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From binary features To elements: Implications for markedness theory and phonological acquisition

PAPER

FROM BINARY FEATURES TO ELEMENTS:

IMPLICATIONS FOR MARKEDNESS THEORY AND PHONOLOGICAL ACQUISITION[1]

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This article aims to assess the two competing models of features that have dominated the history of phonological theory for almost one century: the first, which originates from Trubetzkoy, allows both "privative" and "equipollent" contrasts; the second comes from Jakobson's strict binarism, and has been continued in generative phonology up to the present day. Firstly, it will be argued that the latter model suffers from at least three problems that follow from over-generation, and make it impossible to provide a natural and unified account of systemic and processual markedness. Secondly, it will be shown how these problems can be given a straightforward solution through an approach based on privative elements, in which markedness becomes the result of operations acting on primary segments. Interestingly, such a view turns out to be remarkably compatible with recent findings in L1 acquisition, namely Kuhl's Native Language Magnet Theory.

INTRODUCTION

What is universal and what is particular about phonological representations? The answer provided by structuralism, which prevailed in the language sciences for much of the 20th century, emphasised relativism. Partly derived from the Saussurean concept of "value", itself based on the form/substance dichotomy, and then reinforced by Prague phonology, the long-dominant views favoured a definition of linguistic objects that was both arbitrary and differential: any element of a given system is what the other elements of the system are not. Hence, even though two elements of different systems are substantially identical, they do not necessarily constitute the same object if these systems differ. The advent of generative linguistics did not fundamentally change this state of affairs: while generative phonology did seek to identify general principles and constraints in support of the hypothesis of a Universal Grammar, of which the inventory of features was one of the attributes, the epistemological break with the various structuralisms was not so clear-cut with regard to phonemic representations.

I will try to show here (§1) that this relativism is largely based on a strictly binarist conception of phonological distinctions dating back to Jakobson, which has largely replaced, in scientific practice, the much richer typology of oppositions due to Trubetzkoy. It will then be seen (§2) that binarist models suffer from several problems, which support their replacement with the so-called "unarist" models, where the old Trubetzkoyan idea of the distinction between "privative" and "equipollent" oppositions is revived. The consequence (§3) is a radical change of perspective concerning both the nature of markedness and the structure of phonemic systems. It is remarkable − and this will be stressed in the conclusion − that this evolution of theoretical phonology, defended by certain schools of thought for some forty years, is in line with results

obtained quite independently, during the same period, by research on the categories acquired by children learning their "mother tongue", both in the domain of production and in the recently renewed field of perception.

1 TRUBETZKOY *VERSUS* JAKOBSON

1.1 PRIVATIVE OPPOSITIONS

Phonology was born in Europe from the work of Trubetzkoy, whose "logical classification of distinctive oppositions" forms the core of his *Principles of Phonology* (1939 [1976: 68-93]). In this "pluralist" perspective, in view of the subsequent theoretical drift, any opposition can be classified, from a strictly systemic point of view, according to three criteria:

(1) a. Its relation to the whole system of oppositions in the language:

   bilateral or *multilateral*, *proportional* or *isolated* oppositions.

  b. The relationship between its terms:

   privative, *equipollent* or *gradual* oppositions.

  c. The extent of its distinctive power:

   constant or *neutralizable* oppositions.

Of these three criteria, (1b) is the more important for our purposes. An opposition between two phonemes is said to be *privative* if the distinction is based on the presence in one of them of a quality − a *feature* − which is absent in the other. The one with this feature is said to be *marked*, this distinctive feature being called a *mark*; the one without it is *unmarked*. An oral consonant or vowel such as /b/ or /o/, without the nasal mark, is unmarked compared to its marked nasal counterpart /m/ or /õ/; the opposition

of nasality is therefore privative. The same is true of voiceless consonants such as /p/, /t/ or /k/ vis-à-vis voiced consonants such as /b/, /d/ or /g/: the voicing mark is absent in the former but present in the latter. A privative opposition thus involves a relationship between something (the mark) and its absence, i.e. zero. The relationship between /b/ and /m/ could be expressed algebraically as follows:

(2) a. /m/ = /b/ + nasality

 b. /b/ = /m/ – nasality

Assuming "nasal" ~ Ø or "voice" ~ Ø amounts to denying any phonological existence to [−nasal] or [−voiced]. Therefore, as we shall see, such features cannot be actors in any phonological process.

Quite different is the case of the so-called *equipollent* opposition, in which two phonemes contrast through two different features. If we take the example of the contrast between the plosives /p/ and /t/, it would be wrong to say that /p/ differs from /t/ in that it lacks the latter's "coronal" mark, or that /t/ is a "non-labial": what, then, would the "dorsal /k/" be? We should then say that the phonemes /p/, /t/ and /k/ are distinguished from each other in that their place-of-articulation features are in an equipollent relation: "labial" ~ "coronal" ~ "dorsal". To take a semantic analogy, if the opposition between "tree" and "apple tree" is privative (the former being unmarked), the opposition between "apple tree" and "plum tree" will be equipollent, since it involves two equally present features: "tree bearing apples" ~ "tree bearing plums".

Finally, a *gradual* or scalar opposition involves at least three phonemes and is based on the variable weight of a given feature. If they really exist, these oppositions seem to play a role in phonology limited to vowel height contrasts.

1.2 BINARY OPPOSITIONS

It was against this typology that the binarist thesis developed after the war. Conceived by Jakobson as early as the 1930s, it was to flourish in the United States in Jakobson, Fant & Halle (1952), and was to be pursued by the generative phonology of Chomsky & Halle (1968). This "totalitarian" conception reduces any phonological opposition to a single type based on an *antithetical*, antagonistic relationship between its two terms. Thus, the equipollent opposition structuring, in Trubetzkoy, the triplet /p t k/ is broken down, according to Jakobson, into two binary oppositions: (a) /k/ "compact" is opposed to /p/ and /t/ "diffuse"; (b) /p/ "grave" is opposed to /t/ "acute". These oppositions are formally and conceptually indistinguishable from the opposition between /m/ and /õ/, which are "nasal", and /b/ and /o/, which are "non-nasal". In all cases, the two terms of the antinomy are present and thus have an equivalent status: any opposition is of the type "F" ~ "¬F" (F = feature); privativity disappears with equipollence.[2] Corollary: the difference between two phonemes of a given system is now based on the number of features that distinguish them from each other: thus the oppositions /p/ ~ /b/ and /t/ ~ /d/ are based on 1 feature, whereas /p/ ~ /d/ is based on 2 features (Martinet 1964 [1974: 86]).[3]

The extralinguistic motivations for Jakobsonian binarism combined quick allusions to Wallon (1945) and his theses on "the initial stages of thought and speech" in children, with later studies on speech perception and communication theory (cf. Jakobson 1973: 153-155, 172). But whatever its justifications or sources of inspira-

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[2]   Contrary to a frequent usage in the literature written in English (e.g., Kim 2002), I will stick here to the strict meaning of the term "equipollent" as found in Trubetzkoy, which does not entail any antagonistic relationship between the terms of the opposition, unlike the contrasts that are called "binary" here.

