Why we need roots in Minimalism

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1 Introduction

The analytical concept of 'root' is introduced in a systematic way into the study of language change during the 19th century, and it is one of the first concepts the Indo-European research programme turned its attention to. Of course, in the historical linguistic tradition roots were conceived somehow differently from what they are today. Having said that, it is also the case that a residue of this historical approach can still be traced in several contemporary treatments of *roots as grammatical elements that participate in the combinatorial process*.

For the Indo-European research programme roots amounted to the idealised common denominator of individual words that were understood to be diachronically related. More precisely, a root amounted to a reconstructed ancestral word form, after it was stripped off from all language-specific (inflectional) morphology and after it was 'corrected' for language-specific and family-specific sound laws (*Lautgesetze*). For instance, Old English *nefa* ('nephew, male cousin, grandson'), Old High German *nevo* ('nephew'), Latin *nepōs*, *-tis* ('grandson, nephew'), Homeric Greek *népodes* ('descendants'), Avestan and Sanskrit stem *napāt-* ('grandson, descendant'), Old Lithuanian *nepotis* ('grandson'), and so on were all argued to historically derive from the Proto-Indo-European root **nepot-*.

It is indeed the case that in several contemporary approaches to roots, such 19th century methodological and analytical prejudices persist. Of course, there is consensus by now that roots are not about etymology: they are elements involved in the combinatorics of grammar. Still, even in contemporary grammatical theory, roots are occasionally perceived as (i) forms, (ii) as formal and/or semantic 'common denominators', or (iii) 'small words' with a denotation.

Hence, the 'root' analytical concept carries an analytical legacy of both an emphasis on formal considerations and of being restricted to the word domain. It comes then as no surprise that synchronic linguistics and formal approaches to language in much of the 20th century kept roots as the exclusive stock of morphology. Consequently, roots are customarily cast as elements completely opaque to syntactic processes, also according to the lexicalist assumptions (tacit or express) of most work in grammatical theory until the 1990s (Bruening 2018 for a succinct critical survey of Lexicalism).

Having said that, roots in morphological theory are hardly as prominent as words, at least on an intuitive level. Roots are often pre-theoretically identifiable as the basic building blocks of words, with the added assumption that they somehow carry (or

even encode) the word's denotation, as hinted above. The irony here is that the intuitively straightforward words remain definitionally very elusive (Borer 2013a), whereas for roots morphologists have at least a valuable rule of thumb in Aronoff's (1994: 40): "a root is what remains after all the morphology has been wrung out of a form."[1]

The advent of separationist / realisational theories in Morphology (Ralli 1988; Beard 1995; among others) enabled linguists to finally distinguish the combinatorial aspect of Morphology, which creates morphological structures, from the actual *forms* that realise said morphological structures. Such considerations, combined with work by Hale and Keyser (1993), Levin (1993), and Rappaport-Hovav and Levin (1998), enabled grammatical theory to conceive the combinatorial mechanism underlying morphological and syntactic structures as one and the same, i.e. to go for 'syntax all the way down' (Harley and Noyer 1999, 2000). This reconceptualisation turns roots into a *syntactically relevant* class, giving them a place among the actual building blocks of syntactic structures — 'syntactic structures' being by now a shorthand for 'structures built by the combinatorial mechanism of grammar'.

In our discussion of roots here we will therefore assume a version of separationist / realisational approaches to be true. For concreteness we will couch our discussion within Distributed Morphology (Halle and Marantz 1993; Harley and Noyer 1999). This is so because Distributed Morphology (DM) is a framework making concrete hypotheses about roots, along with that of the Exoskeletal Model developed by Borer (2009, 2013a, 2014a). In Siddiqi's (2006: 35) very felicitous wording: "[Roots] are formal elements of the grammar that, unlike other syntactic features, are linked to extra-grammatical information (such as reference or encyclopedic knowledge)."

In the Minimalist enterprise, the existence of roots is not taken as a tenet, these being generally assumed by non-lexicalist / neoconstructivist approaches to grammar such as DM and the Exoskeletal Model. Nevertheless, the assumption of a separate primitive dedicated to hosting extra-grammatical information — as opposed to functional primitives, such as syntactic features — is entirely compatible with the Minimalist Program (Chomsky 1995a, 2000), once it paves the way for an in-depth evaluation of the interplay of the lexicon with other components of the Faculty of Language (FL), as we will see in this chapter. Assuming roots to be grammatical primitives brings to the forefront of linguistic minimalism the question of what the 'atoms' of syntactic computation are, since it demands a rigorous investigation of which properties are inherent to them and which are emergent (i.e., contextually derived), as well as whether their superficial features are packaged as a whole in the same grammatical component.

[1] Aronoff (1974, 1994) to the best of our knowledge, was the first generative morphologist to look into roots. In pre-generativist traditions, references to roots are quite vague and seem to treat the concept of root very much in the sense of earlier Indian grammarians. More elaborate albeit short discussions can be found in work exploring the history of the term 'morpheme' (Rocher 1969; Kiparsky 1995; Anderson 2018). See Anderson (2018) for Saussure's view on roots.

By highlighting the division between extra-grammatical / conceptual and functional information, roots force us to explain

- which role each kind of information plays in grammar,
- how and whether both are relevant for syntactic computation,
- how they are read by the interpretive components (if similarly or not), and
- what their impact is on morpho-phonological conditioning and semantic compositionality

The above are topics that will be explored separately in the next three sections. Such a theoretical stance to the grammatical primitives leads us to 'approach Universal Grammar (UG) from below' (Chomsky 2007), since instead of maximizing the role that the lexicon is largely assumed to have in the syntactic building (e.g., selectional properties), the adoption of roots invites us to set apart which lexical properties must indeed be listed pre-syntactically, and which should be the result of post-syntactic instructions to the interpretive components.

Furthermore, by isolating the inherent properties of roots we are able to identify the cognitive underpinnings that endowed our species with the ability to atomise conceptual information into linguistic units, and to determine whether such ability is species-specific — hence determined by UG —, or whether it displays phylogenetic precursors in the behaviour of nonhuman animals. Positing roots also allow us to evaluate whether the atomisation of conceptual and functional content developed separately, and to speculate on how they were articulated with a generative engine over the arc of evolution. The evolutionary questions raised by assuming roots meets the minimalist goal of going 'beyond explanatory adequacy' (Chomsky 2004), since by assigning extra-grammatical / conceptual information to a dedicated primitive we are compelled to explain not only what its properties are, but why they are that way so as to be integrated as part of the human language faculty.[2]

In this attempt to show why we need to admit roots in Minimalist, we will base ourselves on work within DM and on work inspired by DM and we commit ourselves to both seperationism and 'syntax all the way down', both of which we will nevertheless submit to scrutiny. In this effort we will be driven by the customary methodological concerns of Minimalism as a meta-theory (see the wonderful discussion and critique in Al-Mutairi 2014), with an emphasis on the prominence of the interfaces both in the interpretation / realisation of structures and in driving structure building, as well as heeding biolinguistic (evolutionary) concerns.

[2] Our lack of understanding about which are and how should be defined the set of grammatical primitives is a long-standing concern of many linguists who subscribe to the Minimalist guidelines (see e.g., Borer 2003, 2005a, 2005b, 2013a; Boeckx 2010, 2013, 2015; Sigurđsson 2012, among others). As Sigurđsson (2012: 368) correctly points out, such lack of understanding is equivalent to doing chemistry without any knowledge or theory of what a chemical element is. We believe that the investigations on the nature and properties of roots, extensively revised in this chapter, move us forward in our theoretical attempt to elucidate what comprises and how is organised the human lexical knowledge.

The DM approach to roots has been shaped by Marantz's (1997) work (Harley and Noyer 1999, 2000). According to it, roots are elements that are:

a. Acategorial (i.e., category-neutral) but syntactically active;
b. Meaningful;
c. Phonologically identified.

We will survey each of these assumptions in turn in Sections 2, 3, and 4. We then offer an alternative account in Section 5 and conclude, in Section 6, with some discussion on the evolutionary development of this primitive. We argue that roots should be seen as a species-specific trait considering the strike differences their core properties have with respect to the distributional properties inferred from nonhuman primate alarm calls.

2 Roots as acategorial syntactic objects

2.1 How roots are categorised

One of the key assumptions regarding roots in contemporary grammatical theory is that free roots, or 'roots by themselves' so to speak, are category-less or 'acategorial'. So, not only are roots grammatical formatives involved in (syntactic) structure building, but they are also without a category (such as 'noun', 'verb', etc.).

Among formal linguists of minimalist proclivities, even among those who generally embrace a separationist / realisational model of grammar without necessarily adhering to DM, there exists by now a growing consensus, as already observed in Baker (2003: 268) and — under different assumptions — in Acquaviva (2009, 2014b). This consensus is summarised in the statement below:

(1) Roots are (i) acategorial and (ii) must be assigned a category (noun, verb, etc.) by grammar, as (iii) they cannot stand within a structure unless categorised.

This ban on bare roots and the necessity for them to be assigned a category is of course Embick and Marantz's (2008: 6) *Categorization Assumption*. This assumption contains an implied entailment, one not often made explicit: bare roots cannot be used as elements of grammar *because* they are acategorial. A welcome exception to leaving this matter undiscussed is that in Adger (2013: 29), who clarifies that "Root Labeling […] has to be stated in any system (note that this issue is orthogonal to the question of the underspecification of roots for category information — even if roots do not carry syntactic information, they must be embedded in something that does carry some syntactic information)," and then goes on to present his own categorisation algorithm.

Whatever the motivation for (1), to which we return later in Section 2.4, categorisation is a necessary condition in order for roots to be used in the building of grammatical structures. More explicitly, roots are categorised in syntax, which is already the claim pioneered in Marantz's work in the '90s and '00s (Marantz 1997, 2000. 2005, 2006), as well as in parallel works in DM (cf. Harley and Noyer 1998, 1999).

Broadly speaking, there are two ways in which the categorisation requirement is understood. The first posits that roots are categorised by their functional superstructure, without the need of a dedicated categorising head: functional material linked to a nominal structure (or extended projection) will get the root to surface as a 'noun', that linked to verbal structure (or extended projection) will get the root to surface as a 'verb', and so on (Alexiadou 2001; Borer 2003, 2005a, 2013a, 2014a; De Belder 2011; Adger 2013; De Belder and van Craenenbroeck 2015 and elsewhere). The second way in which the categorisation requirement is implemented is by claiming for the existence of specialised categorising elements: categorisers such as little *n* (a nominaliser), little *v* (a verbaliser), and little *a* (an adjectiviser), with their obvious roles being to locally and directly 'turn' an acategorial root into a noun, a verb, and an adjective, respectively (Marantz 1996, 1997; Harley and Noyer 2000; Lowenstamm 2008; Embick and Marantz 2008; Embick 2012; Harley 2014; Acedo–Matellán and Mateu 2014 and elsewhere).

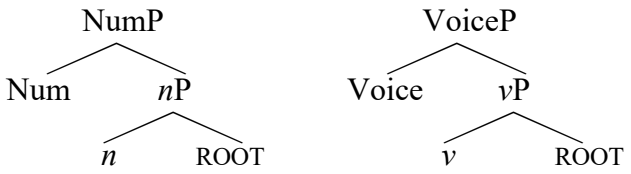
The difference between the two approaches to the categorisation of roots can be illustrated with the help of the (over)simplified diagrams in (2) and (3). According to the proponents of *direct* categorisation, i.e. that roots are categorised by their functional superstructure, the tree diagrams in (2) give a fairly accurate idea of how nouns and verbs respectively come to be: the root embedded within the NumP will be a noun, the one embedded within the VoiceP, a verb. For those who argue for categorisers, both treelets in (2) are illicit, as they claim that a root cannot be *directly* merged with a functional head without the categorising mediation of a *n* and a *v* respectively — like in (3) below (Panagiotidis 2011: 373–374).[3]

(2) *Categorising roots without categorisers*

[3] The assumption that lexical items are unspecified for grammatical category is oftentimes attributed to Chomsky (1970) (see Borer 2013a, 2014a). Chomsky (1970) developed a revision of the theory of lexical category by arguing that the categorial properties of lexical items are structurally defined rather than an inherent feature, hence the categorial properties of a given lexical item is determined by the syntactic structure in which it is inserted, in a way similar to what we observe in the *categorisation without categorisers* approach described in (2). This position, however, did not lead Chomsky to tackle morphological complexity as a syntactic issue, as pointed out by Borer (2014a: 117). Chomsky (1970) exempts syntax from any role related to the derivation of polymorphemic words (see Marantz 1997 for an extensive critique).

[=N] [=V]

(3) *Categorising roots with categorisers*



For most intents and purposes, the two models, the one without and the one with categorisers, are equivalent. There are, however, ways to distinguish their respective predictions on how grammar works.

The main argument of the 'without' camp is parsimony: why is it necessary to posit categorisers? This question actually embraces two assumptions and an observation. The first assumption is that categorisers apparently have no interpretation at the C-I systems, and that they seem to serve purely as grammar-internal flags, something like glorified Class features. This is false however: categorisers bear features that provide an interpretive perspective to the concept their projections fetch, making *n*Ps sortal predicates (and kinds) and *v*Ps predicates occupying time (and sub-events).[4] The second assumption is that categorisers are superfluous in a finely articulated functional structure such as the exoskeletal one of Borer (2003, 2005a, 2005c, 2013a). Of course, this kind of rationale also works the other way round: why should an interpretive perspective operator, which is what categorisers seem to be (Panagiotidis 2015: 100–105), get *a priori* excluded from such a finely articulated structure?

The empirical observation that has been invoked against categorisers is "the lack of cross-linguistic morphological evidence for pure categorizing elements, i.e. for elements that merely signal category and do not thus show any other conceptual dimension of meaning" (Acedo-Matellán and Real-Puigdollers 2019: 412). Still, this is also hardly accurate. Although most exponents of categorisers additionally express some "conceptual meaning," this is not necessarily the case. Setting aside the role of grammatical gender as a feature of the nominaliser *n* (Lowenstamm 2008; Ferrari-Bridgers 2008; Kihm 2008; Acquaviva 2009; Panagiotidis 2018), a clear case of morphological evidence for pure categorisers is that of the Modern Greek verbaliser.

