The Research Institute of Linguistics,
Hungarian Academy of Sciences
Budapest, Hungary
16 November 2017

Acoustic prominence and phonological head-dependent structure

Kuniya Nasukawa
Tohoku Gakuin University
Sendai, Japan

Introduction

- In terms of the roles of heads and dependents, there is a mismatch between phonology and syntax.
- Phonology: heads are structurally and informationally important.
- Syntax: heads are structurally important but their informational role is relatively unimportant.

Introduction

- This talk proposes a reassessment of the roles of heads and dependents in phonology.
- It is argued that heads in phonology are structurally important but lexically unimportant whereas dependents are structurally unimportant but lexically important: phonology = syntax
- This view is supported not only by segmental distribution patterns but also by the size of the modulated carrier signal.

Roadmap

- How syntactic head-dependent structure is reflected in the acoustic properties of its phonetic realisation.
- The sonority scale and carrier signal modulations as ways of measuring stress and segmental salience.
- The differences between syntax and phonology with regard to the phonetic salience of head-dependent structure.

Roadmap

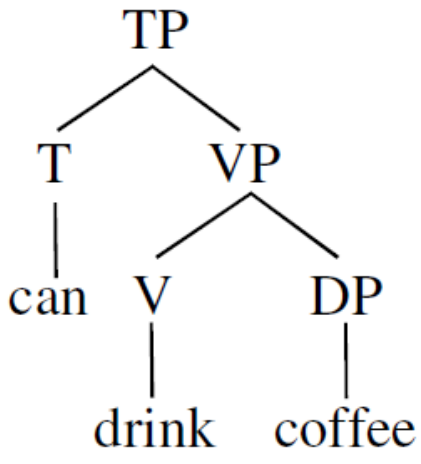
- The primary role of heads is structural and the primary role of dependents is informational.
- Compared with heads, dependents show a wider modulated form of carrier signal when they are phonetically realised.

Head-Dependency (H-D)

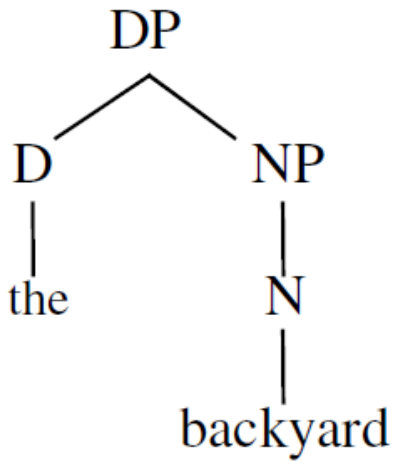
- A linguistically significant expression typically consists of multiple units, rather than just a single unit.
- When units combine, asymmetric relations are established between them.
- The unit which exerts control is the head of a combined set while the unit under the control of the head is a dependent.

H-D in syntax

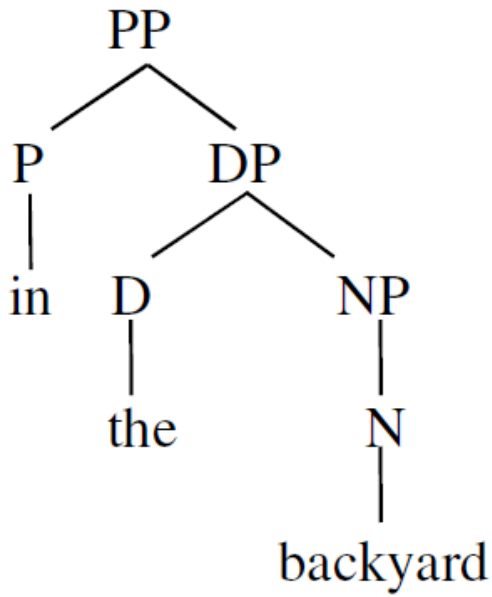
a. ‘can drink …’



b. ‘the backyard’

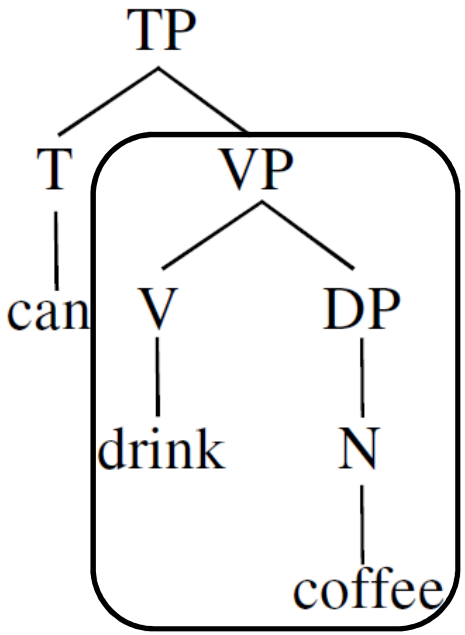


c. ‘in the backyard’

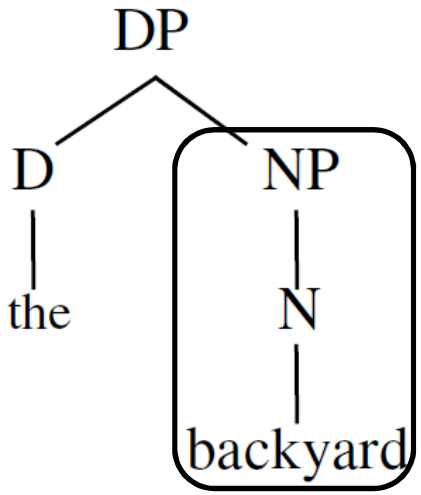


H-D in syntax

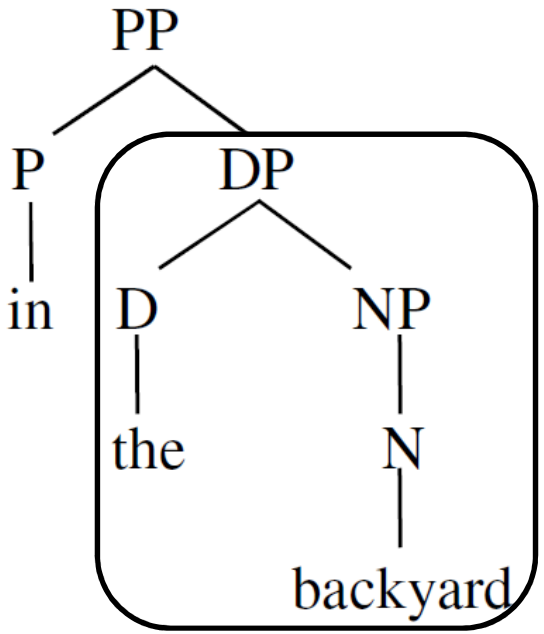
a. ‘can drink …’



b. ‘the backyard’



c. ‘in the backyard’

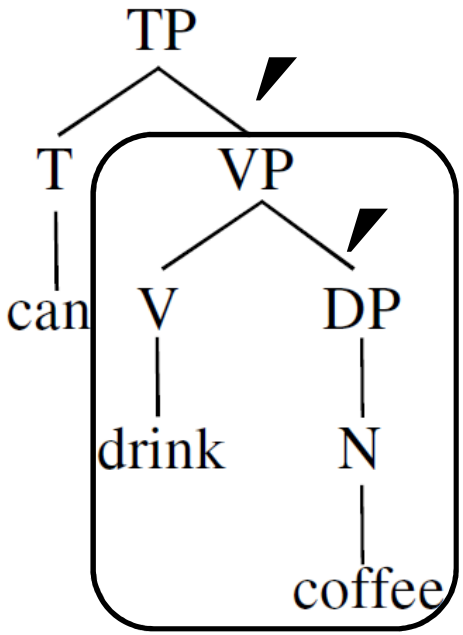


H-D in syntax

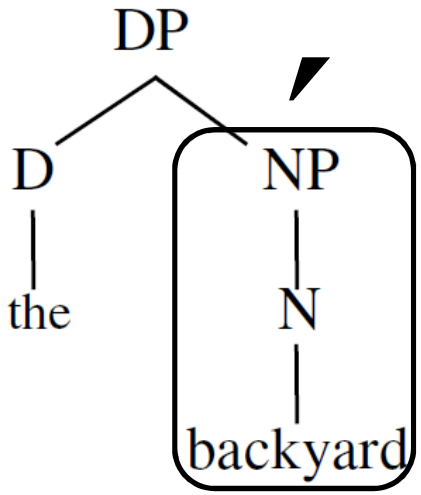
Constituent heads are important structurally but have a low informational load, while dependents are not so important structurally but they are rich in terms of information (Nasukawa and Backley 2015a: 68).

