Progressive front vowel harmony in Warlpiri: A Serial Harmony approach*

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1 Introduction

1.1 Language background

(1) **Warlpiri:**

- Spoken by about 3,000 people in central Australia
- In the Ngumpin-Yapa subgroup of the Pama-Nyungan family
- Not critically endangered, but some signs of language shift

(2) **Vowels in Warlpiri:**

- Three-place vowel system: [i], [u], [a]
- Three types of vowel harmony, originally described and analyzed by Nash (1979, 1986)

1.2 Empirical domain

(3) Progressive [u] → [i] harmony is the only type of Warlpiri vowel harmony that is not restricted morphologically or dialectally; that is, it applies across the board.

(4) ***iCu* constraint** (adapted from Nash 1986: 73–75):
Within a phonological word, [i] may not be followed by [u] unless [a] or a labial consonant intervenes.

(5) **Rule formulation:** /u/ → [i] / $iC_{[-lab]}\_$

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1.3 Theoretical problem

(6) Previous Optimality Theory (OT) analyses of this phenomenon have relied on harmony constraints that have been shown to make implausible typological predictions.

a. **Alignment** (McCarthy & Prince 1993; Prince & Smolensky 1993/2004; Kirchner 1993)
   - For Warlpiri vowel harmony: McCarthy 2003a
   - When used for harmony, ALIGN-type constraints display several "pathologies" (Wilson 2003, 2004, 2006).

b. **Local agreement** (Lombardi 1999; Baković 2000)
   - For Warlpiri vowel harmony: Berry 1998; Harvey & Baker 2005; Hall 2006; McManus 2008
   - AGREE-type constraints suffer from **"sour grapes"** (Padgett 1995; Wilson 2003, 2004, 2006; McCarthy 2003b).

(7) **Sour grapes:** Spreading in domains without a blocker, no spreading in domains with a blocker.

(8) AGREE without a blocker (adapted from McCarthy 2009: 3)

	/m|awa/	MAX(nas)	*NASFRIC	AGREE-R(nas)	DEP(nas)
a. ☞	mãw̃ã				***
b.	bawa	*W			L
c.	m|awa			*W	L

(9) AGREE with a blocker: **sour grapes** (adapted from McCarthy 2009: 4)

	/m|awasa/	MAX(nas)	*NASFRIC	AGREE-R(nas)	DEP(nas)
a. 💣	m|awasa			*	
b. ☹	mãw̃ã|sa			*	***W
c.	bawasa	*W		L	
d.	mãw̃ãs̃ã		*W	L	*****W

(10) **The main problem:** AGREE can *only* predict sour grapes, not normal blocking with partial harmony (McCarthy 2003b, 2009, to appear).

(11) **Another problem:** Sour grapes is said to be unattested (McCarthy 2009: 3–4), but see Walker 2005, 2010.

(12) **Solution:** Use **Serial Harmony** (McCarthy 2009, to appear).

2 Harmonic Serialism and Serial Harmony

(13) **Key assumptions of Serial Harmony** (McCarthy 2009: 1–2):
   a. Harmonizing features are privative, not equipollent.
   b. Harmony is motivated by a markedness constraint SHARE(F), which is violated by any two adjacent elements that are not linked to the same [F] autosegment.
   c. Phonology happens serially; this is implemented via Harmonic Serialism.

(14) **Key properties of Harmonic Serialism**
(McCarthy 2010: 1001–1002):
   a. Gradualness: GEN is restricted to making at most one operation to each candidate before passing the candidate set off to EVAL.
   b. GEN-EVAL loop: After EVAL selects a winning candidate, that form is submitted as the input to GEN. This cycle continues until a fully faithful candidate emerges as the winner, and the derivation converges.

