/	→	C**V**VVC
/CVCVCV/	→	C**V**C**V**VC
/CVCVCVCV/	→	C**V**VCC**V**VC
/CVCVCVCVCV/	→	C**V**VCCVC**V**VC
/CVCVCVCVCVCV/	→	C**V**VCC**V**VCC**V**VC

Stress → Metathesis

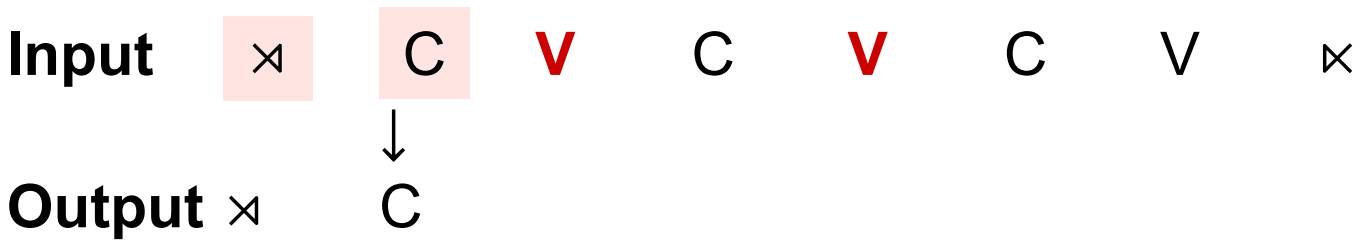
If we assign the stress to the pre-metathesis input...

/C**V**CV/	→	C**V**VC
/C**V**C**V**CV/	→	C**V**C**V**VC
/C**V**CVC**V**CV/	→	C**V**VCC**V**VC
/C**V**CVCVC**V**CV/	→	C**V**VCCVC**V**VC
/C**V**CVC**V**CVC**V**CV/	→	C**V**VCC**V**VCC**V**VC

Kwara'ae's multiple metathesis (over CV sequences) is now 3-ISL.

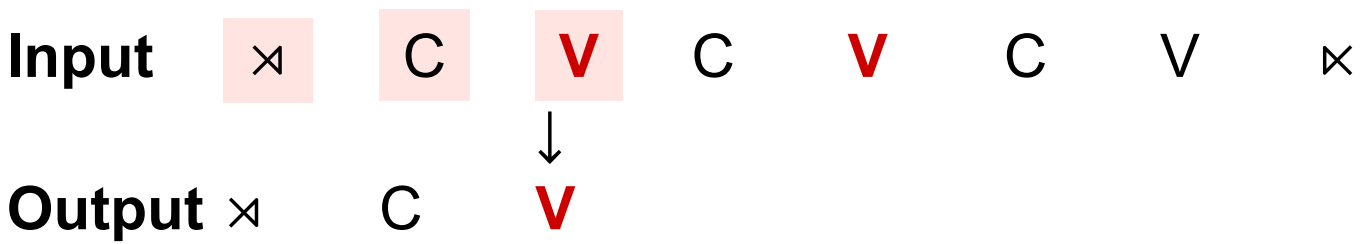
Multiple Metathesis is ISL

- ⋊⋊**C in the in the input: C**
- ⋊C**V** in the output and V in the input: **V**
- C**V**C in the input: λ
- **V**C**V** in the input: C**V**
- C**V**C in the input: λ
- V$\lambda\lambda\lambda$ in the output and x in the input : λ



Multiple Metathesis is ISL

- ⋊⋊C in the output and C in the input: C
- ⋊**CV in the input: V**
- C**V**C in the input: λ
- **V**C**V** in the input: C**V**
- C**V**C in the input: λ
- Vλλλ in the output and x in the input : λ



Multiple Metathesis is ISL

- ⋊⋊C in the output and C in the input: C
- ⋊C**V** in the output and V in the input: **V**
- **CVC in the input:** λ
- **V**C**V** in the input: C**V**
- C**V**C in the input: λ
- V$\lambda\lambda\lambda$ in the output and x in the input : λ

Input	⋊	C	**V**	C	**V**	C	V	⋉
				↓				
Output	⋊	C	**V**	λ				

Multiple Metathesis is ISL

- ⋊⋊C in the output and C in the input: C
- ⋊C**V** in the output and V in the input: **V**
- C**V**C in the input: λ
- **V**C**V** **in the input: C**V**
- C**V**C in the input: λ
- Vλλλ in the output and x in the input : λ

Input	⋊	C	**V**	C	**V**	C	V	⋉
					↓			
Output	⋊	C	**V**	λ	C**V**			

Multiple Metathesis is ISL

- ⋊⋊C in the output and C in the input: C
- ⋊C**V** in the output and V in the input: **V**
- C**V**C in the input: λ
- **V**C**V** in the input: C**V**
- **CVC in the input:** λ
- Vλλλ in the output and x in the input : λ

Input	⋊	C	**V**	C	**V**	C	V	⋉
						↓		
Output	⋊	C	**V**	λ	C**V**	λ		

Multiple Metathesis is ISL

- ⋊⋊C in the output and C in the input: C
- ⋊C**V** in the output and V in the input: **V**
- C**V**C in the input: λ
- **V**C**V** in the input: C**V**
- C**V**C in the input: λ
- **V**C**V in the input : V**C**V**

Input	⋊	C	**V**	C	**V**	C	V	⋉
							↓	
Output	⋊	C	**V**	λ	C**V**	λ	VC	

Multiple Metathesis is ISL

- ⋊⋊C in the output and C in the input: C
- ⋊C**V** in the output and V in the input: **V**
- C**V**C in the input: λ
- **V**C**V** in the input: C**V**
- C**V**C in the input: λ
- Vλλλ in the output and x in the input : λ

Input	⋊	C	**V**	C	**V**	C	V	⋉
Output	⋊	C	**V**	λ	C**V**	λ	VC	⋉

It is 3-ISL because the target sequence is 'VCV'.

