

Intermediate Phonology

Part 3: Syllables

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Contents of the class

1. Prosodic hierarchy; Phonemes, segments, and distinctive features
2. Segmental allophonies
3. **Syllables**
4. Moras, weight and time slots

5. Feet and lexical stress
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7. Prosodic phrases
8. Tones and intonation

Syllables

Syllables **group segments** into phonological and prosodic constituents. Speakers of specific languages are often aware of their presence and can use them in songs, poems and language games.

When the **syllabification** is unambiguous, people can count the syllables in words and sentences, a faculty that is not true of other prosodic constituents and segments.

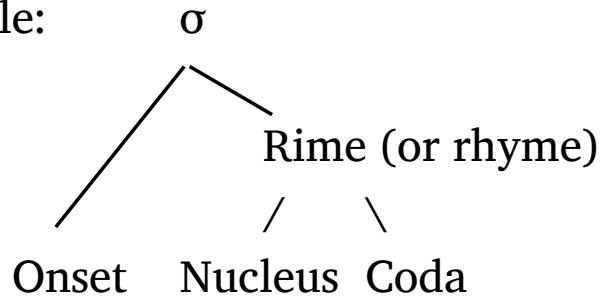
Syllables are crucial for **allophony**: phonological alternations often take place in onset, nucleus or coda of syllables. Besides phonotactic rules, morphology and sandhi rules are important factors in syllabification.

Stress is defined and identified on syllables: syllables can be stressed, secondarily stressed or unstressed. **Tones** are also realized on syllables and can spread on adjacent syllables (this is not true of stress).

The **number of syllables** can vary in rapid (connected) speech: *Je ne sais pas* 'I don't know' in French consists of 4 syllables, but it is often realized as [ʃe.pa], with two syllables.

Syllables

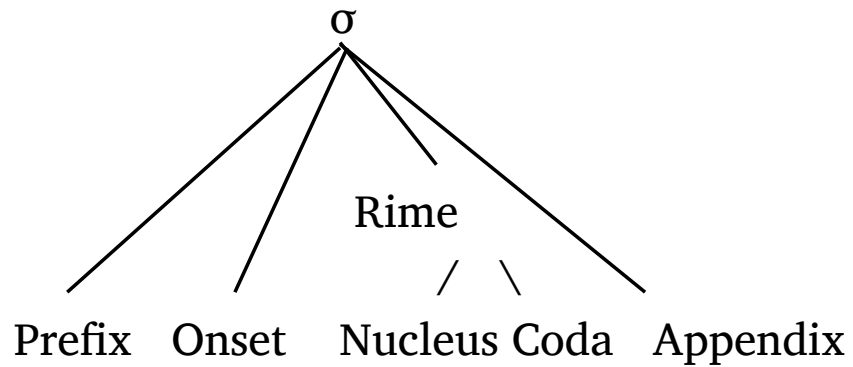
Core syllable:



Onset	Nucleus	Coda	
n	ε	k	<i>neck</i>
d	ʌ	l	<i>dull</i>

Only the nucleus is obligatory

Extended syllable:



Prefix	Onset	Nucleus	Coda	Appendix	
s	tr	a _i	k	s	<i>strikes, minds</i>
	b	ou	n	st	<i>bounced, begged</i>

Syllables

Syllabification, e.g. the grouping of segments in syllables, is not underlying.

If it were, there could be a distinction between [as]_σ [pra]_σ, which means (say) ‘white’ and [a]_σ [spra]_σ, which means (say) ‘black’ but there isn’t and can’t be (although morphemic structure can have an influence on syllabification, see below).

Syllabification in monomorphemes is a mechanism or a process, based on simple rules and principles, one of the most important is the Sonority Sequencing Principle (SSP):

Sonority Sequencing Principle (SSP): In each syllable there is a segment which is the syllable peak; any segment sequences preceding and following this segment have progressively decreasing sonority, or at least not increasing sonority.

Sonority Hierarchy

Plosives	Fricatives	Nasals	Liquids	Glides	Vowels
Affricates					
<hr/>					
p b	f v	m	l	w	i, u e, o a
t d	θ ð	n	r	j	
k g	s z	ŋ			
tʰ dʒ	ʃ ʒ				
tʃ dʒ	ç ʝ				
	x ɣ				

Sonority Sequencing Principle (SSP) from Sievers (1885):

In each syllable there is a segment which is the syllable peak; any segment sequences preceding and following this segment have progressively decreasing sonority.