(15) **GEN's set of operations for autosegmental phonology**
(McCarthy 2009: 14 (27)):
   a. Insertions:
      - A feature and a single association line linking it to some pre-existing structure
      - A single association line linking two elements of pre-existing structure
   b. Deletions:
      - A feature and a single association line linking it to some pre-existing structure
      - A single association line linking two elements of pre-existing structure

3 Warlpiri unrestricted progressive vowel harmony

3.1 No blocking

(16) *No* [i] *to trigger harmony,* [u] *surfaces*[1]
kuɽu-kuḷu-ḷu = lku = cu = lu[2]
child-PROP-ERG = then = 1SG.NSBJ = 3PL.SBJ[3]

(17) *Harmony proceeds unhindered,* [i] *surfaces*
maliki-kiḷi-ḷi = lki = ci = li
dog-PROP-ERG = then = 1SG.NSBJ = 3PL.SBJ

3.2 Blocking

(18) *Harmony blocked by* [a]*,* [u] *surfaces*
   a. minic**a**-kuḷu-ḷu = lku = cu = lu
   cat-PROP-ERG = then = 1SG.NSBJ = 3PL.SBJ
   b. maliki-kiḷi-kir**a** = lku = cu = lu
   dog-PROP-ALL = then = 1SG.NSBJ = 3PL.SBJ

(19) *Harmony blocked by* [p]*,* [u] *surfaces*
   a. milpiri-**p**uɽu
   cloud-during
   b. ŋaminṇi-ki-**p**uɽaŋka
   mother's.brother-DAT-same.gender.kinsman

(20) *Harmony blocked by* [w]*,* [u] *surfaces*
ŋali-**w**uru
1DU.INCL-EMPH

[1] Unless noted otherwise, all examples come from Nash 1986: 86–87.

[2] For clarity in the fine-grained featural analysis used in this paper, I have used the IPA rather than the community orthography. Oral stops are represented as voiceless.

[3] I have occasionally adjusted glosses for clarity and consistency, following the Leipzig Glossing Rules wherever possible. Abbreviations used include 1DU = 1st person dual, 1SG = 1st person singular, 3PL = 3rd person plural, ALL = allative, DAT = dative, EMPH = emphatic, ERG = ergative, INCL = inclusive, NPST = non-past, NSBJ = non-subject, PROP = proprietive, SBJ = subject. Verb roots are given in small capitals.

4 Serial Harmony analysis

4.1 Preliminary assumptions

4.1.1 Front vs. round

(21) Most previous analyses of this phenomenon have assumed that it is unrounding harmony (i.e., it involves spreading of [–round]) because labial consonants are involved as blockers.

(22) Blocking is then a result of **labial attraction** (Campbell 1974), whereby vowels following labials must be round.

(23) **Problem:** In Warlpiri, labial attraction would have to be a derived environment effect (McCarthy 2003a; Hall 2006).

(24) **Problem:** The feature [round] has been argued to be privative because no [–round] assimilatory or dissimilatory processes have been described (Steriade 1995; van der Hulst & van de Weijer 1995).

(25) **Problem:** Serial Harmony requires privative features, so we cannot use Serial Harmony and [–round].

(26) Following Berry (1998), we will assume that the spreading feature is [front].

4.1.2 Stricly local spreading

(27) Feature spreading targets all segments equally (Ní Chiosáin & Padgett 2001; Gick et al. 2006; Benus & Gafos 2007; and others) so there are no consonants that are truly transparent to vowel harmony.

4.2 Feature spreading

4.2.1 Constraints

(28) SHARE(front) (McCarthy 2009: 8)
Assign one violation mark for every pair of adjacent segments that are not linked to the same token of [front].

(29) SHARE(front) *violations*[4]

	a.	b.	c.	d.	e.
	[front]	[front] [front]		[front]	[front]
	ṇi	ṇi	nu	ni	ṇu
	[ṇi]	[ṇ|i]	[n|u]	[n|i]	[ṇ|u]
SHARE	✓	×	×	×	×

(30) IDENT(F) (McCarthy 2009: 10; see (57) for full definition)
Assign a violation mark if an association line to a token of [F] has been inserted or removed.