Phrasal stress pattern in syntax

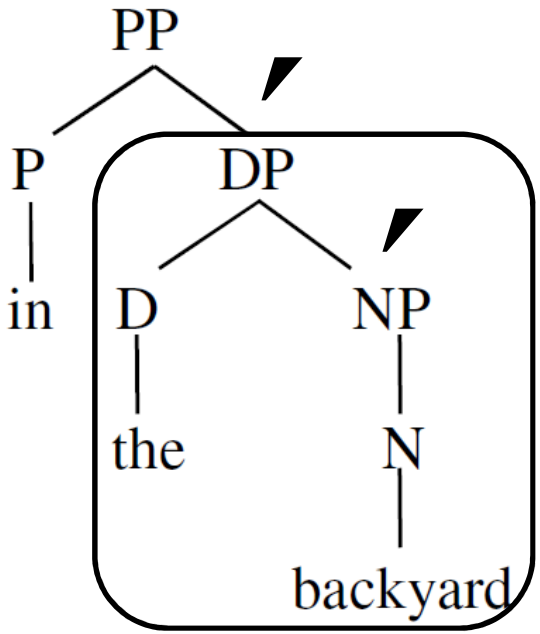
a. ‘can drink …’



b. ‘the backyard’

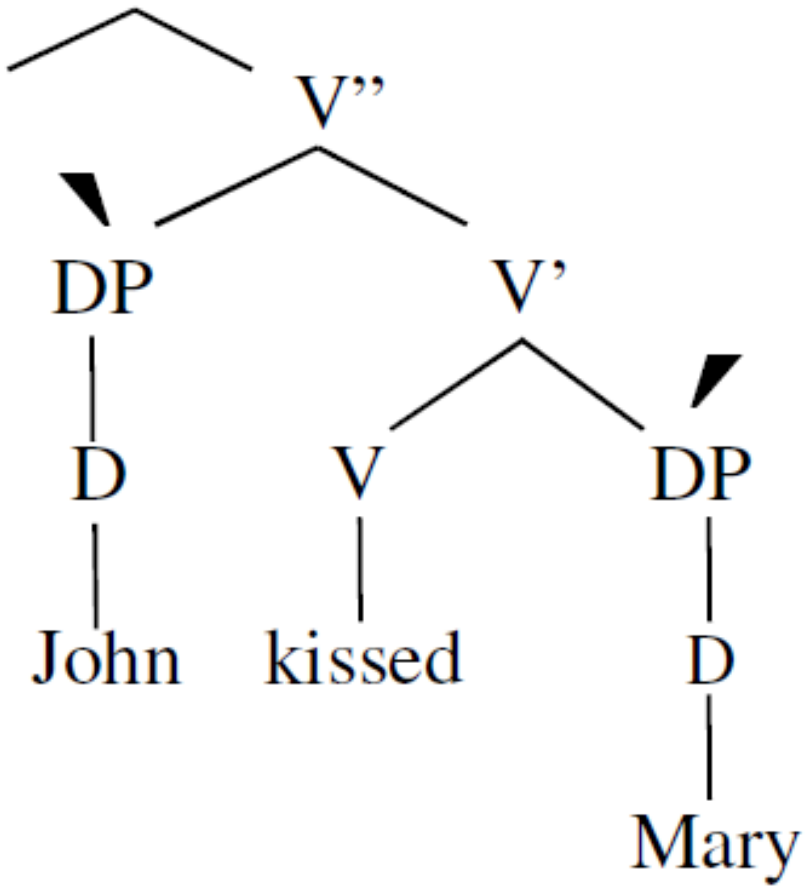


c. ‘in the backyard’



Stress pattern in syntax

[*Jòhn* [*kissed* [*Máry*]]]



Defining the notion of prominence

Harris (2006, 2009)

a. All energy in the speech signal is used for delivering linguistic messages.
b. Only the energy in the modulated carrier signal contains linguistic messages, while the carrier signal itself is linguistically insignificant and merely allows linguistic messages to be audible.

Sonority scale

less sonorous *more sonorous*

plosives > fricatives > liquids > glides > vowels

e.g. a syllable must consist of a sonority peak (usually V) flanked by Cs.

Rising shape (e.g., ***pl****ay*, ***tr****y*, ***tw****eet*)

Falling shape (e.g., *he****l.p****er*, *pa****r.t****y*, *wi****n.t****er*, *cu****s.t****om*)

Sonority scale

less sonorous *more sonorous*

plosives > fricatives > liquids > glides > vowels

The degree of sonority at the phrasal level

less sonorous		*more sonorous*
Heads	<	Dependents

The modulated carrier-signal

Two different types of sound energy (Harris 2006, 2009, 2012, Ohala 1992, Ohala and Kawasaki-Fukumori 1997, Traunmüller 1994, 2006)

a. **The carrier signal**:

   allows linguistic information (the message) to be heard.

b. **Modulations**:

   allows linguistic information (the message) to be understood.

The modulated carrier-signal

Acoustic attributes of modulations of the carrier signal (Harris 2009, 2012)

- Periodicity
- Amplitude
- Spectral shape
- Fundamental frequency
- Duration/timing

The modulated carrier-signal

Modulations of the carrier signal

a. Periodicity
b. Amplitude ←
c. Spectral shape
d. Fundamental frequency
e. Duration/timing ←

The size of modulations at the phrasal level

smaller		*bigger*
Heads	<	Dependents

The modulated carrier-signal

- Degree of sonority

smaller		*bigger*
Consonants	<	**Vowels**

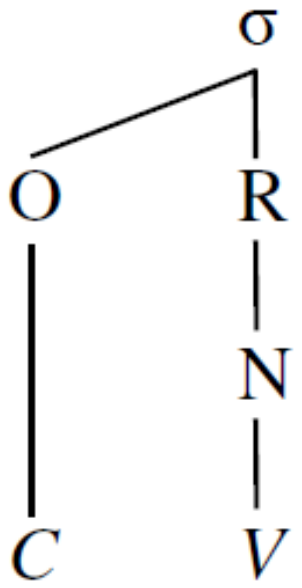
- Size of modulation from the carrier signal

smaller		*bigger*
Vowels	<	**Consonants**

son Cs < fricatives < **plosives**

H-D relations between syllable constituents

Syllable structure



Dep Head

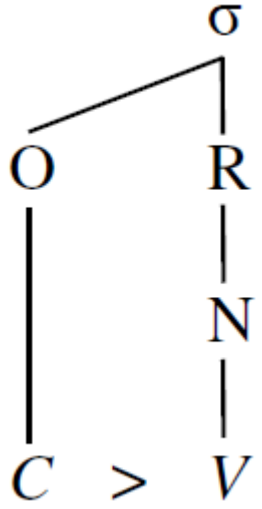
Phonetic saliency

a. Degree of sonority at the syllable level

less son *more son*

Dep < Head

b. The size of modulation at the syllable level



smaller *bigger*

Dep > Head

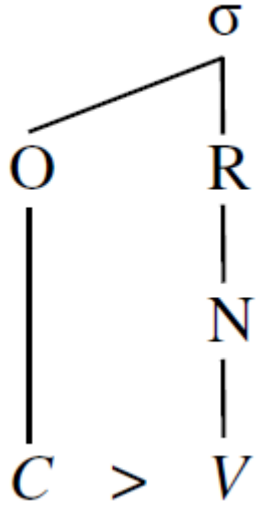
Phonetic saliency

a. Degree of sonority at the syllable level

less son *more son*

Dep < Head

b. The size of modulation at the syllable level



bigger *smaller*

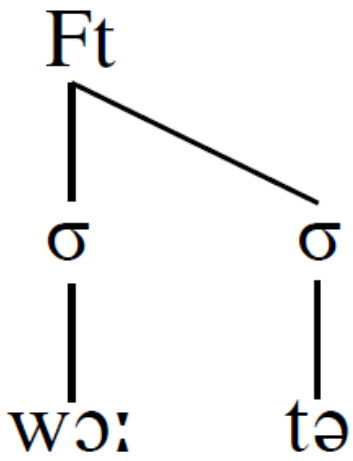
Dep > Head

The size of modulation at the phrasal level

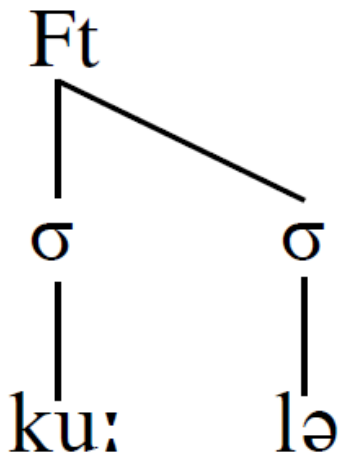
Dep > Head

H-D relations in the foot

a. ‘water’

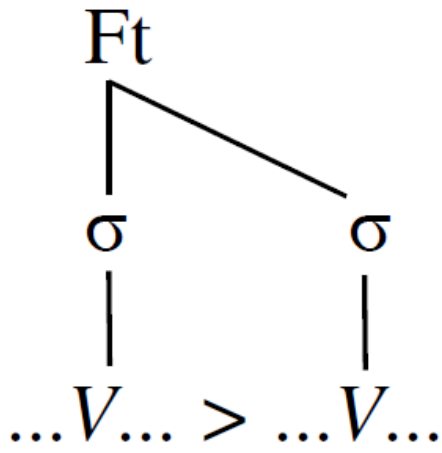


b. ‘cooler’



H-D relations in the foot

Prominence at the foot level



The size of modulation at the foot level

smaller		*bigger* (prominent)
Dependents	<	Heads

Roles of heads/dependents and their modulation in syntax and the foot

	SYNTAX	FOOT
HEADS	structure-building	structure-building
	information-*poor* *smaller* modulation	information-*rich* *bigger* modulation
DEPENDENTS	non-structure-building	non-structure-building
	information-*rich* *bigger* modulation	information-*poor* *smaller* modulation

Two ways to account for this mismatch:

(i) by finding a reason for why the roles of heads and dependents in syntax are swapped when they apply at the foot level;

(ii) by investigating whether the head/dependent roles in phonology, or perhaps those in syntax, have been wrongly specified and must be reassigned in order to bring both modules into line with each other.

