Markedness and Formalising Phonological Representations[1]

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Haspelmath (2006) argues that the concept of markedness is confused and problematic. He urges linguists to dispense with the term. One principle criticism is that markedness solutions seem always to require further explanation rather than actually providing answers (Samuels 2011). Concordantly, Hale & Reiss (2000, 2008), pioneers of Substance Free Phonology (SFP) argue that markedness has no place in what should be a formal theory of linguistic *competence*, thereby excluding phonetics and diachrony. Accepting the significant merit of these strains of thought (and many of their conclusions), this paper shows that there *is* nonetheless space for a theory of markedness in formal phonology. By examining markedness from a highly representational viewpoint, I will show that 'markedness as complexity' does have an explanatory role, at least for syllable structure. I will demonstrate that markedness is explicable in terms of 'structural complexity' and 'length of description'. The core demonstration will be Charette's (1990, 1991, 1992) typology and analysis of consonant clusters (CCs). Her papers discovered important implicational universals she related these directly to representations. As well as enriching the typology, my contribution will be to arrange the principles and parameters into a decision tree that derives the implicational universals. I will demonstrate that the number of parameter settings (the depth in the decision tree) increases the markedness of the resultant grammar (cf. Ulfsbjorninn 2014). Each parametric 'yes' setting corresponds to an *extra* empty phonological category or *extra* ability to license in the representation. For this reason, markedness is not merely a 'metaphor' 'for a cognitive state' (Haspelmath 2006), it is directly convertible into linguistic categories. This markedness is still 'extra-grammatical'; it is not part of the computation of forms (*contra* Optimality Theory) and markedness statements cannot be re-ranked to obtain different grammars. However, markedness *is* one step in the chain of explanation for: (a) the apparent step-wise variation of complexity and implicational universals. (b) the Trubetzkoy hypothesis. I will defend markedness in the same terms as Gurevich (2001) criticises it: '[as a] an encoding of a universal 'naturalness' in the phonology'. Crucially, this naturalness is a product internal to the phonology (adjacency, licensing, parameter settings) and not grounded in phonetics.

[1] Thanks to Monik Charette, John Harris, Andrew Nevins, Tobias Scheer, Yuni Kim, Peter Szigetvari, Noam Faust and Edoardo Cavirani for their comments on this article at various stages of its preparation.

1 Introduction - finding a definition and a role for markedness

Samuel's (2011) summary of the use of the term markedness covers the main traditions in phonology, I present it with some minor alterations in (1) below.

(1) Some roles of markedness

(a) Prague School: Markedness is language specific.

(b) Sound Pattern of English: Markedness is innate and part of universal grammar.

(c) Calabrese (1988, 1995, 2005): Markedness is innate, pairwise and expressed in a universal feature hierarchy. Markedness is often grounded in the phonetics.

Format of marking statements (Calabrese 1995, cf. Dresher 2011)

[*αF, <u>βG</u>] / [___, X]

βG is not allowed in a context of a segment bearing αF and X. Where F and G are features; α and β are values + or –, and X is a set of feature specifications. (e.g. *[+back, <u>-round</u>] /___, [-low] therefore [-round] cannot be found on a segment that also contains [-low, +back]). However, this statement can be overridden in particular grammars because there is an implicit hierarchy of features against which contrast is assessed.

(d) Optimality Theory: Markedness is innate and part of universal grammar, markedness is stated directly in the grammar as a set of well formedness constraints: *NoCoda, *w. These can be overridden by their relative ranking to both other markedness and faithfulness constaints organized in a factoral typology.

More elaborate approaches (DeLacy 2006) separate *performance markedness* from *competence markedness* and rename markedness constraints as *output constraints* and establish universal markedness hierarchies, some of which can be in conflict, resulting in markedness reversals. These are usually grounded in the phonetics.

(e) Greenberg: Markedness exists for linguist's convenience.

(f) Natural Morphology: Markedness is neither part of UG, nor particular grammars, however, it is explanatory (and needs to be explained from without linguistics).

(g) General: Markedness is used in a non-technical sense to mean – difficult, dis-preferred, unnatural, rare, unexpected, bizarre, awesome, balls-y, far out.

This disagreement on the role or definition of markedness has lead to three influential papers taking issue with linguists' use of the term. Gurevich (2001) claims the label 'markedness' is often used as a 'cover term' when in fact it represents a multidimensional property outside of Universal Grammar. Hume (2004) finds that phonologists' use of the term is frequently paradoxical.[2] While it is implied from Haspelmath's (2006) discussion, that markedness is used in a confused way, Haspelmath (2006) also criticizes the term for its vagueness. Putting some order into things, Haspelmath (2006) helpfully categorises markedness into the following: (a) markedness as complexity, (b) markedness as difficulty, (c) markedness as abnormality and (d) markedness as a multidimensional correlation. Gurevich, Hume and Haspelmath all come to the conclusion that markedness is, in-and of-itself, a useless concept because, whatever truth it has illuminated as a heuristic, it needs reducing or explaining in terms of another force/concept/thing. Hume reassigns the useful aspects of markedness in terms of a different property: *predictability*.[3] This predictability is still located in the grammar, but as Samuel's (2011) notes, this predictability is probably syndromic of multiple underlying causes and is therefore just a 'pushing back' of the explanation. Meanwhile, Haspelmath suggests (but does not demonstrate) that the useful component of markedness ought to be replaced in terms of *frequency asymmetries*. As far as this turns out to be true[4], the explanation is somewhat circular and certainly not at its terminus. Because one is left to ask: what is responsible for the patterns in frequency? And why is frequency significant at all in the shaping of language in humans? Does the phonology have a 'natural' reaction to frequency, how did that get set up?

In terms of the role that markedness plays, Hume and Haspelmath both seem to suggest that the problem with markedness is its generality and undisciplined definition. If, however, markedness could be expressed in more formally satisfying terms there could be a place for it in the phonology. In fact, Hume's 'markedness as predictability' is still located in the phonological grammar, and Haspelmath's *frequency asymmetries* can be written into probabilistic grammars. Neither Hume nor Haspelmath have an *a priori* problem with markedness being expressed in the grammar[5], just with the reality of how this is done. In the next section, however, I discuss Substance Free Phonology (SFP), a framework which due to

[2] This is because unmarkedness refers to both segments that easily undergo neutralization, and others that are highly salient (and therefore resist neutralization).
[3] Potentially a very useful concept for segmental markedness – which is not the object of our paper.
[4] Frequency has become central to quasi-generative phonology (Turnbull 2015, Tang 2015).
[5] Said that, we all have our paralinguistic ideologies guiding our hopes and dreams of what language will look like.

its commitment to its formalism and modularity does *a priori* exclude (at least a certain definition of) markedness.

1.1 SFP, modularity and markedness

Substance Free Phonology (Hale and Reiss 2000, 2008) takes issue with attempts at locating markedness in the grammar. It is their view that phonology ought to describe *competence* and not the typological patterns obtained by diachrony and phonetics (*pace* DeLacy 2006). Phonological competence is necessarily formal, and, in line with modularity, it cannot contain material from another module. The features of the phonology cannot, therefore, have intrinsic phonetic content. Incidentally, this is also the conclusion reached by GP, worded in (3).

(2) "Phonology is epistemologically prior to the phonetics." (Reiss 2016)

(3) Phonological Epistemological Principle (PEP)- "The only source of phonological knowledge is phonological behaviour. Thus, phonetics […] plays no role in the postulation of phonological objects nor the interaction of such objects." (Kaye 2005)

Modularity: Phonology → Phonetics.

If what is expressed in (2) and (3) is correct, a truly formal theory of phonology cannot, by definition, contain *phonetically driven* markedness statements. Chomsky and Halle are clear on this point already in SPE. If the features of phonology did not contain intrinsic content then it would be possible to: "[…] systematically interchange features or to replace [αF] by [-αF] (where α is +, and F is a feature) throughout [the] description of English structure. [Without obtaining a] result [that] would be the description of a system that violates certain principles governing human languages".

Chomsky and Halle (1968) take this outcome as a "[…] failure to formulate the principles of linguistic theory, of universal grammar, in a satisfactory manner" and they then introduce universal markedness into the phonological component (Ch.9 of SPE). Hale and Reiss (2000, 2008), on the other hand, see this outcome as desirable. Agreeing with Fudge's (1967) that phonology ought to be 'a genuinely abstract framework', SFP holds that the limits on phonology ought to be 'what is computable' within the set of 'statable languages'.

(4) Hierarchy of Grammars (Hale and Reiss 2008, cf. Hall 2014)

Attested ⊂ Attestable ⊂ Humanly Computable ⊂ Statable

Attested : Cree type grammars, English type grammars.

Attestable: Japanese in 200 years, Joe's "English"

Humanly Computable: p → s / ___ r

Statable: V → V in prime numbered syllables

In this model, the markedness of certain typological patterns results from *production phenomena* such as the substantive limits imposed by diachrony, acquisition and phonetics (cf. Evolutionary Phonology (Blevins 2004)). There is, as it were, a possibilities space bounded by a formal envelope. Parts of that space are rendered unattestable by substantive restrictions. Also, because the causes of these unattested states are exterior to phonology, they should not be expressed within the phonology (Reiss 2016). Consequently, the SFP position is that although markedness might appear to be active in the phonology, it is not a property of the phonological module. Rather, the factors that make phonology appear to contain markedness are all expressed outside of the phonology.

2 Markedness and syllable structure

The SFP objection opposes the use of substantive facts in influencing what must be a formal and abstract component (it entails a violation of modularity (phonology → phonetics)). However, if markedness could be demonstrated to be a formal I-property[6], it *would* clearly have a role in the phonological component.[7]

Syllable structure offers a tantalizing case study for phonological markedness because its highly constrained variation naturally lends itself to parametric analysis. Haspelmath (2006) discusses Blevins' (1995) typology of syllable structure. She reduces syllable structure to six parameters, four of which are listed in a table quoted by Haspelmath as part of this discussion.