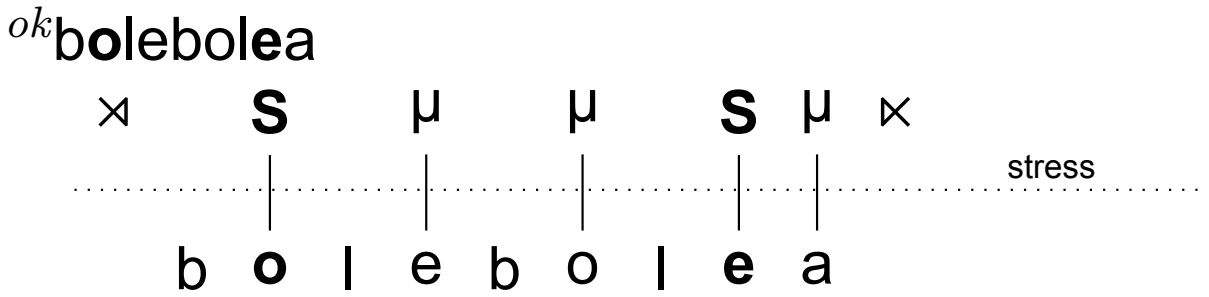
Stress Assignment is TSL

Kwara'ae's Stress Pattern

- Stress assignment is simple as well.
- It can be described with **Tier-Strictly Local (TSL)** Grammar.

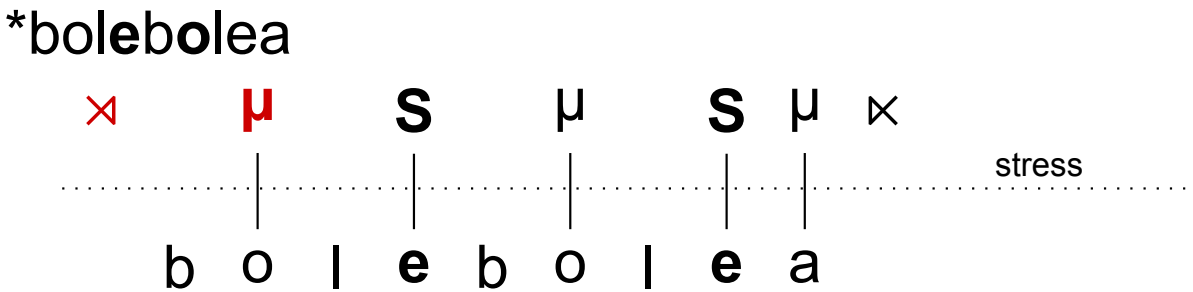
Stress Assignment is TSL

- Project stressed vowel **(S)** and unstressed vowel **μ**.
- Ban a sequence containing
  ***SSS**, *⋊**μ**, *μμ⋉, *μμμ, *S⋉ *SSμμ, *SSμS, or *μSS
  on the tier.



Stress Assignment is TSL

Banned sequences on the tier:
***SSS**, ***⋊μ**, ***μμ⋉**, ***μμμ**, ***S⋉** ***SSμμ**, ***SSμS**, or ***μSS**



Discussion & Conclusion

What did we see?

- Multiple metathesis is much more complex than single metathesis.
- But with the right conditioning factors (stress), it becomes simple again.
- Kawa'ae's multiple metathesis can be described with **3-ISL** functions.
- Stress-assignment in Kwara'ae can be described with **TSL**.

Discussion & Conclusion

Factorization of the grammar into different sub-processes makes it possible to produce simpler computational processes of phonological patterns.

Conjecture

- If phonological mappings are restricted to ISL and OSL, whenever you have multiple metathesis in a language, then there must be some conditioning factors.
- This way of thinking can be extended to other seemingly complex phonological mappings.

References

Chandlee, J. 2014. *Strictly local phonological processes.* PhD Thesis, University of Delaware

Chandlee, J. 2015. *Explaining Phonological Typology: Phonetic and Computational Factors.* Presentation at Reed College, Portland, OR, April 17.

Heinz, J. 2004. *CV Metathesis in Kwara'ae.* MA Thesis, UCLA

Heinz, J., **Chetan** Rawal, and **Herbert** G. Tanner. 2011. Tier-based strictly local constraints in phonology. In *Proceedings of the 49th Annual Meeting of ACL*, 58–64.

Heinz, J. 2015. The computational nature of phonological generalization. *Ms., University of Delaware*.

Problematic cases

Items with non-CV syllable(s)

- Some metathesis patterns necessarily increases the locality to 4-ISL
  - /C**V**CVVC**V**CV/ → ‘C**V**CVVC**V**VC’
  - /C**V**C**V**VCV → ‘C**V**C**V**VVC’
- It is possible that further factorization of the process or enriching the representation could make it possible to lower the locality domain involved in metathesis operation (e.g. Incorporating foot boundaries into the representation)