[3]   Note that, even if they reject the principle of binarism (e.g., Martinet 1964 [1974: 83-89]), later structuralist trends often admit its practice: cf. the oppositions "oral" ~ "nasal", "anterior" ~ "posterior", and, w i t h i n the F r e n c h functionalist school, "sourd" ~ "sonore", "arrondi" ~ "étiré".

tion, binarism owes much of its survival to its adoption by generative phonology in the 1960s. The latter will return to articulatory features in which consonantal and vowel qualities are once again strongly differentiated. It is well known that, apart from its strictly binary aspect, the two other original features of the feature system proposed by Jakobson, Fant & Halle (1952) consisted, on the one hand, in their acoustic-perceptual nature, and, on the other hand, in the assumption of qualities common to consonants and vowels: thus /p/, /t/ and /k/ were supposed to be distinguished by means of the same features as /u/, /i/ and /a/ respectively. Although the abandonment of these two aspects by generative phonology led it to reintroduce equipollent consonantal place features, Jakobson's antinomies were retained. Notationally, they have simply been replaced with [±F], an expression that I will adopt from now on although it has the disadvantage of suggesting a privative type of opposition; in reality, as we shall see, [−F] does not in any way mean "absence of F", since [+F] and [−F] can behave in the same way, by propagating for example.

2 THREE PROBLEMS WITH BINARISM

2.1 CONTRASTIVE SPECIFICATION

A classic justification for binary feature systems is provided by the theory of "contrastive specification", which is supposed to be based on both typological and ontogenetic facts. Let us compare the value of the three closed vowels of French with the three closed vowels of Korean. The distinctive features in each system are shown in (3, 4); the [+high] feature has been omitted, as it is not relevant for our purposes.

(3) French

/i/	/y/	/u/
	−BACK	+BACK
−ROUNDED	+ROUNDED	

(4) Korean

/i/	/ɯ/	/u/
−BACK	+BACK	
	−ROUNDED	+ROUNDED

These systems show complementary implicational relationships. In French, on the one hand, any [−rounded] vowel is [−back], but the reciprocal is false; thus the [−back] feature is not distinctive for /i/ in (3). On the other hand, any [+back] vowel is [+rounded], but the reciprocal is false; thus the [+rounded] feature is not distinctive for /u/ in (3). Conversely, in Korean, any [−back] vowel is [−rounded], but the reciprocal is false; thus [−rounded] is not distinctive for /i/ in (4). Similarly, any [+rounded] vowel is [+back], but the reciprocal is false; thus [+back] is not distinctive for /u/ in (4). Finally, the two features of /y/ and /ɯ/ are necessarily distinctive in French and Korean respectively: /y/ is [+rounded] which, in French, allows /y/ to be distinguished from /i/, and [−back] which distinguishes it from /u/ *ceteris paribus*; /ɯ/ is [−rounded] which, in Korean, allows /ɯ/ to be distinguished from /u/, and [+back] which distinguishes it from /i/ all else being equal.

It follows that /i/ and /u/ have only one distinctive feature (or two with [+high]), while /y/ and /ɯ/ have two (or three with [+high]). Now: (a) /i/ and /u/ are quasi-universal but not /y/ and /ɯ/, which are much rarer in the languages of the world; (b) /i/ and /u/ are supposed to be acquired by the French or Korean child before /y/ and /ɯ/,

and lost by the aphasic after /y/ and /ɯ/.[4] Note that the same classic feature calculation very often demonstrates the remarkable character of /a/. As it is the only low vowel in a majority of systems, the feature [+low] is sufficient to distinguish it from all other vowels; it has therefore only this distinctive feature. Interestingly, /a/ is the only universal vowel.[5] It is also said to be the first vowel to stabilise in children's production, and the last to disappear in aphasics.[6] The structure of systems would thus reflect the typological and ontogenetic complexity of their elements. Binarist models thus seem to account for *systemic markedness*: *a phoneme X is more marked than Y if, and only if, X contains more features than Y*. In short, "who can do more can do less". However, let us note in passing that the application of the principle of contrastive specification to binary features in (3, 4) renders the distinctive features *relative* to the system following the Saussurean viewpoint: in the same way as /y/ and /ɯ/, /i/ and /u/ differ in French and Korean even though there would be, in this case, substantial identity between the two languages.

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[4] It seems that there is no need to reconsider what Jakobson (1941 [1969: 61]) said about the acquisition of /y/: "The rounded palatal vowels, which Rousselot very appropriately called "secondary", appear in child language only after the "primary" vowels, i.e. after the rounded velar vowel and after the unrounded palatal vowel with the same degree of aperture." The implicational relationships brought into play by the loss of distinctions being the reciprocal of those governing their acquisition (*ibid.*: 64), we deduce that the disappearance of /i/ and /u/ in aphasics presupposes that of /y/. The studies quoted by Jakobson for French (*ibidem*: 66, n. 80) are confirmed today by Levelt (1994: §6, esp. p. 133) and Beers (1995) for Dutch, by Elsen (1991) and Geilmann (1993) for German, by Fee (1991) and Zajdó (2002) for Hungarian. Concerning the acquisition of /ɯ/ in Korean, cf. Jun (2006).

[5] Ubykh and Kabardian, which, with only two phonemes, have the minimal vowel system among the world's languages, show /a/, which has a "closed" (featureless) counterpart /ɨ/: cf., for Kabardian, Kuipers (1960) reformulated by Anderson (1991).

[6] On the acquisitional priority of height distinctions by the child, Jakobson's classic theses (1941 [1969: 51 ff.]) are confirmed today by various studies, a summary of which can be found in Bernhardt & Stemberger (1998: 343-353, 364-366).