(5)	Complex nucleus	Obligatory onset	Complex onset	Coda
Totonac	yes	yes	yes	yes
Klamath	yes	yes	no	no
English	yes	no	yes	yes
Cayuvava	no	no	no	no

[6] I-property as in a module *internal* component (cf. I-language vs. E-language) (Chomsky 1986).
[7] Or some more specific replacement of markedness (cf. Hume 2004, and Haspelmath 2006).

Blevin's parametric approach opens itself to a theory of markedness because the 'no' settings correspond to unmarked states while the 'yes' settings increase the markedness.[8] Initially, this looks like a good contender for an example of phonologically internal, formal markedness. However, Haspelmath is able to dispute it. This is because it is not obvious into what linguistic categories the markedness can be translated. Take for instance the comparison of Blevin's **Coda** and **Onset** parameters. **Coda** is stated positively, so that a 'yes' will give a more marked state (You want a coda? Yes = marked). While **Onset** is expressed (essentially) negatively, so that a 'yes' will also give a marked state (You want *not* to have an onset? Yes = marked). This is not dissimilar to the opposite statement of Onset and Coda parameters familiar from OT (Onset, NoCoda). We show the parameters and their relationship to markedness in (6) beneath. Notice how their markedness is not located in the representation or linguistic categories. If the markedness is to be stated at all, it is as a second order description (the basis for which might be sought for in the phonetics).

(6) First order description

(a) First order description

Parameter	**Markedness Implication**
NO CODA	Presence of a linguistic category (a Coda) makes structure marked
ONSET	Absence of a linguistic category (an Onset) makes structure marked

(b) Second order description

Onset > Coda = Onsets are less marked than Codas (explanation in the phonetics)

The second order description comes in the form of a markedness hierarchy (Onset > Coda) that would be listed in the grammar and does not reflect any inherent property of the linguistic categories it references.

This mismatch of parametric and representational complexity comes from the insufficient representational framework that has been chosen. When we select a better representational system, that of Strict CV, there is no need for a second order description to express the implicational universals: 'if Coda then Onset', and 'if Empty Onset then Onset'.

[8] Satisfyingly, the 'yes' value is analogous to the presence of an extra property. Therefore, the more properties the more marked a state is. This is precisely the definition of markedness we expand on.

Before showing this, we briefly introduce Strict CV's main representational assumptions for those not familiar with the framework.

Strict CV conforms to general autosegmental principles, it has two independent tiers of representation, one is the skeletal structure and the other is the melody (features). Where Strict CV strays from general assumptions is its notion that the fundamental unit or building block of syllable structure is the CV (Lowenstamm 1996). It is like Clements and Keyser's (1983) CV phonology in that regard, except with an obligation that could be expressed in precedence terms as: V prec %, C prec V, # prec C. This means that all word-final consonants end in empty nuclei and all vowel-initial words begin in empty onsets.[9],[10]

In this system therefore, codas are C slots found before empty V slots, while onsetless syllables are empty C slots found before filled V slots (we show this in (7) and (8)).

(7) 'coda' [sɛ**n**tənə**l**]

C	V	**C**	**v**	C	V	C	V	**C**	**v**
|	|	|		|	|	|	|	|	
s	ɛ	**n**		t	ə	n	ə	**l**	

(8) 'onsetless syllable' [ɒtə] 'otter'

c	V	C	V
	|	|	|
	ɒ	t	ə

In (9), I reformulate the table of the syllable structure parameters and their markedness implications but, because the table is based on Strict CV representations, this time the table shows a positive correlation between the parameter setting and linguistic categories.

[9] This is a condition inherited from Government Phonology (Kaye et al. 1990; Charette 1991).
[10] Empty categories are written in small caps : c (empty C), v (empty v).

(9) First order description

Parameter	Markedness Implication
(NO) CODA	Presence of an empty category (v), more marked
Empty Nucleus <yes, no> 'yes' leads to more marked status	
(OBLIGATORY) ONSET	Presence of an empty category (c), more marked
Empty Onset <yes, no> 'yes' leads to more marked status	

As shown in (9), the onset and coda parameters are translated into Empty {onset, nucleus} <yes, no>. These are not differentially valued (positive, negative) (*contra* their incarnation in OT and Blevins (1995)). In GP terms, the marked representations involve *licensing* the empty structure and the grammar therefore requires additional parametric settings to do it. The more 'yes' parametric settings required, the more marked the language.

In this system, a positive setting for both Onset and Coda parameters leads to a more marked state (cf. Blevins 1995). But here Haspelmath (2006) cannot claim that the parametric 'markedness' is a just a 'metaphor referring to cognitive states' that does not relate to linguistic categories, because the markedness of the parameters *are* echoed in linguistic (representational) categories: the empty nucleus and the empty onset. Moreover, because the expression of markedness is directly legible from the phonological representations, it should satisfy the SFP requirements for a formal, abstract, internal phonological definition of markedness.

2.1 Formal markedness in phonology

The formal markedness that is described in these sections is still extra-grammatical in the sense that the phonological derivation does not consult the markedness statements in order to evaluate between output forms. Neither are there output markedness constraints in this sense (*contra* DeLacy 2006).

Markedness in this model is an epiphenomenon, translatable as 'extra licensing or empty categories'. Or better, because the emptiness is the non-default state and extra conditions are required to achieve it, the markedness is expressed as 'complexity' of description. This is broadly consistent with the markedness definition to be found in Chomsky (1964), where it corresponds with 'length of description' (Cullicover 2013). This is also the definition of markedness used by Roberts and Holmberg (2010) who apply it to similar (if not identical) syntactic parametric arrangements. The purpose of this markedness in the linguistic system is to aid language acquisition, because it: "guides the learner in formulating hypotheses about what the grammar is for a given body of data. The learner is itself oriented towards the maximally unmarked formulation consistent with the data" (Cullicover 2013).

The underpinning of this notion of complexity shares 'conceptual underpinnings' with non-linguistic conceptions such as Kolmogorov complexity (Cover et al. 1989), and minimum description length (MDL) (Grünwald 1996). In fact, MDL is particularly close to the markedness definition offered in this paper. This is because MDL has redundancy and specification as a core component of the system:[11] "the more redundancy there is the simpler the description of the grammar. The more idiosyncracy there is, the more complex the description of the grammar" (Cullicover 2013).

Though it sounds like this approach calls for the expulsion of markedness from the phonology because the markedness is measured in a method that is not non-specifically linguistic (MDL could measure complexity any system), it would be entirely misguided to say that the phonological component (its representations and parameters) had no role in establishing the markedness. This is because it is the phonology that is being measured. Therefore, though markedness is emergent, it emerges from the shape of the phonological component.

Therefore (as has been said), 'markedness as complexity' is not in the grammar of a language, but it is a feature of the phonological module. It is opportune at this juncture to separate the concepts of phonological grammar and phonological module because they are often confused. A phonological grammar is a list of the idiosyncratic properties that are needed for a specific language. In addition to this, there is also a phonological component, the nature of which is shared by all languages. This division is explicit in Clements' (1986) discussion of the association convention. On this definition, and against OT especially, markedness is not in the

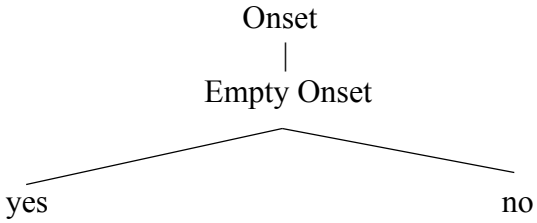
[11] In my model this refers to parameter values and licensing status, not of features (the reader should not think this refers to the theory of featural underspecification).

'grammar' of any language. Markedness cannot be re-ranked or consulted as part of the derivation; it is not output driven or phonetically motivated or teleological. However, markedness is epiphenomenal from the structure of the parameters and the representations. That is to say, *it is a property of the phonological component*.

In this sense, markedness (reducible as complexity or length of description) is explanatory – at least it forms part of the chain of explanation of universal properties of syllable structure. These properties are the implicational universals of this domain.

Returning to the formalization of syllable structure, the parameters given in (10) spontaneously provide a explanation for the following implicational universals: 'if a language has empty onsets, it has filled onsets', and 'if a language has vowel-initial words, it has consonant-initial words'.[12] This is because **ONSET** is a principle and has no decision point (onsets are a 'default'). Therefore, as is shown in (10), both settings of **EMPTY ONSET <yes, no>** are contingent on the presence of **ONSET**.[13]

(10)



The implicational relationship may be epiphenomenal from the wording of the parameters, it is also not an architectural condition, but it is a formal consequence of the shape of the phonological component's parameters.

Elsewhere, the same interplay of parameter and representational structure can be used to explain the following implicational universal: 'if a language has word-final consonants it has word-final vowels'. Before we explain how this works, a quick digression is needed to motivate this implicational universal as there is one widely cited counterexample. Yapese is a language that is reported to have only consonant-final words (cf. Côte 2011, and references within). However, this actually results from a phonological rule that *deletes* word-final short vowels. Underlying long vowels are not deleted, they are merely shortened (ibid.). Therefore at no level

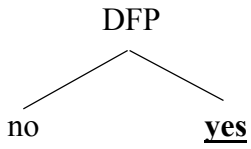
[12] Arrernte does not constitute the only exception to the universal presence of CV syllables (Topintzi 2010; Kiparsky 2013).
[13] When parameters are referred to in prose, they are capitalized and in bold face.

does Yapese violate the implicational universal. Underlyingly there are words with final long and short vowels, while on the surface there are words that end in a consonant or a short vowel.