Sievers, Eduard. 1885. *Grundzüge der Phonetik zur Einführung in das Studium der Lautlehre der indogermanischen Sprachen*. Bibliothek Indogermanischer Grammatiken 1. Leipzig: Breitkopf and Härtel.

Sonority Hierarchy

Several proposals derive the sonority hierarchy from distinctive features:

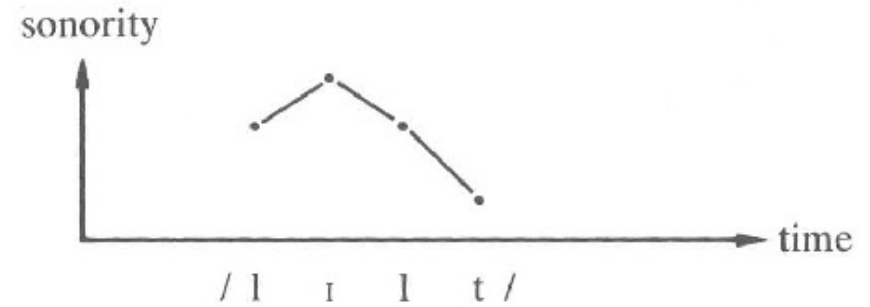
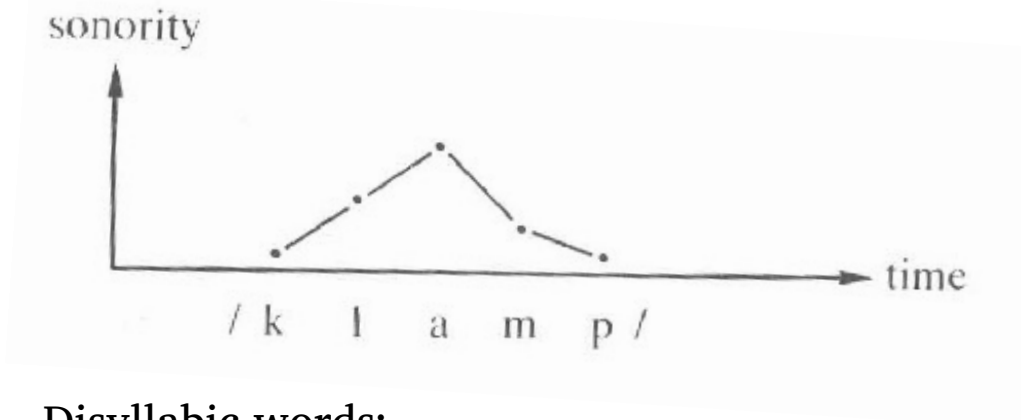
Clements (1990) derives the sonority from the following 'major class' features

	→			
	Obstr	< Nasals	< Liquids	< Glides
syll	-	-	-	-
vocoid	-	-	-	+
approx	-	-	+	+
sonorant	-	+	+	+
Scale	0+	1+	2+	3+ (relative sonority)