2.2   SYSTEMIC AND PROCESSUAL MARKEDNESS

Despite lengthy discussions on the problems posed by feature (under)specification, which are inherent to the adoption of a binarist *a priori* (Carvalho 1997: 14-17), this line of reasoning has persisted: cf. e.g. Steriade (1987, 1995), Clements (1988), Mester & Itô (1989). Apart from the unarist theses discussed below, the only developments challenging the general model illustrated above − the Radical Underspecification Theory (Archangeli 1984, 1988) and the Contrastive Hierarchy Theory (Dresher 2009) − are based on the consideration of *processual markedness*. For example, from the fact that, while being a lexical vowel like any other, /ɯ/ is also, in Korean, the "neutral" vowel by its propensity to syncope and/or epenthesis in particular, the proponents of Radical Underspecification Theory deduce that the features of /ɯ/ are underspecified in the whole Korean vowel system, hence the subsystem in (5), where only one value per feature ever appears.

(5) Korean II

/i/	/ɯ/	/u/
−BACK		
		+ROUNDED

As for the contrastive hierarchy theory, it assumes that features which are active in phonological processes are necessarily specified; thus, since /i/ and /y/ can be the cause of palatalization in Acadian and Quebec French, /i/ will be specified for the feature [−back], contrary to what is predicted by the classical contrastive specification in (3). Thereby, the [±back] feature dominates [±round] in the hierarchy in (6a); as a result, as shown in (6b), only the [+round] feature of /u/ is underspecified.

(6)   French II

a.

[–back]   [+back]

[–rounded]   [+rounded]

/i/   /y/   /u/
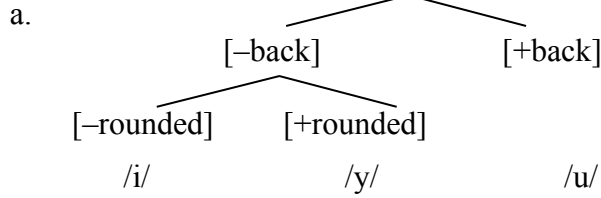
b.

	/i/	/y/	/u/
	−BACK	−BACK	+BACK
	−ROUNDED	+ROUNDED	

Both theories are a timely reminder of the importance of the behaviour of segments, i.e. the processual aspect, in addition to their place in the system, the systemic aspect; processual evidence is indeed far much richer than Trubetzkoy's neutralization. However, I would like to mention one important point: the reformulations in (5, 6b) eliminate the formal basis of systemic markedness provided by (3) and (4): /ɯ/ has, in (5), fewer features than /i/ and /u/ whereas it is an incomparably rarer vowel than the latter; /i/ has, in (6b), as many features as /y/ whereas the latter is also infinitely less frequent than /i/. Thereby, Radical Underspecification Theory and Contrastive Hierarchy Theory erase the most interesting aspect of the classical binarist approach. My thesis is that it is possible and desirable to account for *both* systemic and processual markedness, while getting rid of the problems associated with binary features. The representations in (3, 4) pose, indeed, three problems; one would like to believe they could be overcome in isolation, but their accumulation makes it more difficult.

2.3   NATURALNESS

A first problem with binarist models of phonological features is that they lead to

the postulation of objects whose existence seems counterintuitive. It is therefore the *naturalness* of certain features that is at issue here. For example, what is [−rounded] or, to use French terminology, "étiré"? What is [−voiced] (or "sourd")? It can be rightly objected that these terms equate default postures with articulatory gestures. Can it seriously be argued that one is purposely not rounding one's lips to make /i/ or /e/? Are we really making an articulatory "gesture" by adopting a configuration of the larynx that has many points in common with the normal state of the glottis outside phonation? Structural linguistics has certainly taught us that, in a system of values, absence is also a value, but, precisely, the absence of a given feature F is much more naturally formalised by privative oppositions, where we have F ~ Ø, than by binary contrasts.

As was recalled in §2.2, only specified features are supposed to be active, by being, for example, the vector of harmony or assimilation phenomena (Martinet 1974: 112-113; Steriade 1987, 1995; Dresher 2009). Thus, French *il se bat*, *il se gare* are realized [izba] and [izgaʁ], where the contrastive voicing of /b/ and /g/ spreads onto the preceding /s/, but *il se noie*, *il se lave*, *il se rase* are pronounced, without assimilation, [isnwa], [islav], [isʁaz], since the voicing of the sonorants is not distinctive: there are no voiceless /n/, /l/ and /r/ phonemes in French.

Now, as noted by Van der Hulst (2016: 96), it is impossible to prove both the existence and the non-existence of phenomena like unrounding harmony, devoicing or orality assimilation. Also, whereas palatalizations, involving [−back], abound in the world's languages, nowhere is there a proven case of velarization, i.e. propagation of [+back]; more precisely, no language makes use of the contrast between velarization and pharyngealization (Ladefoged 1971: 63 ff). Interestingly, to confine ourselves to purely phonetic studies, it follows from Esling's (2005) Laryngeal Articulator Model that "there are no back vowels".

I am aware that there is apparent evidence for binary features, though. Kim (2002; review of this article) mentions several cases where [−voice], [+back] and [−nasal] seem to play a role in phonological processes. However, I do not think that the reported facts bring decisive evidence for the existence of such features, for five reasons. Two of them, that are closely linked together, pertain to the theoretical background of my proposal, and apply to all the mentioned cases. Firstly, contrary to what is assumed by Kim (2002: 27-33), I disagree that there could be "phonetic evidence" for binary (or monovalent) features. Secondly, why can there be "three-way contrasts" (involving [+T] ~ Ø ~ [−T] and thus binary features) if they are not phonemic, as Kim herself acknowledges (p. 33)? (See also Raimy (2021), although his primes are assumed to be privative.) Without this condition, [+T], Ø and [−T] cannot be "categorially distinct" (p. 32). The reason for these two remarks is the same: features are inherently phonological objects, and phonology is primarily based on contrast, even though phonological theory should explain and unify both systemic (§2.1) and processual (§2.2) aspects, as will be seen in §3.