In Spyropoulos et al. (2015) we read that "many Greek verbs contain a piece of morphology that unambiguously signals their stems as verbal. These pieces of verbal morphology exist in addition to the presence of Voice, Aspect, Tense and Agreement morphology and include the so-called 'verbal derivational suffixes' *-ev*, *-iz*, *-(i)az*, *-on*, *-ar* and *-en* (Holton et al. 2012; Ralli 2005), which have been traditionally described as forming verbs from nouns, adjectives or adverbs." In the rest of this paper Spyropoulos et al. show that there is also a sometimes non-segmental, stress-

[4] Adjectives, on the hand, seem to be categorially complex (Mitrović and Panagiotidis 2020). The term 'fetch' throughout this chapter is meant to point to the direction of Pietroski (2008, 2012).

shifting piece of morphology (an empty vowel) that unambiguously signals that a stem is verbal, making this a truly pervasive pattern in Modern Greek.[5]

As signalled above, what makes this piece of verbalising morphology significant is that it encodes pure 'verbness'. Indeed, Panagiotidis et al. (2017: 34–42) demonstrate in detail that Modern Greek verbalising morphology is independent of voice, grammatical or inner aspect, tense, causative alternations, agentivity, and agreement. Put differently, Greek verbalising morphology is a prime candidate as the exponence of a categorising *v* head, also one separate from Voice, too (Harley 2013; Anagnostopoulou and Samioti 2014 and elsewhere).

So, there does exist morphological evidence "for elements that merely signal category." At the same time, eschewing categorisers creates their own problems. Two of the matters that arise when we attempt to do away with categorisers are briefly reviewed below.

The first one has once more to do with gender. If nominalisers are not there then gender features will have to be situated on a dedicated functional projection (Picallo 1991, 2008) and/or on roots (Atkinson 2015; Kučerová 2018; Kučerová and Szczegielniak 2019).[6] Beginning with Atkinson's (2015) idea that gender is a feature of roots, we quickly realise it is very problematic, as it entails that roots are nominal or even 'little nouns': what would become of said gender features when roots are categorised as genderless verbs, let alone as gender-unmarked adjectives?[7]

But more problems may arise, even if we do not posit gender itself as a feature on roots. Kučerová and Szczegielniak (2019), who also go for a system of categorisation without categorisers, examine the gender morphology and gender agreement patterns in Polish professional nouns (e.g., *kurier* / *kurier-ka* 'courier', *premier* / *premierka* 'prime minister', **nianiek* / *nánka* 'nanny'). Given the absence of categorisers in their system, and stopping short of arguing for gender features on roots themselves, they are nevertheless forced to argue that "roots of type III nouns [i.e., the **nianiek / nanka* type] are endowed with a syntactic (+AGR) feature and they are inserted early. […] The (+AGR) feature is not a gender valued feature, it is however valued for imposing

[5] "There are a handful of relatively high frequency verbs that lack (overt) verbalizing morphology. These verbs are exclusively of Ancient Greek stock and form a closed class." (Spyropoulos et al. 2015: 313)

[6] Actually both a dedicated gender head *and* another locus (the *n* head) are necessary for languages with gender (Kramer 2009; Atkinson 2015; Merchant 2014; Panagiotidis 2018). Kučerová (2018: 822–823) makes precisely the claim that gender can be a feature of roots, and that these roots cannot be directly verbalized – but see the discussion on Don (2004), who makes similar claims, in Section 2.2.

[7] What Acquaviva (2014b) points out about purported class features on roots is also true of purported gender features on them: "Representing diacritics directly on roots is conceptually problematic, however. Quite simply, if a root has a feature that presupposes a category, then it is not really category-free. Positing an invisible class marker on a root in order to make sure that it ends up in the right nominal or verbal inflectional class simply states the observed correlations (if noun, class X, if verb, class Y), treating them as part of the root itself. But then the root has nominal or verbal information, which is precisely what the lexical decomposition hypothesis is meant to exclude."

or blocking gender agreement that results in a gender valuation" (ibid. 380).[8] We believe it is pretty obvious that this matter, like similar issues arising with the behaviour of semantic gender (mis)matches in a number of languages can be resolved with situating gender on a nominaliser *n*: after all, in gender languages, all nouns have grammatical gender, and nothing but nouns has valued gender: the obvious culprit is the nominaliser *n* (Lazzarini Cyrino et al. 2013; Merchant 2014; Ihsane and Sleeman 2016; Panagiotidis 2018; Adamson and Anagnostopoulou 2021 for more discussion on gender (mis)matches).

De Belder and van Craenenbroeck (2015) apply De Belder's (2011) account of what roots are in order to explain a number of issues in their grammar. They also go for a borerian categorising model that does away with categorisers and even argue that roots may be merged in several places within a structure, not just at the bottom of a spine / extended projection. This enterprise brings them to an interesting juncture when they have to explain the lexicalisation of *wh*-words (4), pronouns (5), and other functional items (6) in Dutch (all examples from De Belder and van Craenenbroeck 2015: 630):

(4) In een krantenartikel komt het wat/hoe/wie/waar
In a newspaper.article comes the what/how/who/where
altijd voor het waarom.
always before the why
'In a newspaper article the what/how/who/where always precedes the why.'

(5) Martha is mijn tweede ik
Martha is my second I
'Martha is my best friend.'

(6) Niets te maar-en!
Nothing to but-INFINITIVE
'Don't object.'

To begin with, examples like the above abound in many languages and have been studied to a considerable extent (Clark and Clark 1977). They can be understood as the nominalisation, verbalisation etc. of

a. constituents, as in the verb *French pastry* in Woody Allen's "I'd like to French pastry myself to death,"
b. citations, as in the case of the adjective *come hither*: "I was given a come-hither look."

[8] In positing a *syntactic* feature on a root, Kučerová and Szczegielniak (2019) acknowledge that they go beyond even the claim in Embick (2015) that roots may mark only 'morphological' features.

Moreover, in the case of functional items like the ones cited by De Belder and van Craenenbroeck, it is possibly not the case that roots are involved at all: the forms that become nouns and verbs in (4), (5), and (6) correspond to functional items, pure bundles of features. But let's go along with the hypothesis that these actually involve roots.

De Belder and van Craenenbroeck's (plausible) understanding of roots as featureless terminals, as empty sets (2015: 641), *coupled with the absence of categorisers* forces them to posit that "in every derivational workspace, there is exactly one root, and for every root there is exactly one derivational workspace" (ibid. 642). This move resolves how (4), (5), and (6) can exist without any categorisers to nominalise and verbalise them, but introduces considerable complexity to the architecture of grammar, with unpredictable and possibly undesirable consequences once different types of compounding are considered (e.g., when considering different compound structural configurations, see Nóbrega and Panagiotidis 2020: 228–233). A clearly simpler solution is that these 'lexicalised' functional elements (and/or citations) are already categorised (cf. Alexiadou and Lohndal 2017b: 223).

We will therefore go for categorisers, and for the state of affairs in (3). We thus follow Panagiotidis (2011) in understanding (1) and the descriptive observation encapsulated by the *Categorization Assumption* as equivalent to an understanding that roots cannot be interpreted at the interfaces unless they are embedded inside the complement of a categoriser. The statements in (1) that (i) 'roots need category' and (ii) 'roots can be only categorised in syntax' are recast as the following hypothesis, which we adapt from Panagiotidis (ibid.):

(7) Roots can be merged with a categoriser (projection), never with a functional head or its projection.[9]

At this point it is necessary to investigate the very idea that bare roots are acategorial. It certainly enjoys by now the status of the received approach, however it is one that is founded mainly on Borer's (2003, 2005a) conceptual and architectural arguments and on evidence from processing in Pfau (2009).[10] Having said that, the fact that the same root can be readily made into a noun, a verb, or an adjective in language after language has been highlighted in study after study for at least the last three decades or so, and the commentary of Chung (2012) by Embick (2012) is pretty suggestive of this state of affairs. Still, a better look at the acategoriality of roots is due.

[9] This is equivalent to saying that functional heads, unlike categorisers, cannot support real descriptive content (Abney 1987: 64–65).
[10] Note that in this work Borer referred to roots as 'listemes'.

2.2 Roots are acategorial, aren't they?

The key position on roots being acategorial is neither obvious nor uncontested. To begin with, to the casual observer it appears that some roots make better nouns than verbs. The roots CAT, DOG, BOY make good nouns in English but not great verbs, if at all, especially when one makes the necessary distinction between root-derived verbs and denominal verbs — recall, for instance, the distinction between the verbs *hammer* (root-derived) and *tape* (denominal) in Arad (2003). Indeed, verbs like *dog* and *cat* appear to be denominal verbs (like *tape*) with the noun functioning like a manner modifier: *to dog* means 'to follow someone around like a dog' and similar facts hold for the verb *cat*.[11] In other languages, things are even more lopsided: Farsi does not verbalise most roots, whereas Hindi/Urdu also seems to work the same way: the vast majority of roots can only surface as nouns (Panagiotidis 2015: 72–73).

At this point it is worth recalling a point in the previous subsection when discussing Polish professional nouns and in footnotes 6 and 7, namely that roots are sometimes treated in grammatical analyses as if they were inherently nominal.[12] Panagiotidis (2020) discusses the case of Harley (2005b: 46–50), "which derives the Aktionsart opposition between unergatives *drool* (atelic) and *foal* (telic) as a result of the semantic properties of the respective roots. Accordingly, the verb *drool* is thought to be atelic because it is derived from an unbounded / mass root DROOL, whereas the verb *foal* is telic because it is derived from a bounded / count root FOAL." The underlying assumption here is that DROOL and FOAL are treated as inherently nominal, with a mass / count distinction actually being intrinsic to them.

Is it then perhaps the case that roots are inherently categorised, a direction traditional grammatical descriptions would follow? Some detailed and poignant empirical criticism of acategorial roots comes from Don (2004). He looks at zero conversions in Dutch to argue that 'the lexical category of roots should be lexically stored' (Don 2004: 933). Don argues that *hammer*-type derivations, i.e. cases where a noun and a verb are directly derived from a root like HAMMER are inexistent in Dutch: the author claims that all Dutch conversions are either denominal verbs (like the English verb *tape*) or deverbal nouns (like the English noun *throw*). Arguments for this claim come from morphological and phonological facts.

The *morphological* argument against category-less roots in Dutch rests on the behaviour of irregular morphology of zero-derived verbs and of gender on zero-derived nouns (Don 2004: 939–942). Don begins with the observation that, regarding morphological (ir)regularity of verbs and gender on nouns, four logical possibilities

[11] This is true for speakers who accept *cat* as a verb with conventionalised meaning and not as a spontaneous coinage (cf. Barner and Bale 2002). See also Harley (2005b) and the overview in Alexiadou and Lohndal (2017b).

[12] Alternatively, roots have been understood as stative predicates (Alexiadou 2001), sometimes even as verb-like, complete with argument structure information (Doron 2003; Levin and Rappaport Hovav 2005). We will return to these in Section 3.

should be available when cross-classifying zero-derived noun–verb pairs. However, not all combinations are attested:

(8) Dutch zero-derived noun-verb pairs

		Verbs	
		regular	irregular
Nouns	common gender	*fiets* ('bike', 'cycle')	*val* ('fall')
	neuter gender	*werk* ('work')	N/A

There are no verb–noun conversion pairs where the verb is irregular and the noun is neuter. Don (2004: 941) appeals to the following straightforward descriptive generalisations in order to explain the gap in (8):

a. V-to-N conversion creates common gender nouns;
b. N-to-V conversion creates regular verbs.

Hence, the verbs *fiets* and *werk* are denominal because they are regular, whereas the noun *val* is deverbal because it is marked for common gender. Zero-converted 'neutral gender noun – irregular verb' pairs do not exist: if the noun were deverbal, it would bear common gender, whereas if the verb were denominal, it would be regular. Don concludes that zero-deriving *both* a noun *and* a verb from a root is impossible. Consequently, roots are categorised, as nouns or as verbs: if roots were category-less, then 'neutral gender noun – irregular verb' pairs would be directly derivable from the root.

The *phonological* argument against category-less roots in Dutch comes from observing a similar gap. Reviewing evidence in Trommelen (1989), Don (2004: 942–945) makes the generalisation summarised below:

(9) Zero derived Dutch verbs and their syllable structure

		Syllable structure	
		simple	complex
Co-radical noun?	yes	abundant (*bal*, *lepel*…)	some (*fiets*, *oogst*…)
	no	abundant (*win*, *kom*…)	N/A

The position of the gap in the above table is quite telling; judging by it, it seems that Dutch zero-derived verbs with complex syllable structure *must* have a corresponding noun. Don interprets this fact as evidence that verbs with complex syllable structure are all denominal, suggesting that zero-derived verbs can only have simple syllable structure — unless of course they are denominal conversions. In other words: only roots with simple syllable structure can be verbal.

The morphological evidence in (8) together with the phonological facts in (9) lead Don (2004) to posit that the simplest way to account for them is to take roots to be categorised. His account unfolds as follows:

(10) Don's (2004) generalisations:
   a. Nominal roots in Dutch can be of either gender, common or neutral — they can have either simple or complex syllable structure;
   b. Verbal roots can only have simple syllable structure but can derive both regular and irregular verbs;
   c. Verb to noun conversion only yields common gender nouns;
   d. Noun to verb conversion only yields regular verbs.

The analysis is straightforward and powerful but we will show in the following subsection that it relies on a pretheoretical conception of what roots are.

2.3 Yes, roots are acategorial

Given that the assumption in (1) and the hypothesis in (7) are hardly uncontroversial, also in the face of evidence such as discussed in the previous subsection, we will now proceed to empirically back that acategorial roots must be categorised in syntax by dedicated categoriser heads. Once this has been taken care of, we will then have to explain away the evidence in the previous subsection, which supports the view that roots inherently bear category.

Let us revisit the evidence in Section 2.1 for verbalisers (*v*) as independent heads. As expected from categorisers (Arad 2003, 2005), such heads categorise both roots and already categorised material (Spyropoulos et al. 2015: 307–312). Hence, the existence of verbalisers does not necessarily entail that roots are acategorial, and it could as well be the case that roots in Modern Greek are overwhelmingly categorised as nominal or adjectival, with only a handful of them being inherently verbal, as noted in footnote 5.

So, in a logic similar to that of Don (2004), most Modern Greek roots would be nominal or adjectival and this would be the reason overt verbalising morphology would be necessary in order to make verbs. Recall that this is what happens in languages like Farsi and Hindi anyway, albeit not through a morphological process (cf. Panagiotidis 2015: 103–105).