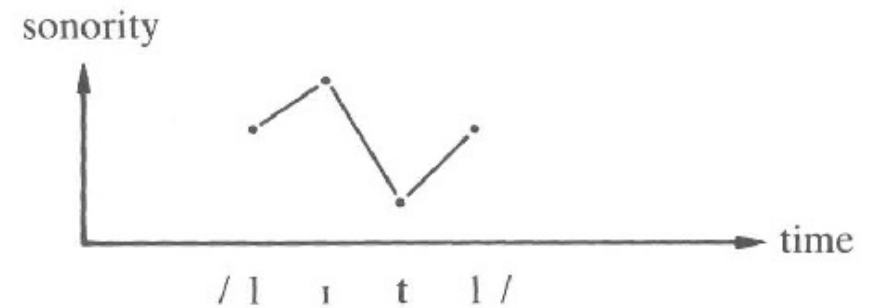
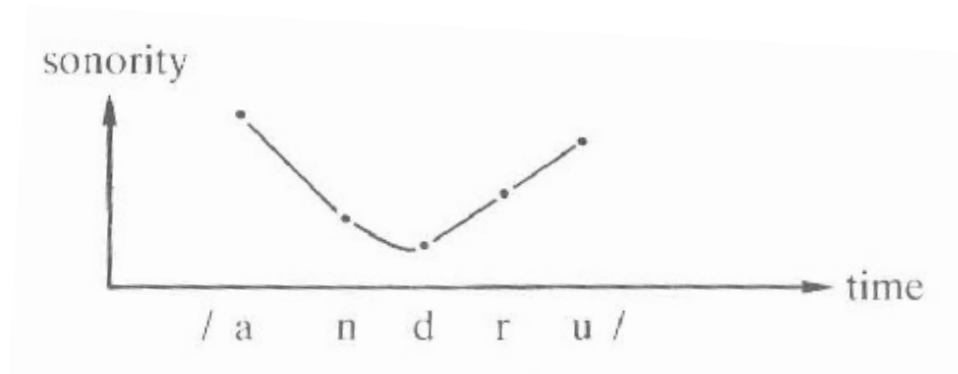
Sonority Hierarchy

Illustrations of the Sonority Sequence Principle in English words

Monosyllabic words:



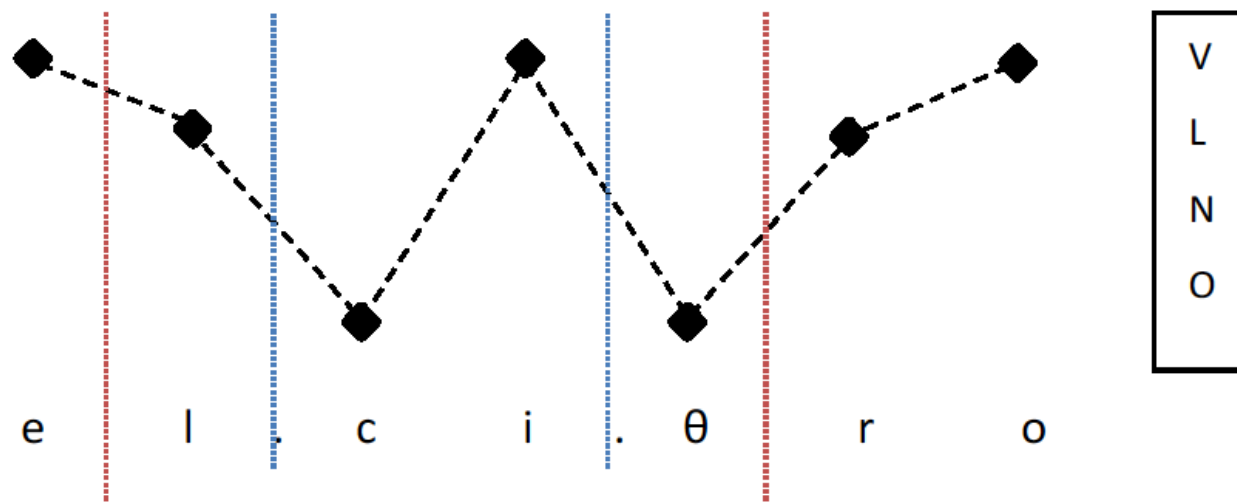
Disyllabic words:



Sonority Hierarchy

Illustrations of the Sonority Sequence Principle in a Greek word: el.ci.θro 'sleigh' (blue lines)

Syllabifications for the word έλκυθρο [élciθro] 'sleigh'



Topintzi, Nina. 2022. Sonority Hierarchy (Modern Greek). In *Encyclopedia of Greek Language and Linguistics*, G. Giannakis (Ed.), Leiden & Boston: Brill.

Sonority Hierarchy in OT

Prince & Smolensky's (1993) universal markedness hierarchy for syllable peaks based on the sonority hierarchy:

*OBSTRUENT(peak) >> *NASAL(peak) >> *LIQUID(peak) >> *VOWEL(peak)

Nuclear Harmony Constraint (HNUC):

A higher sonority nucleus is more harmonic than one of lower sonority.