My three other arguments are more specific, depending on the property or the example at stake. As regards [−voice], without going into details, several facts adduced (namely assimilations) are seemingly problematic for privative oppositions. But this is because laryngeal properties are considered as features, which they are *not* in my view. (Incidentally, the same holds for the sonority categories commonly defined by [±consonantal], [±sonorant] or [±continuant]: see Carvalho 2017.) The data presented by Kim (2002: 41-47) in favour of [−voice] is easily explained, within a revised version of Strict CV (Scheer 2004), if voicing is defined as leftward propagation of the nucleus onto the onset (Carvalho 2008), as shown under (7). Being properly governed by N_2, N_1 cannot associate to its own timing slot, being thus unpronounced. In (7a), this can allow propagation of N_2 to the first onset, hence voicing assimilation. In (7b), the governed N_1

can also disassociate from the onset, hence the so-called "devoicing assimilations" (as in French [meḓsɛ̃] *médecin* 'doctor'), which do not require propagation of any feature.

(7) a. /kba/ → [kba] or [gba] b. /gpa/ → [gpa] or [kpa]
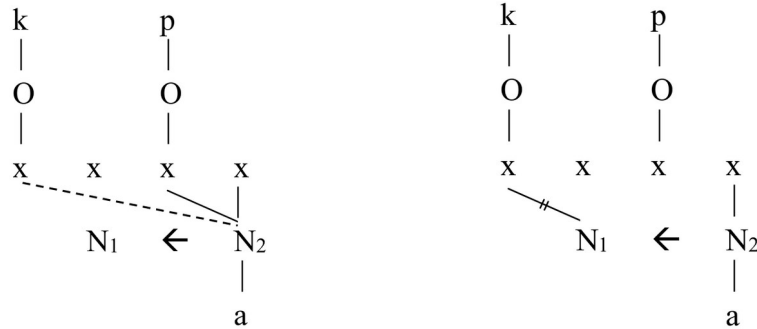
As a result, all cases considered by Wetzels & Mascaró (2001) and Kim (2002: 43) are possible, depending on the "governing strength" of N_2 (which needs further research).

My last arguments refer to the nature of the processes involved, more precisely to whether we deal with lexicalized generalizations (much like the well-known "velar softening") or with the opposite case of low-level phenomena. As regards [back], I contend that Turkish vowel harmony can be usefully analysed in terms of propagation of a "front" feature, since it has the effect of palatalizing certain consonants (Clements & Sezer 1982). Admittedly, as pointed out by Kim, some suffixes containing "back" vowels resist front harmony (Van der Hulst & Van de Weijer 1991). However, vowel harmony is probably the legacy of an earlier stage of Turkish phonology. Possibly like final devoicing (cf. [etyd] *etüd* 'study'), it is no longer phonologically driven in modern Turkish, as is also shown by the existence of many non-harmonic stems, and its purely morphological conditioning (Bacanlı *et al*. 2020).

On the other hand, as regards nasality, no [−nasal] feature is required. The 'shielding' observed between an oral vowel and the preceding nasal onset, whereby /na/ → [nᵈa]

vs. /nã/ → [nã] (cf., e.g., Stanton 2017), appears to me simply for what it is according to most interpretations of the phenomenon: a low-level strategy of contrast enhancement; nasality does not generally spread from onsets to nuclei. A coplanar model – as the one in (7) – may provide a reason for such enhancement by allowing two types of nasality in the same language: one on the C-plane, as in most languages, the other on the V-plane, as in the Min dialects of Taiwan (cf. Chang 1985: 19), which spreads onto the onset.

2.4 UNDECIDABILITY

The second problem with binarist models − with the exception of Radical Underspecification and Contrastive Hierarchy theories (cf. §2.2) − is the representational *undecidability* of high vowels in most of the world's languages, which lack phonemes similar to /y/ in French or /ɯ/ in Korean. Take one of the countless languages that show only /i/ and /u/ as high vowels: do we have (8a) or (8b) in Spanish for example?

(8) a. Spanish I

/i/	/u/
−BACK	+BACK

b. Spanish II

/i/	/u/
−ROUNDED	+ROUNDED

Generative phonology got rid of this problem by proclaiming the redundant status of [±rounded] in any system without rounded front vowels. The basis for what could be called a theoretical sleight of hand was the observation that in most systems distinguishing two low vowels, it is an *unrounded* back /ɑ/ or a central /a/ that contrasts with /a/ or a front /æ/ respectively; hence, the [±back] feature takes prece-

dence over [±rounded]. However, it is questionable why a presumed non-distinctive feature such as [±rounded] participates in several phonological processes (cf. §2.3): Yawelmani, for example, has a rounding harmony while lacking rounded front vowels.

I could play the devil's advocate by claiming, *à la* Chao (1934), that it is precisely in this uncertainty that the unmarkedness of such systems lies: Spanish is not faced with a choice between (8a) and (8b). If we want at all costs an invariant that distinguishes /i/ and /u/, this should be the phonetic content common to [−rounded] and [−back], on the one hand, and to [+rounded] and [+back], on the other hand: let us say, to use Jakobson's terminology, the "sharpened" value of /i/ *versus* the "flattened" value of /u/. Thus, the undecidability in (8a,b) would be due to the inventory of features adopted, not to their binary character, which would remain in the contrast "sharpened" ~ "flattened". Why not? Let us simply point out that, as will be seen below, the problem posed by the non-uniqueness of the representations of /i/ ~ /u/ in Spanish can be solved with the same feature system used for French and Korean but within a non-binarist framework. Thus, the undecidability in (8a,b) adds up to the unnaturalness of [−rounded] and the like (§2.3) in weakening the scope of the binarist representations seen in (3, 4).

2.5 CONTRASTIVE SPECIFICATION AND MARKEDNESS

The third problem with binarist models is that they lead to an empirically false prediction. Let us take seriously the assumption underlying (3, 4) that the structure of phonemic systems *reflects* the typological and ontogenetic complexity of their elements, with the higher number of distinctive features in /y/ and /ɯ/, i.e. the markedness of these vowels, expressing their rarity and the universally late nature of their acquisition (§2.1). If this hypothesis were true, then a system with the *four* closed vowels /i/ and

/u/ plus /y/ and /ɯ/ should not exist, since it would not entail any definite order in the acquisition of these vowels by the child (or in their loss by the aphasic), *all* the features being necessarily distinctive as in (9). However, such systems do exist, notably in almost all Turkish languages. And, although there are, to my knowledge, no detailed studies on the acquisition of Turkish vowels, /y/ and /ɯ/ are expected to be acquired by the Turkish-speaking child after /i/ and /u/.