(31) INITIAL(F) (McCarthy 2009: 9; see (59) for full definition)
Assign a violation mark if [F] has spread to the left.

(32) FINAL(F) (McCarthy 2009: 9; see (61) for full definition)
Assign a violation mark if [F] has spread to the right.

4.2.2 Ranking for rightward spreading of [front]

(33) *Possible derivational path from* /maliki-l̪u/ *to* [maliki-l̪i] 'dog-ERG' (Laughren & Hoogenraad 1996: 83)

Pass	Operation	Output
1	link [front] to [k]	m|a|l|iḳ|i|-l̪|u
2	link [front] to [i]	m|a|l|iḳi|-l̪|u
3	link [front] to [l̪]	m|a|l|iḳi-l̪|u
4	link [front] to [u]	m|a|l|iḳi-l̪ʉ
5	delink [round] from [ʉ] and delete [round]	m|a|l|iḳi-l̪i
6	delink [back] from [i] and delete [back]	m|a|l|iḳi-l̪i
7	identity	m|a|l|iḳi-l̪i

(34) SHARE(front) ≫ FINAL(front) *and* SHARE(front) ≫ IDENT(front)

Pass 1	/m|a|l|i|k|i|-l̪|u/	SHARE(front)	FINAL(front)	IDENT(front)
a. ☞	m|a|l|iḳ|i|-l̪|u	******	*	*
b.	m|a|l|i|k|i|-l̪|u	*******W	L	L

[4] Pipes [|] separate segments not linked to the same token of [front]. Counting pipes yields the number of SHARE(front) violations.

4.2.3 Ranking for no leftward spreading of [front]

(35) *Derivational path from* /juɽi/ *to* [juɽi] 'tree top'

Pass	Operation	Output
1	identity	j|u|ɽ|i

(36) INITIAL(front) ≫ SHARE(front)

Pass 1 /j|u|ɽ|i/	INITIAL(fr)	SHARE(fr)	FINAL(fr)	IDENT(fr)
a. ☞ j|u|ɽ|i		***		
b. j|u|ɽ̪i	*W	**L		*W

4.3 Changing vowel quality

4.3.1 Constraints

(37) *ROUNDFRONT (*ROFRO) (Kaun 2004: 105)
Assign one violation mark for every segment that is linked to a token of [round] and a token of [front].

(38) *BACKFRONT (*BAFRO)
Assign one violation mark for every segment that is linked to a token of [back] and a token of [front].

4.3.2 Ranking for [u] → [i]

(39) SHARE(front) ≫ *ROUNDFRONT *and* SHARE(front) ≫ *BACKFRONT

Pass 4 m|a|l|iḷi-l̪|u	INIT(f)	SH(f)	FIN(f)	ID(f)	*ROFRO	*BAFRO
a. ☞ m|a|l|iḷi-l̪u		***	*	*	*	*
b. m|a|l|iḷi-l̪|u		****W	L	L	L	L

(40) *ROUNDFRONT ≫ IDENT(round)

Pass 5 m|a|l|iḷi-l̪u	INIT(f)	SH(f)	FIN(f)	ID(f)	*ROFRO	*BAFRO	ID(r)
a. ☞ m|a|l|iḷi-l̪i		***				*	*
b. m|a|l|iḷi-l̪u		***			*W	*	L

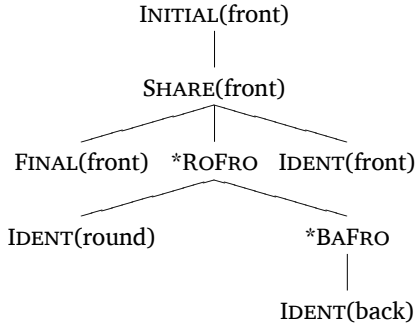
(41) *BACKFRONT ≫ IDENT(back)