I now return to the explanation of the implicational universal that 'word-final consonants imply word-final vowels'. In Strict CV *all* words end in a skeletal V position (V prec %). This means that word-final singleton consonants are always phonologically represented with a final V position that is exceptionally licensed to be empty (therefore phonetically invisible). The parameter that dictates this kind of licensing is called the *Word Final Parameter* or the *Domain Final Parameter* (Kaye 1990; Harris and Gussmann 2002). I opt for the latter term and abbreviate it as DFP. As we demonstrate in (11), domain final consonants are one step more marked than word final vowels. These words must contain an empty category with its special form of licensing. Fittingly, this representational option corresponds to an extra 'yes' setting in the parameters.

(11) [pɒsəm] 'possum'[14]

C	V	C	V	C	**v DFP**
|	|	|	|	|	
p	ɒ	s	ə	m	



We again see that markedness is representationally correlated with empty categories for which there must be extra licensing. This extra licensing increases the length of description. Both the increase in structural complexity and length of description are entirely internal to the phonological component.

In the next section we will speculate on the reason for the positive correlation between markedness and the emptiness of categories. We will then continue with a case study of markedness and syllable structure: the distribution and typology of consonant clusters (CCs).

2.1.1 Speculation on why markedness = emptiness

The fact that emptiness equates with increased markedness might have something to do with the fact that the SM interface is principally concerned with externalization. In Strict CV, at least in the way that I understand it, the interface of the phonology to the phonetics runs through the skeleton. The CV tier is the locus of the operation Parse and the features that are not linked to the CV skeleton are stray erased, by which what is meant is that they are never shipped to the

[14] P-licensed V slots (phonologically marked as non-transducible) are in small caps.

phonetics.[15] As is shown in (12), the final <t> of the root /petit/ 'small' is only pronounced when it is associated with a skeletal position, either in the feminine form or when a following vowel-initial word supplies a position.

(12) /petit/ 'small' (French)

(a) [peti] /peti<t>/ 'small.M'

C	V	C	V	
|	|	|	|	
p	e	t	i	t

(b) [petit] 'small.F'

C	V	C	V	C	v
|	|	|	|	|	
p	e	t	i	t	

(c) [petitami] /peti<t> ami/ 'boyfriend.M'

C	V	C	V	+	C	V	C	V
|	|	|	|			|	|	|
p	e	t	i	t		a	m	i

So we see that the two tiers of representation have a defined role with regard to parse (and phonetic transduction). If melody is not attached to skeletal structure, there can be no externalization.

It makes sense, formally speaking, that an optimal[16] externalizing system should be set up to produce outputs and that the parts of representations that do not produce outputs are specially licensed by extra-grammatical means.[17] This is not a violation of modularity or a phonetic motivation in an important sense; it describes the internal mechanisms of phonology in relation to its interface property.

[15] One clear counterexample to this is downstep, a tonal process by which a non-associated L tone can nevertheless lower subsequent (associated) high tones (Salffner 2003). Clearly more work needs to be done in this area, but it is interesting that it should be a tonal process that violates this condition (particularly given the anecdotal 'anything you can do I can better' nature of tonal vs. segmental phonology (Larry Hyman p.c.)).
[16] In the (Chomskyan) minimalist sense.
[17] Cavirani and Oostendorp (this volume) also pursue this direction with a form of morphosyntactic licensing.

There is reason to suspect that the phonological module is set up to ship information to the next module. The interface component of phonology is still part of the phonology. It is the part of the phonology that decides what information gets shipped to the next module (phonetics), and how and when. This does not mean that we can propose that there are phonetic features in the phonology (this would violate modularity) but we can suppose that the phonology is set up to produce forms for transduction.

By definition, empty (p-licensed) are not merely *illegible* to the phonetics, they are *not transducible,* they are not even shipped to the phonetics. In GP and Strict CV, featurally empty syllabic positions have (a language specific) phonetic interpretation. Therefore, if a vowel is not pronounced in correspondence with a nuclear position, information about that nucleus never reached the phonetics. Therefore, when the phonological module label parts of the representation as non-transferable, this is (a) its own module's business, and (b) it is more special than having objects for transfer. One can assume that transfer of skeletal positions for phonetic transduction is automatic in GP and for a skeletal position not to be shipped to the phonetics requires a special inhibition. This inhibition is extra licensing (extra statements in the representation). It is for this reason that empty onsets and nuclei (that are never shipped to the phonetics) are more marked than their filled counterparts. The representation contains objects and its forces (structural relations). Licensing is a force and therefore part of the representation; consequently, it adds to the structural description of that representation.

3 Consonant clusters and markedness

So far, I have shown that syllable structure does point to the presence of markedness in the phonological module (defined in terms of complexity). In previous sections we demonstrated this objective's 'proof of concept' with two implicational universals: 'if a language has vowel initial words it also has consonant initial words' and 'if a language has consonant final words it also has vowel final words'. In order to cement the claim that syllable structure implies a formal theory of markedness, we turn to a self-contained case study: the formal description of consonant clusters (CCs).

Consonant clusters are a good case study for this paper because they are an aspect of phonology that is prototypically 'marked'.

In typology, it is frequently claimed that the only universal syllable structure is CV and consonant clusters (CCs) have a clear and direct relationship to complexity (descriptively establishing these kinds of complexity metrics for syllable structure (WALS syllable structure

(Maddieson 2013))). This is often done in highly informal terms that cannot possibly refer to phonological competence. For instance, consonant clusters are described in terms of 'number' of Cs in clusters: CC, CCC, CCCC, CCCC. This 'counting' of adjacent CCs has even been written into the widespread Optimality Theory constraint *CCC. The model we propose has no need for such a counting constraint.

Similarly, a good amount of work in the first language acquisition of phonology has focused on CC development. The key observation is that children's phonological representations start simple and become complicated in terms of CCs and prosody (Fikkert 1994; Levelt et al. 2000). This increase in complexity has been explained in terms of markedness. In OT terms, all structural constraints such as markedness constraints and syllable structure constraints, start out ranked higher than all faithfulness constraints (Demuth 1995; Gnanadesikan 1995; Levelt 1995; van Oostendorp 1995; Boersma 1999). Conversely, language pathology has shown that CCs are systematically and (often categorically) lost in various kinds of linguistic pathologies. The output of the pathological phonology is often explicitly referred to as reducing in markedness (Grammatical SLI (Marshall et al. 2003; van der Lely 2005; Gallon et al. 2007 and Harris et al. 2007) and aphasia (Romani and Calabrese 1998; Ulfsbjorninn 2009).

First language acquisition and linguistic pathology have the opposite relationship with respect to phonological/syllable structure complexity. This forms the basis for one of the core markedness observations: the *Trubetzkoy's hypothesis*. Paraphrased it observes that pathological states of speech follow simplification trajectories that mirror complexification in first language acquisition (Trubetzkoy 1939).

To some extent, Trubetzkoy believed that markedness was grounded in the phonetics: 'articulatory and especially acoustic phonetics, phonological statistics and functional load' (Gurevich 2001). [18] Even though this impression is potentially overemphasized in Gurevich (2001), it is irrelevant to this paper because the connection between acquisition, pathology and typology that I present here is stated in exclusively formal phonological terms. Whether this approach is successful is a matter for the next section.

[18] A marginal case is his theory of phonological combinatoriality which is phonologically abstract, though still in a sense grounded in the phonetics.

3.1 Syllable structure markedness and CCs

3.1.1 CV

It is *not* true that CV is (universally) the most phonetically optimal syllable organization. In fact, laterals, taps and trills, retroflexes, the glottal stop and (perhaps) pharyngeals are best heard in a post-vocalic context: VC. To a lesser extent, even oral stops are best heard in a V1CV2 context where the listener can benefit from both the formant transitions *exiting* V1 and the burst characteristics *entering* V2.[19] Regardless, it remains a fact that every human language has #C initial words and *no* language has exclusively #V initial words[20]. Moreover, no language has obligatory word-final consonants, or a condition banning word-final vowels, or (as a reviewer suggests) a process that adds a consonant to all vowel-final forms.

These typological observations are recapitulated in acquisition and pathology. It has long been observed that vowel-initial words are relatively late in child acquisition ([**æ**bəkə**s**] 'abacus' > [bakə]. These are also systematically targeted for deletion 'errors' in pathological phonologies, especially when they are unstressed ([**ə**raiv] 'arrive' > [raiv]).

In section (2.1), it has already been demonstrated that licensing parameters reflect this markedness and that these parametric states correspond to extra licensing or extra empty categories in the Strict CV representations. Given this representation we can say, with some confidence, that there is a formally definable universally unmarked structure: CV.

3.1.2 CCs

This section turns to the relative markedness of CCs. As part of this demonstration, I will not discuss the phonology of s+C clusters, these deserve their own full length discussion (cf. Kaye 1992; Vaux 2009; Sanoudaki 2007; Tamburelli et al. 2015, on the 'special' nature of s+C(C) clusters). The discussion also does not include CCs produced by synchronic syncope: [pteɪrou] *p'tato* 'potato'. These are the products of a phonological rule, they are phonetic outputs, therefore there is no *phonological* cluster to describe (*contra* Reiss' (2016) who uses them as evidence against formalizing CC phonotactics). In this chapter I do not discuss CCs formed by the post-lexical juxtaposition of phrases because these are probably invisible to each other in terms of phonological domains/phases. Another very good reason for using mostly monomorphemic clusters is that they produce consistent patterns that seem to underpin a

[19] This is partly why the primers for learning the IPA give CV and VCV structures: '[ɭa]… [aɭa]'.
[20] A lexicon made up minimally of the VCV shape. Aranda is not a counterexample – at the very least because 25% of words begin with consonants (Breen and Pensalfini 1999) as well as some loanwords (that do not even have a prosthetic phonetic schwa) (Kiparsky 2013)).

formalized system. A good example of the necessity of this is supplied in Harris (1994) work on CCs in English.