Roles of heads/dependents and their modulation in syntax, the syllable and the foot

	SYNTAX	FOOT	SYLLABLE
HEADS	structure-building	structure-building	structure-building
	information-*poor* *smaller* modulation	information-*rich* *bigger* modulation	information-*poor* *smaller* modulation
DEPENDENTS	non-structure-building	non-structure-building	non-structure-building
	information-*rich* *bigger* modulation	information-*poor* *smaller* modulation	information-*rich* *bigger* modulation

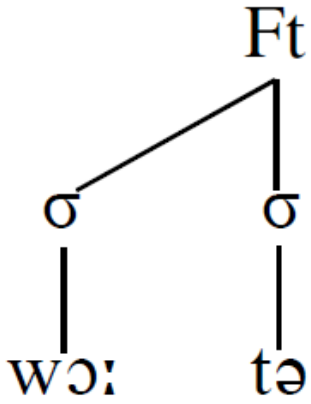
Two ways to account for this mismatch:

(i) by finding a reason for why the roles of heads and dependents in syntax are swapped when they apply at the foot level;

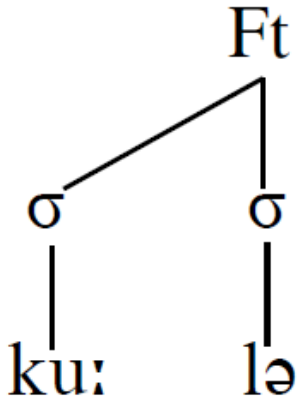
(ii) by investigating whether the head/dependent roles in phonology, or perhaps those in syntax, have been wrongly specified and must be reassigned in order to bring both modules into line with each other.

Redefining H-D relations in the foot

a. ‘water’



b. ‘cooler’

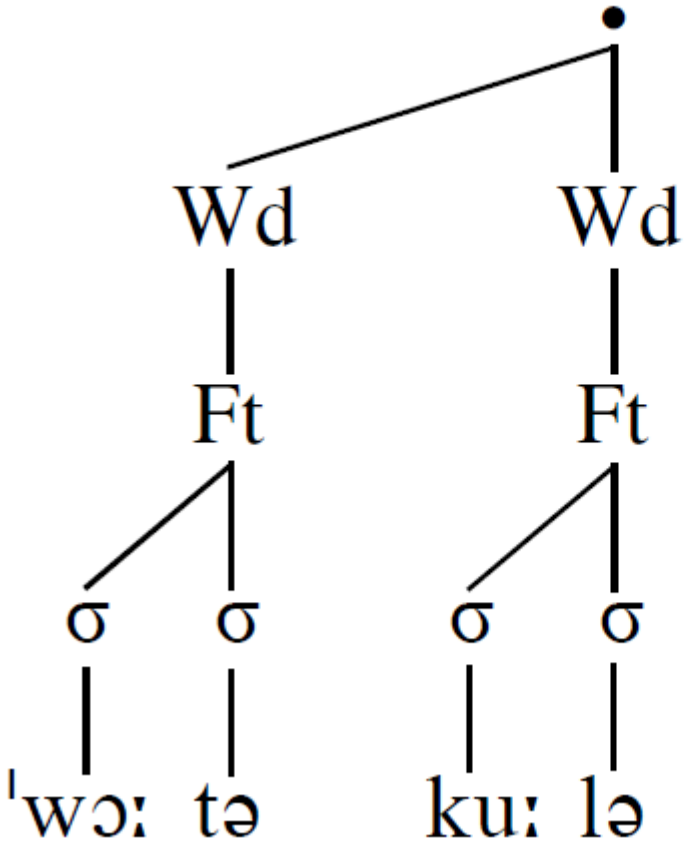


b. The size of the modulated-carrier signal at the foot level

smaller		*bigger* (prominent)
Heads	<	Dependents

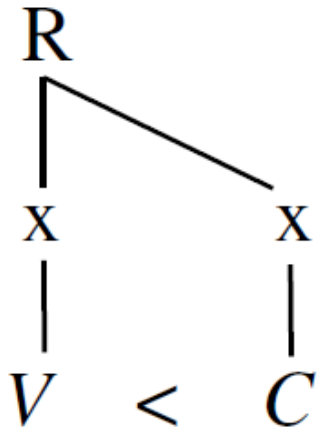
Redefining H-D relations in the word

‘water cooler’ (proposed right-head structure)



Redefining H-D relations in the rhyme

The relative size of modulation in the rhyme



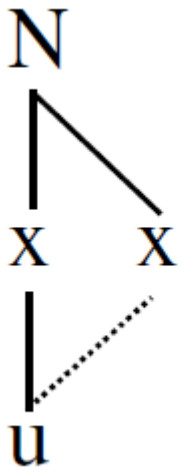
The size of modulation

smaller < *bigger*

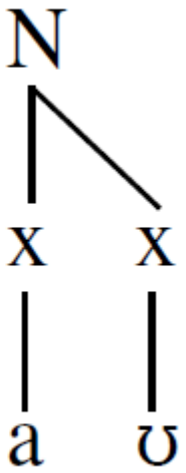
Heads < Dependents

Redefining H-D relations in the nucleus

a.



b.

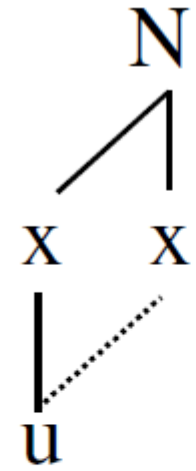


The left positions in (a) and (b) support a wider range of segmental contrasts than we find in the right positions.

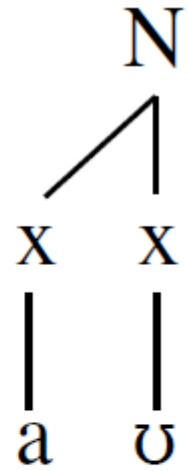
- the left-hand positions are informationally rich
- the right-hand positions have limited scope for lexical contrasts.

Redefining H-D relations in the nucleus

a.



b.

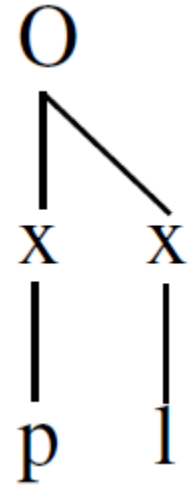


c. The size of modulation

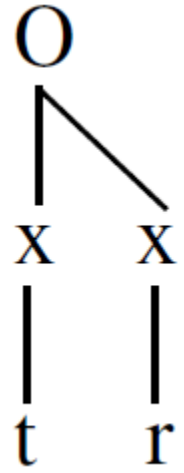
smaller		*bigger*
Heads	<	Dependents

Redefining H-D relations in the onset

a.

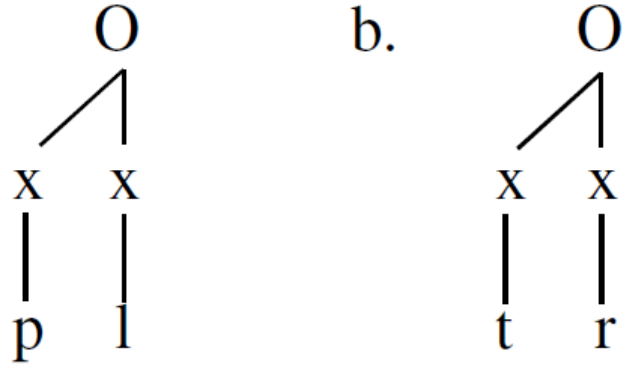


b.



Redefining H-D relations in the onset

a. b.



c. The size of modulation

smaller		*bigger*
Heads	<	Dependents

The left positions in (a) and (b) support a wider range of segmental contrasts than we find in the right positions.

- the left-hand positions are informationally rich
- the right-hand positions have limited scope for lexical contrasts.