NUC(x) is a constraint requiring that a segment x (that can be an obstruent, a nasal etc.) be the nucleus of a syllable. A vowel is always allowed to be a peak:

In Greek, only vowels can be peaks:

*OBSTRUENT(peak) >> *NASAL(peak) >> *LIQUID(peak) >> NUC(x) >> *VOWEL(peak)

In English, a sonorant can also be a peak: NUC(x) is ranked higher than in Greek.

*OBSTRUENT(peak) >> NUC(x) >> *NASAL(peak) >> *LIQUID(peak) >> *VOWEL(peak)

In Tashlihit Berber, any consonant can be a peak: NUC(x) is ranked highest.

NUC(x) >> *OBSTRUENT(peak) >> *NASAL(peak) >> *LIQUID(peak) >> *VOWEL(peak)

Phonotactics in English

Phonotactics in English

Nucleus is obligatory:

dog culpit, connect, connection

Sonorants can be nuclei:

rhythm, meter, able, gull [gʌt] or [gt]

Hayes, Bruce (2009:31) *Introductory Phonology*. Oxford. Blackwell Publishing.

Phonotactics in English

Onsets are optional.

Onsets:

All consonants of English are possible simple onsets except for dorsal nasal [ŋ] and glottal stop [ʔ].

The core onsets consists of maximally two positions plus a prefix.

Syllables with different kinds of onset

- | | |
|----------------------------------|----------------------------------|
| a. No onset (V, VC): | I, eel, eye, oak |
| b. Simple onset (CV, CVC): | pie, sun, wind, Canada |
| c. Complex onset (CCV, CCVC): | prey, blue, cloud, Brazil |
| d. Prefix + onset (sCCV, sCCVC): | spray, strike, spleen, sclerosis |
| e. Bad onset: | *nmV, *lbV, *tslV etc. |

Phonotactics in English: complex onsets

x ₂	r	l	m	n	w
x ₁					
p	+	+			
b	+	+			
f	+	+			
t	+				+
d	+				+
θ	+				+
k	+	+			+
g	+	+			+
s		+	+	+	+
ʃ	+	?	?	?	

prune, brown, free, tree, dry, three, cry, grim, shrew

please, blue, flea, clue, glue, slow

smoke

snow

twinkle, dwell, thwat, queen, Gwen, swear,

(shlep, schmuck, schnaps)

[j] is ignored in the tables since it is often an allophone of [i], e.g. *Italian, familiarity*

Phonotactics in English: complex onsets

Prefixes: Before some (complex) onsets, [s] is the only consonant that can be present, generally at the beginning of a word (but not only: *ab.stract*, *ob.struent*...)

[spr]: spring

[str]: string

[skr]: scream

[spl]: split

[skl]: sclerosis

[skw]: squat

Restrictions (negative conditions) on complex onsets that have the right sonority sequence

No stop + nasal: *kn, *km, *pn, *tm...

No nasal + more sonorous sonorant: *ml, *nl,

No lateral + more sonorous sonorant: *lr...

No voiced fricatives + any sonorant (except for [j]): *zr, *ðl, (but vl in Vladimir)

No coronal + coronal: *tn, *dn, *θn, *tl, *dl, *θl, ...

Phonotactics in English: complex codas

Codas are optional.

Codas consist of maximally two positions plus an appendix. They fulfill the SSP, except for the appendix that can be more sonorous than the preceding coda segment.

- a. No coda: boy, pie, sea
- b. Simple coda: seat, meal, hair
- c. Complex coda: art, ant, bald, film
- d. Not possible *mlp, *sjt, *rtr
- e. Coda + appendix: strikes, clamps, minds, laughed, begged

Syllable construction in English

Algorithm for syllable construction

1. Find the **nucleus**, a sonority peak, in English both vowels (obligatorily) and sonorants (optionally) can be nucleus.

	σ	σ		σ	σ
<i>contract</i>	k	ɑ	n	t	ɪ
	æ	k	t	<i>rhythm</i>	r
					ɪ
					ð
					m

2. Onset formation

Maximal Onset Principle (Jespersen 1904) Maximize the onset

Join consonants to the following nucleus according to the Maximal Onset Principle, provided the resulting cluster meet the SSP.