Starting with the onset (again with the exception of 's'), there is a hard limit on *two* consonants (tr, pl, kl, θr…). However, when it comes to the coda the number of Cs varies wildly if examples are drawn exclusively from monomorphemic forms or not. Word-finally, if cross-morphemic CCs are counted, one can achieve as many as four Cs in a coda: [traijʊ**mfst**] '(thou) triumphedst' (or the famous three-member [sɪ**kths**] 'sixths'). Meanwhile, the number of C's in a monomorphemic word-medial coda is sobering, only one consonant is permitted: ca**r.**pet, pu**l.**pit, a**c**.tor.[21]

Elsewhere, if the monomorphemic word-final position is investigated, it reveals that the maximum number of consonants is two: ra**nd**, plu**mp**, ca**rd**, sphy**nx**, bi**nge**. Or is it one? As Harris (1994) notes, the cluster phonotactics of these monomorphemic complex codas are structurally identical to word-internal rime-onset sequences. It stands to reason therefore that these word-final complex codas have the same syllabification as rime-onset sequences. The formal advantage of this approach is two-fold. Firstly, it unifies the phonotactic conditions on clusters. Secondly, it means that the number of Cs in a coda in English is not variably one or two depending on position in the word, but it is always limited to 1: ra**n.**d, plu**m.**p, ca**r.**d, sphy**n.**x, bi**n.**ge. The only obstacle to this simple analysis is that there is not a phonetically visible final vowel in these forms, but this assumes that word boundaries and syllable boundaries ought to be coextensive, however, (as John Harris p.c. notes) this is far from obvious. Indeed, if these are supposed to be two different phonological levels there should be even less expectation that they would *necessarily* overlap.

Another added benefit to this syllabification (which is highly relevant for the rest of the paper) is that, following Charette (1990), it means that the CCs are always composed of two members: a head and a dependent. In rime-onset sequences the head is on the right, while in branching onsets the head is on the left.[22, 23] Preempting the analysis a little bit, we will call branching onsets: Indirect CCs, and coda-onset clusters: Direct CCs.[24]

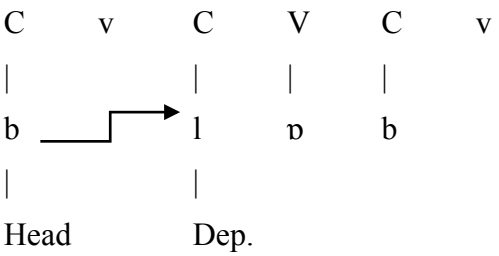
[21] The only apparent exceptions are the products of compounds or compounds lexicalized into proper names etc… whi**rl**wind and Ca**rl**ton, Pli**mp**ton.

[22] We use a Strict CV notation while the authors would have used Standard GP representations with branching constitutents. For those readers familiar with GP and Strict CV, I note here that throughout this paper we will be using GP's standard licensing assumptions (Government Licensing) on a Strict CV representation (Cyran 1998).

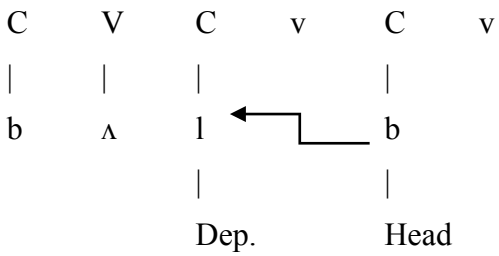
[23] There are other representational hypotheses about branching onsets (Lowenstamm 2003), but this view is not hugely widespread and its discussion would distract from the point that I am presenting here.

[24] Readers not familiar with the GP literature might want to 'play along' by figuring out the meaning of the label 'Direct' and 'Indirect'.

(13) Branching onset [blɒb] ‘blob’



(14) Coda-onset [bʌlb] ‘manta (ray)’



Harris (1990) and Charette (1990) would have us notice that the head in both types of CC consists of a consonant stronger than its dependent.[25] In GP terms, the Head governs the dependent.

Typologically, these cluster types are prone to simplification. Take for example Middle Indic Prakrit that became Šuḍḍha Sinhala. Indirect CCs (and Direct CCs) were phased out to be replaced by a purely CV syllable structure either through deletion or epenthesis (Gunasinghe 1983): [pa**tr**ə] → [patə] ‘leaf’, [**pr**ija] → [(a-) pirija] ‘distasteful’. Later, in the 12th Century Sinhala incorporated a very large number of Sanskrit loans and reintroduced many CCs and geminates back into the language (ibid.).[26]

Similarly, in first language acquisition and pathology, it is these very same CC structures that are acquired relatively late in acquisition and destroyed in pathology: [kikɪ] ‘**cr**icket’ and [pætə] ‘pa**nth**er’. Ulfsbjorninn (2009) raises a particularly relevant case of pathological CC reduction. This paper describes the syllable structure pattern of a special Aphasic patient and it is particularly relevant to our discussion of markedness for two reasons. Firstly, the pattern of reduction is predictable from (13, 14) and it is consistent with the findings for SLI (Marhsall et al. 2003; van der Lely 2005 and Harris et al. 2007). Secondly, the CC simplification cannot be claimed to be phonetically motivated because the aphasic patient’s deficit was limited to ‘long words of more than 2 syllables’. Compounds where each part was less than two syllables but which were of equal syllable structure complexity were unaffected, showing that there was no physiological motivation for the cluster reduction.

[25] According to a complexity scale based on the number of features per consonant (Harris 1990).
[26] It would be possible to show how Modern Sinhala demonstrates the markedness we propose at work. It has reabsorbed a great deal of Sanskrit loanwords but only established Direct CCs not Indirect CCs. It did recomplexify, but it settled in a less marked state than the spellings and words it was reintroducing justified. We present Colloquial Modern Sinhala in section (4.2).

(15) Syllable structure (elicitations from picture naming task)

(a) Compounds with Indirect CCs

[æpu**tr**i:] ‘apple **tr**ee’.[27]

(b) Indirect CC reduction

[pəpɛlə] ‘**pr**opeller’

[kæri, kærə] ‘**cl**arinet’

(c) Direct CCs retained, Indirect CCs lost

[kæntə] ‘deca**nt**er’

[fəmiŋgəu] ‘**fl**ami**ng**o’

This section establishes a rather ‘typical’ argument for syllable structure markedness, achieved by observing CCs in typology, acquisition and pathology. We will now explain the pattern in terms of a special arrangement of principles and parameters.

3.2 Formalising a typology for CCs

Charette (1990, 1991, 1992) demonstrates something rather unexpected about consonant clusters. The distribution of CCs in the word is correlated with three factors: (a) the status of the nucleus that follows the CC, (b) the position of that nucleus in the word, and (c) the type of cluster being licensed, Direct or Indirect.

Taking English as an example language, the Direct CCs (standardly referred to as ‘falling sonority clusters’, ‘rime-onset sequences’, ‘heterosyllabic clusters’) are only possible when the nucleus to their right is filled (16a-b), unless that empty nucleus is domain final (16c).[28]

(16) Direct CC distribution in (rhotic) English

(a) Rightward nucleus is medial

Filled: [pʊ**lp**ɪt] ‘pulpit’

C	V	**C**	**v**	**C**	**V**	C	v
|	|	|		|	|	|	
p	ʊ	l		p	ɪ	t	

[27] The ‘u’ in app**le** tree is a dialect appropriate contextual vocalization ‘l’.

[28] For those who know the GP literature, the nucleus needs to be non-p-licensed or properly governed. Meaning, it must not be labelled as invisible to the phonetics (making sure it has no phonetic interpretation). For convenience of the non-GP reader we will call v̲s that are marked as being invisible to the phonetics as ‘empty’ and Vs that do get read by the phonetics for interpretation as filled.

(b) Rightward nucleus is final

Filled: [ha**rpi**] ‘harpy’

C	V	**C**	**v**	**C**	**V**
|	|	|		|	|
h	a	r		p	i

(c) Empty: [fa**rm**] ‘farm’

C	V	**C**	**<u>v</u>**	**C**	**<u>v</u>**
|	|	|		|	
f	a	**r**		**m**	

Conversely, what we are calling Indirect CCs (standardly referred to as ‘rising sonority’, ‘branching onsets’, ‘tautosyllabic clusters’) can occur only when the nucleus to their right is filled. This is demonstrated beneath.

(17) Indirect CC distribution

(a) Rightward nucleus is filled: [ɒkrə] ‘okra’ (cf. ‘harpy’ (16b))

c	V	**C**	**<u>v</u>**	**C**	**V**
	|	|		|	|
	ɒ	k		r	ə

(b) Rightward nucleus is empty: *[kætr] ~ [kætrə][29] (cf. ‘farm’ (16c))

C	V	**C**	**v**	**C**	**v**
|	|	|		|	
k	æ	t		r	

The full distribution of CCs in English words is presented in (18 and 19) beneath. They are laid out according to their type (Direct, Indirect), with respect to the status of their following nucleus (Filled, Empty), and the position of that nucleus (Medial, Final).

[29] This could be an English L2 attempt to recreate the French [katr] ‘four’

(18) Direct CC distribution

(a) Before filled nuclei

Initial	Medial	Final
no	yes	yes
*rtap	ma**rti**n	bu**lk**

(b) Before empty nuclei

Initial	Medial	Final
no	no	yes
***rt**pa	*ma**rt**ni	mi**nt**

(19) Indirect CC distribution

(a) Before filled nuclei

Initial	Medial	Final
yes	yes	yes
train	pe**tro**l	ma**cro**

(b) Before empty nuclei

Initial	Medial	Final
no	no	no
***tr**nai	*pe**tr**lo	*pe**tr**

Quebec French has the same pattern as English with one exception: Indirect CCs are permitted before word-final empty nuclei: [ka**tχ**] *qua**tre*** ‘four’ [su**pl**] *sou**ple*** ‘supple’. In another dialect, Morin’s French, Direct CCs are additionally found before medial empty nuclei: [po**ʁʃ**ʁi] ‘pig sty’ (cf. Quebec French [po**ʁʃə**ʁi]). Other grammars have other conditions and differences. These patterns are collated in the following table (20). Côte d’Azure French, Pulaar & Colloquiam Modern Sinhala, and Korean & Pohnpeian are new to the discussion, the data for these systems is introduced in their relevant sections.