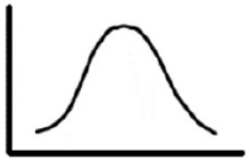
Redefining H-D relations in melody

Acoustic signatures of elements

	label	*spectral shape*
|A|	'mass'	mass of energy located in the centre of the vowel spectrum, with troughs at top and bottom
|I|	'dip'	energy distributed to the top and bottom of the vowel spectrum, with a trough in between
|U|	'rump'	marked skewing of energy to the lower half of the vowel spectrum
|ʔ|	'edge'	abrupt and sustained drop in overall amplitude
|H|	'noise'	aperiodic energy
|L|	'murmur'	broad resonance peak at lower end of the frequency range

Acoustic exponence of |A I U|

Typical acoustic exponence of elements (Harris 2005: 126, cf. Harris and Lindsey 2000)

element	*spectral shape*	*schematic filter response* (y-axis=amplitude, x-axis=frequency)
a. |A| 'mass':	mass of energy located in the centre of the vowel spectrum, with troughs at top and bottom	
b. |I| 'dip':	energy distributed to the top and bottom of the vowel spectrum, with a trough in between	
c. |U| 'rump':	marked skewing of energy to the lower half of the vowel spectrum	

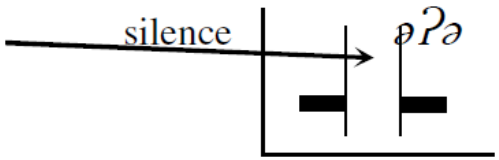
Acoustic exponence of |ʔ H N|

Acoustic exponence of |ʔ H N| (Nasukawa 2015: 226; cf. Harris 1994 Harris and Lindsey 1995: 68-73)

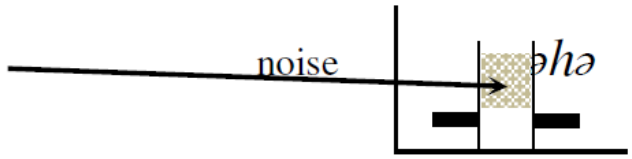
element *spectral shape* *stylised spectrographic frame*

(y-axis=frequency, x-axis=time)

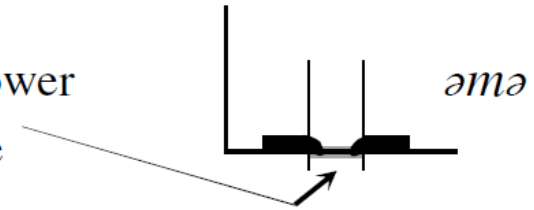
a. |ʔ| 'edge': abrupt and sustained drop in overall amplitude



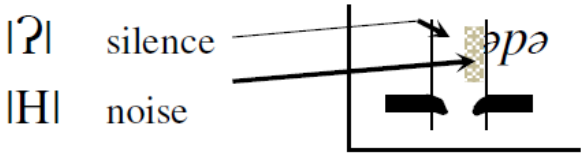
b. |H| 'noise': aperiodic energy



c. |N| 'murmur': broad resonance peak at lower end of the frequency range



d. |ʔ H| in occlusives



Precedence-free Phonology (PfP)

In PfP (Nasukawa 2012, 2014, 2016; Nasukawa & Backley 2015):

- elements still function as the building blocks of phonological structure, but they represent not only melodic but also prosodic properties.

- That is, they project onto higher levels as organizing units, where they concatenate to form prosodic constituents without referring to traditional prosodic labels such as nucleus, mora, rhyme, syllable and foot.

Precedence-free Phonology (PfP)

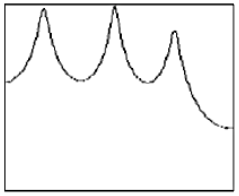
- This model assumes that the constituent regularly referred to as 'nucleus' must be one of the vowel elements |A|, |I| or |U|.
- When |A|/|I|/|U| appears in its minimal or most basic form (i.e., as a single element without dependent structure), it is realised as a central vowel [ə]/[ɨ]/[ɯ].
- The choice of default vowel is assumed to be determined by parameter: *ə* in English, *ɨ* in Cilungu and *ɯ* in Japanese. (For detailed discussion, see Nasukawa 2014.)

Precedence-free Phonology (PfP)

Typological variation: default vowels

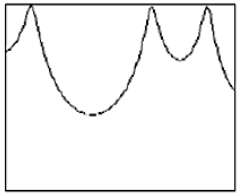
a. English [ə]

|A|′
|
|A|



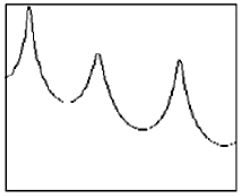
b. Cilungu [ɨ]

|I|′
|
|I|



c. Japanese [ɯ]

|U|′
|
|U|



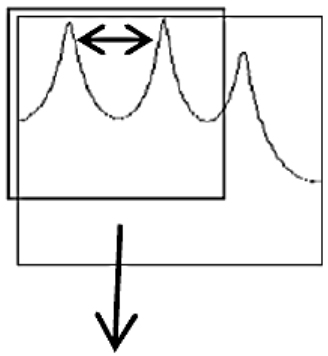
They appear in loanwords, when the native phonology requires a nucleus to be pronounced even if there is no corresponding vowel in the original word.

e.g., English: as in the place name ‘Gdansk’ [gədænsk].
Japanese: as in loanwords such as ‘slim’ [s**ɯ**ɾim**ɯ**].

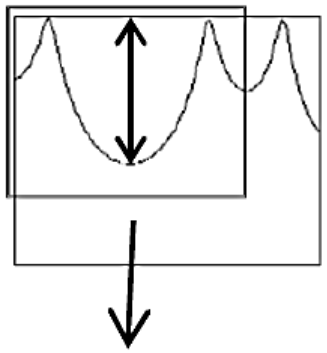
Precedence-free Phonology (PfP)

The phonetically weak realizations of |A|, |I| and |U|

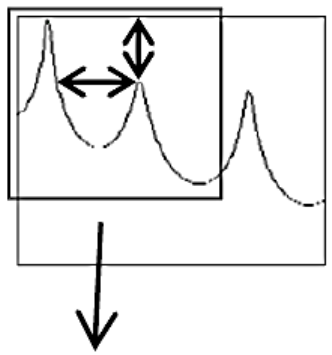
a [ə]



b. [ɨ]

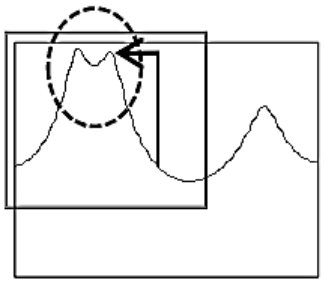


c. [ɯ]

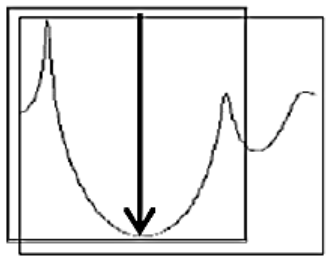


The phonetically strong realizations of |A|, |I| and |U|

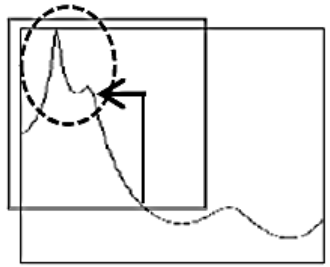
a [a]



b. [i]

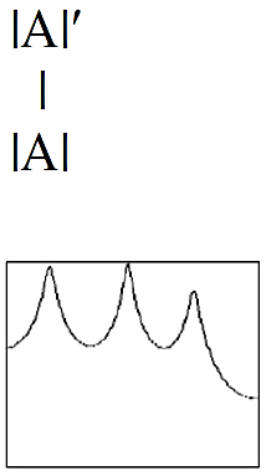


c. [u]

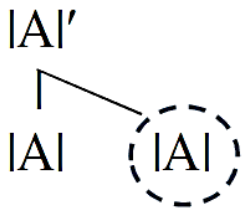


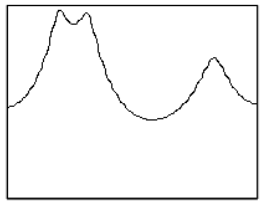
Default vowels vs. full vowels

a. [ə]

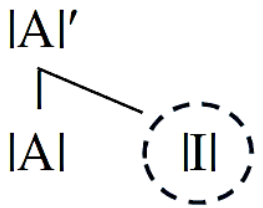


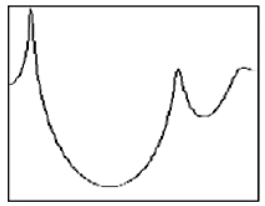
b. [a]



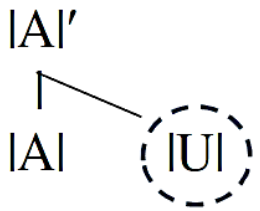


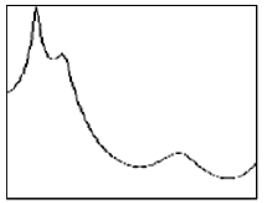
c. [i]





d. [u]





More complex melodic compounds

In models such as standard ET and DP:

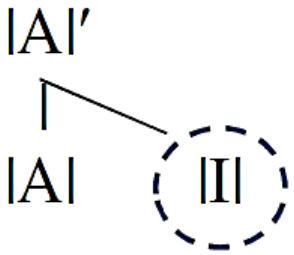
mid vowels have compound structures in which constituent elements enter into head-dependency relations.

|A|+|I|: (a) [|A||<u>I</u>|]
realised as [e] when |I| is headed
(b) [|<u>A</u>||I|]
realised as [æ] when |A| is headed
in English