Still, if roots that must be verbalised in Greek had inherent category (say nominal or adjectival), then we would expect them to also emerge as nouns or adjectives, after the relevant inflectional morphology would have been added, given that in synthetic languages like Modern Greek roots and stems are typically bound morphemes. Interestingly, this is not what always happens, suggesting that roots bear no inherent categorial specification. Consider first Modern Greek sound-mimic verbs, deriving from onomatopoeic roots (Spyropoulos et al. 2015: 309):

(11) Sound-mimic verb stems

gar-iz-	bubun-iz-	gavg-iz-
GAR-*v*	BUBUN-*v*	GAV(G)-*v*
‘bray, yell’	‘rumble’	‘bark’

The above roots can directly yield neither nouns (which would be expected if they were inherently nominal) nor adjectives (which would be expected if they were inherently adjectival).[13] To wit, nouns about braying or yelling, rumbling, and barking are all clearly deverbal:

(12) Sound-mimic deverbal nouns

gar-iz-ma	bubun-iz-ma	gavg-iz-ma
GAR-*v*-*n*	BUBUN-*v*-*n*	GAV(G)-*v*-*n*
‘bray, yell’	‘rumble’	‘bark’

Hence, (at least) onomatopoeic roots are acategorial and they are not the only ones (see footnote 13). Another example of verbalisations that is worth examining is when an identical root yields very different verbs according to the verbaliser that attaches on it.[14] Observe the following triplet (Panagiotidis et al. 2017, 46):

(13) Same root, different verbs

kur-ev-	kur-az-	kur-ar-
KUR-*v*	KUR-*v*	KUR-*v*
‘give a haircut, shear’	‘tire, be tiresome’	‘treat as a patient’

Leaving irrelevant details aside, the question here is which category the root KUR would belong to. Attempting to derive a noun directly from the root will give us *kur-*

[13] This is certainly *not* restricted to onomatopoeic roots: there are several roots that yield no root-derived nouns but do yield verbs. Roots like RUF, TIN, or PROST are three of them: the former yields the verb *ruf-a-* (‘suck’) combined with the (sometimes empty) vowel verbaliser described in Spyropoulos et al. (2015), but no nouns; the latter yield the verbs *tin-az-* (‘toss’, ‘flick’) and *prost-az-* (‘decree’), combined with a regular segmental verbaliser *-az-*, but no nouns. We are grateful to Ioanna Papadopoulou for pointing out the above to us. Other roots that are definitely neither ‘nominal’ nor ‘verbal’ are the following (Panagiotidis et al. 2017: 47)

a. oɾɣ-ón-o ‘I plough’
b. skil-év-o ‘I despoil’
c. kaliɣ-ón-o ‘I shoe (a horse or a mule)’
d. kutup-ón-o ‘I shag’

[14] According to Spyropoulos et al. (2015) and Panagiotidis et al. (2017) the verbalising *morpheme* in Modern Greek is the same, i.e., bears the same feature [V], with the different forms amounting to just different allomorphs thereof. For some discussion on the repercussions of this, see Panagiotidis (2020).

os (‘kouros’), *kur-á* (‘shearing’, ‘tonsure’) and *kúr-a* (‘treatment of a patient’, ‘post-surgery rest’). The first noun is irrelevant, because there is no verb related to it, and the other can be related to *kur-ev-* (‘give a haircut, shear’) and *kur-ar-* (‘treat as a patient’) in (13). There is no fatigue-related root-derived noun:

(14) Noun-verb pairs for KUR

kur-ev-	kur-á
KUR-*v*	KUR-N.FEM
‘give a haircut, shear’	‘shearing’, ‘tonsure’
kur-ar-	kúr-a
KUR-*v*	KUR-N.FEM
‘treat as a patient’	‘patient treatment’, ‘post-surgery rest’
kur-az-	N/A
KUR-*v*	
‘tire, be tiresome’	

The picture in (14) is quite revealing. Whether *one* root KUR is involved in the derivation of the words, or two or three, the important issue here is that there is no root-derived noun for KUR yielding the ‘tire’ verb. If roots are nominal, this is an unexpected state of affairs, especially given that homophonous roots — or the same root KUR under other interpretations, as argued in Panagiotidis (2020) — do yield root-derived nouns. Talking about a ‘lexical gap’ in (14) will not explain anything, given that a noun for ‘tiredness’ or ‘fatigue’ does exist and it is a deverbal one, like in (12): *kur-a(z)-si*.

At this point the obvious question is how the acategorial approach to roots can explain data like those examined in Don (2004). Here we will briefly summarise and update the remarks in Panagiotidis (2015: 74–77), also building on a similar treatment of Don’s data and account in Acquaviva (2009).

As in (9), verbs with complex syllable structure are always denominal. A first way to interpret this would be that the verbal category will only be assigned to roots with a simple syllable structure, cf. (10). This claim is odd even within a lexicalist framework, because it correlates category membership of a root with syllable structure. However, if the discussion in Section 4 is on the right track, and root *forms* (Vocabulary Items) undergo Late Insertion, then we can recast this generalisation as follows: roots in the complement of *v* are spelled out as forms with a simple syllable structure.

What about the situation in (8), as summarised in (10)? Why is it the case that verb to noun conversion only yields common gender nouns and not neuter gender ones? In Panagiotidis (2015: 74–77) this is taken to be a fact about *n* heads, nominalisers, with

zero exponence, hence to be a fact about the form of nominalising heads, and not about the root itself. Indeed, "there is no blanket ban on neuter gender nominalizers of verbs. Don (2004: 941–942) discusses the neuter gender morpheme element *-sel*, which nominalizes verbs like *zaag* ('to saw'), giving *zaagsel* ('sawdust')" (ibid.).

Thus, the generalisation here is rather that the null exponent of *n* bears common gender, when it is spelled out with a *v*P in its complement, hence yielding deverbal zero conversions: an *n* in an [$_{n\text{P}}$ *n* *v*P] syntactic environment cannot surface both as Ø and neuter. Hence, clause c. in (10) is a generalisation about the morphology of categorisers and not about roots. More specifically, it is a morphological constraint on null nominalisers with a *v*P complement.

However, and returning to the unattested conversion pair 'irregular verb – neuter gender noun' in (8), as summarised in clause d. of (10), the question is why a Ø-exponence *n* marked for neuter gender cannot take a root complement that also derives an 'irregular' verb. Again, the answer will have to be about the morphology of Dutch categorisers, not about roots (Panagiotidis 2015: 74–77). Irregular verbs in Dutch are Germanic strong verbs: verbs that synchronically display opaque stem allomorphy, i.e. genuine root allomorphy (see Section 4), e.g. *koop-*, *kocht-*, *ge-kocht-t* 'to buy' or *val-*, *viel-*, *ge-val-en* 'to fall' (Don 2004: 940). Hence the correct generalisation is that a null nominaliser cannot bear the neuter gender when taking as its direct complement a root displaying allomorphy.

Summarising, Don's generalisations in (10) can be captured as follows (Acquaviva 2009; Panagiotidis 2015: 76):

(15) An *n* head bearing [gender:neuter] will surface as Ø only if it takes nonallomorphic root complements.

2.4 Roots are special

Now that we have some idea of the empirical support available for (1), we need to explain why roots are acategorial and why root categorisation is obligatory. The answer lies somewhere within a general idea that roots are *special*. Of course, this statement is both circular and vague: Why must roots be categorised? Because they are special. Why are they special? Because they must be categorised.

Still it is important to remember that roots have been treated as special primitives since the earlier days of DM (Harley and Noyer 1999, 2000), in ways that go well beyond questions of categorisation. Recall that at least until the middle of the '00s, the DM consensus was that roots are not only both acategorial and syntactically active, but also meaningful (i.e., *encoding* conceptual content), and phonologically identified (i.e., carrying their phonological structure through the derivation, what Borer (2005a, 2005b, 2013a) calls *a phonological index* — see Harley (2014: 227–231) for cogent

criticism. The last two claims (i.e., 'meaningful' and 'phonologically identified') would commit us to Early Insertion for roots:

(16) *Are roots special? A DM approach*
   a. Roots are exempt from Late Insertion, making them quasi-saussurean signs; they are introduced together with formal features into the combinatorial mechanism (the 'syntax');
   b. As expected from quasi-signs, roots carry conceptual content ('meaning') to some degree, making them the only syntactic nodes whose semantic interpretation does not have to wait until the interface with the Conceptual-Intentional systems (the 'Encyclopedia').

Already in these early approaches to roots as grammatically active elements, the emerging consensus is the following:

(17) *Some generalisations on why roots are special*
   a. Roots are neither formal features themselves (like number or tense), nor composed of formal features, like functional heads are; roots may however bear 'non-syntactic' features;[15]
   b. Roots are not *just* pure forms, i.e. they are not Vocabulary Items – but see (16) above;
   c. Roots behave as units that (are used to) denote, denotation being a par excellence language-external function (Chomsky 1995b).

Now, the points above, i.e. roots being inserted early and carrying content, did not resist methodologically minimalist scrutiny (Acquaviva 2009; Borer 2009; De Belder 2011; Borer 2014a; Harley 2014; Panagiotidis 2014a) but in hindsight they seem reasonable answers to the peculiarity of roots:

(18) Roots neither are (composed of) formal features, nor are they forms; roots fetch denotations.[16]

The 'fetch denotations' part is quite interesting. A grammatical structure that involves no roots at all is limited to encoding only those "notions that are grammatically encoded," which are of course limited in number (Cinque 2013). So, rootless structures would be made up exclusively of UG features and typically involve

[15] Like Marantz's (1996) [±animate] features; see also footnotes 7 and 8.
[16] See footnote 4.

expressions like ‘This is her’, ‘I got that’, ‘It is here’ and so on (cf. Emonds 1985, chap. 4; van Riemsdijk 1998; Haider 2001; Schütze 2001; Panagiotidis 2003; Harley 2005a).[17] Therefore, the grammar’s ability to include roots within the structures it creates enables FL to manipulate concepts beyond those encoded by UG features. Ultimately, the availability of roots entails that we can use language to ‘refer’ to the world (Acquaviva and Panagiotidis 2012; Borer 2014b: 356–358; Panagiotidis 2014a: 290). We will return to this point in Sections 5 and 6.

Once we accept that roots are special, we can proceed to tackling why they *must* be categorised. Under minimalist assumptions there are at least two possible paths of explaining the necessity of categorisation. The first path is the one already mentioned and taken by Panagiotidis (2011), echoing Arad (2003: 741, 747, 2005): categorisation, like any other grammatical operation, can be visible only at the interfaces, so it will have to be forced in order to make roots readable at interface level: roots cannot be *interpreted* at the interfaces unless they are categorised.

A second path is that taken by Mitrović (2018), whereby categorisation renders roots visible at the onset of a derivational process, possibly making them labelable (Nóbrega and Panagiotidis 2020: 228–236 for a treatment of compounds based on this assumption). In this chapter we will argue in Section 3 that there are good reasons to believe that indeed roots cannot be interpreted at the interfaces unless they are categorised, but we will also suggest reasons in Section 5 on why they could neither participate in the derivational process to begin with, unless categorised. In any case, we will go by (7), taking the *Categorization Assumption* to be equivalent to roots becoming ‘usable’ if and only if they are embedded inside the complement of a *categoriser*.

2.5 Merging and projecting roots

The most common assumption about the placement of a root in a syntactic structure is that they are merged as complements of category heads, as illustrated in (3). In the last two decades, however, this extensively held idea has been revisited, primarily due to two reasons:

(19) Different merging sites for roots, so as
  (i) To secure locality, in order to account for allomorphy (Marantz 2013) or for the assignment of non-compositional readings (Nóbrega and Panagiotidis 2020; Nóbrega 2021), or

[17] As evident from the references cited, a rootless structure built on a categoriser yield semilexical elements. Lack of space prevents us from presenting a critique of an account of semilexicality that actually involves roots, as suggested in Acquaviva (2009) and further developed in Acedo-Matellán and Real-Puigdollers (2019).

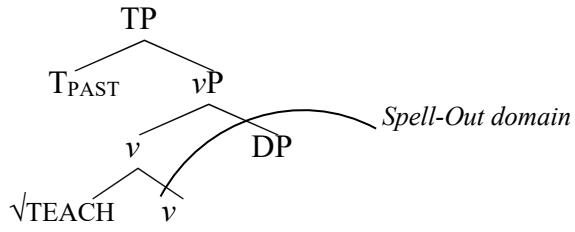
(ii) To capture interpretive differences, mostly in the verbal domain (Embick 2004, 2010; Alexiadou and Anagnostopoulou 2013; Alexiadou et al. 2015).

For the first context, it is argued that roots are merged as adjuncts of category heads so as to avoid their being sent to the interfaces without relevant syntactic material, whereas in the second context both structural configurations are assumed to be possible (Alexiadou and Lohndal 2017b for an extensive review of possible structural configurations for roots).

Let us initially explore the locality issue and the adjunction hypothesis. Marantz (2013) argues that contextual allomorphy requires a root to be adjoined to a categorising head, specifically *v*. The argument comes from irregular past tense morphology in English, which is dependent on the [past] feature of T. The root √TEACH, for instance, has to be realised as /tɔ/ in the environment of T_{PAST}, and T_{PAST} has to be realised as /t/ in the environment of √TEACH (2013: 98). This phenomenon raises a critical locality issue: admitting that *v* is a phase head, √TEACH and T would be on opposite sides of a phase boundary if roots were merged as complements of category heads. In this configuration, *v* would be interfering with T_{PAST} serving as the context for the Vocabulary Item at the root.

