1. Prosodic hierarchy, prosodic constituents and Strict Layer Hypothesis

Indirect reference hypothesis (Inkelas & Zec 1990): there is a prosodic representation mediating between syntax and phonetics. Phonological rules and generalisations do not apply directly on syntax (or semantics), but apply in prosodic constituents. Morpho-syntactic units are mapped to prosodic units of different sizes, even if the mapping is not always strictly one-to-one (Nespor & Vogel 1986, Selkirk 1980, 1984, 1995, 2011, Truckenbrodt 1995, 1999 and many others). Mismatches between syntax and prosody are common. There are fewer prosodic than syntactic units, and prosodic structure is organised in a flatter way.

(1) Prosodic hierarchy

\[ \begin{align*}
\text{\( \nu \)} & \quad \text{utterance} \quad \text{(corresponds roughly to a paragraph or more)} \\
\text{\( \iota \)-phrase} & \quad \text{intonation phrase} \quad \text{(corresponds roughly to a clause)} \\
\text{\( \Phi \)-phrase} & \quad \text{prosodic phrase} \quad \text{(corresponds roughly to a syntactic phrase)} \\
\text{\( \omega \)-word} & \quad \text{prosodic word} \quad \text{(corresponds roughly to a grammatical word)} \\
\text{\( F \)} & \quad \text{foot} \quad \text{(metrical unit: trochee, iamb…)} \\
\text{\( \sigma \)} & \quad \text{syllable} \quad \text{(strings of segments: CV, CVC, …)} \\
\text{\( \mu \)} & \quad \text{mora} \quad \text{(unit of syllable weight)}
\end{align*} \]

(2) Strict Layer Hypothesis (SLH, Nespor & Vogel 1986:7, Selkirk 1984) as a tendency:

**Principle 1.** A given nonterminal unit of the prosodic hierarchy, \( X_p \), is composed of one or more units of the immediately lower category, \( X_{p-1} \).

**Principle 2.** A unit of a given level of the hierarchy is exhaustively contained in the superordinate unit of which it is a part.

(3) Big birds don’t fly

(4) Miss Sarah called Jim’s stepson last week
Prosodic constituents may be universal, but not all languages treat all constituents alike. (As an example, even if syllables seem to be universal, some languages do not refer to them in any phonological rule, see Hyman on Gokana)

2. Results of the syntax-prosody interface

The syntactic component is submitted to an algorithm – a set of rules or constraints – the aim of which is to map a prosodic structure to it. Theoretical issues relate to the way this correspondence is formulated as well as to the resulting prosodic constituency.

![Diagram](image)

(5) \(((\text{Good})_{\text{AP}} \text{ novels})_{\text{DP}} \quad \text{(read)} \quad \text{(easier)}_{\text{AP}})_{\text{VP}}\)

Two big categories of approaches: relation-based and edge-based (ALIGN)

(6) Alignment
a. ALIGN(XP, Φ, L), ALIGN-XP,L
   The left edge of a syntactic XP must be aligned with the left edge of a Φ-phrase.
b. ALIGN(XP, Φ, R), ALIGN-XP,R
   The right edge of any syntactic XP must be aligned with the right edge of a Φ-phrase.

Align constraints favour iteration/sequences of prosodic domains by letting the edges of Φ-phrases falling together with the edges of syntactic phrases, at their beginning or end. In other words, alignment partitions a sentence into a sequence of Φ-phrases corresponding to syntactic phrases (at least at one edge).