	σ	σ		σ	σ
	/	//		/	/
<i>contract</i>	k	ɑ	n	t	ɪ
	æ	k	t	<i>rhythm</i>	r
					ɪ
					ð
					m

Syllable construction in English

3. Coda formation

Join any consonants not yet syllabified to the preceding syllable.

The rime (nucleus + coda has maximally three positions)

	σ	σ		σ	σ			
	/ \	// \		/	/			
<i>contract</i>	k	ɑ	n	t	ɹ	æ	k	t
				<i>rhythm</i>	r	ɪ	ð	m

In *rhythm*, since [m] is more sonorous than [ð] and since nasals can be nuclei, [m] cannot be a coda: instead it is a nucleus, and [ð] is the onset. Same with *connection*, *meter*, *able*

Syllabification is sometimes motivated by morphological consideration (see presentation 6).

Compare the syllabification in monomorphemes and in complex words:

a.tone vs. *Oat.ly*: *ly* is a separate morpheme and [tl] is not a possible onset.

dwell (dw is okay as an onset) vs. *Ed.ward* where the syllable boundary is between [d] and [w] because [ɛ] is too light to be stressed and needs a coda.

Syllable construction in Greek

Algorithm for syllable construction in Greek

1. Find the **nucleus**, a sonority peak: in Greek only vowels can be nucleus.

2. **Onset** formation

Join consonants to the following nucleus according to the Maximal Onset Principle provided the resulting cluster meet the SSP.

3. **Coda** formation

Join any consonants not yet syllabified to the preceding syllable.

ηλεκτρονικό ilektronikó ‘electronic’

Nuclei	Onsets	Codas
σ σ σ σ σ	σ σ σ σ σ	σ σ σ σ σ
	/ // / /	/ \ // / /
i l e k t r o n i k ó	i l e k t r o n i k ó	i l e k t r o n i k ó

Phonotactics in Greek: onsets

Syllables with different kinds of onset

- | | |
|----------------------------------|---|
| a. No onset (V, VC): | αίμα [é.ma] ‘blood’ and αέρασ [a.é.ras] ‘air’ |
| b. Simple onset (CV, CVC): | καλά/ καλάσ [ka.lá(s)] ‘well’ |
| c. Complex onset (CCV, CCVC): | δρόμοσ [ðro.mos] ‘road’, κτίριο [ktí.ri.o] ‘building’ |
| d. Prefix + onset (sCCV, sCCVC): | στροφές [stro.fés] ‘curves’ |
| e. Bad onset: | *nmV, *lbV, *tslV etc. |

Onsets and codas are optional.

Most consonants of Greek are possible simple onsets; [t^s], [d^z] are affricates, [ps written ψ and ks written ξ] are not affricates, but complex onsets: the two parts are not homorganic.

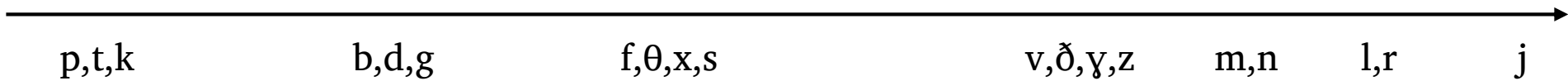
The core onsets consist of maximally two positions plus a prefix.

Sonority hierarchy in Greek

Sonority hierarchy plays a role in the Greek syllable, too.

Some authors do not rank stops and fricatives.

voiceless stops > voiced stops > voiceless fricatives > voiced fric. > nasals > liquids > glides



In the tables of the next slides, the blue clusters do not exist in English.

Kappa, Ioanna. 1995. *Silbenphonologie im Deutschen und Neugriechischen*. PhD Universität Salzburg.

Malikouti-Drachman, Angeliki. 1984. Syllables in Modern Greek. In *Phonologica* 1984, 181–187. Cambridge: Cambridge University Press.

Topintzi, Nina. 2022. Syllable Structure. In *Encyclopedia of Greek Language and Linguistics*, G. Giannakis (Ed.), Leiden & Boston: Brill.