In order to allow for √TEACH to be in the same Spell-Out domain as *v*, Marantz proposes that roots are *adjoined* to the verbal category head, therefore escaping the Spell-Out domain of *v*, as depicted in (20). As a result, both the root √TEACH and T will be spelled-out at the same time, in the complement domain of a phase head higher up in the structure (i.e., C), allowing both heads to be available at the moment of vocabulary insertion.[18]

(20) Root adjunction



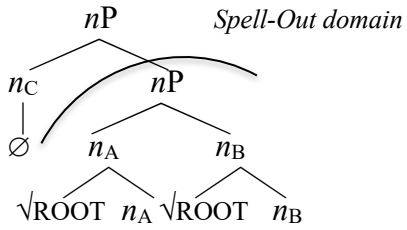
Nóbrega and Panagiotidis (2020) and Nóbrega (2021) resort to the same rationale to explain the assignment of non-compositional interpretation in compounds. They show that even non-compositional compounds must have both roots independently

[18] A reviewer suggests that an alternative account could involve a weak version of the Phase Impenetrability Condition (PIC) (Chomsky 2000), which would allow the domain of a phase head to remain accessible until the next phase head is merged to the structure. In this case, T_{PAST} and the root √TEACH would be able to influence the phonological exponence of each other since C is not merged yet.

categorised, contrarily to the hypothesis that primary compounds are made up of two bare roots directly merged (Zhang 2007; Bauke 2013, 2014, 2016; Borer 2013a, 2013b; Hu and Perry 2018). One piece of evidence is the fact that non-compositional primary compounds comprise internally complex structures. First, they encode different grammatical relations, such as attribution (e.g., *sword fish*), subordination (e.g., *apron string*), and coordination (e.g., *actor director*). Second, their first and second members can bear plural marking, indicating the availability of functional material attached to both roots; consider Brazilian Portuguese *car-a-s+metad-e-*(*s*) lit. face-TV-PL+half-TV-PL 'soul mates'; *bói-a-s+fri-a-*(*s*) lit. meal-TV/F-PL+cold-F-(PL) 'seasonal farm workers' etc.

Non-compositional meaning, however, requires both roots to be in the same Spell-Out domain, allowing such combination to receive a single idiosyncratic interpretation. If roots were merged as complements of category heads — and hence of phase heads —, the roots making up a compound would be spelled-out separately, precluding the assignment of a single *fixed* meaning to them. Thus, in order to allow both roots to be in the same Spell-Out domain (and categorised), Nóbrega and Panagiotidis follow Marantz (2013) in assuming that roots are adjoined to category heads, as illustrated with the generic nominal compound structure below.

(21) Roots in compounds



Note that the sole purpose of resorting to the adjunction hypothesis is to solve locality problems arising from the idea that categorisers are phase heads (Marantz 2006). Both accounts explored above do not suggest that adjoining roots to a category head leads to any particular interpretive effect, as is the case with the second perspective to be explored below. The adjunction hypothesis thus seems to be telling us much more about the validity of the assumption of categorisers as phase heads, rather than about the placement of roots in a syntactic structure. Further developments on the mechanisms involving cyclic Spell-Out and interpretation in the word domain will unquestionably demand a revision of the adjunction strategy (see e.g. Borer 2013a; Panagiotidis 2014). Finally, since adjunction is optional, this hypothesis predicts that there should exist sentences without roots, and that roots do not need to be unavoidably categorised (Alexiadou and Lohndal 2017b: 220). The former prediction is in fact borne out (see Section 4.2). We are rather sceptical about the latter, especially in the realm of compounding, a topic that deserves further research (but see De Belder 2017).

On the other hand, the second perspective about the placement of roots in a syntactic structure ascribes an interpretive value to each structural configuration entertained. This perspective aims to capture distinct event readings in the verbal domain, building on the idea that roots come in at least two types — viz., manner roots and state / result roots —, and that roots can be integrated into a verbal structure either as arguments of primitive predicates, viz. result roots, or as modifiers of an event, viz. manner roots (Rappaport Hovav and Levin 1998, 2010: 23–26). The most representative works suggesting the availability of such structural possibilities are Embick (2004, 2010; see also Alexiadou and Anagnostopoulou 2013; Alexiadou et al. 2015).

Embick proposes that state / result roots, such as in *flatten*, are merged as complements of *v* heads, while manner roots, such as in *hammer*, act as their modifiers, i.e. they are merged as adjuncts of *v*. In his view, the nature of Merge is sensitive to such root ontology, giving rise to a series of syntactic-semantic consequences. For instance, result / state roots make up accomplishment predicates, while manner roots make up activity predicates. Moreover, the meaning associated with each root type informs their potential categorisation possibilities and the availability of arguments.

Finally, let us briefly consider the selection properties ascribed to roots. The conventional idea that roots are merged as complements of category heads is also linked to the assumption that roots can take complements prior to categorisation (i.e., that roots *select* internal arguments), and therefore are able to head phrasal constituents (Marantz 1997; Alexiadou 2001, 2004, 2009; Embick 2015). One of the main arguments in favour of this assumption is anchored on Kratzer's (1996) claim that internal arguments cannot be severed from the verb, and that argument selection is category blind; that is, independently of the nature of the categoriser merged with a root, the resulting word will take a uniform set of selected arguments (but see Merchant 2019).

Harley (2014) gathers syntactic (*one*-replacement), semantic (verb-object idioms), and morpho-phonological (root suppletion in Hiaki) arguments to argue in favour of the root-as-predicate position. For instance, she argues that *one*-replacement in argument structure nominals reveals that roots and their objects must be sisters (2014: 249–253). Only nominal adjuncts, but not selected arguments, can be stranded under *one*-replacement (e.g., **the student of chemistry and the one of physics* vs. *the student with long hair and the one with short hair*, see Jackendoff 1977). According to Harley, such distribution is indicating that the PP *of physics*, in the first sentence, is not the sister of *n*P or *v*P, such as the case of adjunct PPs (e.g., *with short hair*), but that it must be a sister of the root √STUD, which after being merged with its PP complement, is subsequently nominalised by *n* (*-ent*).

The assumption that roots select, however, is highly controversial, and has been extensively disputed in the literature, Harley's arguments notwithstanding (Borer 2003, 2013a, 2014a, 2014b; Gallego 2014; Alexiadou 2014; Alexiadou and Lohndal

2017b; Merchant 2019). Merchant (2019) has recently revisited the claim that roots exhibit a uniform selectional behaviour. He observes that a considerable amount of roots in English display idiosyncratic prepositions heading their PP complements, and that their distribution is category-sensitive, hence could not be determined by any selectional properties encoded by roots (e.g., *she prides herself on/*in/*of her thoroughness*; *her pride in/*on/*of her thoroughness is understandable*; *she is proud of/*on/*in her thoroughness*; 2019: 329). Such preposition variation cannot be accounted for by resorting to the conjecture that the root √PRD, for example, selects for an underspecified P, while different Vocabulary Items (i.e., *on*, *in*, *of*) compete for insertion into the P node post-syntactically (2019: 332). Furthermore, the assumption of an underspecified P is not able to account for roots where a (verbal) direct object alternates with a PP complement to a noun or an adjective, such as the case of the root √OPPOS (e.g., *oppose x*, *opposition*/*opposed to x*), since postulating a set of selectional features, such as D and P, would ignore their category-sensitivity, and predict optionality of either.

We therefore subscribe to the following position:

(22) Roots do not take complements and they do not project their own phrases.

The arguments are manifold and are both theoretically (e.g., the proper feature-less nature of roots; see e.g. Borer 2003, 2009), and empirically grounded. Admitting that roots are devoid of any functional information — hence that they lack any syntactic properties of their own —, they unequivocally depend on the merger with categorising material to be integrated into an argument structure. The above would hold even in a system where Merge applies freely.

3 Roots are meaningless

So far we have established that roots do not project, hence that they take no complements. Relatedly, we have also sided with Alexiadou and Lohndal (2017b) in our cautious understanding that roots are special in how they merge, possibly as adjuncts that still must definitely be categorised by getting merged within the projection of a categoriser, as already in (7). Before that we had already pointed out in (18) that roots (i) are not (composed of) formal features, (ii) are not pure forms (contra Borer — more on this in Section 4), and (iii) fetch denotations. It is now time to turn to the question of what conceptual content roots carry.

The question of root content is seriously posed with Marantz (1996), who introduces the idea that roots are something like placeholders.[19] This idea seems to inaugurate the assumption that roots are semantically impoverished (Arad 2003, 2005), or at least that their conceptual content plays no role pre-syntactically. Two decades into the 21st century, few in a generative framework would disagree that the conceptual content of roots (if any) is irrelevant to the syntactic computations.[20] Here we will review accounts building on an even more radical idea, one that became established with Borer (2005a, 2009, 2013a, 2014a) and with Acquaviva (2009, 2014a, 2014b): that there is hardly *any* conceptual content in roots.

We understand the early DM conception of roots as meaningful units to stem from the much earlier bias towards roots as 'small words', as reviewed in Section 1. Indeed as, pointed out in (16), the received claim that "roots carry descriptive content ('meaning') to some degree" seems to be a persistent one, cf. Embick's (2015) formulation that roots may encode morphological and 'concept encoding' features (see also Kučerová and Szczegielniak 2019). In what follows, we will review evidence and arguments on why this bias of roots as quasi-signs is empirically problematic.

3.1 Radical emptiness?

If one has a casual look at groups of words derived from the same root one will reach the conclusion that they seem to share a common conceptual core, cf. Hale and Keyser (1993, 2002); Rappaport-Hovav and Levin (1998, 2010); Levin and Rappaport-Hovav (2005). Examples like *butter* the noun and *butter* the verb, a triplet like *red*, *redness*, *redden* or Hale and Keyser's *foal* the noun and *foal* the verb are pretty telling in this respect.

Of course we must first of all make sure we distinguish between which words in a 'word family' are directly derived from the root and which may be derived from an already categorised noun, verb, or adjective — recall the subtleties involved in this dilemma, e.g. from Section 2.3.

In some languages it can be easier to decide whether two words are derived directly from the same root or the one from the other. In English-like cases (which are not necessarily language-wide), on the other hand, we can go by the rule of thumb in Arad (2003): direct derivation of, say, a noun-verb pair like *hammer* the noun and *hammer* the verb, may involve a degree of idiosyncratic divergence between their meanings; to wit, *to hammer* does not necessarily involve using a hammer. According to Arad, this stands in stark contrast with a denominal verb like *tape*, where the actual

[19] An idea that is of course brought to its logical conclusion in De Belder (2011) and De Belder and van Craenenbroeck (2015).
[20] With notable exceptions including Rappaport-Hovav and Levin (1998, 2010), Rappaport-Hovav (2014 et seq.).

noun *tape* is part of the verb's meaning, thus *to tape* means 'to fasten with tape' (pace Harley and Haugen 2007; Borer 2014a: 140–141).

The reason we returned to this well-known distinction is in order to caution against taking the relative semantic homogeneity observed in families of words derived from the same root as granted. The said homogeneity is illusory and partially results from a large number of words in a given 'word family' being derived from the same categorised root, i.e. from a noun, a verb, or an adjective, like in *tape*, and not directly from the root, as in *hammer*. An example of this is the root NOM in Modern Greek: a great number of words about law and the Law are derived from it, but most of them seem to be actually derived from the noun *nomos* ('law'). Quite interestingly, a verb *nom-iz-* meaning 'think', and more nouns about distribution, administration, currency etc. are also derived from the same root (Panagiotidis 2014a: 295–297, 2020).

(23) The Greek root NOM

Derived from the noun nóm-os *'law'*

nom-ik-os	'legal$_1$, juristic'
nom-im-os	'legal$_2$, lawful'
para-nom-os	'illegal, outlawed'
nom-o-thet-	'legislate'

Derived directly from the root NOM

nom-ós	'prefecture'
nom-í	'distribution', 'grazing'
ypo-nom-os	'sewer'
astr-o-nom-ia	'astronomy'
nom-iz-	'think, believe'
nom-iz-ma	'coin', 'currency'

Still, even when we look at pairs like *hammer* the noun and *hammer* the verb, both directly derived from the root, we cannot fail to notice an affinity between their denotations. After all, *to hammer* is to hit in a (repeated) hammer-like motion: maybe there is something about a shadow of the hammer concept encoded in the root.

This is precisely the intuition that Arad's *Multiple Contextual Meaning* of a root captures (Arad 2005: 65), namely the thesis that an uncategorised root contains the 'common semantic denominator' (Arad 2005: 4–6, 55–59, 271–274) of the words (directly) derived from it. An example of this is the by now celebrated Hebrew root QLT (Arad 2005: 97):

(24) The Hebrew root QLT

Nouns:

miqlat ('shelter')

maqlet (‘receiver’)
taqlit (‘record’)
qaletet (‘cassette’)
qelet (‘input’)

Verbs:

qalat (‘absorb’, ‘receive’)
hiqlit (‘record’)

The words derived from QLT have very different denotations, ranging from *qaletet*, the learned word for cassette, to the verbs ‘absorb’ or ‘shelter’. Intuitively they nevertheless seem to share a (very) abstract common meaning core, along the lines of ‘keep, preserve’. This ‘keep, preserve’ (proto-)concept would be encoded by the acategorial root QLT in isolation, i.e. before it enters the derivation.[21]

At the same time, ‘word families’ like the one in (23) have cast serious doubt on the feasibility of a root encoding some sort of a denotational core, no matter how abstract or (exasperatingly) vague. The idea that roots are completely devoid of any semantic content is alluded to in Aronoff (2007) and advanced in Acquaviva (2009, 2014b), Borer (2005a, 2009, 2013a, 2014a), De Belder (2011), Panagiotidis (2011, 2014a, 2014b), Acquaviva and Panagiotidis (2012) and Harley (2014). In this body of work the quasi-saussurean, i.e. the ‘small word’, approach to roots is radically rejected and roots are reconceived as indeed something special even beyond the description in (18): they are typically recast as indices.

3.2 A spectrum of content?

There exist of course systematic attempts to strike a compromise between the radical emptiness of roots and the more traditional approach to them as small words. One prominent idea, advanced in Saab (2016) and Alexiadou and Lohndal (2017a), goes as follows: while some roots like DOG seem to be very specific in isolation and do look like words, quasi-Saussurean signs, others only carry vague content, like QLT in (24), while others carry no content at all, like NOM in (23).[22]

Saab (2016) follows this rationale to argue that roots are arranged along a ‘content scale’ according to the ‘amount’ or ‘specificity’ of denotation they encode *before* categorisation, i.e. in isolation. On the one end of this scale we would have roots like

[21] This approach presupposes that something along the lines of most concepts being non-atomic (Fodor 1998, 2008; Acquaviva and Panagiotidis 2012); most concepts would be constructed by grammar around a ‘denotational core’ supplied by the root.