![Diagram](image)

(7) ((Miss Sarah)$_{\Phi}$ (called Jim’s stepson)$_{\Phi}$ (last week)$_{\Phi}$)

(8) Predictions of AlignR
a. Miss Sarah$_{\Phi}$ (called Jim’s stepson)$_{\Phi}$ last week$_{\Phi}$
b. Miss Martin$_{\Phi}$ went to the market$_{\Phi}$ with a basket full of eggs$_{\Phi}$
c. The girl who wears a shirt that she just bought$_{\Phi}$ wants to become a lawyer$_{\Phi}$
d. That the weather$_{\Phi}$ will improve$_{\Phi}$ is not sure$_{\Phi}$

(9) With exhaustive parsing
a. ((Miss Sarah)$_{\Phi}$ (called Jim’s stepson)$_{\Phi}$ (last week)$_{\Phi}$)
b. ((Miss Martin)$_{\Phi}$ (went to the market)$_{\Phi}$ (with a basket full of eggs)$_{\Phi}$
c. (((The girl who wears a shirt that she just bought)$_{\Phi}$ (wants to become a lawyer)$_{\Phi}$)
d. (((That the weather)$_{\Phi}$ (will improve)$_{\Phi}$ (is not sure)$_{\Phi}$)
English is a language with lexical stress and relational prominence: Liberman (1975), Liberman & Prince (1977), Pierrehumbert (1980), Halle & Vergnaud (1987) and many others. Culminativity: there is a single head in every prosodic domain.

Do we need recursivity in the prosodic structure? Probably.

3. Syllables ($\sigma$) and moras ($\mu$)
3.1 Syllables in English and Japanese

(a) Miss Martin went to the market with a basket full of eggs

(b) 'stormed'
In Japanese (see Trubetzkoy 1939, Kubozono 1999:31), moras are more important in phonology than syllables. The following words feel the same, they all contain 4 moras.

(15) a. to-o-k'o-o  `Tokyo'
b. a-ma-zo-n  `Amazon’
c. a-me-ri-ka  `America’

Phonological operations demonstrate the relevance of moras in Japanese: blends, compensatory lengthening, substitution errors and perceptual units are all mora-based, see Kubozono (1999, 2008). But nevertheless, the syllable is necessary: It is crucial to know which segments form the rime of the syllable in order to know which are moraic: in loanwords, the word accent is assigned to the syllable carrying the antepenultimate mora.

(16) Accent assignment in Japanese loanwords
a. /dóràma/ do.ra.ma ‘drama’
   /rekóodo/ re.ko-o.do ‘record’
   /sutoráiki/ su.to.ra-i.ji ‘strike’
b. /puráton/ pu.ra.to-n ‘Plato’
   /pokétto/ po.ke-t.to ‘pocket’

(17) a. myá-n.ma-a ‘Myanmar’
    ró-n.do-n ‘London’
    wa.sí-n.to-n ‘Washington’
b. sá-j.pi-a-n ‘Saipan’
    su.pá-j.da-a ‘spider’
    de.zá-j.na-a ‘designer’
c. sá-g.k.a.su ‘circus’
    pé-g.pi-a-a ‘paper’
    pí-j.na.tu ‘peanut’
d. só-k.ku.su ‘socks’
    de.rá-k.ku.su ‘deluxe’
    pí-ť.tya-a ‘pitcher’

Moras are not counted in all languages: French for instance treat all syllables alike.

3.2 Syllables in French
Core syllables have the structure in (18), where neither the nucleus nor the coda are allowed to branch. It is thus assumed that the syllable rhyme is maximally binary. This is partly in accordance with the analysis proposed in Dell (1995), except for the fact that Dell considers all final consonants as extrasyllabic, thus that French does not accept any codas, whereas the analysis proposed here allows for a coda after a short vowel.