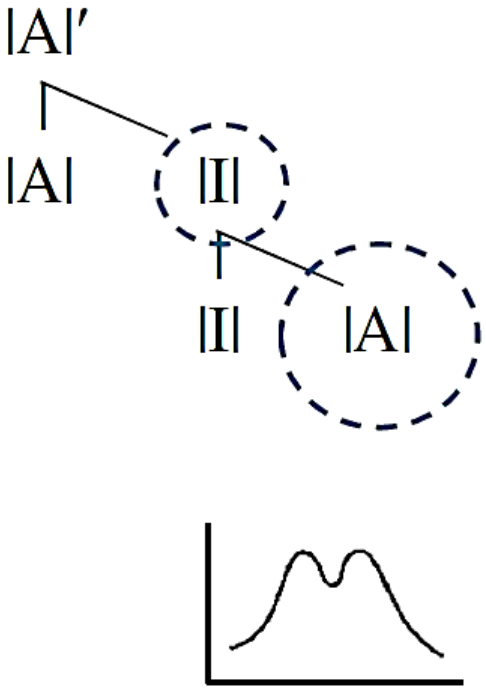
Iterative vowel concatenation

Further endocentric concatenation (deeper embedding)

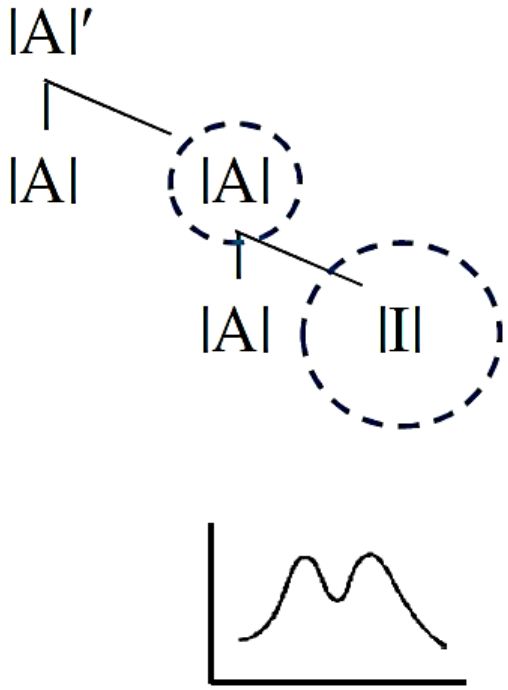
a. [i]



b. [æ]



c. [e]



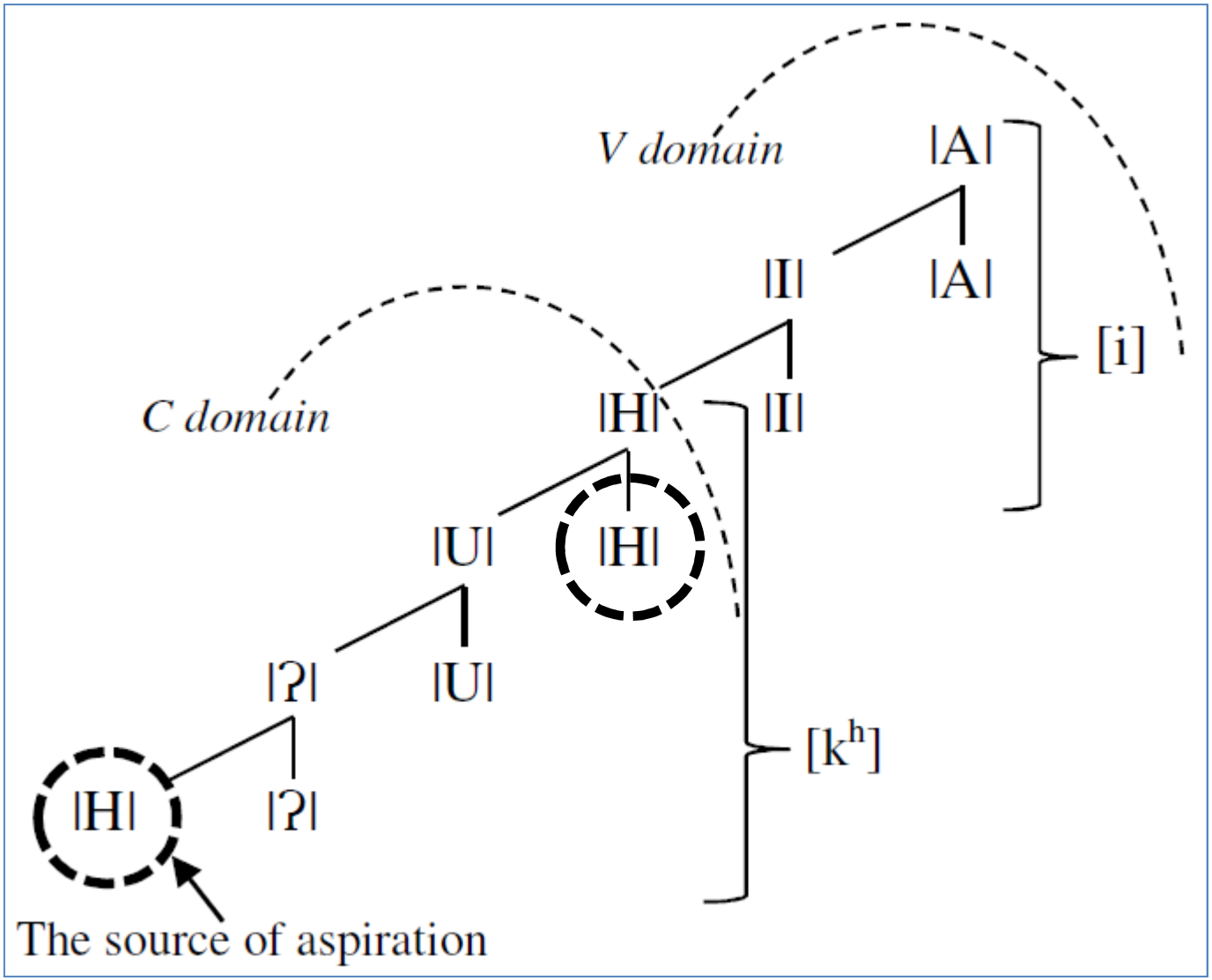
Iterative vowel concatenation

Phonetic interpretation depends
(i) on which elements are present and also
(ii) on the headedness of their concatenated structures.

Furthermore, successive levels of embedding can be introduced recursively until all the required vowel categories are uniquely represented.

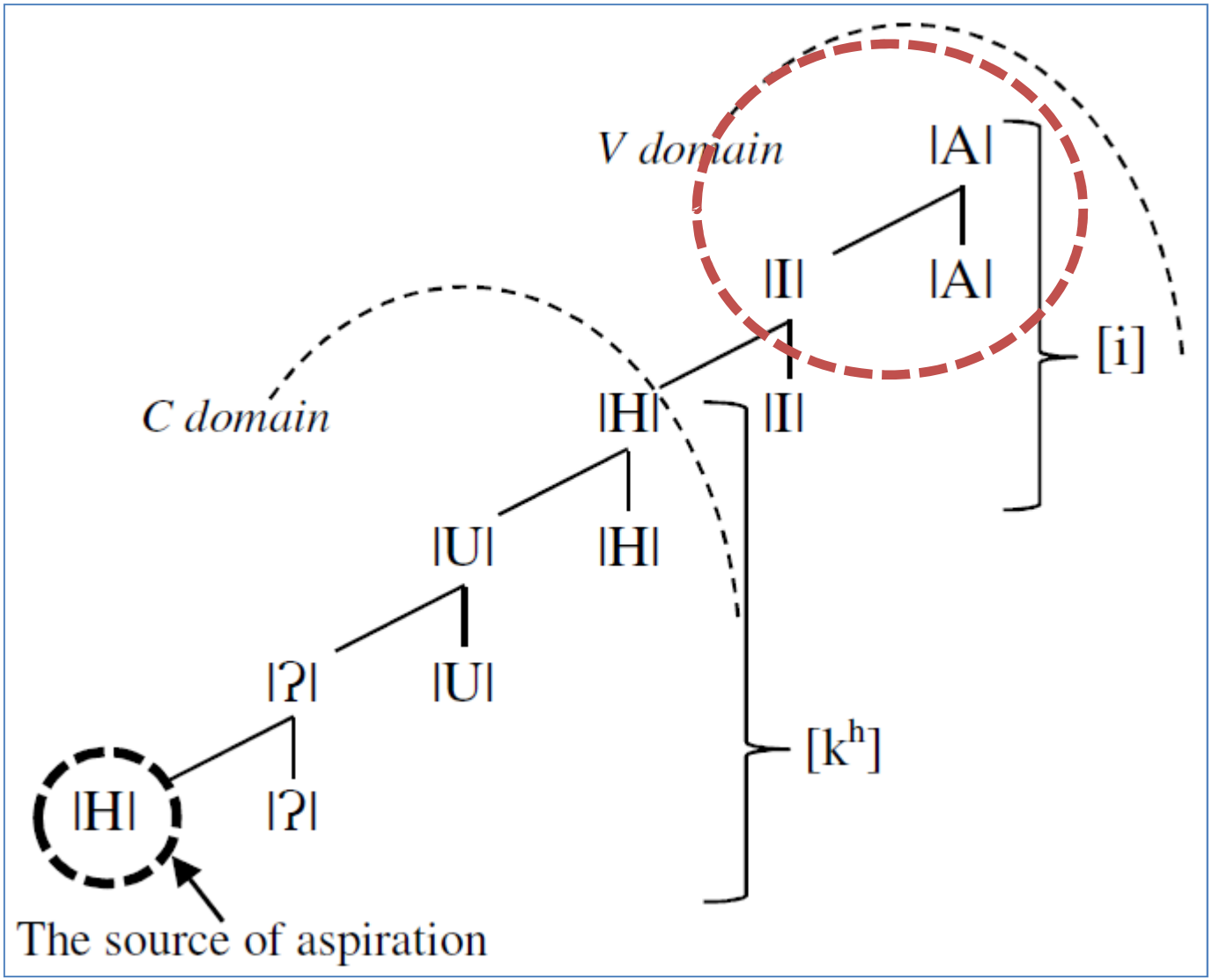
Iterative consonant concatenation: The phonological structure of [k^{h}i] in PfP