[22] Before we continue, note that from a conceptual viewpoint it is extremely hard to draw an argument based on the specificity or vagueness of the *concepts* that roots in isolation would be supposed to be associated with: by which metric is the ‘dog’ concept more precise and/or more specific than the ‘keep, preserve’ concept exemplified in (24)?

NOM, which are completely meaningless in isolation. On the other end of the scale we would have roots like DOG or, perhaps, SUGAR (to which we return below), which would possess rich and specific content. In the middle of such a scale one would find roots like QLT: roots that either (i) bear a shadow of content, associated with a vague 'common denominator', or (ii) are polysemous in isolation, until they are categorised (Levinson 2007; Marantz 2013), as discussed in Section 3.3.

The next step to take would be to follow up on the idea of this content scale along which uncategorised roots are arranged in order to claim that less specified roots (like NOM) give rise to "crazier", i.e. more idiosyncratic, word meanings whereas more specified and contentful roots (like DOG) lend themselves to yielding more 'compositional' word meanings. This is essentially the claim in Alexiadou and Lohndal (2017a), according to which languages like English possess a repertory of QLT and SUGAR type roots, whereas Semitic has predominantly QLT type roots. The descriptive generalisation emerging here would be that Hebrew roots mostly belong to the least specified side of the purported root content spectrum, with English roots being distributed mainly towards the opposing end.

Alexiadou and Lohndal (2017a), like Saab (2016), build on this generalisation in order to draw a correlation between the conceptual concreteness and the morphological unboundedness of a root: the fact that English tends to have contentful roots correlates with English roots surfacing as free morphemes; the fact that Hebrew roots tend to be vague or even empty correlates with them being always bound. Interestingly, this more specific correlation could accommodate differences in root content within the same language: DOG, surfacing as a free morpheme, also has pretty concrete content, whereas MIT, which always surfaces as a bound morpheme in verbs like *commit*, *submit*, *admit*, *permit* etc., is radically empty.

There are of course at least two serious issues regarding this assumed correlation: The first has to do with the architecture of the FL: why would morphological behaviour, a matter of realisation and linearisation and, consequently, pertaining to the interface with the Articulatory-Perceptual systems, would correlate with the 'amount' and type of denotation an uncategorised root is associated with? The second issue is of course asking ourselves if this is indeed a valid correlation. Before the necessary statistics is run, one can have a cursory look at inflecting languages like Italian or Greek where the vast majority of roots are bound, but they are nevertheless scattered throughout the purported spectrum.

Still, the correlation that Saab (2016) and Alexiadou and Lohndal (2017a) are drawing is not ungrounded. It is however not morphological boundedness that appears to correlate with how contentful the root appears to be but, rather root *productivity*: more productive roots in the languages in question are usually morphologically bound, like MIT, and they seem to possess less content than the least productive roots, like DOG, which tend to be realised as free morphemes and to pass as the most denotationally concrete ones.

Closely following Panagiotidis (2020) we illustrate this correlation between root productivity and apparent root concreteness with the relatively new root LASER in English, and with a slightly older one, the Modern Greek root ZAXAR, from which the word for sugar is derived.

Consider first the case of the English word *laser*, synchronically derived from a root LASER. This is originally an acronym coined c. 1957: "Light Amplification by Stimulated Emission of Radiation". Now, the root LASER looks like it has a *very* concrete and rich meaning. Still, there exist no other words derived from this root, so we cannot really know how vague or concrete the root would be *in isolation*. Hence the nouns *laser* and the uncategorised root LASER give the illusion of having identical meanings — recall the *dog*-DOG case, too.

Having said that, the range of meanings associated with the noun *laser* seems to be expanding through metaphorical use, possibly resulting to the root becoming "less contentful" or "less concrete" in the near future. To wit, urbandictionary.com defines *laser* also as "a synonym for 'cool'", whereas Google searches yield *a laser stare* (this being a sharp direct stare, like the ones that metaphorically 'burn holes') and *throwing a laser* (this being a strong direct shoot in American football).

This kind of diachronic opening up of or 'diminishing' of 'root content' once a root has become more productive is also witnessed in the case of the Greek root ZAXAR (Panagiotidis 2014a: 300–301). The word *zaxari* 'sugar' was introduced into the Greek language at some point in the 19th century, along with the substance it names. We can presume that initially, just like the English root LASER, the Greek root ZAXAR would indeed look like one with a concrete and rich meaning, also deriving just one noun, the noun for sugar.

Fast forwarding to the 21st century the picture has developed into one partially captured in (25) below:

(25) More than just sugar

zaxar-i	'sugar'
zaxar-o	'diabetes', 'blood sugar'
zaxar-en-ios	'made of sugar' (not necessarily 'sweet')
zaxar-ux-o	'dulce de leche' (a substantivised adjective: 'having sugar')
zaxar-on-	'crystallise (for edibles)', 'leer at something (transitive)', 'get turned on (intransitive)'

By now the root ZAXAR looks more like QLT in (24), possessing a much vaguer 'content'. The emerging generalisation is then not one about morphological boundedness of roots, but about their overall productivity. Simply put, and once more recalling the root NOM in (23), the greater the number of words *directly* derived from

a root, the vaguer, and indeed the more elusive, the 'semantic content' of this root will tend to be. This can be subsumed in the following generalisation:

(26) The illusion of semantic concreteness of a root is created in cases when very few words are directly derived from it.

3.3 Polysemy?

A somehow popular alternative to radical contentless for acategorial roots and for Arad's Multiple Contextual Meaning is that of *root allosemy* (Marantz 2000, 2013; Levinson 2007). Allosemy in general is defined on a par with allomorphy, as the semantic version of allomorphy: to wit, allosemy in Marantz (1997) is the availability of "special meanings in particular contexts."

In the case of roots, arguing for allosemy amounts to claiming that different allosemes are inserted in different structural contexts. So, a root like HOUSE would display "contextual allomorphy (special voicing of the final fricative in the environment of the little *v* head) and contextual allosemy (literal house nor even a literal container is implied by the verb)" (Marantz 2013: 102–103). Put simply, the default (or 'elsewhere') alloseme of the root is inserted in the context of an *n*, yielding the meaning of '(a) house', while an alloseme about hosting something in an enclosed space is selected in the structural context of *v*.

In order for this to work, one has to acknowledge the existence of (pretty extensive) root homophony; this is to be expected but no criteria are provided to distinguish between cases of homophonous roots R_1 and R_2 (as in the case of BANK, ibid.) versus two allosemes of R_1 (as in the case of HOUSE). Marantz supplies some expected nodding towards the prospects of neurolinguistically resolving this in the future, however this might not be the only way to establish criteria for root homophony (see Panagiotidis 2020: 72–79).

For root allosemy to work one also has to make a statement that marginally compromises root acategoriality: "[A]s explained, for example, by Levinson (2010) among others, roots can be seen as belonging to semantic types associated with the meanings of the category heads *n*, *a*, and *v*. If the usual interpretation of *v* is to introduce an event variable, of *a* to introduce a state variable, and of *n* to introduce an entity variable, then "verbal" roots are those that modify events, "adjectival" roots those that modify states, and "nominal" roots those that modify entities. […] In the context of a little *v* head, then, a root that might normally be given an entity-modifying meaning might receive an event-modifying manner reading, in a sort of type-shifting allosemy" (Marantz 2013: 103–104).

For us there are at least two serious issues in the whole idea of root allosemy. First, while the insertion of allomorphs is regulated by a set of context-sensitive ordered rules, no such rules are even sketched for root allosemy: allosemes are inserted where they are inserted. In the case of the root HOUSE the suggestion seems to be that the 'residence' alloseme is the elsewhere one because HOUSE is by default a 'nominal' root. This is hardly substantial and eventually leads to making up just-so stories: what 'kind' of root is X and how is this to be decided *before* X is categorised? Of course, one could always leave the issue of alloseme insertion rules to future research, but still one cannot help but feel that purported 'allosemy' is qualitatively different from allomorphy as it is certainly *not* governed by sets of context-sensitive ordered rules.

The second issue is the one raised by examples like in (23): the purported alloseme is not selected locally. In order to bypass this problem Marantz (Marantz 2013: 108–112) is forced to posit "an alloseme of the little *v* head that is semantically null", a solution applied to cases of "apparent deverbal derivation, built on stems with phonologically overt verbalizing morphology" which involve "a meaning for the root that is not built on the meaning of the embedded verb" (ibid. 106).[23]

Conceptually, positing semantically null categorisers in order to get the morphology right but ignore whatever semantic contribution it might make is anything but elegant.[24] Moreover, "semantically null" categorisers might do the trick in the Japanese and Greek cases Marantz reviews (see also Anagnostopoulou and Samioti 2014), but not e.g. in the case of roots like NOM in (23). Let us illustrate this by taking a close look at the treatment of some words derived from it in Panagiotidis (2014a: 296), citing from his example (17):

(27) [$_{v\text{P}}$ nom-íz-] → 'think'
[$_{n\text{P}}$ [$_{v\text{P}}$ nom-íz-] ma] → 'coin'

Panagiotidis (ibid.) comments that "[a]lthough the meaning 'think' is fixed at the *v*P phase, and it [would be] supposed to feed the nominalization of the verbal stem *nom-iz-*, the run-of-the-mill nominalization [*nom-iz-ma*] has a completely unrelated meaning [i.e. 'coin']". Suppose now, along with Marantz that in *nom-iz-ma*, the *-iz-* form does not realise the semantically contentful *v* head of *nom-iz-* ('think') but that

[23] Marantz (2013: 104–106) reviews this distinction in an effort to explain away the fact that such as *nationalise*, *existentialism* and the like are not predictable from *national* and *existential* respectively, an argument made in Borer (2013b) and Harley (2014). He tries to explain it away by "complex words can acquire special meanings and uses; like phrases, complex words can be idiomatic in the sense of conveying meanings not computable from the meanings of their parts". Still, as Borer (p.c.) points out, idiomatic expressions have an available compositional version available: "kicking the bucket" (an idiom) can be about dying and about kicking a referentially salient bucket; *existentialism* (a structure with idiosyncratic meaning) is only about the philosophical school, and no invocation of world knowledge will blur the distinction between the two.

[24] It also paves the way for arguing for curious subclasses of categorisers, like Steddy's (2019) δ, which is an *n*, only different from *n*.

instead it is a "semantically null" variant.[25] Accordingly, for the purposes of interpretation *nom-iz-ma* would be a direct nominalisation of the root NOM, and *nom-iz-ma* should mean something like 'law' or 'edict'. Of course, this is hardly the case.

Summarising, root allosemy is hardly a better alternative to fixing the interpretation of *the structure* containing the root at the interface (Acquaviva and Panagiotidis 2012; Harley 2014). Moreover, although it is conceptually desirable to assume the First Phase, the categoriser phase, as the domain within which idiosyncratic interpretation is defined, this comes at the cost of having conveniently posited an otherwise undiagnosable class of "semantically null" categorisers. We do not wish to blur the focus of this chapter by further investigating the issue of how far the domain for the idiosyncratic interpretation of structures containing roots extends, but we believe that Borer's (2013a, chap. 9, 2013b) proposal (*en*-search, where *en* stands for Encyclopedia) that it stretches as far as the lexical domain is the most accurate up to now.

3.4 Meaningless roots, meaningful structures

From the survey above, it emerges that we need to reconsider root content in a thorough fashion. The centuries-old working idea that roots contribute *the* conceptual content or *some* conceptual content (Multiple Contextual Meaning style) to the word cannot stand up to detailed empirical scrutiny, especially so when we abstract away from derivations built on already categorised structures (i.e. away from denominal verbs, deverbal nouns, and the like): a single root can derive words with wildly different meanings. This remains the case even when we factor in root homophony, less widespread than we would think (Panagiotidis 2020: 72–79), metaphor, and the vagaries of the abstract-concrete distinction.

The illusion that some roots possess clearly defined concrete semantic content is a by-product of such roots directly deriving a number of words. This is why roots participating in the creation of verbs typically 'feel' vaguer, while roots deriving only a handful of words typically (but not necessarily) feel more concrete and well-defined.

Root allosemy, on the other hand, cannot solve the problem of the non-local determination of idiosyncratic meaning. Although not raised earlier, root allosemy also presupposes a less than parsimonious understanding of roots as meshing together a number of unrelated Saussurean signs: somehow, genuinely meaningful signs ('allosemes') about law, coins, having an opinion and so on come under the same root NOM in (23), whereas the famous QLT subsumes signs about shelters, recording media, input, absorbing etc. in (24).

[25] The fact that "semantically null" categorisers in Greek would look identical to non-null ones is also an issue, given the interesting variety of forms that realise *v* in Greek (Spyropoulos et al.2015).

Summarising, the understanding that roots are indeed special in that they are acategorial in isolation and unable to project structure goes hand in hand with them being neither 'small words' nor 'word cores'. Seriously understanding them as indices, as we will establish in Section 5, is better off implemented as roots being indices that get structures to fetch denotations. Consequently, we subscribe by Acquaviva's (2009) formulations:

(28) Roots have no meaning by themselves.

(29) All lexical information, including the denotation of the structures in which they are embedded, is root external.

In other words, (even) the Saussurean sign is structured (Borer 2013a), as we will see in Section 5.

4 Roots are not their forms

One of the residues of the 19th century take on roots still marring research on roots in the 21st century is what Paolo Acquaviva (p.c.) calls "the hopeless confusion about how lexical / morphological atoms relate to conceptual substance." More specifically, said confusion concerns the distinction between roots as syntactic objects and the exponence of roots, i.e. the actual forms that realise roots.[26] Of course this confusion survives partially because of the older DM thesis that roots are privileged in that their phonological features are inserted early, recall the c. point of the list in Section 1.

In this section we will contribute to dissolving misunderstandings regarding the distinction between roots and their form. We will first briefly rehearse the extensive argumentation in Galani (2005), Siddiqi (2006), Haugen (2009), and Harley (2014) that root forms are inserted late, like all other forms (Vocabulary Items in DM terms). We will then point out that not all stem-like elements contain roots, as already discussed in Embick and Marantz (2008), the misunderstanding of which may create an impression that roots can be inserted in more structural positions than they actually can (Svenonius 2014; Acedo-Matellán and Real-Puigdollers 2019).[27] Finally we contribute a brief note on possible ways to distinguish between different allomorphs of a root and root homophony.