Phonotactics in Greek: complex onsets

x ₂	p	b	β	f	v	t	d	θ	ð	s	z	k	g	x	γ	m	n	l	r
x ₁																			
p						+				+							+	+	+
b																		+	+
t										+						+			+
d																			+
k						+				+							+	+	+
g																		+	+
m																	+		

pt *πτήση* ptísi ‘flight’, ps *ψάρι* psári ‘fish’, pn *πνεύμονες* pnévmones ‘lungs’, pl *πλύσιμο* plísimo ‘washing’ pr *πρόβατο* prónato ‘sheep’

bl *μπλε* ble ‘blue’, br *μπράβο* brávo ‘bravo’

ts *τσάντες* tsándes ‘bags’, tm *τμήμα* tmina ‘section’, tr *τραπέζι* trapézi ‘table’

dr *ντροπή* dropí ‘shame’

kt *κτίνος* ktínos ‘beast’, ks *ξιλα* ksila ‘sticks’, kn *Κνωσός* knosós ‘Knossos’, κλειδιά kliidiá ‘wrenches’, kr *κρατάω* ‘to hold’

gl *γκλίτσα* glítsa ‘walking stick’, gr *γκρεμός* gremós ‘cliff’

mn *μνήμη* mními ‘memory’

[j] is ignored in the tables: ðj *διώχνω* ðjóxno ‘I send away’ vj *βιάζομαι* vjázome ‘I am in a 21 hurry’ etc.

x ₂	p	b	v	f	v	t	d	θ	ð	s	k	g	ɣ	x	m	n	l	r	
x ₁																			
f						+		+			+						+	+	
v									+				+				+	+	
ð																		+	
θ																	+	+	+
s		+				+		+			+			+			+	+	
z			+										+		+				
x							+		+								+	+	+
ɣ									+								+	+	+

ft φτερνίζομαι 'to sneeze' fθ φθινόπωρο 'fall/autumn', fk φκιάνω fcáno 'I fix, make', fl φλογέρα flojera 'flute', fr φρούτα fruta 'fruits'

vð βδομάδα vðomáda 'week', vɣ βγάζω vɣázo 'remove', vl βλέπω vlépo 'I see', vr βράδυ vráðu 'evening'

ðr δρόμος ðrómos 'road'

θn θνητός θnitós 'mortal', θl θλιμμένος θliménos 'sad', θr θρανίο θranío 'school desk'

sp σπόρος spóros 'seed', sf σφυγμός sfigmós 'pulse', st στην stin 'in', sθ σθεναρός sthenarós 'courageous', sk σκύλος skílos 'dog', sx σχεδόν schedón 'almost', sn σνομπ 'snob', sl σλάβος slávos 'Slav'

zv σβούρα svúra 'spin', zɣ σγουρός zɣurós 'curly' zm σμήνος zmínos 'swarm'

xt χτένα xténa 'brush', xθ χθες xthes yesterday, xn χνάρι xnári 'trace', xl χλωμός xlomós pale, xr χρήσης xrísis 'use'

ɣð γδέρω γðérno 'I skin', ɣn γνώμη ɣnómi 'opinion', ɣl γλυκό ɣlikó 'sweet', ɣr γύρορα ɣrígɔra 'fast'

Phonotactics in Greek: complex onsets

Obstruent + sonorant complex onsets

frequent: pl, kl, fl, xl, pr, tr, kr, fr (*tn)

rare: (pn), (kn) (θn), (fθ), (θl) xn

Besides obstruent + sonorant complex onsets, sonority plateaus are tolerated in the onset

[pt] in *πτήση* ptísi ‘flight’

[kt] in *κτήριο* ktírio ‘building’

[fθ] in *φθείρω* fθíro ‘impair’

[vɣ] in *βγάζω* vɣázo ‘remove’

[xθ] in *χθες* xθes ‘yesterday’

[mn] in *μνήμη* mními ‘memory’

Goad, Heather. 2011. The representation of sC clusters. In van Oostendorp, Marc, Colin J. Ewen, Elizabeth Hume and Keren Rice (eds). *The Blackwell Companion to Phonology*. Blackwell Publishing.

Tzakosta, Marina & Jeroen Vis. 2009. Phonological representations of consonant sequences: The case of affricates vs. "true" clusters. In *Proceedings of the 8th International Conference on Greek Linguistics*, 558-573. Ioannina: Department of Linguistics, University of Ioannina.

