Why mid vowels are not always mid vowels

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Puzzle Chain Shifts are phonological processes where an input element /A/ surfaces as [B] while /B/ becomes [C] in the output. However, /A/ does not surface as [C]. Well-known examples of Chain Shifts are partial height harmonies, as exemplified by Nzebi in (1). In these systems, /a/ becomes [e] and /e/ becomes [i], but /a/ does not become [i].

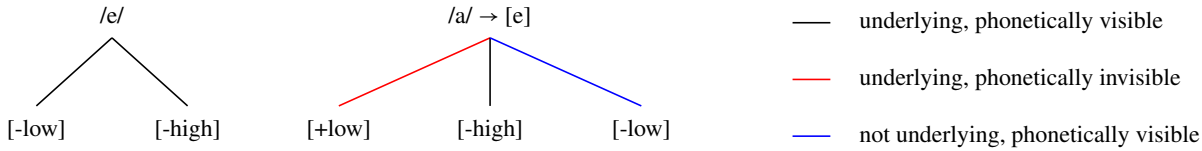
(1) Nzɛbi (Bantu, Gabon) (Clements 1991; Parkinson 1996)

a	→	ɛ	salə	→	sɛli	'work'	e	→	i	betə	→	biti	'carry'
ɛ	→	e	sɛbə	→	sebi	'laugh'	o	→	u	βoomu	→	βuumi	'breathe'

I will show that the opacity problems posed by **Chain Shifts** can easily be analysed within Containment Theory (Prince & Smolensky 1993; van Oostendorp 2003, 2006; Trommer 2011; Trommer & Zimmermann 2014). In Containment, phonological features are never deleted but remain in the phonological structure. Specifically, I suggest that a shift from /a/ to [i] leads to illicit combinations of features.

Chain Shifts in Containment Theory In Containment Theory (Prince & Smolensky 1993; van Oostendorp 2003, 2006; Trommer 2011; Trommer & Zimmermann 2014), deletion of phonological elements is impossible. Rather, phonological features can be inaccessible to phonetics but remain in the phonological structure. Thus, an underlying segment has a different featural specification than a derived segment. I make use of the consequence that an underlying vowel /e/ has different features than a vowel [e] that is derived by vowel raising. While an underlying /e/ is specified as [-high, -low], a derived [e] is necessarily specified as [-high, -low, +low] since the [+low] feature of the underlying /a/ remains phonologically accessible, as schematized in (2).

(2) Featural specifications of underlying vs. derived vowels



Furthermore, I adopt the *Cloning Hypothesis* (Trommer 2011) by assuming two versions of constraints:

1. **P-Constraints** only refer to the phonetically visible elements. marked with indexed $_{P}$
2. **I-Constraints** refer to all elements. marked with indexed $_{I}$

I suggest that the featural specification prevents derived /e/ vowels from changing into [i]. This can be obtained by markedness constraints sensitive to all features in the candidate against illicit combinations of features within a segment: *[+LOW,+HIGH]$_{I}$, *[+LOW,+ATR]$_{I}$ and *[+HIGH,-ATR]$_{I}$. Crucially, these constraints build on a strong phonological basis - evidence comes from the typology of vowels inventories (Casali 2014), the patterns of phonological processes (Archangeli & Pulleyblank 1994) or the phonetic markedness of certain segments (Hall 2000; Lulich & Cavar 2018).
The constraints that are used to model this idea in OT are listed in the following table:

1. *[+LOW,+HIGH]$_{I}$ Avoid [+low,+high] vowels.
2. *[+LOW,+ATR]$_{I}$ Avoid [+low,+ATR] vowels.
3. *[+HIGH,-ATR]$_{I}$ Avoid [+high,-ATR] vowels.
4. [FAITH]$_{F}$ Do not make features of [±F] phonetically invisible.
5. [HARMONY]$_{F}$ Avoid contradictory features of [±F].

As seen in the tableau in (3), raising is driven by three harmony constraints, necessarily ranked higher than the respective faithfulness constraints. However, the constraint *[+LOW,+HIGH]$_I$ rules out [i] as it penalizes a combination of a +low and +high feature on a single vowel and exactly such a combination arises if an underlyingly low vowel is raised to a high vowel.

(3) Nzɛbi, a → ɛ

/a/ - /i/			*[+LO,+HI]$_I$	*[+LO,+ATR]$_I$	*[+HI,-ATR]$_I$	[HARM]$_{HI}$	[HARM]$_{LO}$	[HARM]$_{ATR}$	[FTH]$_I$
a.		a [-hi,+lo,-ATR]				*	*	*	
b.	☞	ɛ [-hi,+lo,-ATR,-lo]				*		*	*!
c.		e [-hi,+lo,-ATR,-lo,+ATR]		*!		*			**
d.		ɪ [-hi,+lo,-ATR,+hi,-lo]	*!		*!			*	**
e.		i [-hi,+lo,-ATR,+hi,-lo,+ATR]	*!	*!	*!				***

(4) Nzɛbi, ɛ → e

/ɛ/ - /i/			*[+LO,+HI]$_I$	*[+LO,+ATR]$_I$	*[+HI,-ATR]$_I$	[HARM]$_{HI}$	[HARM]$_{LO}$	[HARM]$_{ATR}$	[FTH]$_I$
a.		ɛ [-hi,-lo,-ATR]				*		*!	
b.	☞	e [-hi,-lo,-ATR,+ATR]				*			*
c.		ɪ [-hi,-lo,-ATR,+high]			*!			*	*
d.		i [-hi,-ATR,-lo,+hi,+ATR]			*!				**

(5) Nzɛbi, e → i

/e/ - /i/			*[+LO,+HI]$_I$	*[+LO,+ATR]$_I$	*[+HI,-ATR]$_I$	[HARM]$_{HI}$	[HARM]$_{LO}$	[HARM]$_{ATR}$	[FTH]$_I$
a.		e [-hi,-lo,+ATR]				*!			
b.		ɪ [-hi,-lo,+ATR,+hi,-ATR]			*!			*	**
c.	☞	i [-hi,-lo,+ATR,+hi]							*

Discussion Chain Shifts have previously been analysed by Kirchner (1996) who implements the mechanism of Constraint Conjunction (Smolensky 1993) . Concretely, he suggests that the top-ranked constraint is a conjunction of two markedness constraints FAITH$_{HIGH}$ & FAITH$_{LOW}$ which is violated only if both markedness constraints are violated thus preventing /a/ from becoming [i]. However, Neasom (2016) has argued that Chain Shifts do not form a coherent phenomenon and challenges approaches to Chain Shifts that need additional mechanisms to solve the opacity problems specific to Chain Shifts. The analysis that I have suggested here differs from previous analyses as it makes use of independently motivated constraints and a theory that has previously been shown to account for cases of opacity, like incomplete neutralization (van Oostendorp 2008) or grandfather effects (Zimmermann & Trommer 2016). Moreover, my analysis can be extended to other Chain Shifts such as the partial neutralization in Nzema (see (6)) as it seems natural that the shift from /t/ to [n] is prevented by a constraint *[+NAS,-VOICED].

(6) Nzema (Niger-Congo, Ghana) (Clopper 2001)

t	→	d	tia	→	on-dia	'he does not walk'
d	→	n	di	→	on-ni	'he does not eat'

Conclusion I will show that all types of Partial Height Harmonies can easily be analysed within Containment Theory by means of a number of independently motivated constraints which make powerful and potentially overgenerating mechanisms like Constraint Conjunction superfluous.

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