(18) Core syllables

\[
\begin{array}{c}
\text{Onset} \\
\text{Nucleus} \\
\text{Coda}
\end{array}
\]
Additional consonants project a so-called semi-syllable (sometimes called degenerate syllable), which consists of an onset only. Evidence for this analysis is the fact that segments of rising sonority can project a semi-syllable, but not segments of decreasing sonority. Phonetically all final consonants are part of the final coda. However, the fact that they easily become real syllable in allowing an epenthetic schwa, can be taken as evidence that this analysis is on the right track. Compare siècle, aigle without schwa with le siècle des lumières, l’aigle noir with schwa.

\[(19)\]
\[
\begin{array}{ccc}
\text{Core syllable} & + & \text{Semi-syllable} \\
\sigma & & \sigma \\
/ & \setminus & | \\
\text{Onset} & \text{Rhytme} & \text{Onset} \\
/ & \setminus & / \\
\text{Nucleus Coda} & \\
\text{f} & \text{c} & \chi & \text{t} & \text{(forte)} \\
\text{u} & \chi & \text{s} & \text{(ours)} \\
\text{k} & \text{a} & \text{t} & \chi & \text{quatre} \\
\text{a} & \text{v} & \text{b\v} & \text{(arbre)} \\
\text{sj} & \varepsilon & \text{kl} & \text{(siècle)} \\
\varepsilon & \text{gl} & \text{(aigle)} \\
\end{array}
\]

The taking over of semi-syllables into the syllable theory has the consequence that all syllables of French obey the Sonority Sequencing Principle formulated in (20)a. The sonority hierarchy is shown in (20)b.

\[(20)\] Sonority
\[a.\] Sonority Sequencing Principle
The most sonorous segment of a syllable is the nucleus. From the nucleus to the edges of the syllable, segments have a decreasing sonority.
\[b.\] Sonority Hierarchy

<table>
<thead>
<tr>
<th>Stops</th>
<th>Fricatives</th>
<th>Nasals</th>
<th>Liquids (l r)</th>
<th>Glides</th>
<th>Vowels</th>
</tr>
</thead>
</table>

Onsets can be empty in French, which implies that they are optional. They can be occupied by a single consonant or by a complex one, as shown in (21).

\[(21)\] Onsets:
\[a.\] Stop +
\[\cdot\] Fricative: only marginally possible: ps (psychologie, pseudo, psaume)
\[\cdot\] v: p\v (près), t\v (trois), k\v (cri), b\v (bras), d\v (drap), g\v (gras)
\[\cdot\] l: pl (plat), kl (climat), bl (bleu), gl (glace)
  (The lack of tl and dl is systematic: *[cor + cor])
\[\cdot\] w: pw (pois), tw (toi), kw (quoi), bw (bois), dw (doigt), gw (gouache)
b. Fricative + • θ: fθ (frère), vθ (vrai)
   • l: fl (fleur), vl (Vladimir)
   (The lack of sl, l, zl and ʒl is systematic: *[kor + kor])
• w: fw (foie), vω (voie), sw (soie), zw (zouave), ɻw (choix), ʒw (joie)
• η: fη (fuite), (vη (Vuiton)), η (suite), ύ (chuinter), ʒη (juillet)
• j: tj (tiers), bj (bien), dj (diable), (gj)(Enghien)
   (The lack of kj and gj is systematic: *[dors + dors])
Moreover: gʁw (groin), bʁɥ (bruit), plɥ (pluie), tʁw (trois), plw (ploie)

b. Fricative + • θ: fθ (frère), vθ (vrai)
   • l: fl (fleur), vl (Vladimir)
   (The lack of sl, l, zl and ʒl is systematic: *[kor + kor])
• w: fw (foie), vω (voie), sw (soie), zw (zouave), ɻw (choix), ʒw (joie)
• η: fη (fuite), (vη (Vuiton)), η (suite), ύ (chuinter), ʒη (juillet)
• j: tj (tiers), bj (bien), dj (diable), (gj)(Enghien)
   (The lack of kj and gj is systematic: *[dors + dors])
Moreover: gʁw (groin), bʁɥ (bruit), plɥ (pluie), tʁw (trois), plw (ploie)

c. Sonorant + • w: mw (moins), nw (noir), lw (lof), ɻw (roi)
   • η: nη (nuit), lη (lui), ɻη (ruine)
• j: mj (miel), nj (Iranien), lj (lien), ɻj (rien)

Allophony between [w] and [u]: [w] is found only before [a] and [ɛ̃] while [u] appears only before [j]. All other vowels are excluded in these environments. It is not entirely clear whether the glides [j], [w] and [ɥ] are parts of the onset or parts of the nucleus.
Nuclei in French are optional, too, but only final syllables can have an empty nucleus, because semi-syllables are only allowed in the word-final position.
In (22), all phonetic complex codas are listed: those respecting the sonority hierarchy and those that do not respect it (and are analyzed as a syllable + a semi-syllable).