(20) CCs typology correlated with state of rightward nucleus

		Filled Nuclei				Empty Nuclei			
		Medial		Final		Medial		Final	
		Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
1	Yoruba & Ewondo	no	no	no	no	no	no	no	no
2	Pulaar & Sinhala	yes	no	yes	no	no	no	no	no
3	Côte d'Azur FR	yes	yes	yes	yes	no	no	no	no
4	Korean & Pohnpeian	yes	no	yes	no	no	no	yes	no
5	English	yes	yes	yes	yes	no	no	yes	no
6	Quebec FR	yes	yes	yes	yes	no	no	yes	yes
7	Morin's FR	yes	yes	yes	yes	yes	no	yes	yes
8	Polish	yes	yes	yes	yes	yes	yes	yes	yes
		A	B	C	D	E	F	G	H

The table is arranged by ascendant complexity. Starting with the most unmarked state (Yoruba) and ending with the most marked state (Polish). The variation is complicated because it could be stated as three overlapping waves.[30] The patterns are isolated in (21).

(21) Major patterns

(a) Empty implies Filled

Filled boxes are almost all 'yes', while the Empty boxes contain many 'no's

Filled boxes start to show 'yes' on row 2.

Empty boxes only start to show 'yes' on row 4.

Conclusion: *Filled nuclei are stronger licensors than empty nuclei.*

[30] In fact there is a predicted pattern that's missing: a language with no Indirect CCs at all which also has Direct CCs but only before word-final filled (non-p-licensed) nuclei.

(b) Medial Empty implies Final Empty

Final Empty starts to show 'yes' setting at 4, G.

Medial Empty starts to show 'yes' setting at 7, E.

Conclusion: *Final empty nuclei are stronger licensors than Medial empty nuclei.*

(c) Indirect implies Direct

In Final Empty –	Direct (G)	starts to show 'yes' setting at 4.
	Indirect (H)	starts to show 'yes' setting at 6.
In Medial Empty –	Direct (E)	starts to show 'yes' setting at 7.
	Indirect (F)	starts to show 'yes' setting at 8.

Conclusion: *Indirect CCs need a stronger licensor than Direct CCs.*

The conclusions listed in (21) lead to the following implicational universals that need to be explained by the parametric theory that we will propose.

(22) Implicational relationship and markedness

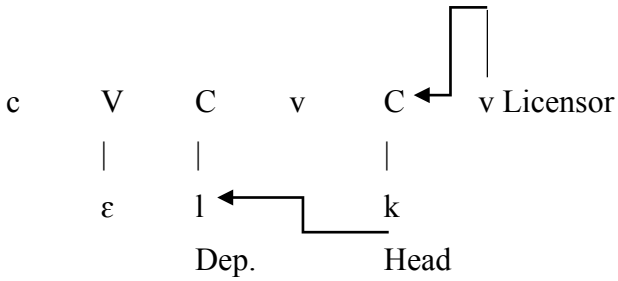
	Implicational Relationship	Markedness
(a)	If **Empty** then **Filled** licensor	Empty over Filled
(b)	If **Medial Empty** then **Final Empty** licensor	Medial over Final
(c)	If **Indirect** then **Direct** clusters	Indirect over Direct

The core of Charette's analysis involves exactly these two asymmetries. The strength of the category that provides the licensing for the CC, paired with the inherent difficulty of licensing one type of CC over another.

Now it will become obvious why the terms *Direct* and *Indirect* are used. Charette (1990) observes that there is one fundamental representational difference between Direct and Indirect CCs relative to their licensor. The head of the Direct CC is always *adjacent* to its licensor. While the head of the Indirect CC is never adjacent to the head of the Indirect CC. This difference is shown in (23) beneath.

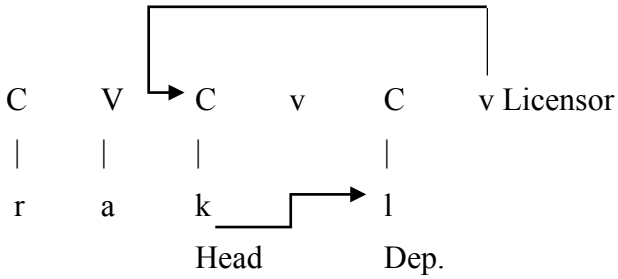
(23) Direct Government Licensing

Other names: *RT, Transconstituent government, heterosyllabic CC, coda-onset cluster, cluster of equal or falling sonority.*



(24) Indirect Government Licensing

Other names: *TR, Constituent government, tautosyllabic CC, branching onset, complex onset, cluster of rising sonority*.



For Charette (1990, 1991), the fact that the head of the cluster is adjacent to its licensor in Direct CCs explains, in a formal and phonologically internal way, why these are less marked than Indirect CCs. It also explains the implicational universal: **Indirect iff Direct**. If a nucleus is strong enough to license indirectly (non-adjacent Cs), it must also be strong enough to license directly (adjacent Cs). The inverse, from a formal perspective would have no coherent meaning.

3.3 Decision trees, empty nuclei and licensing in Strict CV

Ulfsbjorninn (2014) formalizes the parametric interaction discovered by Charette (1990, 1991, 1992) in terms of a decision tree.[31]

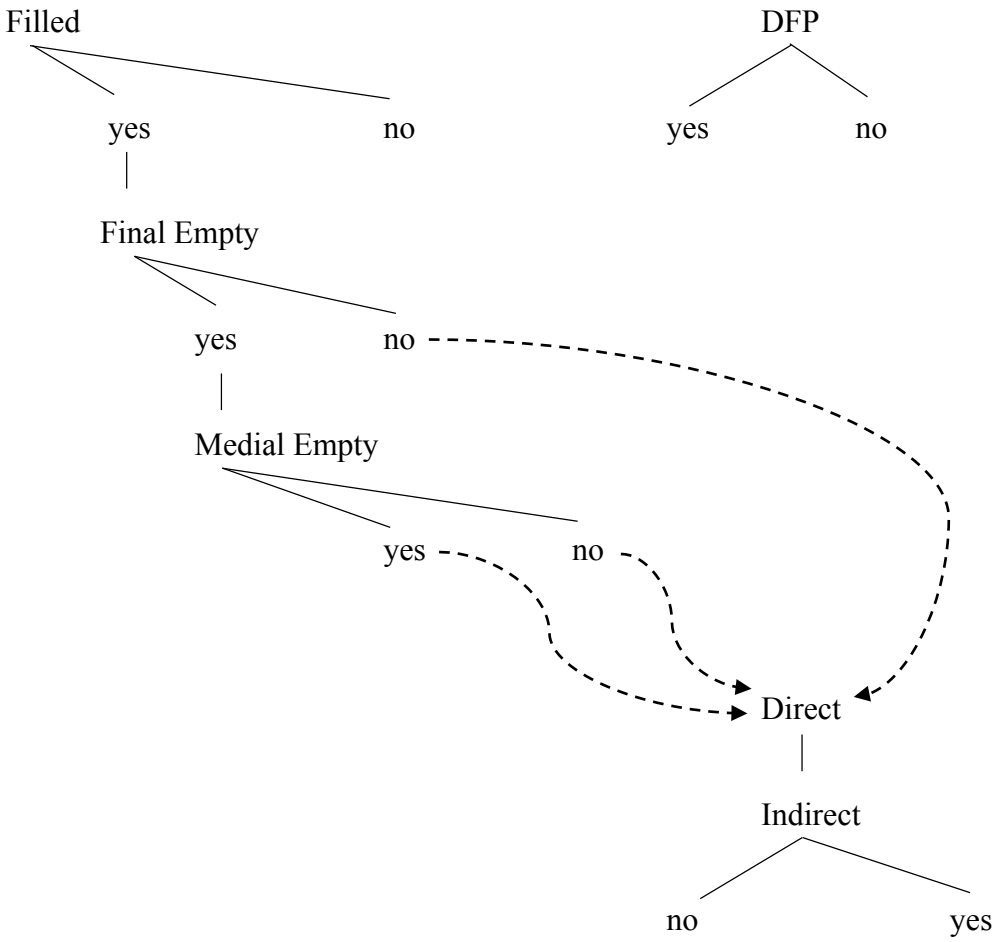
The typology that we presented as the table in (20) can be explained in terms of a decision tree where the depth of the tree equates with the number of parameter settings. In this model, the amount of 'yes' settings equates with the 'parameter depth' required to obtain a

[31]Though in Ulfsbjorninn (2014) the main focus is to then apply this kind of parametric structure to prosodic structure.

given grammar. This is positively correlated with markedness in the sense that it is explanatory of the typology and the relationship that typology has with acquisition and pathology.

(25) Government Licensing Parameters (decision tree)[32]

(a) CC parameters (b) Domain final parameter



This parametric approach to markedness is not merely located in what Haspelmath (2006) refers to as 'cognitive states', but it is directly legible from the phonological representations that correspond to these parametric settings. Each 'yes' setting corresponds with an extra empty category or extra licensing in the representation.

To explain how the decision tree operates and how it relates to markedness. We will show the stepwise increase in markedness grammar by grammar, starting with Yoruba and ending with Polish.[33]

[32] The choice of Direct vs. Indirect are here presented as subordinate to the Goverment Licensing parameter stack (starting with Filled). Direct has no decision point because if GL is possible at all it must be Direct.
[33] Not all the steps are shown, but enough to demonstrate the principle.

4 Demonstration, P&P decision tree and stepwise increase in markedness

4.1 CV only

It is considered a hard typological universal that CV is the only syllable type shared by all languages. It is generally taken to be a substantive Universal (Hyman 2008) but in Strict CV it does have a formal description. The only skeletal categories are C and V, therefore, CV.CV.CV$^{(n+1)}$ is the simplest syntagmatic contrast of this paradigmatic contrast.