(9) Turkish

/i/	/y/	/ɯ/	/u/
−BACK	−BACK	+BACK	+BACK
−ROUNDED	+ROUNDED	−ROUNDED	+ROUNDED

3 RETURN TO TRUBETZKOY

3.1 BINARISM AND OVERGENERATION

I admit there seems to be a residue of binarism in two cases: vowel height and tone, where both H and L are necessary so far, especially in 3-tone systems for which no single privative tone (Hyman 2001) can be invoked. However, I remain hopeful that these issues can be given a representational solution, for example by assuming that vowel height and ATR/RTRness – like voice (cf. §2.3) – are not based on features but on structure (cf. Pöchtrager 2006; Carvalho & Faust 2017; Cavirani & van Oostendorp 2020), probably in association with headedness (cf. Ulfsbjorninn 2021). Leaving aside these two points for further research, I contend that multiplying ¬T features leads to an overgeneration of phonological processes, most of which lack solid empirical evidence.

Let us consider the set of high vowels examined so far. The two binary features used to differentiate them, plus the zero corresponding to the non-distinctive value, imply 9 combinations, i.e. 9 possible matrices for only 4 phonemes. Hence such unnatural

specifications as [−rounded], [−nasal] or [−voiced] (cf. §2.3), hence the undecidability noted in (8) (cf. §2.4), and the disappearance of the markedness hierarchy in (9), where /i/ and /u/ can have as many distinctive features as /y/ and /ɯ/ (cf. §2.5). It is the binarist bias that, through the overgeneration of features and therefore of representations it entails, is directly at the source of the problems mentioned so far.

The issues associated with this overgeneration had been glimpsed by Chomsky & Halle (1968: §9): for example, why are /y a ɯ/ or /æ ɨ ɒ/ forbidden vowel patterns despite being as simple as /i a u/ in terms of number of features? As Lightner (1963) and Stanley (1967) pointed out very early on, the speciously trivalent character of a binary system admitting underpecification is responsible for the overgeneration of segmental representations. While these problems did give rise to objections in the 1980s and 1990s (Goldsmith 1985; Steriade 1987, 1995; Mester & Itô 1989; Lombardi 1991, 1996), they did not lead to a systematic critique of binarism, leaving room either for the postulation of *ad hoc* "marking conventions" or for a preference for fully specified feature matrices that preclude any possibility of formal expression of markedness (cf. Carvalho 1997).[7]

Let us therefore turn back to Trubetzkoy's typology of oppositions where any quality is opposed either to its absence (privative opposition) or to another (non-antinomic) quality (equipollent opposition). This is the basis of the so-called *unarist* or *monovalent* hypothesis which, in the form of various theories and models − Particle Phonology (Schane 1984, Carvalho 1994), Element and Government Theory (Kaye, Lowenstamm & Vergnaud 1985, 1990), Dependency Phonology (Anderson & Ewen 1987) − has developed over the last forty years alongside the neo-Jakobsonian binarism of classical

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[7]   Incidentally, Halle's (1959) famous "argument against the phoneme" only holds in a binarist framework, not in a privative framework that excludes 3-way contrasts (cf. Anderson 2021: §5.5). One of the reasons for the attachment of generative phonology to binary features may have been its desire to deny the relevance of the classical phonemic level.

generative phonology.[8] This step backwards is all the more interesting as the question of whether phonological primitives are privative or binary has received little attention in the recent literature (some exceptions being Kim 2002, Van der Hulst 2016, Purnell, Raimy & Salmons 2019, and Raimy 2021).

3.2   MONOVALENCY AND MARKEDNESS

We know that the existence of /y/ in the languages of the world presupposes the existence of both /i/ and /u/. Let us therefore accept the following equation:

(10)   /y/ = /i/ ⌒ /u/

It is also known that:

(11)   /y/ = {front, rounded}

We can therefore deduce:

(12)   /i/ = {front} and /u/ = {rounded}

where [back] disappears.

    What, then, is /ɯ/? We know that this vowel is the chromatic complement of /y/. So, if /y/ = /i/ ⌒ /u/ = {front, rounded}, then:

(13)   /ɯ/ = /i/ ⊔ /u/ = Ø

The so-called f e a t u r e [back] is therefore nothing else than the default realisation of

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8   I am leaving aside here Van der Hulst's (2020) Radical CV Theory, whose primitives, albeit privative, are organized in antagonistic pairs, like binary features. This "hybrid" model would deserve a specific review, in particular with regard to markedness-related aspects.

the feature [high], i.e. when it is not associated with other features, as in /i, u, y/.[9]

The vowel subsystems examined so far have thus the following representations:

(14) Spanish

/i/	/u/
FRONT	
	ROUNDED

(15) French

/i/	/y/	/u/
FRONT	FRONT	
	ROUNDED	ROUNDED

(16) Korean

/i/	/ɯ/	/u/
FRONT		
		ROUNDED

(17) Turkish

/i/	/y/	/ɯ/	/u/
FRONT	FRONT		
	ROUNDED		ROUNDED

The features [front] and [rounded] can be called the "*elements*" |I| and |U| respectively, as in the most widespread of unarist approaches, Government Phonology. The third

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9   The non-existence of "+back" has been extended to dorsal consonants by Carvalho (2013).

basic vowel element, constitutive of /a/, is |A| = [low]. Note that it is from the combination of |A| with |I| or |U| that the mid vowels /e/ and /o/ respectively are derived, which captures Trubetzkoy's "gradual" oppositions (cf. §1.1).[10]

There are no less than four points to note which show the interest of (14-17) compared to the binarist representations seen in §2.

Firstly − and this is the major contribution of this work to the theory of phonological primitives −, systemic markedness is not an arithmetic variable based on the number of features (cf. §2.1). "Unmarked", or primary, phonemes are those that show "stand-alone pronounceability". "That is, each element on its own characterizes a possible phonological segment" (Van der Hulst 2016: 88), like |I|, |U| and |A| in /i/, /u/ and /a/. "Marked" phonemes are those that either lack elements or imply an operation on primary phonemes, like /y/ and /ɯ/ as defined in (10) and (13). It follows that the existence and acquisition of /y/ presupposes those of /i/ and /u/; there is no need to resort to arbitrary markedness conventions like those in Chomsky & Halle (1968: §9) to explain this.