(10)



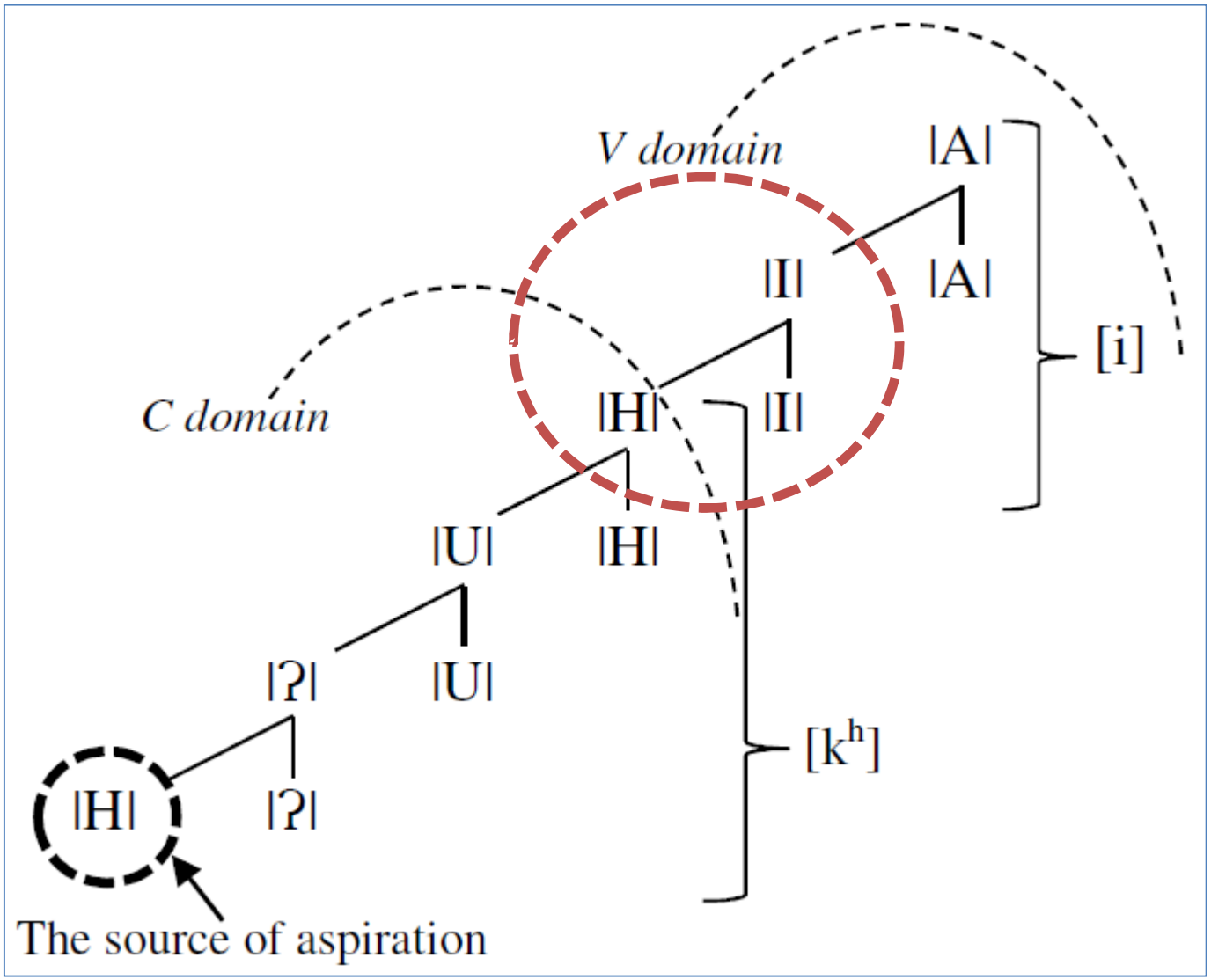
The phonological structure of [k^{h}i] in PfP

(10)



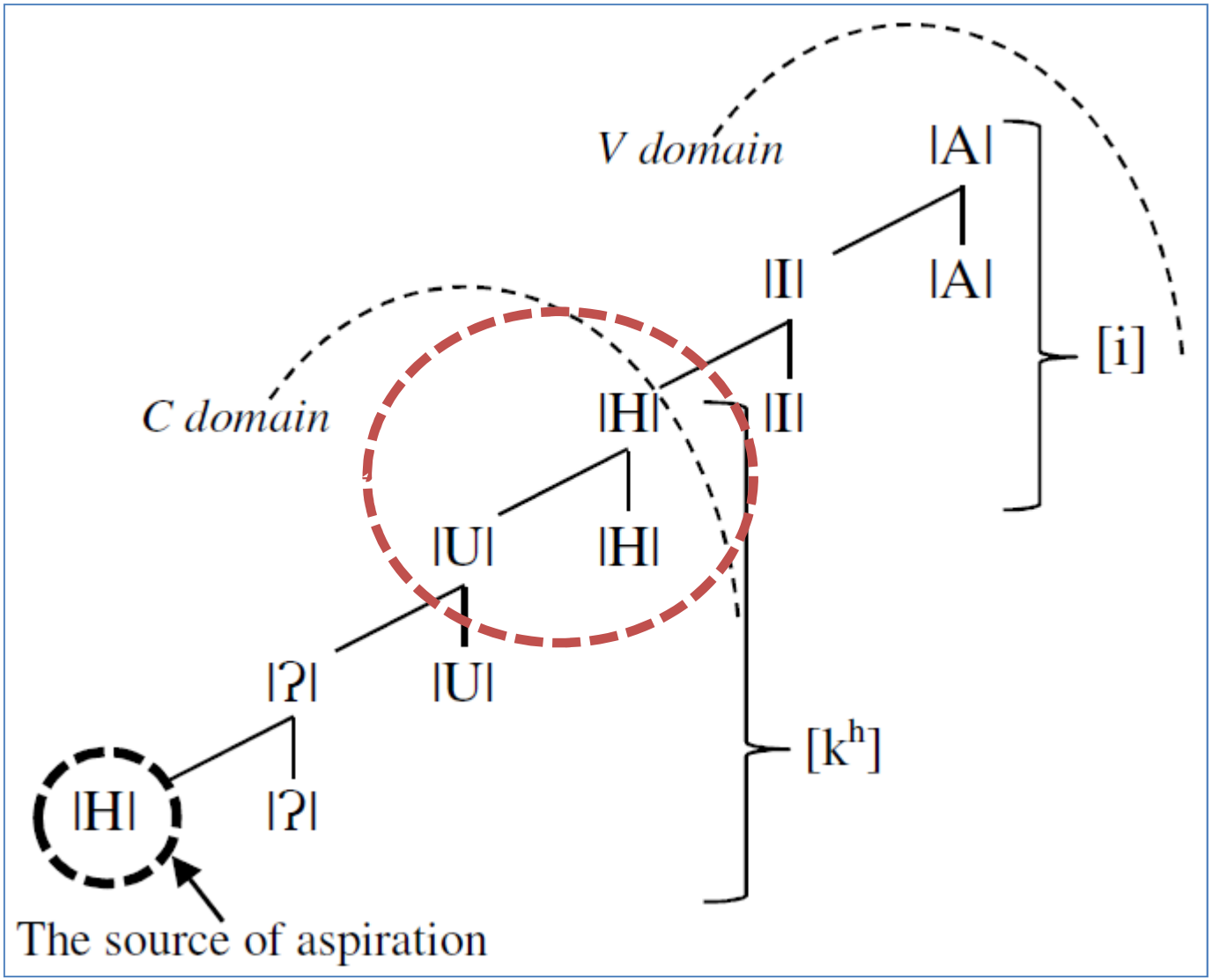
The phonological structure of [k^{h}i] in PfP

(10)