Pass 6 m|a|l|iḷi-l̪i	INIT(f)	SH(f)	FIN(f)	ID(f)	*ROFRO	*BAFRO	ID(r)	ID(b)
a. ☞ m|a|l|iḷi-l̪i		***						*
b. m|a|l|iḷi-l̪i		***				*W		L

(42) *ROUNDFRONT ≫ *BACKFRONT

Pass 5 m|a|l|iḷi-l̪u	INIT(f)	SH(f)	FIN(f)	ID(f)	*ROFRO	ID(r)	*BAFRO	ID(b)
a. ☞ m|a|l|iḷi-l̪i		***				*	*	
b. m|a|l|iḷi-l̪y		***			*W	L	L	*W

(43) *Ranking summary (intermediate)*



4.4 Harmony blocking

4.4.1 Blocking by [a]

(44) *Derivational path from* /watija-l̪u/ *to* [watija-l̪u] 'stick-ERG' (Laughren & Hoogenraad 1996: 97)

Pass	Operation	Output
1	link [front] to [j]	w|a|t|ij̪|a|-l̪|u
2	identity	w|a|t|ij̪|a|-l̪|u

(45) *FRONTLOW (*FROLO)
Assign one violation mark for every segment that is linked to a token of [front] and a token of [low].

(46) *FRONTLOW ≫ SHARE(front)

Pass 2	w|a|t|iɻ|a|-l̻|u	*FROLO	INIT(fr)	SHARE(fr)	FIN(fr)	ID(fr)
a. ☞	w|a|t|iɻ|a|-l̻|u			******		
b.	w|a|t|iɻæ|-l̻|u	*W		*****L	*W	*W

4.4.2 Blocking by labial consonants

(47) *Derivational path from* /ŋali-wuru/ *to* [ŋali-wuru] '1DU.INCL-EMPH'

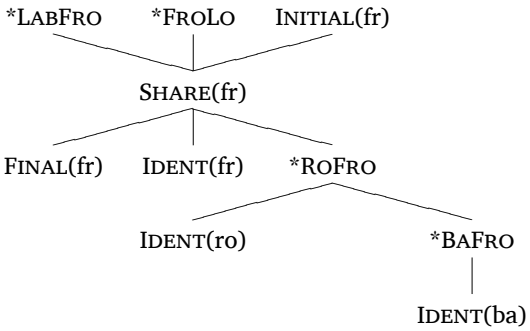
Pass	Operation	Output
1	identity	ŋ|a|l|i|-w|u|r|u

(48) *LABIALFRONT (*LABFRO)
Assign one violation mark for every segment that is linked to a token of [labial] and a token of [front].

(49) *LABIALFRONT ≫ SHARE(front)

Pass 1	/ŋ|a|l|i|-w|u|r|u/	*LAB FRO	*FRO LO	INIT (fr)	SHARE (fr)	FIN (fr)	ID (fr)
a. ☞	ŋ|a|l|i|-w|u|r|u				*******		
b.	ŋ|a|l|i-ʋ|u|r|u	*W			******L	*W	*W

(50) *Ranking summary (final)*



5 No sour grapes with Serial Harmony

(51) *Possible derivational path from* /ŋaminɻi-ku-puʈaŋka/ *to* [ŋaminɻi-ki-puʈaŋka] 'mother's.brother-DAT-same.gender.kinsman'