4.1 Late Insertion for everything, including roots

[26] This does not affect those who explicitly believe a root is "a unit which is fundamentally phonological in nature […]", explicitly arguing that roots are "terminals which have nothing but phonological properties" (Borer 2014b: 356).

[27] See also the discussion on De Belder and van Craenenbroeck (2015) in Section 2.12.4.

The realisation that it is conceptually more elegant for 'lexical' (i.e. 'non-functional') material to be also inserted *late* in the derivation comes from one of the early champions of Late Insertion, Emonds (1985, 2000). But let us look at why someone would argue for roots being inserted early in the first place. An indicative answer comes from languages like Greek, where the exponence of verbal morphology (Voice, Aspect, Tense etc.) depends on which root sits at the bottom of the Extended Projection of the verb. Galani (2005, chaps 4–6), while still going for early insertion, intriguingly shows that early insertion is not necessary, once we have divorced the root that is verbalised from the verbal *stem* (i.e., the Vocabulary Item that realises it): she characteristically notes that "what undergoes suppletion is not the root but its homophonous stem" (2005: 172–173).[28]

Siddiqi (2006, chap. 3) is, to our knowledge, the first both to explicitly and coherently acknowledge suppletive root allomorphy (e.g., *mouse-mice*) and to introduce an account to explain it based on late insertion for Vocabulary Items realising roots, thus showing that "DM does not need two different "grammars" for morphology (one set of operations for roots and one for functional morphemes)" (ibid., p. 47). He applies to roots all morphological principles that DM avails itself to for the insertion of forms into functional nodes, doing away with the need for readjustment rules. For instance (example from ibid., p. 60):[29]

(30) *The root √SPEAK and its forms (Vocabulary Items)*
Vocabulary Entry for *speak*
√SPEAK → *speak* /spik/
[v]
Vocabulary Entry for *spoke*
√SPEAK → *spoke* /spowk/
[v]
[past]
Vocabulary Entry for *speech*
√SPEAK → *speech* /spitS/
[n]

Haugen (2009) takes the divorce between roots and their VIs one step further, by revisiting the customary DM distinction between functional (*f*-) and lexical (*l*-), i.e. 'non-functional', nodes. He points out that "for *f*-nodes, the spell-out is deterministic, being required by the features presented by syntax (e.g. tense or aspect). VI's must compete and the one that matches the most features is what gets inserted (as per the

[28] Revithiadou et al. (2019) present an interesting system of handling the Greek verb stem allomorphy data.

[29] The customary DM objection to this would be that "free-choice late insertion and root suppletion are incompatible", along the lines of Marantz's (1996) 'hound' thought experiment: if the elsewhere /dɑg/ has a special suppletive form /hawnd/, which is inserted in the context of plural, the suppletive form /hawnd/ would block every single other one in the context of plural, as roots bear only syntactic features, if at all. Of course this is not a genuine problem once we divorce roots from their exponents *and* assume roots to be indices — see Harley (2014) and Section 5 below.

Elsewhere Principle). Conversely, the spell-out of *l*-nodes is non-deterministic. Hence, multiple VI's may be licensed for a given set of features. This follows from the notion that encyclopedic information attached to roots is irrelevant to the syntax" (ibid. 250–251). This passage is pretty interesting in that it links the non-deterministic nature of VI insertion into root (*l*-)nodes with the absence of formal features in precisely these nodes. Consequently, Late Insertion also for roots falls out from the roots' lack of formal features.

Harley (2014) provides empirical arguments for Late Insertion for root VIs from Hiaki / Yaqui and other languages where root suppletion is extensive. She shows that the verbs that display genuine root suppletion are not necessarily high-frequency 'bleached' verbs (of the likes of *do-did* and *go-went*), but include verbs such as the following (selected from ibid. 234):

(31) *Hiaki root suppletion*

weama ~ rehte	'wander.SG ~ wander.PL'
kivake ~ kiime	'enter.SG ~ enter.PL'
vo'e ~ to'e	'lie.SG ~ lie.PL'
weye ~ kaate	'walk.SG ~ walk.PL';
mea ~ sua	'kill.SGOBJ ~ kill.PLOBJ'

Not only is this kind of suppletion "a typical 'Uto-Aztecan pattern" (ibid.), but data like these are complemented by the those collected in Veselinova's (2006) survey of suppletion in 193 languages, which yields genuine suppletion patterns for verbs possessing meanings as highly specific as ' fall.in.water', 'swim', 'bet', 'make.netbag' (conditioned by number) or 'hear', 'drink', beat' (conditioned by Aspect).

4.2 Roots are not 'something like stems'

So, we can safely deduce that genuine root suppletion does exist, entailing that a single root can be associated with different forms (VIs) in different morphological contexts, as in Siddiqi's (30), or similar. A root is then identifiable by virtue of being a featureless index, a point which we will expand upon in Section 5.

There are of course those who subscribe to the view, different from the one held here, that roots are purely phonological elements, albeit underspecified, that a root is "a unit which is fundamentally phonological in nature […]. [T]he most basic (and hence often overlooked) evidence that roots are essential in the syntax emerges from the compelling fact that they are systematically obligatory, even when corresponding to neither syntax nor Content. […] The conclusion, counter-intuitive as it may appear at

first, is that for the item at the bottom of an extended projection, root, Content is entirely dispensable, but not so phonological representation" (Borer 2014b: 356–357).

But what about those of us who take roots to be featureless formal objects, along the lines of (18)? Without wishing to sound overly dramatic, "the hopeless confusion" between a root and its form(s) remains even among the proponents of roots as structure building blocks (recall for instance Adger 2013, chap. 2).

Acedo-Matellán and Real-Puigdollers (2019) put forward an account according to which (i) categorisers do not exist and (ii) roots are predicted "to be insertable into any node for which there is no dedicated VI, including inflectional nodes" (ibid. 413). They argue that the latter scenario gives us semi-lexical elements, such as classifiers (ibid. 426–432).

Before that, they apply the idea in De Belder (2011), Lowenstamm (2014) and Acedo-Matellán and Real-Puigdollers (2014) that roots and derivational affixes are indistinguishable from each other, namely: derivational affixes are also roots. We believe this kind of blanket approach blurs the distinction between *featureless* terminals (roots) and terminals with *features* (which include derivational affixes). This is multiply problematic, although it is a choice that seems easier to make if one eschews categorisers.

Let us however focus on what it takes to insert a root into an inflectional node. Now, De Belder (2011) and De Belder and van Craenenbroeck (2015) take roots to be the empty set, while Lowenstamm (2008, 2014) acknowledges the existence and central role of categorisers. Acedo-Matellán and Real-Puigdollers (2019: 421–22) appear to follow a more old-style view on roots, claiming them to be something like phonologically specified allosemous 'small words'. To wit, they begin with a statement that "the root is not a node, but a VI inserted into *c* [a categoriser]" (p. 421).[30] They then discuss the insertion of this VI as follows: "We take a VI to be composed of, on the one hand, a set containing phonological (Φ) and semantic information (Σ) to be used by each interface, and, on the other hand, a context of insertion, C. […] A VI involves allomorphy if its Φ set contains more than one element, and it involves allosemy if its Σ set contains more than one element" (p. 422). Somehow a root, a Vocabulary Item and its phonological features, and semantic information (belonging to the Encyclopedia) are conflated, albeit in a framework using DM machinery.

On a completely different note, Svenonius (2014) presents some empirical evidence for null roots from Koasati (a Muscogean family language). As he points out, the existence of phonologically null roots would be strong evidence against proposals identifying roots with their forms (their "phonology") and his evidence is prima facie pretty telling, as we see that the verb "give" in Koasati is expressed by a single verbal class marker, which is of course embedded within agreement morphology.

[30] "The categorizer *c* and the root do not correspond to two different terminal nodes." (ibid.)

Now, Acedo-Mattelán and Real-Puigdollers (2014, 2019) propose that roots are Vocabulary Items of category heads and are thus inserted late and directly into syntactic nodes. This would entail that the node dedicated to root insertion should not overlap with nodes linked to categorisers. This becomes a problem when we consider cases of multiple category heads (e.g., in complex words such as *crystallisation*). Would there be more than one root in their structure? Moreover, since roots must be associated with category heads (Acedo-Matellán and Real-Puigdollers 2014, 8), we should expect to find roots even in semilexical structures where roots are definitely absent, e.g. in the case of the nominaliser in *I found those (ones)* (see also Section 2.4).

Furthermore, this assumption misses a very important contrast between roots and derivational morphemes: while the former are vacuous semantically (or, even, underspecified), derivational morphology always displays a fully specified content (i.e., derivational morphemes do not display "polysemy", as roots do). Finally, if a category head filled with root VI instantiates derivational morphology, then why don't we find "*is(e)-ation*" as a well-formed word? Even more generally, what would differentiate a derived word from a compound?

The word of caution from Embick and Marantz (2008) about not taking everything that belongs to the verbal word class as being built on a root matters here: oft-cited cases of root suppletion in English involve bleached verbs such as *be* / *was* / *were* / *is* / *are* / *was* / *were* and *go* / *went*. Embick and Marantz (2008) refute such cases as instances of root suppletion, recasting them as instances of functional allomorphy, where no roots are involved.

Embick and Marantz (2008) go on to claim such verbs to be 'functional', but that's not accurate. A more precise way to understand verbs like *be*, *go*, *get*, lexical *do* etc. is as lexical verbs devoid of conceptual content, as 'grammatical verbs' (Emonds 1985, chap. 4), what is by now known as semi-lexical verbs (van Riemsdijk 1998; Haider 2001; Schütze 2001; Panagiotidis 2003; Harley 2005a). These express very basic notions, hence their bleached meaning, and are constrained by and interpreted according to the UG features their root-less *v*Ps encode: semi-lexical nouns and verbs are feature structures without any roots inserted (Panagiotidis 2011, 2015: 98–100).[31] As such feature structures they can only encode fundamental relations, such that are expressible by combinations of UG features and their structural configurations: existence, possession, transfer, location etc. Still, such structures are of course matched with VIs as well, such as *be / was*, *get / got / gotten*, *go / went* and the like.

While this leaves us without the valuable evidence for phonologically null roots promised in Svenonius' paper, it even further clarifies the difference between a root and its exponence. A trivial example by way of a mnemonic is the form *will* in English: while it may realise the root WILL underlying the noun and the archaic verb,

[31] Contrast this with the account by Acedo-Matellán and Real-Puigdollers in this subsection, see also footnote 17.

it also may realise the functional future marker. In other words, we would not wish to claim, taking the account in Acedo-Matellán and Real-Puigdollers (2014, 2019) to its logical conclusion, that a root WILL is inserted at the Tense node. Claiming that anything that looks like a 'word' contains one (or more) root(s) is simply a fallacy.

Summarising, roots are not stems and not everything 'lexical' is built around a root; we still think that roots can only appear inside categoriser phrases, as in (7). The justification for not wanting roots as stem-like elements or as mere diacritics in functional nodes will be presented and defended in Section 5.

4.3 Root allomorphs or root homophony? A note.

Before discussing roots as indices, we need to make a brief note about how one is to distinguish between homophonous roots versus a single root with a variety of different words derived from it.

Now, roots cannot identified on their basis of the conceptual content they contribute; moreover, root identification (or 'individuation' in Harley's 2014 terms) cannot be completely form-based: even if root suppletion did not exist, there is always the question of root homophony, especially in those languages where roots abound. Naturally, this is a learnability question rather than matter of abstract grammatical cognising.

Recall that roots sit at the heart of (some) words and are not necessarily readily identifiable: whereas in Semitic retrieving the typically triconsonantal root might be a straightforward matter, in synthetic languages with fusional morphology the task of isolating the root is hardly as straightforward, and that is true without even touching the thorny question of how to distinguish a derivational affix from a root (Pullum 2010). Thankfully, children are avid parsers and skilled in decomposing words (Yang 2016).

Still, once words have been broken down to their phonologically salient parts, segmental or not, then what? We hold that root identification must proceed in a principled way: if getting your indices right is at stake, stochastic methods will not do. Such principles governing the identification of roots must be both general and elementary. While such principles must piggy-back on word learning and the various language-external skills and biases it involves (Bloom 1997, 2000), they must also make reference to both grammatical structure and its morphological exponence.

Finally, we think that interpretation, as a soft test (but not a *criterion*) for lexical identity should matter. After all root identification is where grammatical acquisition meets word learning: roots will inevitably have to be extracted from both the lexical stock and from the structures in which they are embedded – structures that are of course externalised in very language-specific ways, governed by morphological rules and phonology. Roots will have to be identified the way they are interpreted: within a structural context; at the same time, they come prepackaged in 'words'.

A proposal about how exactly root identification works is offered in Panagiotidis (Panagiotidis 2020, sec. 5). As expected, the interested reader is referred there. It is however time to turn to the index approach to roots.

5 Roots as indices

So, what is a conceptually desirable — or even "virtually necessary" — alternative to the older DM roots-as-small-words approach and to the borerian roots-as-forms account? We need a kind of approach that can capture all three of the current hypotheses based on the empirical work on roots, namely

i) the contentlessness of acategorial roots before they are merged,
ii) the syntactic inertia of roots and
iii) Late Insertion of the forms associated with roots.

The account we will present here is the one already put forward by Acquaviva (2009, 2014b), developed, buttressed and popularised by Harley (2014): roots are *indices*; i.e. roots are akin to addresses. Let us look at this account in some detail, first by looking at what roots *are* and then at what roots *do* in the syntactic derivation.

5.1 What roots are: unique identifiers

Roots, not their forms, are indices. Pfau (2009: 90) was the first to work with this idea in order to explain certain processing errors. Within the domain of grammatical theory, here is how Acquaviva (2009: 15) originally forms his proposal on roots as indices:

> The minimal units of interpretation are those that define a semantic type, and these are not roots, but core nouns and verbs. Roots are smaller; in this sense, they have no meaning by themselves but co-occur with category-assigning heads to form interpretable typed grammatical entities. But how does *dog* differ from *cat*, then, if both have the structure [root+*n*]?
>
> My answer is that the root DOG acts as an index that makes the noun dog different from nouns based on other roots. In the abstract syntactic representation before Vocabulary insertion, roots have the function of differential indices. They do not mean anything by themselves, but act as name-tags which define identity and difference.