The fact that the skeleton is universally CV and not VC does still need explaining: the V is the 'head/licensor' of C, in the sense that they are held in a lateral relationship (Scheer 2004).[34]

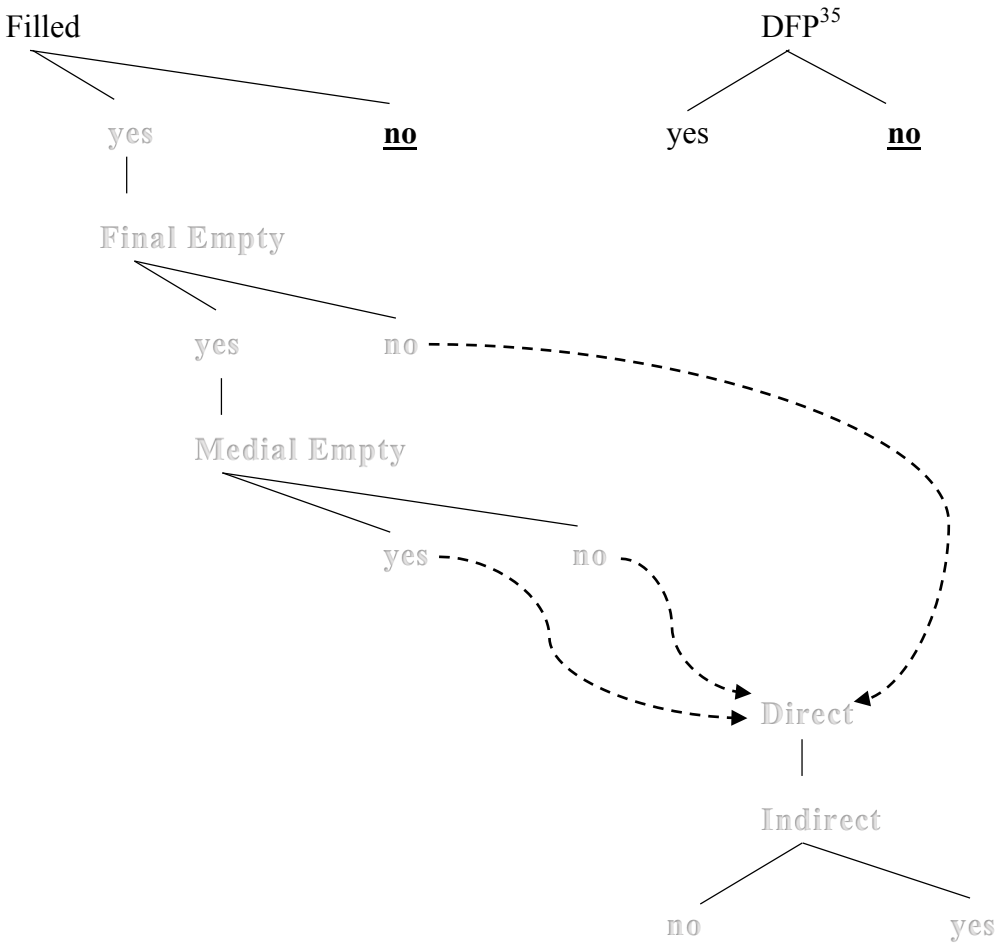
From a formal, phonologically internal representational perspective, CV is the least marked syllable structure. This does not, however, mean that it will be the most common language type. Markedness here refers to formal complexity and length of description, not the other categories of markedness identified by Haspelmath. There are (no doubt) many substantive facts that drive languages towards more complex syllable structures (the parameters we propose merely constraint the variation) but what can be demonstrated is that this structural simplicity of the representation corresponds to the few parameter settings required to generate it. Moreover, the description of syllable structure complexity is the same in typology, acquisition and pathology.

For our purposes, the types of languages with only open (CV) syllables includes both the Yoruba and Ewondo types (Kaye 1990). There are no monomorphemic consonant clusters in either Yoruba or Ewondo type languages. Even under standard descriptions, Yoruba has no closed syllables. Ewondo, on the other hand, does have closed syllables under standard descriptions. The word-final Cs of Ewondo are entirely restricted to word-final position. It is therefore appropriate to analyse Ewondo as banning codas, while the word-final consonants are taken to be word-final onsets (products of the DFP, Section (2.1)).

The syllable structure parameter settings for Yoruba are shown in (26). The P&P decision tree means that once **FILLED <yes, no>** selects the 'no' setting, no further CC parameters are available to be set. The rest of the CC decision tree atrophies beneath the top parameter (this is shown in grey outline in the diagram).

[34] Taking the V as the licensor of the C in a CV is connected with the (perhaps surprising) fact that CC clusters are also licensed by their following V.

(26) Parameters for Yoruba



The most unmarked syllable structure state is a product of two separate 'no' settings. In terms of linguistic categories, this corresponds to the formally simplest syllable structure possible (CV), where no empty categories or extra licensing is required.

As has been said, Ewondo is also a CV only language, but it allows word-final consonants. This means that the domain final nucleus is allowed to be empty. This requires an extra empty category and extra licensing. Correspondingly, compared to Yoruba, Ewondo has just one difference in its syllable structure settings: **DFP <yes, no>** is set to 'yes'. This additional parameter positive parameter setting adds to the markedness of the language because it introduces final empty nuclei.

[35] In Yoruba the DFP is also set to 'no'.

4.2 Direct CCs before Filled not before Final Empty

The next level of complexity is represented by languages like Pulaar and Colloquial Modern Sinhala.

(27) Pulaar clusters (Niang 1997, glosses not given)

(a) Direct Medial Filled

hu**mtu**de (cf. Indirect *ma**t**rina)

(b) Direct Final Filled (glosses not given)

a**sk**o (cf. *ask)
hi**rd**e
a**wd**i

(28) Colloquial Modern Sinhala (Gunasinghe 1983)[36]

(a) Direct Medial Filled

[ka**lde:**rəmə]	‘cauldron’
[as**ʈa:**nə]	‘unfounded’
[a**wkə**nə]	‘place name’

(b) Indirect Medial Filled

*[**pr**ijə]	~	[pirijə]	‘beloved’
*[**kr**i:m]	~	[kirim]	‘cream’

(c) *Indirect Final Filled (and Direct Medial Filled)

*[was**ʈr**ə]	~	[was**ʈ**ərə]	‘clothing’

(d) *Direct Final Empty and Direct Final Filled

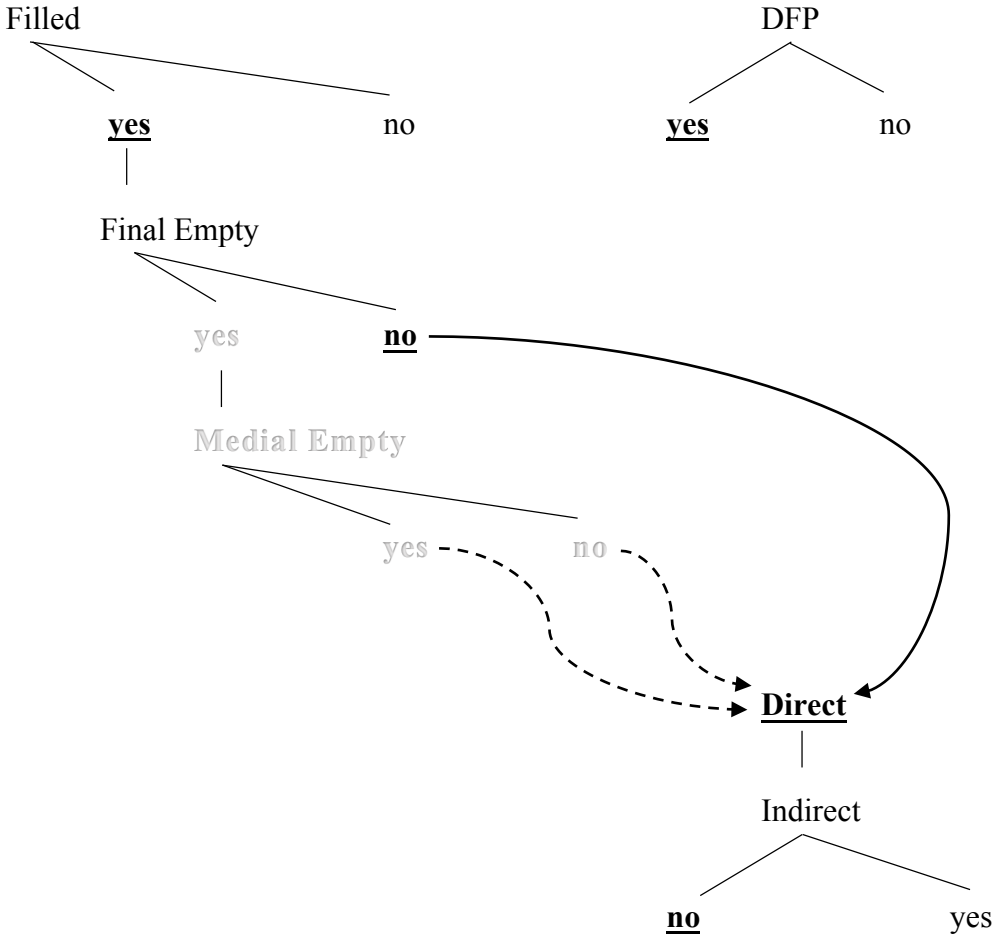
*[**ʈark**]	~	[**ʈarkə**]	‘argument’
*[ka**lp**]	~	[ka**lpə**]	‘eons’

[36] The source calls this version ‘uneducated’, however, this appears to mean the non-spelling ‘school’ pronunciation. The system we describe in this paper is the spontaneous speech of Modern Sinhala.