Phonotactics in Greek: complex onsets

Clusters of three consonants are also allowed both word initially and medially

Three consonant onsets typically of the sCC type:

spr:	σπρώχνω	[spró.xno]	‘push’
spl:	σπλήνα	[splí.na]	‘spleen’
str:	στροφές	[stro.fés]	‘curves’
skl:	σκληρά	[sklirá]	‘hard’
skr:	σκρίνιο	[skrí.no]	‘kind of cupboard’
skn:	σκνίπα	[skní.pa]	‘gnat, midge’
sfr:	σφραγίδα	[sfra.jí.ða]	‘stamp’

Prefix + onset (sC clusters): sp, st, sk, sf, sx, (sθ), (sm), (sn), *sl, *sr

Longer clusters are rarer, but possible, normally at morphological boundaries and only medially, e.g. [xθr] as in εχθρός [exθrós] ‘enemy’, [kstr] as in εκστρατεία [ek + stratía] ‘campaign’.

Holton, David, Peter Mackridge, Irene Philippaki-Warburton. 2004. *Greek: An essential grammar of the language*. London: Routledge.

Holton, David, Peter Mackridge, Irene Philippaki-Warburton. 2012. *Greek: A comprehensive grammar*. London: Routledge.

Phonotactics in Greek: Coda

Codas are maximally simple (Kappa 1997: Greek is a language with primarily open syllables that only exceptionally admit codas.)

In word-final position: only [s] or [n]: σκύλων [sci.lon] ‘dogs.GEN.PL.’

[s] is more frequent than [n]. [n] is often dropped, or there is final [e]-epenthesis: γράφουνε [γράfune] instead of formal γράφουν [γράfun] ‘they write’

Word medially: also [l] and [r]

άλμα [ál.ma] ‘jump’ κέρμα [cér.ma] ‘coin’

Syllabification is sometimes variable (Nina Topintzi, p.c., also Kappa, p.c.): [‘as.tro] or [‘a.stro] ‘star’

[lis’tis] ‘burglar’, [as’falia] ‘security’, [ek’tos] ‘except’, [‘pextis] ‘player’, [riθ’mos] ‘rhythm’

Topintzi (2022):

Loanwords, acronyms or onomatopoetic forms allow complex codas:

σοκ [sok] ‘shock’, [snob] and [znob] σνομπ ‘snob’, [bar] μπαρ ‘bar’, [boks] μποξ ‘boxing’

ΟΠΑΠ [opáp] ‘Greek Organisation of Football Prognostics (acronym)’, μαμ [mam] ‘munching sound’, τανκ [taŋk] ‘tank (combat vehicle)’ φιλμ ‘film’

Phonotactics in Greek: complex onsets

‘Legal’ clusters, attested word-initially: [zm], [ɣn], [θn], [xn], [pn], [tm], [kn]

‘Illegal’ clusters, not attested w.i.: [vm], [ɣm], [ðm], [vn], [ðn], [fn], [θm], [xm], [tn], [km]

Legality	Cluster	C.C	.CC
Not attested word-initially	[vm]	65	32.5
	[ɣm]	51.25	48.75
	[ðm]	65	33.75
	[vn]	68.75	31.25
	[ðn]	65	35
	[fn]	58.75	41.25
	[θm]	72.5	27.5
	[xm]	68.75	31.25
	[tn]	60	40
	[km]	71.25	28.75
Attested word-initially	[zm]	50	48.75
	[ɣn]	62.5	37.5
	[θn]	53.75	46.25
	[xn]	50	48.75
	[pn]	50	50
	[tm]	62.5	37.5
	[kn]	61.25	38.75

Gratsouni, Dimitra & Nina Topintzi. 2020. On the syllabification of ON (Obstruent-Nasal) clusters in Greek. *Studies in Greek Linguistics* 40: 105-113.