The idea is straightforward, once we divorce our thinking from a 19th century bias: roots are indices / conceptual addresses.[32] These indices are completely devoid of formal features (Embick 2015) or, rather, of *all* features (Acquaviva 2009), for

[32] The use of term "conceptual address" to describe roots belongs, as far as we know, to Boeckx (2010: 28). He attributes this idea to Pietroski (2018), we return to Boeckx's description of roots in Section 5.2.

reasons extensively discussed earlier. Their featurelessness makes them indeed equivalent to empty sets, as diagnosed by De Belder (2011), but only as far as UG-features are concerned, formal or other. Their featurelessness can also be made to derive their syntactic inertia: they do not project (what label would featureless objects project?), a fact that renders their insertion in the structure a tricky matter, more (Alexiadou and Lohndal 2017b) or less (Adger 2013, sec. 2.3). Moreover, the featurelessness of roots makes their categorisation obligatory, as already discussed in some length in Section 2.

Harley (2014: 242) floated (and popularised) the idea that these *formal* indices be notated numerically, i.e. as $\sqrt{}_{322}$, $\sqrt{}_{77}$, $\sqrt{}_{683}$ and so on. This is a reasonable way to go and it notationally relieves us from the trouble of actually *naming* the root that derives the noun *oeil / yeux* ('eye(s)') in French, with its two suppletive VIs, as either 'OEIL' or 'YEUX'. Still, notating roots as numerical indices leaves unanswered the inevitable question of what such indices *are*, i.e. the formally taboo question 'what are roots *made of*?' remains.

Given that roots are featureless, unlike everything else that the combinatorial system manipulates, one can think of them as "UG-extraneous elements […] essentially 'imported' into the syntactic derivation" (Panagiotidis 2014a: 290). Here is a relevant point to made: functional elements, bundles or structures of UG features, cannot be coined, as creators of, say, neo pronouns have repeatedly found out the hard way. At the same time, roots can be coined, as happens in the case of the roots like LASER, and can even be coined on the basis of borrowed lexical items.[33] The obvious divide between word learning (and borrowing and coinages) versus grammatical acquisition could be partially attributable to acquiring UG features versus learning or making UG-external roots.

Once we admit the UG-external origin of roots, we can possibly follow Richard Larson (p.c., reported in Panagiotidis 2014b: 425) in thinking of their existence as the result of "the hijacking of the successor function by the Faculty of Language". This would make roots abstract indices "differentiated from each other by means of natural number" (ibid.). This approach could make some sense, especially when one considers the evolutionary origins of roots, in Section 6.

These indices function as unique identifiers. What of?

5.2 What roots uniquely identify: "words"

The idea that roots are indices, conceptual addresses, is discussed in Boeckx (2010: 28), who correctly understands them as "pre-syntactic units" on which syntax operates. Like Pfau (2009: 90), he however argues them to point directly to concepts, taking Pietroski's (2008) idea that lexical items are instructions to "fetch" or activate

[33] An anecdotal case of the latter is the English noun hacker, borrowed into Greek as 'xaker' around the early 1990s. A new Greek root XAK was coined, via back formation, giving rise to a verb 'xak-ev-' ('to hack') and even a noun 'xak-ia' ('a feat of hacking').

concepts and applying it to roots (viz. indices as conceptual addresses).[34] We have already seen in Section 3 that it is not roots by themselves that fetch concepts. As Pietroski (2008) is careful to claim, it is 'lexical items', i.e. *the structures in which roots are embedded*, that actually do fetch concepts. So, what do roots as indices do? What do they point at?

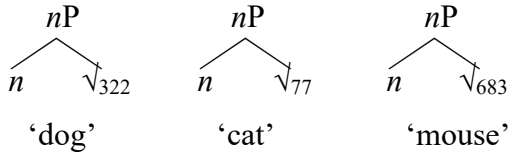
Roots in a derivation act as abstract differential indices. Two words sharing the same abstract root are very likely to be conceptually related, but this is not because the root by itself fetches a shared concept. On the contrary roots are the only syntax-internal criterion of lexical identity (Acquaviva 2009, 2014b; Acquaviva and Panagiotidis 2012; Panagiotidis 2014a, 2014b).

Backtracking a bit, it is intriguing that roots, UG-external numerical indices, have grammatical structure typically built *around* them after they are categorised: roots hardly qualify as peripheral or ancillary elements of grammar. We believe that roots are what enables language to express concepts beyond those encoded in (possible) UG features (Cinque 2013 for a tentative inventory).

Let us illustrate how roots enable language to encode such concepts in their richness and intricacy (cf. Panagiotidis 2020). For ease of illustration, we will use simple *n*Ps, what Harley (2014: 243) calls the "basic case": a structure "that is a Saussurean sign". The basic idea is that different roots, i.e. different indices, enable the same simplex syntactic structure — an idealised *n*P consisting of nothing but a root and a categoriser *n* in this basic case — to be associated with different concepts.

Keeping in mind that it is syntactic structures like our *n*P, and not roots in isolation, that are associated with concepts we can illustrate what roots $\sqrt{_{322}}$, $\sqrt{_{77}}$, and $\sqrt{_{683}}$ do:

(32) *Same structure, different roots*



Importing featureless UG-external indices into the derivation enables even the simplest structures to be associated with different concepts: by inserting different roots in otherwise identical structures, these structures are distinguishable at the interface with the Conceptual-Intentional systems and thus can be matched with different concepts. At the same time, the different roots $\sqrt{_{322}}$, $\sqrt{_{77}}$, and $\sqrt{_{683}}$ guarantee

[34] Boeckx (ibid.) goes on to vividly illustrate his view of roots as addresses: "Like addresses generally, conceptual addresses are not meant to mirror the [concepts] they point to. Think of snailmail or email addresses: they are silent on the physical specifications of the person they are tagging, or the arrangement of the furniture. They have a flattening, atomizing effect. This is what I want conceptual addresses to do: I want them to activate concepts, but they are not concepts themselves, they are only one (efficient) way to get to concepts."

that the three otherwise identical *n*Ps above will be identified as different 'words', i.e. be matched with different forms at the interface with the Articulatory-Perceptual Systems. Hence, roots enable an otherwise closed combinatorial system, natural language, to *create* Saussurean signs by building structures that can actually fetch a wealth of concepts. Put differently, roots create families of 'words'.

As noted earlier, if roots were not available to it, the Language Faculty would be limited to expressing only what can be composed out of UG-features, such as "This is her", "I got that", "It is here" etc. (Emonds 1985, 2011: 376; De Belder 2011). Indeed, in the absence of a roots, we have semilexical nouns and verbs, recall the discussion in Section 4.2.

Concluding this section, it is worth reiterating that roots are "abstract symbols, purely formal objects internal to the faculty of language in the narrow sense, where they act as formal indices marking lexical relatedness in a precise, syntax-internal sense. […] [A root] is not a sign, but determines an interpretation for the syntactic structure that embeds it (possibly a structure where nothing else is spelled out at word level, as in *cat*). As a syntax-internal criterion of lexical identity, it marks formal, not conceptual relatedness" (Acquaviva 2014a).[35]

In the next section, we turn our attention to the fixation of roots in the evolutionary development of human lexical competence, assessing the extent to which correlates can be found in the vocal behaviour of nonhuman primates.

6 Beyond roots

6.1 Roots and Darwin's Problem

Successive attempts of rethinking the nature of grammatical primitives, especially after the advent of the Minimalist Program, did not promote our understanding of the biological bases of the human lexicon. In fact, due to the lack of a more convincing hypothesis, part of the lexical entries — viz., formal features, their bundles, and even entire functional projections — are relegated to UG (Cinque 1999, 2013; Chomsky 2000, 2001). Such a conjecture, in addition to not providing a biologically and cognitively grounded explanation for the origins of the lexicon, has a negative impact when viewed from the standpoint of the Darwin's Problem, i.e. the (alleged) recent evolutionary development of the FL and of its internal complexity (Fujita 2009; Hornstein 2009; Chomsky 2010), as well as from the theoretical expectation to go 'beyond explanatory adequacy' (Chomsky 2004; see Al-Mutairi 2014; Boeckx 2015 for critical reviews).

[35] On the relation between roots as indices and semantic decomposition of concepts, see Acquaviva and Panagiotidis (2012).

In this final section, we explore whether there are correlates of under- or un-specified categories, such as roots as indices, in the vocal behavior of nonhuman primates. With this preliminary attempt we aim to draw a suggestive evolutionary history of the human lexicon by evaluating the extent to which the set of referential categories employed by our closest relatives displays a phylogenetic relationship to the (conceptual) content-hosting units observed in present-day human language. To establish this correlation, we compare the properties assigned to roots with the vocal behaviour and perceptual abilities of nonhuman primates, whose phylogenetic relationship to humans is well proven.

We find that, contrary to what is largely assumed by works in theoretical linguistics and in animal communication studies, the correlation between alert calls and human language words does not reside in the latter's substantive units, but possibly *in their functional units* (Nóbrega 2018). The rigid denotation of alert calls resembles the semantically fixed nature of the functional primitives of human language, since both are not subject to content variation. This characteristic is diametrically opposed to what has been observed in roots, which are primarily defined by their highly polysemous nature, as discussed in Section 3. In the next subsection, we present evidence for the rigid character of the representational categories conveyed by nonhuman primates, based on naturalistic observations about the ontogeny of vocal use, and discuss a possible alternative for the emergence of root-like elements in evolution.

6.2 The rigid nature of nonhuman primate calls and its implications for the evolution of roots

In the early 80's, the assumption that the vocal behaviour of wild populations of vervet monkeys (*Chlorocebus pygerythrus*) involved referential abilities prompted a first approximation between primate vocalisations and human language words (Marler 1980; Marler et al. 1992; Seyfarth and Cheney 1997, 2011; Evans and Marler 1995; Hauser 1997). Vervets' alarm-calling system mainly consists of three acoustically distinct calls to at least three predator types: leopards (*Panthera pardus*), martial eagles (*Polemaetus bellicosus*), and pythons (*Python sebae*) (Struhsaker 1967). Each call elicits a predator-specific escape response in the recipients, which serves as evidence to link a given call to a particular referent class. To test whether call perception was stimulus-independent and not a reflex of the animal inner states, Seyfarth et al. (1980a, 1980b) conducted playback experiments with free-ranging vervet populations in the absence of any predator cue, and evaluated the responses performed by the groups. Although there was variation in their reactions, the correlation between a vocalisation and a particular anti-predator escape strategy was statistically significant. Such findings indicated that vervet monkeys are able to

represent classes of entities and events from the exposure to a given vocal stimulus (Zuberbühler et al. 1999; Zuberbühler 2001, 2003).[36]

The referential abilities inferred from vervets' and subsequently from other nonhuman primates' alarm-calling systems suggested, at first glance, that there could be continuity between primate vocal behavior and the conceptual portion of the human lexicon (Marler et al. 1992; Seyfarth and Cheney 1997, 2011; Hauser 1997; Evans and Marler 1995; Evans 1997; Miyagawa et al. 2013; Miyagawa et al. 2014; Nóbrega and Miyagawa 2015). Nevertheless, by analysing these two systems more closely, we find that they do not display any parallel features capable of indicating an axis of evolutionary gradation. If such continuity were true, we would expect the human counterpart — i.e., roots — to exhibit properties only slightly distinct from those observed in nonhuman primate (referential) categories, taking into account their evolutionary proximity.

Roots, however, show properties entirely distinct to those inferred from the categories underlying nonhuman primate vocalisations, and many of these properties are species-specific, particularly: (i) their quantity, which largely exceeds the signals used by primates (Marler and Tenaza 1977; Goodall 1986); (ii) their unlimited acquisition (Tallerman 2009, 2011); (iii) their culturally learned character (Hockett 1960a, 1960b; Seyfarth et al. 1980a, 1980b; Pinker and Jackendoff 2005; Bickerton 2007) and, more importantly, (iv) their polysemous nature, a single root can be associated with different meanings, often idiosyncratic (see Section 3).

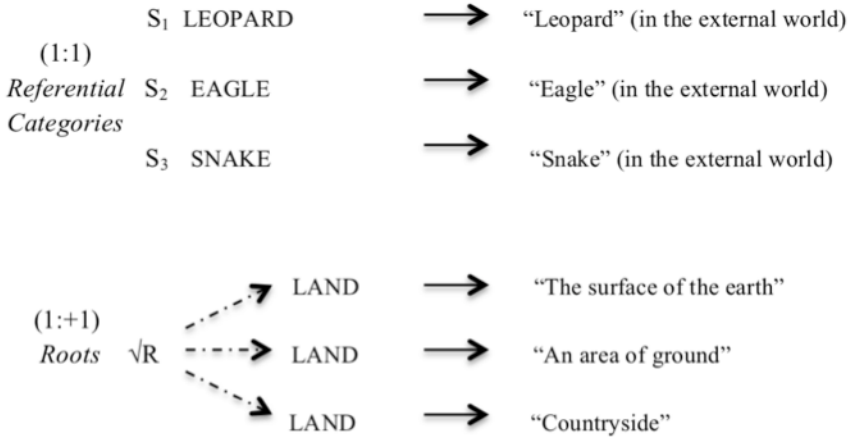
Nonhuman primate vocal signals, in turn, are severely restricted as far as the mapping between a given class of entities or events and a vocalisation is concerned. Both the inventory of categories conveyed and the acoustic structure of each call are genetically pre-determined; this is a condition that imposes critical limits in the expansion of primate vocal repertoires (Snowdon et al. 1997; Seyfarth and Cheney 1997, 2010; Fitch and Zuberbühler 2013). The innate character of nonhuman primate categories and of their vocal exponents indicates that the referential abilities ascribed to primates are realised in a co-extensive and unidirectional manner. That is, each referential category expressed by a vocalisation fetches a specific class of entities or events in the external world, which was adaptively determined in the evolutionary development of the species. It is thus unreasonable to claim that nonhuman primate categories show signs of underspecification in any way similar to human language roots.

We can characterise such denotation antagonism as follows: the categories conveyed by primate vocalisations essentially follow a one-to-one correspondence, in which every element of the set of pre-adapted categories is paired exactly with only a single element of the set of entities or events. Roots, on the other hand, are highly polysemous. This suggests that, differently from nonhuman primates' categories, roots display a one-to-many correspondence, since a single root can be freely

[36] A conclusion that does not necessarily imply that signalers have a communicative intent (Seyfarth and Cheney 2003, 2011; Macedonia and Evans 2010; Fitch and Zuberbühler 2013).

associated with more than one element of the set of entities or events.[37] In Figure 1, we illustrate the mapping contrast between the pre-adapted categories of nonhuman primate repertoires (S) and the root √LAND (√R) in English:

Figure 1. Mind-internal representations underlying nonhuman primate calls and human language roots.