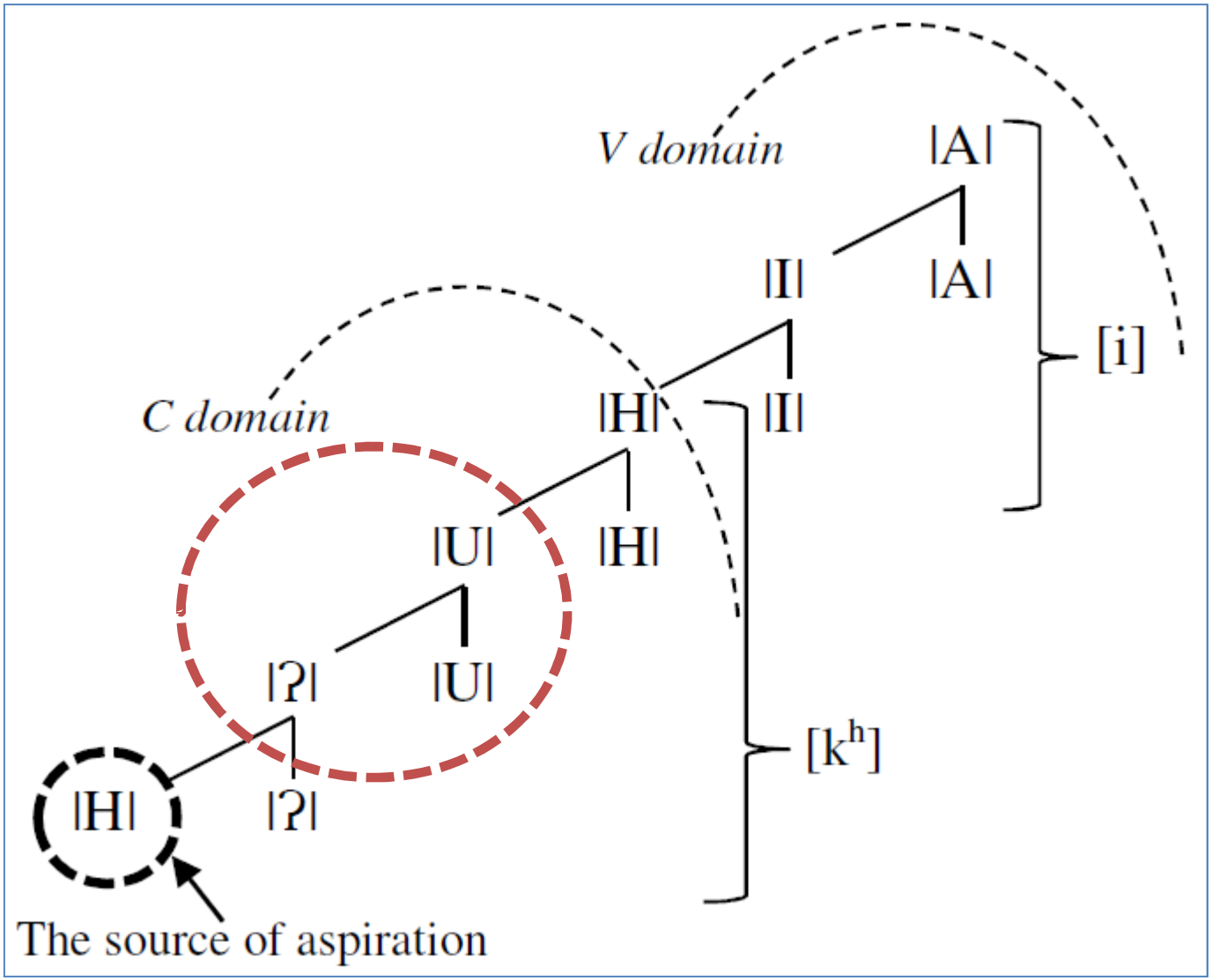
The phonological structure of [k^{h}i] in PfP

(10)



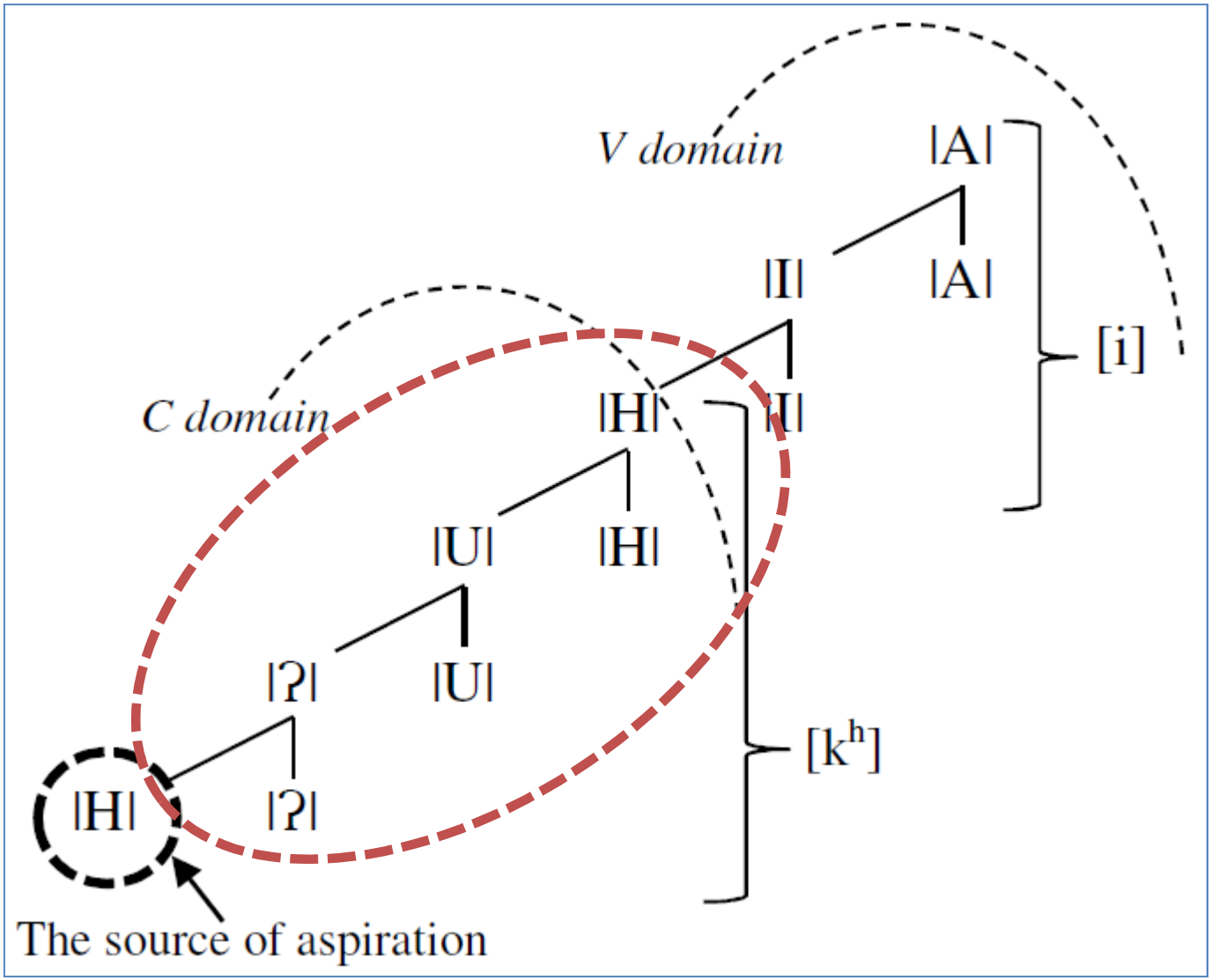
The phonological structure of [k^{h}i] in PfP

(10)