Phonotactics in Greek: syllable boundaries

Word-internal syllable boundaries also respect word-initial consonant clusters

kt: νεκταρίνια	[ne.kta.rí.nia]	‘nectarine’
θμ: βαθμός	[va.thmós]	‘degree’
st: ζεστό	[ze.stó]	‘warm’
str: αστραπή	[a.stra.pí]	‘thunder’
spr: άσπρος	[á.spros]	‘white’

Double consonants in the orthography correspond to a single consonant. There is no geminate and no ambisyllabicity:

κόκκινο	[kó.ki.no]	‘red’
μέλισσα	[mé.li.sa]	‘bee’
άλλος	[á.los]	‘other’
Ελλάδα	[e.la.ða]	‘Greece’

Phonotactics in OT: Onsets first

Onset Maximization and hiatus resolution translate in OT into the constraint ONSET

ONSET: Syllables have onsets

This constraint is often in conflict with faithfulness constraints, especially in words starting with a vowel: *apple* in English and *αίμα* [é.ma] ‘blood’ in Greek. There is no repair in these languages: onsetless syllables are allowed.

MAX-IO : No deletion

For every instance α of the segment S in the input, assign a violation-mark if there is not an instance α' of S in the output, such that $\alpha \mathcal{R} \alpha'$.

(Each segment in S_1 has a correspondent in S_2 (S_1 is input and S_2 is output).)

DEP-IO : No epenthesis

DEP-IO: For every instance α' of the segment S in the output, assign a violation-mark if there is not an instance α of S in the input, such that $\alpha \mathcal{R} \alpha'$.

(Each segment in S_2 has a correspondent in S_1 (S_1 is input and S_2 is output).)

Phonotactics in OT: Onsets first

	/VCV/	MAX/DEP	ONSET	NoCODA
☞	a. .V.CV.		*	
	b. .VC.V.		**!	*!

αἷμα [é.ma] ‘blood’

ONSET has an effect in /VCV/ sequences: they syllabify as Candidate a. in all languages (everything else being equal). Onset Maximization is also a direct effect of these constraints. The Emergence of the unmarked (TETU ‘stubborn’ in French in Prince & Smolensky) predicts that a constraint can be low ranking, but that it can nevertheless have an effect.

Onset is obligatory in Maba, Klamath and Arabela. Onset may be complex in Arabela, Dutch, Spanish, Finnish, Greek and English. It may not be complex Hawaiian and Klamath: NOCOMPLEXONSET.

Phonotactics in OT: Codas

NOCODA: Syllables have no coda.

This constraint is higher ranking in Greek than in English.

NOCOMPLEXCODA is undominated in Greek

Codas are not allowed in Hawaiian, Arabela and Fidjian.

Codas may be complex in French, English and Klamath; they are disallowed in Italian, Spanish, Japanese and Greek.

Which consonant is allowed as coda in a specific language must be parametrized by special constraints.

Greek and English: differences in syllabification

Greek has *enchânement* thus codas of syllables functioning as onsets of vowel-initial words, like in French (example from Nespor & Vogel 1986:215)

(Στην Ελλάδα ο κόσμος δεν είναι μαθιμένος να πίνει καφέ μετά το φαγητό),

(stin elaða o kosmos ðen íne maθi me nos na píni kafe metá to fajitó),

‘In Greece people are not used to drinking coffee after meals.

σ σ σ σ σ σ σ σ σ σ σ σ σ σ σ σ
 //\ | / / | / \ \ / \ / \ | / / / / | \ / | / / / / |
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σ σ σ σ σ σ
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 m e t á t o f a j i t ó

σ σ σ σ σ σ σ σ σ σ σ σ σ σ σ σ
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 s t i n e l a ð a o k o z m o z ð e n í n e m a θ i m e n o z n a p í n i k a f e

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Summary: syllabification in Greek and English

English has no *enchânement*. It aligns ends of words and even morphemes with syllables.

(subordinate)_ω
[sə.'bɔr.də.nət]

((sub)_ω (optimal)_ω)_ω, submarine, sub.lease
[sΛb.'ɔp.tə.məl]

(enable)_ω
[ə.'neɪbɫ]

((un)_ω.(able)_ω)_ω
[Λn.'eɪbɫ]

Differences between English and Greek in the syllable:

Both have complex onsets, and a prefix [s],

English also has complex codas, but Greek only has simple codas

We will see in Presentation 6 that resyllabification is the rule in Greek, in inflection and derivation. This is a major property of Greek but not of English that has implications for the Prosodic Word.