(22) Codas
a. Stop + Sonor.
   | Vson.stop | V_stop.son/Vson.st.son |
   | p η, l | harpe, Alpes | âpre, couple |
   | b η, l | Serbe, (Elbe) | arbre, cable |
   | t η, l | verte, (moultie) | quatre |
   | d η, l | garde | cadre |
   | k η, l | orque, calque | ocre, siècle |
   | g η, l | orgue, algue | aigre, aigle |
b. Stop + s
   | p s | laps |
   | k s | axe |
c. Fricative + Sonor.
   | f η, l | elf | moufle, offre |
   | s η, l | ours |
   | s m | matéralisme |
   | r l | merle |

Two kinds of consonant sequences, which are perfect from the point of view of the sonority, are nevertheless not allowed. First, a nasal plus consonant sequence is excluded: such a sequence is always realized as a nasal vowel plus a consonant. Second, glides stand alone in the coda. There is thus no complex coda involving a glide.
In French, sequences of segments can be resyllabified across word boundaries, as is well-known from the phenomena of liaison and enchaînement. Inside of a word however, onsets are maximized and the syllable contact law (Vennemann 1986) is respected. This law accounts for the fact that a word like adroit is syllabified in maximizing the onset segments of the second syllable thus delivering a.droit ([dr] is a possible onset) but a word like ardoise is syllabified in ar.doise since [rd] is not a possible onset. It would violate the Sonority Sequencing Principle.
Some dialects have preserved the vowel length contrast which is now lost in the standard dialect.

(23) Lexical contrasts in the vowel length (dialectal)

a. mis mie abîme abîme il île
b. cru crue venu avenue su sue
c. bette bête lettre l’être mettre maître
d. bout boue joug joue loup loue
e. mal mâle patte pâte sac Pâques
f. sot seau

4. Foot

The foot in English

(24) a. Trochee: récord noun, zéro, úrgent, sólid
b. Iamb: raccóon, corrúpt, complète, recórd verb, appéal
c. Dactyl: wónderful, élephant, cápital, ánagram
d. Anapest: rendezvóus, colonnáde, commandánt
e. Amphibrach: illúsion, tomáto, aróma, horizon, amázing, triumphant

The words in (25)a have penultimate stress, those in (25)b have antepenultimate stress, those in (25)c have final stress and those in (25)d have preantepenultimate stress with a secondary stress on the penultimate syllable.

(25) a. párrot, átom
b. é.le.phant, a.spá.ra.gus
c. ra.ccóon, ba.bóon
d. ál.li.gà.tor, dán.de.li.on

Regardless of their superficial structure, the words in (24) and (25) all have a trochaic structure, as shown in the next example.

(26) a. (récord), (párrot), (éle)phant, A(méri)ca
b. il(lúsion), to(máto), (Áugust)
c. rac(cóon), cor(rúpt), (hóle), bal(lóon), in(ténse)

Other facts also speak for a basic trochaic metrical structure of English. First, in long words, not only the last two syllables are organized in a trochee, but the preceding syllables also often are.

(27) a. (Missi) (síppi), (pára)(móunt), (nightín)(gâle)
b. (músic)/mu(sícian), (átom)/a(tòmi)(zátion), (mili)ta(rístic)

(28) Universal foot inventory (Hayes 1995, McCarthy & Prince 1986)

a. Syllabic trochee: (canonical form: σ σ)
b. Moraic trochee: (canonical form: µ µ)
c. Iamb: (canonical form: σ σ)
In many languages, the foot is the minimal part of a prosodic word. But again, stress may not be universal, and feet can have only a limited function in some languages, or not at all. In French, diminutives and hypochoristics have an iambic foot structure: Dodó, nounours, etc, but since there is no lexical stress in French, foot is not relevant for metrical reason.