Pass	Operation	Output
1	link [front] to [ɳ]	ŋ|a|m|iɳ̻|i|-k|u|-p|u|ʈ|a|ŋ|k|a
2	link [front] to [i]	ŋ|a|m|iɳ̻|-k|u|-p|u|ʈ|a|ŋ|k|a
3	link [front] to [k]	ŋ|a|m|iɳ̻|i-k̻|u|-p|u|ʈ|a|ŋ|k|a
4	link [front] to [u]	ŋ|a|m|iɳ̻|i-k̻ʉ|-p|u|ʈ|a|ŋ|k|a
5	delink [round] from [ʉ] and delete [round]	ŋ|a|m|iɳ̻|i-k̻i|-p|u|ʈ|a|ŋ|k|a
6	delink [back] from [i] and delete [back]	ŋ|a|m|iɳ̻|i-k̻i|-p|u|ʈ|a|ŋ|k|a
7	identity	ŋ|a|m|iɳ̻|i-k̻i|-p|u|ʈ|a|ŋ|k|a

(52) *No sour grapes in Serial Harmony*

Pass 7	ŋ|a|m|iɳ̻|i-k̻i|-p|u|ʈ|a|ŋ|k|a	*LABFRO	SHARE(f)	FIN(f)	ID(f)
a. ☞	ŋ|a|m|iɳ̻|i-k̻i|-p|u|ʈ|a|ŋ|k|a		10		
b.	ŋ|a|m|iɳ̻|i-k̻i-p̻|u|ʈ|a|ŋ|k|a	*!	9	*	*

6 Conclusion

(53) AGREE(F) is not suitable for analyzing harmony systems with blockers.

(54) Serial Harmony provides a framework for analyzing vowel harmony phenomena with blocking, avoiding the problems inherent in previous OT analyses.

(55) **Further research:**

a. Extend Serial Harmony analysis to the other two types of Warlpiri vowel harmony.

b. Investigate the phonetics of participating versus blocking consonants in Warlpiri.

c. Consider how (and whether) truly transparent segments may be accounted for in Serial Harmony.

A Appendix

A.1 Details of the analysis

(56) *Feature specifications*

		[front]	[back]	[low]	[round]	[labial]
Attested	i	+				
	u		+		+	
	a			+		
	C					
	C̬	+				
	p, m, w					+
Unattested	y	+			+	
	i̬	+	+			
	u̬	+	+		+	
	ɯ		+		+	
	æ	+		+		
	ɑ		+	+		
	p̬, m̬, w̬	+				+

(57) IDENT(F)
Let input F tier = $f_1 f_2 \ldots f_m$.
Let input segmental tier = $s_1 s_2 \ldots s_n$.
Let output F tier = $F_1 F_2 \ldots F_o$.
Let output segmental tier = $S_1 S_2 \ldots S_p$.
Assign one violation mark for every pair $s_i \Re S_j$, where:
f_k is associated with s_i, and
there is no F_l such that $f_k \Re F_l$ and F_l is associated with S_j
or
F_l is associated with S_j, and
there is no f_k such that $f_k \Re F_l$ and f_k is associated with s_i.

(58) *Structures that violate* IDENT(F)
a. f_k (|) s_i → (F_l) S_j b. (f_k) s_i → F_l (|) S_j

(59) INITIAL(F)
Let input F tier = $f_1 f_2 \ldots f_m$.
Let input segmental tier = $s_1 s_2 \ldots s_n$.
Let output F tier = $F_1 F_2 \ldots F_o$.
Let output segmental tier = $S_1 S_2 \ldots S_p$.
Assign one violation mark for every pair $s_i \Re S_j$, where:
$f_k \Re F_l$,
f_k is associated with s_i, and there is no s_x that precedes s_i and is also associated with f_k, and
F_l is associated with S_j, and there is some S_y that precedes S_j and is also associated with F_l.

(60) *Structure that violates* INITIAL(F)
f_k (|) $(s_x)s_i$ → F_l (/|) $S_y S_j$

(61) FINAL(F)
Let input F tier = $f_1 f_2 \ldots f_m$.
Let input segmental tier = $s_1 s_2 \ldots s_n$.
Let output F tier = $F_1 F_2 \ldots F_o$.
Let output segmental tier = $S_1 S_2 \ldots S_p$.
Assign one violation mark for every pair $s_i \Re S_j$, where:
$f_k \Re F_l$,
f_k is associated with s_i, and there is no s_x that follows s_i and is also associated with f_k, and
F_l is associated with S_j, and there is some S_y that follows S_j and is also associated with F_l.