The denotation rigidity of primate vocal behaviour can be more clearly observed when we analyse their vocal development, especially the ontogeny of their vocal production and usage. Seyfarth et al. (1980b) and Seyfarth and Cheney (1986) noticed that, although infants (i.e., animals under 12 months of age) and juveniles (i.e., 1–5 years) produce alarm calls for non-predatory species, their vocal production is not random. For instance, when infant vervets first begin giving alarm calls, they often give calls to inoffensive species, such as pigeons and warthogs. However, the range of species eliciting alarm calls in infants and juveniles display some physical and/or behavioural features resembling those of the real predators.

Seyfarth et al. (1980b) and Seyfarth and Cheney (1986) found that a considerable variety of animals is able to provoke alarm calls in vervet monkeys: the set of predator species mentioned above, as well as potential predators (i.e., animals that prey on species the size of vervet monkeys), and non-predators (i.e., animals or

[37] Price et al. (2015) re-analysed the vocal production of vervet monkeys, including the materials collected by Struhsaker (1967) and Seyfarth et al. (1980a, 1980b). The authors observed that, when only predatory contexts are considered, females produced expected calls for the predator type in 98,7% of the cases, while males produced in 93,2% of cases. However, they also verified a suggestive lack of context-specificity: the vocalisation for snakes is produced when there is intergroup aggression, and the vocalisation for eagles is produced in intra-group aggression. The distinction made by vervet monkeys declines slightly when these two contexts (predatory and non-predatory) are contrasted, which suggests that the same vocalisation could be linked to different «meanings». Price et al. (2015: 6) point out to the possibility that the researchers may not have identified some acoustic features that stands out to the monkeys, allowing the latter to distinguish these (possibly four) vocalisations. For this reason, we insist on the validity of one-to-one mapping.

objects that were observed to elicit alarm calls, but do not prey on monkeys); see a summary in Table 1 (from Seyfarth et al. 1980b, 1072–1073).[38]

Table 1. The set of animals and objects that elicited alarm calls from vervet monkeys.

	Confirmed predators	Potential predators	Non-predators
Mammalian carnivore alarms	Leopard (*Panthera pardus*)	Lion (*Panthera leo*) Hyaena (*Crocuta crocuta*) Cheetah (*Acinonyx jubatus*) Jackal (*Canis mesomelas*)	Warthog (*Phacochoerus aethiopicus*)
Avian predator alarms	Martial eagle (*Polemaetus bellicosus*)	African hawk eagle (*Hieraetus spilogaster*) Black-chested snake eagle (*Circaetus pectoralis*) Tawny eagle (*Aquila rapax*) Verreaux's eagle own (*Bubo lacteus*)	African goshawk (*Accipiter tachiro*) Bateleur (*Teranthopius ecaudatus*) Egyptian goose (*Alopochen aegyptiacus*) Grey heron (*Ardea cinerea*) […] Pigeon (*Streptopelia* ssp.) Secretary bird (*Platalea alba*) Spoonbill (*Trigonoceps occipitalis*) Falling leaf
Snake alarms	Python (*Python sebae*)	Cobra (*Naja* ssp.) Black mamba (*Dendroaspis polylepis*) Green mamba (*D. angusticeps*) Puff adder (*Bitis arietans*)	Tortoise (fam. *Testudinidae*) Mouse (? *Arvicanthus* ssp.)

The vocal deviations (of infants and juveniles) portrayed in Table 1 display regularity: infants gave eagle alarm calls only to birds and objects in the air (e.g., a falling leaf), but never to animals on the ground (Seyfarth et al. 1980b; Seyfarth and Cheney 1986). Similarly, although infants gave leopard alarm calls to a variety of species that posed no danger to them (e.g., warthogs), they restricted their leopard alarm calls predominantly to terrestrial mammals (e.g., lions, hyenas, cheetahs, jackals). Finally, they gave snake alarm calls exclusively to long snake-like objects or slow terrestrial animals (e.g., tortoise) (Seyfarth et al. 1980b: 1072–1073). These correspondences suggest that although vervet monkeys practice their vocalisations during their first five years of life by progressively restricting them to a specific species, they behave as if "[…] they were predisposed, from birth, to divide different species into predetermined categories, namely: predators vs. non-predators, and terrestrial carnivores, eagles and snakes" (Seyfarth and Cheney 1997: 252, 2010: 94).

[38] Vervets come into contact with more than 150 species of birds and mammals, from which only a few pose any danger to them (Seyfarth and Cheney 1999: 393). Infants thus must recognise which species are predators and identify which of them fall into the categories designated by their innate calls. It is important to highlight that the alarm calls produced by infants and juveniles are acoustically similar to those produced by adult monkeys, i.e., animals over 5 years of age (Seyfarth and Cheney 1997: 250), and that there is no active pedagogy from the parents to instruct them on how to behave vocally in these circumstances (Seyfarth and Cheney 1986; 1997).

Bearing in mind such distribution, and other results presented by Seyfarth and Cheney (1986, 1997, 2010, 2011), it is reasonable to argue that the pre-adapted categories associated with vervet monkeys' alarm calls are co-extensive with the classes of predators that they denote. Since the alarm call for eagles is not elicited outside a context in which the entity in the world displays physical and/or behavioral features associated with that class, we cannot claim that such categories give rise to polysemy, as is the case of roots. Although the fixation of these primate categories substantially depends on the individual's experience, the entities in the world that can serve as potential referents are considerably restricted and somewhat uniform.

As Seyfarth and Cheney (1986: 1645) point out:

> "Although many species elicited alarm calls, infants and juveniles were nevertheless selective in their alarm-calling: eagle alarms were given only to birds, and within this general class over 30 avian species were seen regularly during the study but did not elicit alarms. Eagle alarms were given most often to raptors (family *Falconidae*), a group whose members are distinguished from other birds by their relatively large size, curved beak and talons."

These observations support our hypothesis that the referential categories linked to nonhuman primate vocalisations have a rigid denotation. Their severely restricted character must be due to the fact that such categories result from adaptive pressures, which make the mappings between a vocalisation and a particular content an innate property, i.e. the biological endowment of a (nonhuman primate) species determines what can compose its experience (see Chomsky 1986, 1975; Gould and Marler 1987; Jackendoff 1994; Lewontin 2001; Lust 2006; Gallistel 2010; Epstein 2016).

According to this rationalist perspective, experience consists of aspects of the environment circumscribed by the anatomical and cognitive constitution of a species, which restricts what it can experience and in turn convert into knowledge. The development of nonhuman primate vocal behaviour is a perfect example. We have seen that vervet monkeys are predisposed from birth to draw from the acoustic and visual disturbances they experience three specific categories of the world: terrestrial carnivores, eagles, and snakes. This is justified by the uniformity of the physical and behavioural features of the entities capable of provoking their vocalisations, which, from a very young age, are not randomly produced (Seyfarth et al. 1980b; Seyfarth and Cheney 1986, 1997, 2010, 2011).

Given the pre-adaptive character of the categories linked to primate calls, we assume that they involve a rigid internal structure that, if externalised, causes the referential mappings to follow a one-to-one correlation with the entities or events denoted, as we illustrated in Figure 1, and that the small variations observed in ontogenesis falls within this rigid denotation.

To describe such structural rigidity, we propose that every primate category consists of an ordered pair. The members of this ordered pair are: (i) an attribute (ATTR),

which corresponds to the category that will determine the experience of a certain species; and (ii) a value (VAL), which corresponds to information extracted from the sensorial disturbances accessible to experience, essentially delimited by an ATTR. Note that the fixation of a VAL is regulated by the descriptions made by an ATTR, that is, an ATTR and a VAL are in a part-whole relationship (i.e., <ATTR, VAL> | VAL ∈ ATTR). Thus each category vervets are predisposed to discriminate instantiate, in our terms, an ATTR. The entities in the world subject to being experienced correspond to their VALs (determined by the individual's experience). In the case of vervet monkeys, different species can serve as a VAL, as we have seen in Table 1. However, vervet monkeys gradually limit a particular VAL for each ATTR, as they identify which species are, in fact, a predator. We can say that for an infant vervet, if ATTR=FLY, then VAL=any entity satisfying ATTR=FLY.

The variability of VALs verified during their vocal usage indicates that their ATTRs do not represent a class of entities per se (e.g., "LEOPARD," "EAGLE," "SNAKE"), but are suggestively codified in terms of a behavior or mode of attack (e.g., "WALK," "FLY," "SLITHER").[39] This would explain why boars, a falling leaf, and tortoises are equally able to elicit alarm calls of infants. For this reason, we propose that the set of ATTRs of nonhuman primates can be translated in terms of the generalisations about the predator's behavior — as far as alarm calls are concerned —, rather than in terms of a particular class of entities. This assumption is described in (29):[40]

(33) Set of referential categories underlying vervet monkeys call system
<ATTR, VAL>
a. <WALK$_{vervet}$, x>
b. <FLY$_{vervet}$, x>
c. <SLITHER$_{vervet}$, x>
=where x stands for a VAL, a variable to be determined through the experience of the individual based on the constraints imposed by an ATTR.

Interestingly, the co-extensive and unidirectional mapping of alert calls indicates a suggestive correlation with the properties observed in the functional lexicon, theoretically instantiated by formal features. Similarly to the categories underlying alert calls, a formal feature expresses a single content, characterised by the grammatical class to which it belongs, and that content is not subject to polysemy.

Furthermore, grammatical classes tend to be restricted and distributed uniformly across the species (Wiltschko 2014), similarly to what is observed in the inventory of categories in the primate vocal repertoire. For instance, a formal feature specified with the content [plural], cannot abstractly fetch the content [singular], or even an

[39] This is a suggestive approximation of what may be describing the set of categories underlying nonhuman primate vocal signals. Another possibility to be tested is whether these categories are not defining modes of attack but a Cartesian decomposition of their visual space.

[40] Our proposal is very similar to Hurford's (2007), in admitting a type function / argument mechanism involved in the vocal behavior of nonhuman primates.

idiosyncratic content such as [female] or [1person], such as the root √LAND in Figure 1 does. A formal feature is circumscribed to the content that it conveys and it is not subject to variation, since it must be computed compositionally at the semantic interface. These similarities suggest that the cognitive mechanisms underlying nonhuman primate vocal systems, as in (29), can serve as a possible phylogenetic candidate to the units comprising the human language functional lexicon (Nóbrega 2018, chap. 3).

We can see that the semantically defective nature of roots largely differs from the rigid denotation of primate referential categories. Their referential malleability — dissociated from a genetic predetermination — places the emergence of roots in a different evolutionary branch. In our view, roots seem to be more closely associated with the development of primate perception. Nonhuman primates have sophisticated perceptual skills, and are able to associate sounds with content in an unlimited way. However, primates are not able to manipulate the contents extracted from perception. Cheney and Seyfarth (2005: 149) point out that "[…] nonhuman primates dominate many concepts for which they have no words." In our understanding, the establishment of an underspecified primitive internally to FL was the evolutionary innovation that allowed the atomization of the conceptual representations extracted from perception into linguistic entities, as well as its later manipulation by the grammar, which consequently boosted the human lexicon.

We have to take into account that there are at least two types of meaning to be explained by a theory of grammar. On the one hand, we have a properly linguistic meaning derived by FL through the concatenation of formal features into structural arrangements hierarchically organised. The semantically rigid nature of formal features is what promotes a compositional interpretation of every structure generated. What a root delimits, in turn, is a domain of the syntactic structure dedicated to the insertion of another type of meaning, which is generally defined in terms of an encyclopedic meaning. Such encyclopedic meaning "has no formal properties and is equivalent, [...] to a 'material' that is poured into the structural mold to be attributed to grammatical properties" (Borer 2005b: 108). We conjecture that such empty locus dedicated to encyclopedic content, i.e. roots, may have been brought into existence either by Merge itself (i.e., structurally defined) or by the appearance in modern humans of a dedicated empty primitive.

Finally, assuming the validity of the rationalist perspective underlying nonhuman primate vocal behavior, we should expect that modern humans were also endowed with a set of ATTRs, and that part of their experience was circumscribed by a specific group of innate categories. We conjecture that rigid structures similar to the ones described in (29) may play a role in the fixation of what we currently understand as "formal features." We suggestively hypothesize that the ATTRs comprising the human functional lexicon may possibly correspond to a set of generic classes, such as 'classification', 'point of view', 'anchoring', and 'linking', along the lines of Wiltschko (2014, 2015), from which language-specific functional categories are assumed to be constructed (e.g., tense, number, location, aspect, etc.). Such generic classes are inherently neutral with respect to category, such as verbal or nominal (e.g., point of view could be involved in the fixation of grammatical aspect in the verbal

domain, and of φ features in the nominal domain). This conjecture may possibly account for the uniformity of the syntactic domains that harbour the human functional lexicon cross-linguistically, and elucidate why certain types of content are not codified in terms of functional units in natural languages, such as "peril," "fear," or "hunger" (Emonds 2011; Cinque 2013; Leivada and Barceló-Coblijn 2020).

7 Conclusion

In this chapter, we advanced the claim that roots stand as an independent grammatical primitive, whose core function is to single out the syntactic nodes prone to hosting extra-grammatical / conceptual information. We explored empirical evidence supporting the validity of roots as primitives by considering their acategorial nature. We also explored empirical arguments arguing in favour of the assumption that roots lack selectional and projection properties, which in turn should be restricted to the functional items composing the syntactic structure. Subsequently, we revisited the idea that lexemes or any residual version of lexemes are irrelevant for syntax by showing that roots are devoid of any inherent semantic and/or phonological content. Meaning and form (also 'lexical' ones) are matched with structures, not atoms. We subscribe to the *roots as indices* approach, where roots are individualized by means of alphanumeric indexes responsible for fetching the appropriate concepts and phonological exponents at the interpretive interfaces. Finally, we compared the semantically vacuous property of roots —which is assumed to give rise to their polysemous nature— with the referential abilities inferred from nonhuman primate alarm-calling systems, suggesting that the semantically underspecified nature of such primitive also serves as candidate for a species-specific trait, hence an innovation of FL.

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