The pattern expressed in these languages is that Indirect CCs are never permitted. Direct CCs are permitted but only when they precede a filled nucleus. While there are word-final empty nuclei, Direct CCs may not be licensed in this position.[37]

When it comes to the distribution of Direct CCs, the Pulaar and Colloquial Modern Sinhala system is one parameter setting less marked than English. This is because English *does* allow Direct CCs to be licensed by word-final empty nuclei: stea**lth**, da**mp**, li**st**.

(29) Parameters for Pulaar and Colloquial Modern Sinhala



These parameter settings mean that while filled nuclei can license CCs, final empty nuclei cannot. As shown in the previous decision tree, this correctly kills off the path for parameters that dictate the medial licensing of CCs.

The setting of 'no' to **FINAL EMPTY <yes, no>** leads to **DIRECT**. This is a parameter without a decision point; it is a state, however, that can only be reached if the antecedent

[37] Like Pulaar, Colloquial Modern Sinhala has geminates and partial geminates (subtypes of Direct CC).

parameter (**FILLED <yes, no>)** is set to 'yes'. This system does not permit Indirect CCs therefore **INDIRECT <yes, no>** is set to 'no'.

This system, with its atrophied **MEDIAL EMPTY <yes, no>** center, is described by the setting of only one 'yes' CC parameter. The setting of only one 'yes' CC parameter keeps the system relatively unmarked. However, it is more marked than Yoruba or Ewondo which do not have any 'yes' settings in its CC parameters.

4.3 Indirect CCs but only before Filled

The next level of complexity is activated by languages such as Côte d'Azure French. This system has both Direct and Indirect CCs before filled nuclei but *neither* Direct or Indirect CCs are permitted before word-final empty nuclei, these must always be filled.

(30) Côte d'Azure French

(a) Direct before filled

*[pɔ**rʃ**ri]	[pɔ**rʃ**əri]	'pig sty'
*[ma**rg**rit**]**	[ma**rg**ərit**]**	'daisy'

(b) Indirect before filled

*[p^{w}a**tr**n]	[p^{w}a**tri**n]	'chest'

(c) Direct before empty

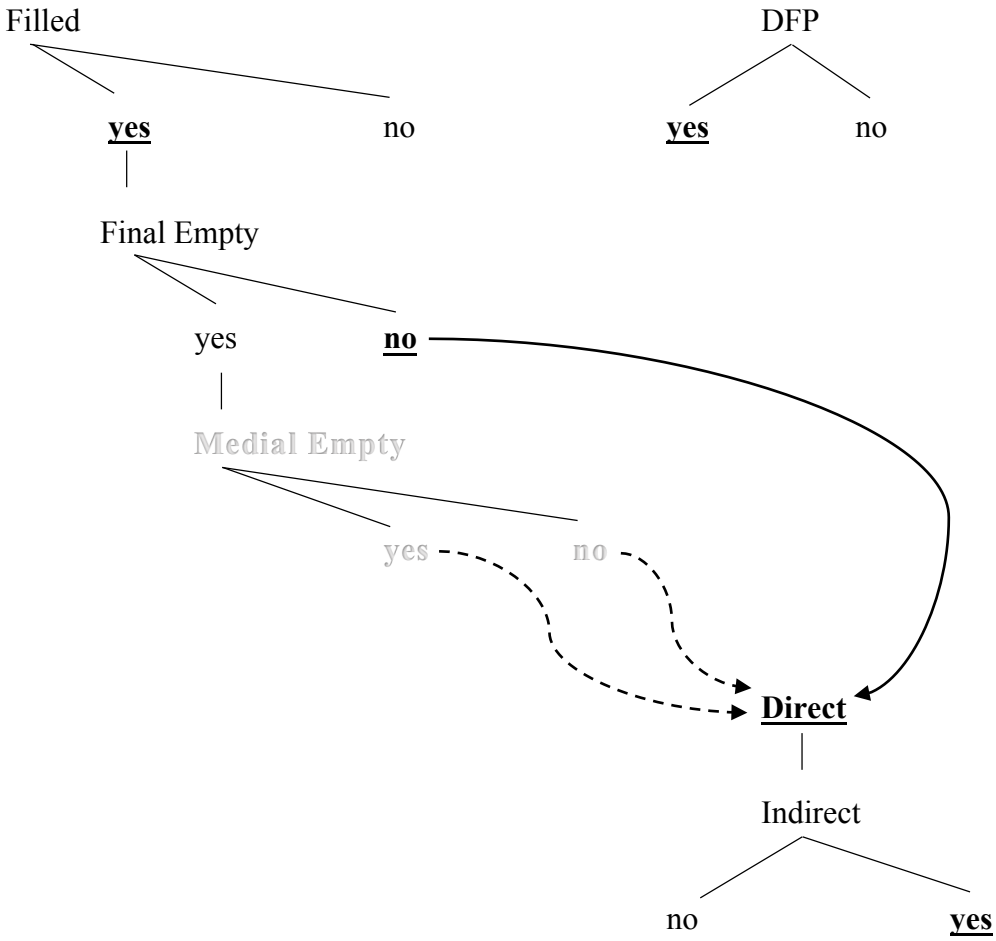
*[kart]	[ka**rtə**]	'card'

(d) Indirect before empty

*[katr]	[ka**trə**]	'four'

This system constitutes an addition in markedness to the Pulaar system, to which it is otherwise identical. It additionally allows the licensing of Indirect CCs before filled nuclei word-medially. This is dictated by the 'yes' setting to **INDIRECT <yes, no>**. The **MEDIAL EMPTY <yes, no>** parameter is atrophied just as they are for Pulaar.

(31) Parameters for Côte d'Azure French



4.4 Direct CCs also before Final Empty

Standard Korean (some speakers only) & Pohnpeian constitute a level of complexity that is, relative to one property, more marked than Pulaar. Meanwhile, for another property, it is less marked than Côte d'Azure French. Standard Korean and Pohnpeian do not have any Indirect CCs (unlike Côte d'Azure French). Direct CC's are also licensed by final empty nuclei (unlike Pulaar).

(32) Korean (Lee 1990)

(a) Direct Medial Filled

ka**m.d**ok	'manager'
cha**ng.s**o	'place'

(b) Direct Final Empty (some speakers only)

u**lp**-ta	u**lp**	'recite'
pa**lp**-ta	pa**lp**	'to step on'
ki-su**lk**		'mountain side'

(33) Pohnpeian clusters (Kennedy 2002)

(a) Direct Final Filled

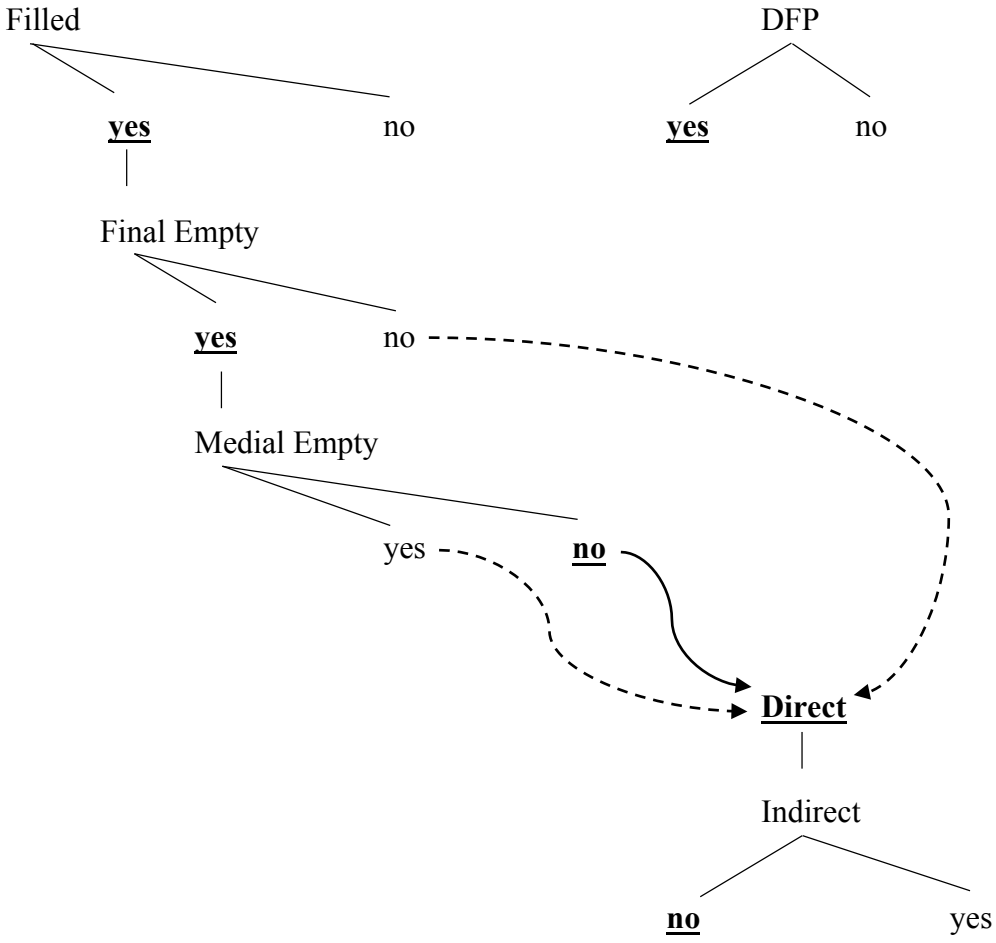
m^{w}e**ŋ.g**e	'eat'

(b) Direct Final Empty[38]

ma.ma**nd**	'tame'
le.le**ŋk**	'acrophobic'
ke.ke**ns**	'ulcerate'

In terms of markedness, this system is formally more complicated than Pulaar for its 'yes' setting to **FINAL EMPTY <yes, no>**. Though in another sense, it is less marked than Côte d'Azure French for its 'no' setting to **INDIRECT <yes, no>.**

(34) Standard Korean and Pohnpeian



[38] We know these nasal + consonant sequences are not complex segments, like presnasalised stops. The reduplicant selected identifies the base as containing a heavy syllable. The prosody identifies the nasal + consonant as a real cluster (in addition to the other clues – lack of voicing or continuancy assimilation) etc…

4.5 Fully marked

Polish represents a language with an extremely marked syllable structure. In fact, there are many cluster types that we will not discuss (s+C, and bogus clusters) because they deserve their own treatment ([**tkn**ina] 'laundry' (cf. Cyran and Gussmann 1999)). Polish is a language where Indirect CCs can be licensed by empty nuclei even word medially. Indirect CCs can be found both before filled nuclei, as in the nominative, and before empty nuclei, as in the genitive and other forms.