(62) *Structure that violates* FINAL(F)
f_k (|) $s_i(s_x)$ → F_l (|\) $S_j S_y$

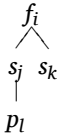
A.2 Phonological word boundaries as blockers

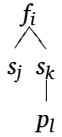
(63) *Harmony blocked by phonological word boundary,* [u] *surfaces*
$[[\text{piki}]_{\text{PrWd}}\text{-}[[\text{ŋuma}]_{\text{PrWd}}\text{-mi}]_{\text{PhWd}}]_{\text{PhPhr}}$
danger-LIE-NPST
(Laughren & Hoogenraad 1996: 121)

(64) See Pentland & Laughren 2005 for discussion of phonological versus prosodic word boundaries in Warlpiri vowel harmony.

(65) CRISPEDGE(PhWd, front) (CRISP)
Let output [front] tier = $f_1 f_2 \ldots f_m$.
Let output segmental tier = $s_1 s_2 \ldots s_n$.
Let output phonological word tier = $p_1 p_2 \ldots p_o$.
Assign one violation mark for every f_i, where:
f_i is associated with s_j and s_k, and
s_j is associated with p_l and s_k is not associated with p_l
or
f_i is associated with s_j and s_k, and
s_k is associated with p_l and s_j is not associated with p_l.

(66) *Structures that violate* CRISPEDGE(PhWd, front)

a. 

b. 

(67) *Derivational path from* /piki-ŋuna-mi/ *to* [piki-ŋuna-mi][5]

Pass	Operation	Output
1	link [front] to [k]	p|iḵ|i|-[ŋ|u|n|a|-m|i][6]
2	link [front] to [i]	p|iḵi|-[ŋ|u|n|a|-m|i]
3	identity	p|iḵi|-[ŋ|u|n|a|-m|i]

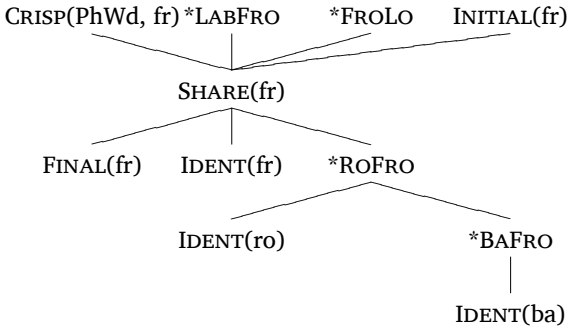
(68) CRISPEDGE(PhWd, front) ≫ SHARE(front)

Pass 3	p|iḵi|-[ŋ|u|n|a|-m|i]	CRISP	*LAB FRO	*FRO LO	INIT (f)	SHARE (f)	FIN (f)	ID (f)
a. ☞	p|iḵi|-[ŋ|u|n|a|-m|i]					*******		
b.	p|iḵi-[ŋ|u|n|a|-m|i]	*W				******L	*W	*W

[5]Presumably this part of the derivation takes place after prosodic structure has been built.

[6]Square brackets are used to mark phonological words.

(69) *Ranking summary (final)*



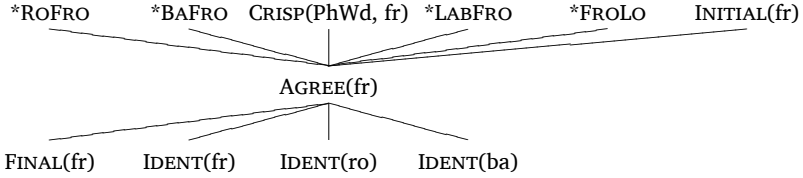
A.3 Local agreement and sour grapes

(70) AGREE(front)
Assign one violation mark for every pair of adjacent segments *xy*, where:
x is associated with a token of [front], and
y is not associated with a token of [front]
or
y is associated with a token of [front], and
x is not associated with a token of [front].