Secondly, there is a *privative* opposition between /y/ and /i u/, and between /i u/ and /ɯ/, while /i/, [front], and /u/, [rounded], are in an *equipollent* relation.[11] The "unrounded" and "back" features therefore have no phonological existence, as can be proven by *reductio ad absurdum*: if "front" were the unmarked term, then the primary vowels would be /y/ = {rounded} and /ɯ/ = {back}, and the derived vowels, /u/ = /y/ ⌢ /ɯ/ = {rounded, back} and /i/ = /y/ ⊔ /ɯ/ = Ø, which is empirically false.

Thirdly, /i/ and /u/ have consistently the same representation in (14-17), whereas this was only the case for /y/ and /ɯ/ in the binarist model; thus, two unmarked phonemes from two different systems should always have the same representation, the

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[10] Given element combination, further gradual oppositions emerge from headedness (cf. /i/ ~ /e/ ~ /ɛ/ ~ /a/), and can be generalized beyond vowel height (cf. Swedish /i/ ~ /y/ ~ /ʉ/ ~ /u/).

[11] More specifically, |I| and |U| are in an equipollent opposition in the (non-antagonistic) sense that this word has been defined in fn. 2. It follows that these elements do not necessarily share the same tier, which precisely allows for the existence of front rounded vowels (cf. Kaye *et al.* 1985).

differences between languages consisting in the combination of features, i.e., as we have seen for /y/ and /ɯ/, in the existence or non-existence of operations on primary phonemes.

Fourthly, the representation of Korean vowels in (16) turns out to be identical to that given in (5), obtained on the basis of their behaviour. The emptiness of /ɯ/ is thus *both* a reflection of its systemically marked character by virtue of (13) and of its processual unmarkedness, whereby, for the same reasons as many *schwas*, it is an under-specified vowel.[12] The systemic and processual facets of markedness are thus unified with the same representations.

FINAL CONSIDERATIONS

I would like to draw three conclusions from the comparison between binarism and unarism in phonology. Firstly, on the epistemological level, the problem of knowing whether features are binary or unary is not a purely scholastic matter of notation, despite certain appearances, since the scope of a theory depends closely on the "alphabet", the primitives, that it uses. As we have just seen, the abandonment of a system of binary features in favour of a unary system allows us to move from relativistic representations, where, in the Saussurean tradition, the value of an element is dictated by its place in a given system, to universal representations; universalism follows from unarism as relativism follows from binarism.

Secondly, as is often the case in the history of science, two observations must

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12 Not all default epenthetic vowels are underspecified as in Korean. It is well-known that many of them are "coloured": cf. Brazilian Portuguese and Finnish [i], Spanish or Polish [e], and even the "*e muet*" of modern standard French, which has the same melodic content as the lexical vowel /ø/ (Carvalho 2020). Leaving aside possible cases of lexicalization, I think there should still be a formal basis for identifying such vowels. The easiest way resorts to their autosegmental representation. Especially if they alternate with zero, either they have floating material, or they receive their neighbour's melody; in both cases, they can thereby be argued to be underlyingly empty. Otherwise, the very concept of autosegmental association should be revised accordingly (see Cavirani 2015).

be made: on the one hand, an erroneous theory is not necessarily useless; on the other hand, we often end up making something new out of something old. Indeed, if the criticism of the predominant binarist views will have provoked a return to Trubetzkoy, it will also have made it possible to arrive, on purely linguistic grounds, at conclusions that Trubetzkoy would perhaps not have accepted. For example, as a system based on privative oppositions rules out three-way contrasts, there is nothing to distinguish the unmarked phoneme from what he called an archiphoneme.

Finally, and above all, through the universality of the representations and the reformulation of markedness that it entails, this evolution of phonological theory over the last decades is in line with results obtained quite independently, during the same period, by research on the acquisition of the L_1. This domain has been marked, if not by the discovery, at least by the theoretical recognition of a fact that was absent from the work, essentially based on speech production, to which Jakobson ([1941] 1969) had access and which supported the binarist theory of segmental markedness (cf. §2.1): to take up the subtitle of Kornfeld & Goehl's article (1974), "kids know more than they say". In other words, there is a fundamental asymmetry between production and perception in the process of L_1 acquisition (cf., for example, Kornfeld & Goehl 1974, Pinker 1984, Gibbon 1990, Faber & Best 1994, Hale & Reiss 1998). On the one hand, classical implicational views, where /e/ implies /i/ ~ /a/ and /y/ implies /i/ ~ /u/, etc., still seem to be supported by research on speech *production.* The development of speech in children would therefore involve markedness as defined above, i.e. the ability to perform operations on primitive unary objects. By this means, the ability to produce both the underspecified vowel /ɯ/ and the overspecified vowel /y/ implies the existence of the unary categories I and U, and thus the ability to produce the primary vowels of which I and U are the constituent categories: one does not acquire zero *ex nihilo*, since there are no "negative evidences" (Hale & Reiss 2000); so it

is not surprising that /ɯ/ – like /ə/, /ʔ/ and /h/, other underspecified segments resulting from intersections – is a late-acquired and marked phoneme, and thus not universal.

On the other hand, however, several studies have revealed surprising facts about the *perception of* the very young learner. According to some, children under 3 months of age show an extremely early discrimination ability and perceive phonic differences that are absent in their linguistic environment (Trehub 1976, Tees & Werker 1984, Goodman & Nusbaum 1994). One could certainly object that these are not "phonemes" at this stage; this early perception would not be linguistic, and the notion of markedness would remain alien to it, like, I would suggest, clicks, which are both highly marked consonants in a phonological system and possibly universal as sounds with paralinguistic value. However, these results concerning the universality of early perception are completed by further research on the cognitive foundations of perception, which may support the universal character of phonemic representations based on unary primitives. From Kuhl's theory of "*magnet effects*"*,* it emerges that the perceptual space progressively contracts around a certain number of phonetic "prototypes", a phenomenon which would exert a detectable influence on the perception of speech from the age of 6 months.[13] Interestingly, this seems to be closely associated with the child's "specialisation" in the categories of his native language, which can be assumed to reflect progressive assignment of adult-like phonological representations.