(35) Polish clusters

(a) Direct Final Empty

pa**rk**	'park'

(b) Indirect Final Empty

sios**tr**	'sister'

(c) Indirect Medial Filled (NOM) and Empty (GEN)

NOM	GEN	
pweć	**pw**ć-i	'sex'
brev	**br**v-i	'brow'
kref	**kr**f-i	'blood'

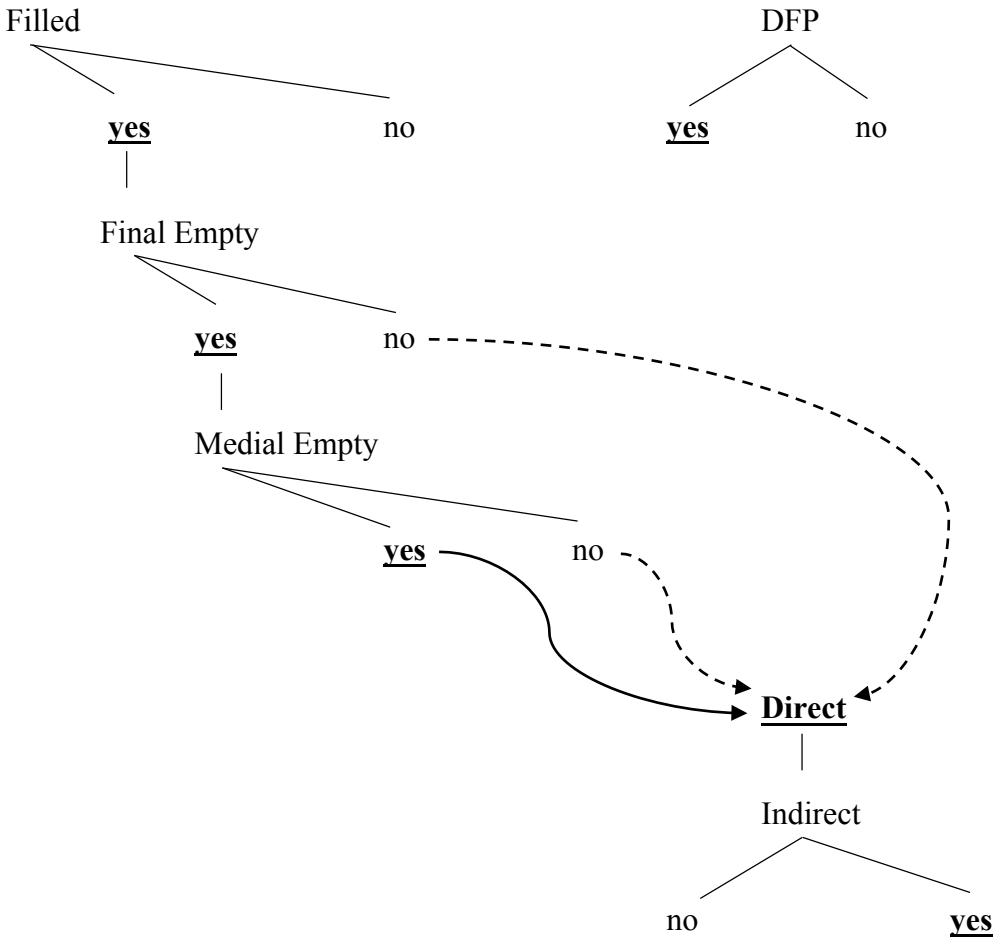
(d) Indirect Medial Empty (other forms)

brnąć	'plod'
krtań	'larynx'

The parameters needed to explain this highly marked state require many 'yes' settings and the whole of the CC decision tree. In fact, this is the most highly marked parameter setting possible.[39]

[39] Given this set of parameters. Examining different kinds of Direct cluster (geminate, partial geminate, s+C) will probably yield a larger parameter tree, with more settings and therefore more gradations of markedness.

(36) Polish CC parameter settings



Readers can play with the settings exhausting the statable CC grammars.[40] What we will now conclude with is a demonstration of how the decision tree arrangement of parameters gives the implicational universals that are observed with clusters.

5 Nodes in the decision tree and markedness

Essentially, the 'yes' setting nodes of the decision tree correspond to implicational universals.

(37) Implicational universals of cluster licensing

All other things being equal…

(a) If **Empty** can license then **Filled** can license
(b) If **Medial Empty** can license then **Final Empty** can license
(c) If **Indirect** can be licensed then **Direct** can be licensed
(d) If **Indirect** and **Direct** are licit, forms can have both CCs adjacent

[40] Note that this does not distinguish between the types of heterosyllabic clusters: geminates, partial geminates, RT clusters and TT clusters. This is deliberate because there is probably no *formal* way to distinguish between the markedness of different types of geminates, these are almost certainly substantive phonetic and diachronic factors (Blevins 2004).

The part of the P&P model that explains (37a) is right at the head of the decision tree. The parameters regulating the licensing potential of empty nuclei are contingent on **FILLED <yes, no>** being set to 'yes'. Because of this parametric arrangement, it is not possible to generate a grammar where empty nuclei license CCs but filled nuclei do not. This is also how (37b) is formalized, because **MEDIAL EMPTY <yes, no>** can only offer its choice of a 'yes' setting after passing through the 'yes' setting of **FINAL EMPTY <yes, no>**. The explanation for (37c) is that **DIRECT** inherently acts as a 'yes' setting, it does not offer a choice of 'no'. Crucially, the decision point for **INDIRECT <yes, no>** can only be accessed by the grammar by going through **DIRECT**. Therefore there a grammar with Indirect CCs can only be generated if it also permits Direct CCs. Lastly, the explanation for (37d) is that CC licensing is conditioned by a decision tree where Direct and Indirect CCs are set by independent parameters. When a grammar (say that of Standard Italian) allows both Direct and Indirect CCs: [a**rt**e] 'art' & [a:**kr**o] 'acrid', it always also allows both CC types adjacently: [ko**n.kr**ɛ:ta] 'concrete'. This is true for all the varieties of French described in this paper: [ma**l.gʁ**é] malgré 'eventhough', as well as English: *co**ngr**eve*, and all other languages known to the author.

The reason for this phenomenon is that the source of the CC licensing is the following nucleus and it is only *its* status that determines the cluster types in the language. This is an improvement on traditional grammars that limit consonant clusters by counting the number of consonants: *CCC. While this correctly excludes *[a**rp.t**e] and *[**trl**eno], there must always be a caveat for [a**l**.**tr**o].

Traditionally and in OT, words like [ma**n.tra**] violate *Complex Coda and *CCC, so they violate the markedness constraints of the grammar. This markedness violation is irrelevant, however, because it is lower ranked than faithfulness. However, in the approach presented in this paper no part of [ma**n.tra**] violates UG and there are no markedness constraints in the grammar. *Every part of the structural representation of* [ma**n.tra**] *is explicitly licensed to exist.* The grammar is essentially stated positively, so that if nuclei are entitled to license both Indirect and Direct CCs then they may do so simultaneously. Therefore, in a word like [ma**n.tr**a] 'mantra', the 't' of the 'nt' and 'tr' clusters is being licensed to fulfill *both* Direct and Indirect functions. However, though there are no markedness constraints in the grammar, because the structural representation of [ma**n.tra**] has a longer description than a CVCV word, [ma**n.tra**] is formally more marked than a CVCV word. This markedness is equivalent to the more licensing that is required to describe these forms.

6 Conclusion

The hypothesis that markedness is not part of a formal theory of phonology has been discussed with reference to syllable structure. It is argued in this paper that 'markedness as complexity' does have a formal phonological definition. Though markedness is not a (rankable) concept written into the grammar (like a markedness constraint), and the phonological derivation does not consult markedness in order to select an output. Markedness is explanatory of typological patterns and implicational universals, as well as having a clear relation to acquisition and linguistic pathology.

Markedness is expressed as 'length of description'. Specifically, the more 'yes' settings there are, (the greater the parameter depth) the more marked the system. Crucially, the 'yes' settings also correspond with the structural complexity of the representations (permitted by the system). In this sense, markedness *is* directly legible from the representations. Every 'yes' setting corresponds to an extra empty category or extra ability to license. Markedness therefore can be shown to be a property of the phonological module, in that the attested patterns in CC typology (Côte d'Azure French, Pulaar, Sinhala, Standard Korean, Pohnpeian etc…) can be systematized into a possibilities space which is incrementally more structurally complex in the representation and incrementally longer to describe in the P&P decision tree.

Yoruba, for instance, has an unmarked CV structure. This CV structure is shared by every human language and primary in phonological acquisition and robust in phonological pathology. Fittingly, the parameter set-up needed to express this unmarked state is a single 'no' setting. Following that, the rest of the decision tree atrophies because the 'no' is a dead end and the rest of the CC decision tree inaccessible but from the 'yes' setting. Conversely, a language like Polish, which allows Direct and Indirect CCs to be licensed by Medial and Final nuclei, requires four 'yes' settings and it exploits the whole of the decision tree.

Overall, the system of markedness that we have posited does exactly what Gurevich (2001) [critically] describes: '[it] links the generativist-posited symbolic system to some physical reality'. Except that (also in line with SFP and modular assumptions) that physical reality is not explicable in terms of the phonetics but in terms of the phonological representations that correspond to the parameter settings and the patterns they create for the learner.

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