(71) AGREE(front) *versus* SHARE(front)

	a. [front] ṇi	b. [front] [front] ṇi	c. nu	d. [front] ni	e. [front] ṇu
	[ṇi]	[ṇ|i]	[n|u]	[n|i]	[ṇ|u]
AGREE	✓	✓	✓	×	×
SHARE	✓	×	×	×	×

(72) *Ranking scenario for* AGREE*-based analysis*



(73) *Total harmony in a word without a blocker*[7]

	/wati-ŋku/	CRISP	*LAB FRO	*FRO LO	INIT (fr)	AGR (fr)	FIN (fr)	ID (f)	ID (r)	ID (b)
a. ☞	wati-ŋ̟ki					*	***	***	*	*
b.	wati-ŋku					**!				

(74) *No harmony in a word with a blocker*

	/ŋali-wuru/	CRISP	*LAB FRO	*FRO LO	INIT (fr)	AGR (fr)	FIN (fr)	ID (f)	ID (r)	ID (b)
a. ☞	ŋali-wuru					**				
b.	ŋali-ẉi̟ri		*!			*	****	****	**	**

(75) *No harmony in a word with a blocker: sour grapes*

	/ŋaminʲi-ku-puɾaŋka/	CRISP	*LAB FRO	*FRO LO	INIT (fr)	AGR (fr)	FIN (fr)	ID (f)	ID (r)	ID (b)
a. 💣	ŋamuɳu-ku-puɾaŋka							**	**	**
b. ☹	ŋaminʲi-ki̟-puɾaŋka					*!*	***	***	*	*
c.	ŋaminʲi-ku-puɾaŋka					*!*	*	*		

A.4 Both SHARE(F) and Harmonic Serialism are necessary

(76) SHARE(front) *in parallel OT*

	/ŋ|a|m|i|ɳ|i|-k|u|-p|u|ɽ|a|ŋ|k|a/	SH (fr)	FIN (fr)	ID (fr)	ID (ro)	ID (ba)
a. 💣	ŋ|a|m|iɳ̟|i-ki̟|-p|iɽ̟|a|ŋ̟k|a	8	8	8	**	**
b. ☹	ŋ|a|m|iɳ̟|i-ki̟|-p|u|ɽ|a|ŋ|k|a	10!	4	4	*	*
c.	ŋ|a|m|u|ɳ̻|u|-k|u|-p|u|ɽ|a|ŋ|k|a	14!		**	**	**

[7] Example from Laughren & Hoogenraad 1996: 83.

(77) *Spontaneous fronting with* SHARE(front) *in parallel OT*[8]

	/k|u|ɽ|u/	CRISP	*LAB FRO	*FRO LO	INIT (fr)	SH (fr)	FIN (fr)	ID (fr)	ID (ro)	ID (ba)
a. 💣	k̟i̟ri							****	**	**
b. ☹	k|u|ɽ|u					*!**				

(78) *No spontaneous fronting with Serial Harmony*

Pass 1	/k|u|ɽ|u/	CRISP	*LAB FRO	*FRO LO	INIT (fr)	SH (fr)	FIN (fr)	ID (fr)	ID (ro)	ID (ba)
a. ☞	k|u|ɽ|u					****				
b.	k̟|u|ɽ|u					****		*!		

(79) AGREE(front) *in Harmonic Serialism*

Pass 2	mal|iki̟|-l̻u	CRISP	*LAB FRO	*FRO LO	INIT (fr)	AGR (fr)	FIN (fr)	ID (fr)	ID (ro)	ID (ba)
a. 💣	mal|iki̟|-l̻u					**				
b. ☹	mal|iki̟-l̻|u					**		*!		

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[8] Example from Laughren & Hoogenraad 1996: 30.

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