The place of these prototypes in the acoustic space is a function of the environment and the child's experience; they therefore differ somewhat from language to language − an /i/, an /u/ or an /a/ are not realised in the same way everywhere − and even more clearly according to the distribution − and hence the value, distinctive or not − of each sound in the different languages. However, the "magnetic effect" is universal and

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[13] For the original version of the theory, see Kuhl (1991, 1992, 2000b), Kuhl *et al.* (1992), Iverson & Kuhl (2000) or the summaries in Kuhl (2000a, 2004). A later, extended version is proposed in Kuhl *et al.* (2008).

the emergence of prototypes underlying categorial perception is remarkably consistent with the idea of unarist approaches, according to which, contrary to classical relativistic views of contrastive specification, the representation of a given segment is based on a small number of universal elements. The first prototypes to emerge would then be the primary segments, those that contain only one of the elements such as |I|, |A|, |U|, these thus playing the role of "attractors" in the perceptual space of vowels (other elements concern consonants). The subsequent emergence of other prototypes would only involve interactions between pre-existing objects, through operations on primary prototypes. Thus, after long and separate journeys, we might now witness, if not a general convergence between phonology and acquisition theories − some *usage-based* and probabilistic trends leave little room for the very idea of representation −, at least a punctual and remarkable concordance on the issue of phonemic categories.

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DISCUSSION WITH YUNI KIM
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COMMENTS

Carvalho's article is a welcome exploration of whether the primitives of phonological representation are privative or binary, a topic that has received undeservedly little attention in the recent literature (with some notable exceptions such as van der Hulst 2016; Purnell, Raimy & Salmons 2019; and Raimy 2021). Following Carvalho (and contra, e.g., Kim 2002), I will reserve the term 'equipollent' for its original Trubetzkoyan meaning of contrast along a dimension consisting of distinct properties (like labial, coronal, and dorsal), and use 'binary' to refer to the idea that a single property, such as nasality, has antagonistic (plus and minus) values of equal formal status.

The debate between privative and binary primitives gets slippery because it is multi-dimensional: privative *features* are a different type of object from privative *elements*, although both have differences, some the same and some different, when compared to binary features; and since 'binary elements' is an oxymoron, the systemic comparison is asymmetrical. And this is to say nothing of differences in computational systems, or in broader representational geometries, that can generate varying predictions from the same representational primitives. Still, I very much agree with Carvalho's assessment that the issue of privativity versus binarity is a substantive matter that goes beyond mere notation: namely, it is a channel for the formal encoding of answers to fundamental empirical and typological questions, and so throughout the discussion we must stick close-

ly to these. What structural types of oppositions are possible along a single phonological dimension, as evidenced by contrast, natural-class behavior, and other phonological activity? To what extent are the behaviors predicted by different types of oppositions attested in the world's languages? What is the relationship between various types of complexity – acquisitional, articulatory – and segments' patterning within phonological systems?

Carvalho observes that the axiomatically privative approaches to phonological representations include Particle Phonology, Element Theory, Government Phonology, and Dependency Phonology. These are contrasted with the strict binarism of generative phonology starting in the 1960s. Within the neo-Jakobsonian tradition, however, rumblings of discontent with binary features appeared in the 1980s (Goldsmith 1985, Steriade 1987, Mester & Itô 1989) and gathered steam throughout the 1990s (Lombardi 1991, 1996; Steriade 1995; Ewen & van der Hulst 2001: §2.1.1) before fizzing out with the ascent of Optimality Theory. Even Clements & Hume (1995), whose feature system was arguably conservative in allowing both plus and minus values of features such as [nasal] and [round], replaced binary [±back] with the articulator features [coronal] and [dorsal].

The main argument for privativity has usually been the overgeneration one covered by Carvalho, namely that certain feature values like [-nasal] and [-round] seem to be phonologically inactive, squaring nicely with the fact that they can be seen as not involving any active articulatory gesture or deviation from the resting state. As noted by van der Hulst (2016: 96), it is impossible to prove the non-existence of phenomena like unrounding harmony, devoicing assimilation, or assimilation of orality. Even in apparent cases, it is possible that an analysis can be found that does not actually involve propagation of a minus value, as Carvalho proposes for the devoicing assimilations discussed by Kim (2002). He also suggests that Turkish, where it is has been argued that both values of [±back] are needed (see Kim 2002, based on Clements & Sezer 1982), can be dealt

with using privative frontness as attempted by van der Hulst & van de Weijer (1991), but with some other way of dealing with invariant back vowels that resist harmony (which have been the main obstacle to this type of analysis).

I am not clear on what this some other way would be, but it is obviously a matter for future research. In general, many previous arguments for binarity rest on the need for underlying prespecification of [+F], [-F], and Ø in order to deal with three-way contrasts in phonological behavior (Stanley 1967). Carvalho rejects this line of analysis as conflating the processual with the phonemic/systemic. I think this is a very interesting argument, but cannot immediately think of another way to encode these kinds of fundamentally lexical differences in underlying representations, without falling afoul of the same criticism.

Carvalho and I disagree over whether it is valid to argue for binary features on the basis of surface underspecification, as diagnosed through phonetic evidence (Keating 1988, Cohn 1990, Myers 1998). It is true that not everyone agrees on where phonological representations end and 'The Phonetics' beings, so precise phonetic realizations may not always be relevant to establishing phonological representations; but in cases where surface distinctions between minus and zero values exist within a single language, the phonology which yields that result deserves careful scrutiny. I suspect that further pursuit of this point would lead back to the rich and complex topic of processual versus phonemic/systemic aspects of phonology.

Something that I found quite stimulating was the idea that Front and Round can be thought of as being in an equipollent opposition. The feature-theoretic concept of autosegmental tiers requires fixed ideas about what constitutes a single 'dimension' for purposes of defining an opposition. But how do we define similarity versus difference in a property, when two ends of a putative continuum will always be different in some ways? It is also abundantly clear from parasitic harmony, consonant harmony, and other

phenomena that some featural interactions are dependent on certain values being present on other tiers; the autonomy of autosegmental tiers is, in reality, limited. Binary feature theory minutiously parcels out phonological properties into separate tiers – below the Element Theory standard of stand-alone pronounceability – but then has virtually no theory of how the tiers relate to each other and interact; in my opinion, even Feature Geometry had rather little to say about this.