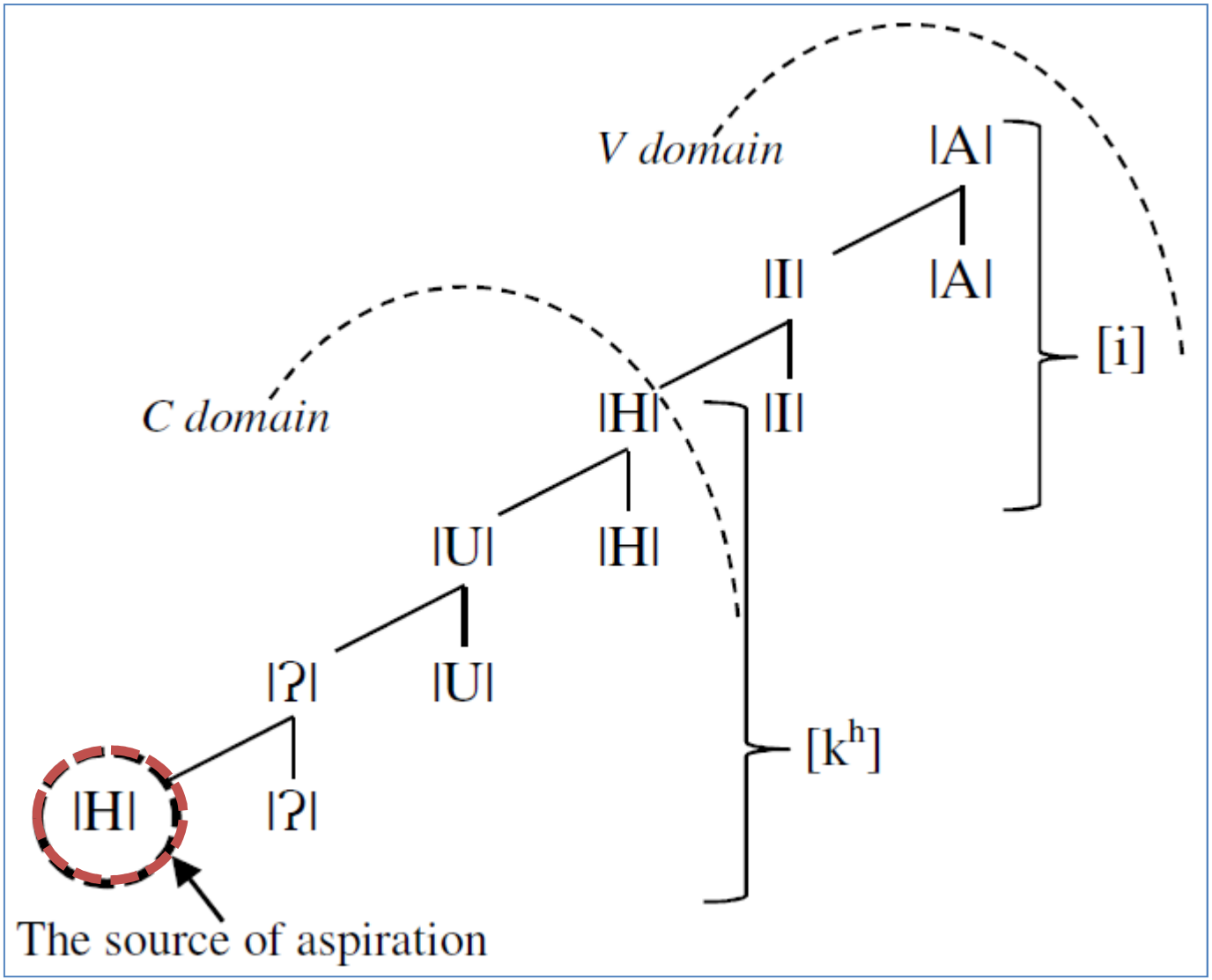
The phonological structure of [k^{h}i] in PfP

(10)



The phonological structure of [k^{h}i] in PfP

(10)



Summary

- In order to achieve a greater degree of uniformity between syntax and phonology, I have proposed a reassessment of the roles of heads and dependents in phonology.
- Contrary to the widespread view, it is not only in syntax but also at all levels of phonology (i.e., word, foot, syllable, rhyme, nucleus, onset, intra-segmental) that heads are structurally important but lexically recessive whereas dependents are structurally less important but richer in terms of lexical information.

Summary

- When a given head-dependent structure is phonetically realised, the relative prominence between heads and dependents is reflected in the acoustic signature of the whole expression.
- This means that dependents, which are not necessary for structural well-formedness, are phonetically more salient in terms of their modulated carrier signal (rather than the sonority scale) than heads, which are important for building structure.

References 1

Abney, Steven Paul (1987). The English noun phrase in its sentential aspect. PhD dissertation, Cambridge, Mass.

Backley, Phillip & Kuniya Nasukawa (2009). Representing labials and velars: a single 'dark' element. *Phonological Studies* 12. 3–10.

Backley, Phillip & Kuniya Nasukawa (2010). Consonant-vowel unity in Element Theory. *Phonological Studies* 13. 21–28.

Charette, Monik (1991). *Conditions on Phonological Government*. Cambridge: C.U.P.

Harris, John (1994). *English Sound Structure*. Oxford: Blackwell.

Harris, John & Geoff Lindsey (1995). The elements of phonological representation. In Jacques Durand & Francis Katamba (eds.), *Frontiers of Phonology: Atoms, Structures, Derivations,* pp. 34–79, Harlow, Essex: Longman.

Kaye, Jonathan D. (1990). 'Coda' licensing. *Phonology* 7. 301–330.

Kaye, Jonathan D., Jean Lowenstamm & Jean-Roger Vergnaud (1990). Constituent structure and government in phonology. *Phonology* 7. 193–232.

Nasukawa, Kuniya (2005). *A Unified Approach to Nasality and Voicing*. Berlin/New York: Mouton de Gruyter.

References 2

Nasukawa, Kuniya and Phillip Backley (2008). Affrication as a performance device. *Phonological Studies* 11. 35–46.

Nasukawa, Kuniya and Phillip Backley (2011). The internal structure of 'r' in Japanese. *Phonological Studies* 14. 27–34.

Nasukawa, Kuniya and Phillip Backley (2015). Heads and complements in phonology: a case of role reversal? *Phonological Studies* 18. 67–74.

Scheer, Tobias (2004). *A Lateral Theory of Phonology: What Is CVCV and Why Should It Be?* Berlin/New York: Mouton de Gruyter.

Szigetvári, Péter (1999). VC phonology: a theory of consonant lenition and phonotactics. PhD dissertation. Eötvös Loránd University, Budapest.

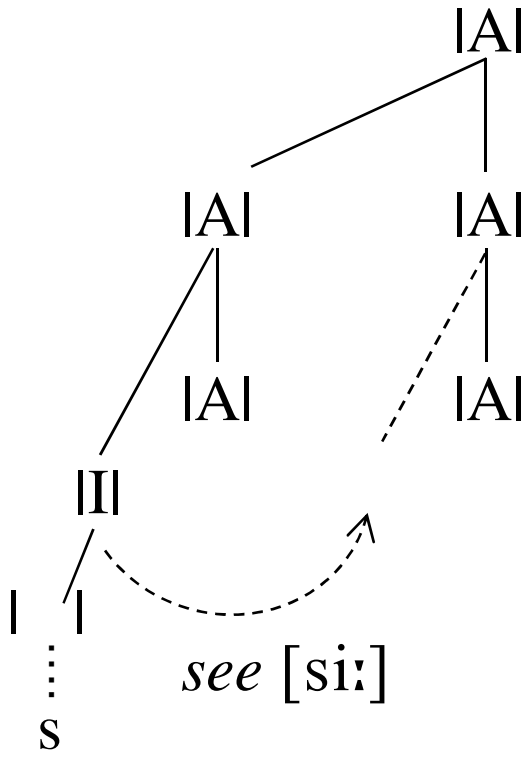
Živanovič, Sašo & Markus A. Pöchtrager (2010). GP 2, and Putonghua too. *Acta Linguistica Hungarica* 57(4). 357–380.

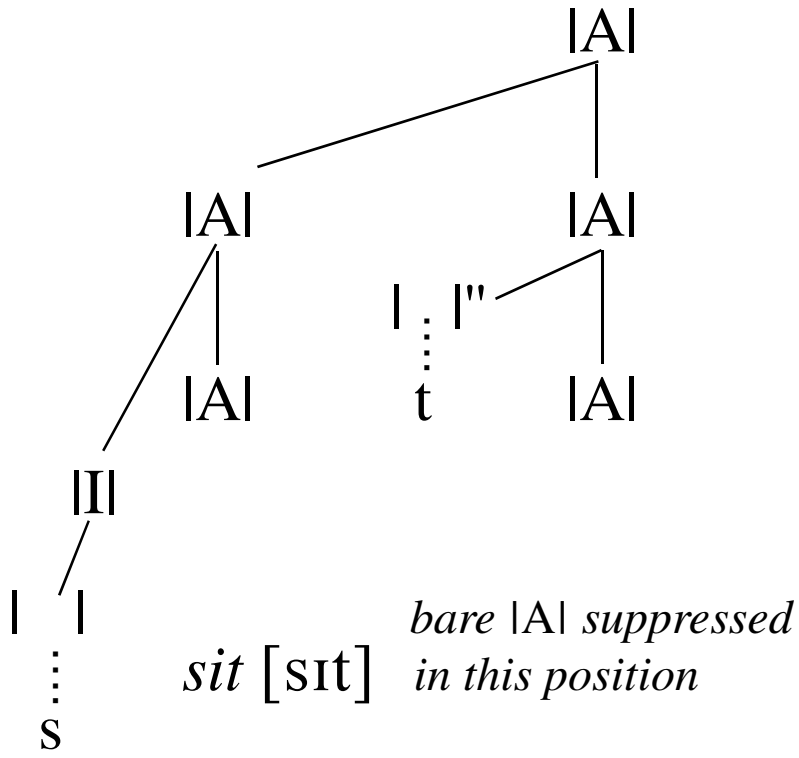
Acknowledgement

This work was partially funded by a grant (no. 26284067) from the Japanese government (Grant-in-Aid for Scientific Research (B), Ministry of Education, Culture, Sports, Science and Technology (MEXT)).

Heavy Syllables

Heavy syllable = concatenation of two |X|" constituents i.e. similar in prosodic terms: CVCV (*city*), CVV (*see*), CVC (*sit*)





Coda Consonants

Following the Strict CV approach (Szigetvári 1999, Scheer 2004), a coda consonant is a dependent of an unspecified nucleus, e.g. *think* [θɪŋk]