5. Prosodic word

From \(\omega\)-word level on, prosodic domains are interface levels.

Proodic word in English

(29) Simplex \(\omega\): green, atom, raccoon, alpaca, rhinoceros, hippopotamus

(30) Complex \(\omega\)-words consisting of one \(\omega\)
   a. Derivation with stress-shifting (or class 1) affixes: atom-ic, music-al-ity, music-ian, picture-esque, Canton-es, lemon-ade
   b. Inflection: nut-s, boy-s, bush-es, laugh-ed, intend-ed, laugh-ing

(31) Complex \(\omega\)-words consisting of more than one \(\omega\)
   a. Derivation with stress-neutral (or class 2) affixes: penni-less, happi-ness, neighbour-hood, bank-less
   b. Compounding: blâckbird, pêticoat

(32) Foot structure of \(\omega\)
   a. \(((\text{nätion})_{\omega})_{\alpha} \rightarrow ((\text{nàti}o)_{\Omega} (\text{ná}lı)_{\Omega} \text{ty})_{\alpha}\)
   b. \(((\text{átom})_{\Omega})_{\alpha} \rightarrow (a(\text{tóm}i)_{\Omega}c)_{\alpha} \rightarrow ((\text{ató})_{\Omega} (\text{míci})_{\Omega} \text{ty})_{\alpha}\)
   c. \(((\text{mús}i)_{\Omega})_{\alpha} \rightarrow (\mu(\text{s}i)_{\Omega}cian)_{\alpha} \rightarrow ((\text{mùs}i)_{\Omega}(\text{cá}li)_{\Omega} \text{ty})_{\alpha}\)
   d. \(((\text{bóy})_{\Omega})_{\alpha} \rightarrow ((\text{bóys})_{\Omega})_{\alpha}\)
   e. \(((\text{búsh})_{\Omega})_{\alpha} \rightarrow ((\text{búshes})_{\Omega})_{\alpha}\)

(33) a. \text{mu.sic} + -’ian \rightarrow \text{mus.si.cian}
    b. \text{boy} + s \rightarrow \text{boys}

(34) Prosodic structure of complex \(\omega\)-words consisting of more than one \(\omega\)
   a. \(((\text{háppy})_{\Omega})_{\alpha} + ((\text{ness})_{\Omega})_{\alpha} \rightarrow ((\text{háppy})_{\Omega})_{\alpha} ((\text{ness})_{\Omega})_{\alpha} + ((\text{less})_{\Omega})_{\alpha}\)
   b. \(((\text{meter})_{\Omega})_{\alpha} + ((\text{like})_{\Omega})_{\alpha} \rightarrow (((\text{meter})_{\Omega})_{\alpha} ((\text{like})_{\Omega})_{\alpha})_{\alpha}\)

(35) a. \text{na.tion} + less \rightarrow \text{na.tion.less}
    b. \text{black} + \text{bird} \rightarrow \text{black.bird}

(36) Prosodic structure of complex \(\omega\)-words
   a. \((\text{nátion})_{\alpha} + (\text{al})_{\alpha} + (\text{ity})_{\alpha} + (\text{less})_{\alpha} \rightarrow (\text{nationálityless})_{\alpha}\)
   b. \((\text{síster})_{\alpha} + (\text{hood})_{\alpha} + (\text{like})_{\alpha} \rightarrow (\text{sísterhoodless})_{\alpha}\)

(37) Prosodic words arising in syntax
   (Pat’s)_{\alpha} (they’d)_{\alpha} (wanna)_{\alpha} (doesn’t)_{\alpha} (she’ll)_{\alpha}