Acquisition is yet another dimension of what is classically seen as 'markedness'. I had lots of questions about this aspect of the paper, as I endeavored to disentangle the different levels and senses of acquisition: as Carvalho notes, perception and production proceed on different timelines, and presumably, so too does the process of mapping an acoustic category to a phonological representation. For example, I did not completely understand the argument that acquisition of the Turkish vowel system should be impossible if the vowels consist of binary features. It is true that there is no obvious hierarchy of simplicity in the representations, but are there not other factors that influence the path of acquisition? And, is it really impossible to acquire more than one segment at the same time, such that the absence of a clear linear sequence causes acquisition to fail?

Carvalho cites Kuhl's work on perceptual magnets in acquisition as a potential source of evidence for elements. As categories are acquired, infants 'warp' the perceptual space to minimize within-category differences, so there is proportionally much higher sensitivity to differences of comparable acoustic magnitude when they straddle category boundaries. Again, I wonder at what stage representations emerge relative to the formation of perceptual categories, and I think there could be a lot of complexity in trying to disentangle the predictions of elements versus features (privative or binary) here. I am thinking, for example, of work by Paul Boersma and colleagues (e.g., Boersma, Escudero & Hayes 2003; Boersma, Chládková & Benders 2021). If acquisition of a perceptual category *precedes* (or is in back-and-forth dialogue with) the assignment

of a phonological representation, then there may be ample room for varying interpretations of acquisitional studies vis-a-vis phonological theory. However, if acquisition of a perceptual category – as defined by the presence of warping effects – is assumed to entail assignment of an adult-like phonological representation, then I see how magnet effects around prototypes of [i], [a], and [u] might be taken as evidence for elements. Possibly, one type of counterevidence, in favor of features, would be if the emergence of warping effects around those prototypes was *preceded* by other kinds of sensitivity to the endpoints of acoustic continua corresponding to peripheral points in the vowel space, which in many languages would also be [i], [a], and [u] – making the possibilities tricky (but not impossible) to distinguish. In other words, are the acquisitional and phonological facts simply independent consequences of [i], [a] and [u] lying at the peripheries of the acoustic/articulatory space, or is there really something else going on?

Boersma, Paul, Kateřina **Chládková** & Titia **Benders**. 2021. Phonological features emerge substance-freely from the phonetics and the morphology. Manuscript available online at https://www.fon.hum.uva.nl/paul/papers/BoeChlaBen23public.pdf. **Boersma**, Paul, Paola **Escudero** & Rachel **Hayes**. 2003. Learning abstract phonological from auditory phonetic categories: an integrated model for the acquisition of language-specific sound categories. *Proceedings of ICPhS 15*, 1013-1016. **Clements**, G. N. & Elizabeth **Hume**. 1995. The internal organization of speech sounds. In J. Goldsmith (ed.), *The Handbook of Phonological Theory*, 245-306. Oxford: Blackwell. **Clements**, G. N. & Engin **Sezer**. 1982. Vowel and consonant disharmony in Turkish. In H. van der Hulst & N. Smith (eds.), *The Structure of Phonological Representations, Part II*, 213-255. **Cohn**, Abigail. 1990. Phonetics and Phonological Rules of Nasalization. *UCLA Working Papers in Phonetics* 76. **Ewen**, Colin & Harry **van der Hulst**. 2001. *The Phonological Structure of Words*. Cambridge University Press. **Goldsmith**, John. 1985. Vowel harmony in Khalkha Mongolian, Yaka, Finnish and Hungarian. *Phonology* 2: 253-275. **Inkelas**, Sharon, C. Orhan **Orgun** & Cheryl **Zoll**. 1997. The implications of lexical exceptions for the nature of grammar. In I. Roca (ed.), *Derivations and Constraints in Phonology*, 393-418. Oxford: Clarendon Press. **Keating**, Patricia. 1988. Underspecification in phonetics. *Phonology* 5: 275-292. **Kim**, Yuni. 2002. Phonological features: privative or equipollent? AB thesis, Harvard University. **Lombardi**, Linda. 1991. Laryngeal Features and Laryngeal Neutralization. Amherst, MA: GLSA Publications. **Lombardi**, Linda. 1996. Postlexical rules and the status of privative features. *Phonology* 13: 1-38. **Mester**, Armin & Junko **Itô**. 1989. Feature predictability and underspecification: palatal prosody in Japanese mimetics. *Language* 65(2): 258-293. **Myers**, Scott.

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COMMENTS

Current phonological research often obliterates some "less young" issues and topics that have been abandoned my most recent perspectives. The price of this is costly: to mention but a few of the main limitations of this kind of hasty approach, one could refer to (i) working on hypotheses that previous, ignored research has already deemed inappropriate, or (ii) insisting redundantly on results that previous, ignored research has already proven worthy and robust. Ignoring the study of the history of the discipline – I mean, the main results of prominent phonologist who are not read anymore – shows a lack of linguistic culture and is a risky way to waste time and energy.

This is not the case, obviously, with this paper. With a bullet-proof amount of knowledge of the most important scientific results of different phonological schools throughout the history of the discipline, the author develops an insightful review of those questions that still are at the very core of phonological theory: How can we conceive of the "phoneme" and "contrast" one century after Trubetzkoy? What is the real feedstock of phonological units? How tenable is the notion of markedness still nowadays?

In this paper, the author enters the very core of these fundamental questions and allows us to think of the phonological component of the grammar as an ever-growing jigsaw. The main achievement of this paper is the ability to interrelate aspects like: (1) The "oppositional nature" of linguistic units as we have been taught since Saussure's *Cours,*

(2) The classical types of phonological opposition as found in Trubetzkoy's *Principles of Phonology,* (3) The different assumptions of the pair "marked/unmarked" throughout the 20th century, (4) The postulate of phonological primitives in different phonological schools of thought, and (5) The parametric nature of phonemes as confirmed by recent experimental and data-driven approaches. Departing from the interrelation of questions such as these, the author provides us with solid arguments in favour of a view of phonology as the module that regulates subsegmental and segmental units as their crucial components.

Together with some previous work by the author ("De quoi sont faites les voyelles?" (1993), Dresher's (2009) work on phonemes and their relation to the Contrastive Hierarchy, and Durand's (2005) chapter on phonological primitives, this paper will remain as a fundamental reference for our understanding of the essential nature of segments and their constituents either as ontological objects and as epistemological constructions. A better understanding of the pertinence of keeping some traditional distinctions – such as the distinction between vowels and consonants, for instance – will also be attained thanks to this work.

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