Minimalism and I-Morphology*

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The Minimalist program asks the following questions: How good is the language design? How perfect is grammar? It asks two basic questions about the Language Faculty. The Internalist question is: what kind of system is the Language Faculty? The Externalist question is: how does language relate to other parts of the mind and to the external world? The Minimalist answer to the Internalist question is that Language Faculty is well designed, close to perfect in satisfying the external conditions. In the optimal design, no new features are introduced in the derivation. No structural relations exist other than the ones forced by the legibility conditions, namely adjacency at the phonemic level, argument structure and quantifier-variable relations at the semantic level, local relations between features. The Minimalist answer to the Externalist question is that the Language Faculty is embedded within the broader architecture of the mind/brain. It interacts with other systems imposing conditions that language must satisfy to be usable at all. The sub-systems of the mind/brain in which the Language Faculty is embedded must be able to read the linguistic expressions and use them as instructions for thought and action.

Minimalism approaches the Language Faculty as a unique biological organ. It opens new avenues of research on the properties of the basic operations of the Language Faculty, the emergent vs. gradualist view of the development of language, and the factors limiting the complexity of the derivations (Chomsky 1995, 2005, 2011, Hauser, Chomsky and Fitch 2002, Chomsky 2005, 2011, Piattelli-Palmarini et al. 2009, Di Sciullo et al. 2010, Larson et al. 2010, Kayne 2011, Di Sciullo and Boeckx 2011, a.o.).

I address the question of how morphology, which is generally assumed to be the locus of idiosyncrasies, can be approached within the Minimalist program, focusing on the research paradigm targeting the notions of symmetry, asymmetry and symmetry breaking, which have been shown to contribute to the understanding of language and other complex systems.

Firstly, I will distinguish the Internalist from the Externalist approach to morphology Secondly, I discuss the properties of the operations deriving morphological expressions, including the structure building operation and the operation governing the relations between features. Thirdly, I raise the question whether morphological and syntactic complexity is limited by the same kind of conditions stemming from other sub-systems of the mind/brain.

1. Morphology

Assuming the distinction between I-language (intentional and internalized) and E-language (extensional and externalized) (Chomsky 1986, 1997, 2001), I introduce the

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expression ‘I-morphology’ to denote the properties of I-language devoted to the computation of morphological expressions. I-Morphology is opposed to E-morphology, whose investigation leads to consider the extensional properties of the externalized morphological expressions.

The distinction between I-Morphology and E-Morphology can be traced back to early works in generative morphology. For example, Di Sciullo and Williams (1987) singled out the ‘grammatical word’ as opposed to the ‘lexical word’. Di Sciullo and Williams distinguished three sorts of words: morphological objects, lexemes and syntactic words. The grammatical word is derived by the grammar, and thereby is a morphological object. Morphological objects differ from syntactic objects as follows. Morphological objects bare only one stress, they are opaque with respect to phrasal syntactic rules, and their interpretation is partly compositional. Syntactic objects on the other hand bare more than one stress, they are subject to phrasal syntactic rules, and their semantics is compositional. As opposed to the grammatical word, the lexical word is part of the lexicon, which is the list of items whose properties do not follow from the morphological operations of the grammar. Di Sciullo and Williams used the term ‘lexeme’ to denote a lexical word. Thus, there is no lexicon in the sense of a repertoire including the list of all the existing lexical items of a language, as it is the case for example in Jackendoff (1990, 2002). Furthermore, the lexicon is not a generative module of the grammar, as it is the case for example in Pustejovsky (1995). In addition to the notions of lexeme and morphological object, Di Sciullo and Williams coined the expression ‘syntactic word’ to denote words that are formed in the syntactic derivations and passed on to the morphological component for further computation. Morphological objects and syntactic words are derived by the computational procedure of the Language Faculty, contrary to lexemes, which are listed in the lexicon.

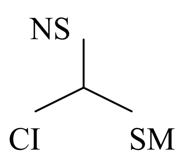
According to the Asymmetry Theory (Di Sciullo 2005a et seq.) asymmetry is deep-rooted in I-morphology. I-morphology and I-syntax combine different kinds of objects. They differ with respect to the features they combine as well as with respect to what counts as units of the computation and how these units are interpreted by the external systems. These differences lead to a model of the Language Faculty according to which morphological and syntactic objects are derived by Merge on different computational workspaces related via phase transfer. In this model, the operations of the Language Faculty have a generic form that is relativized to the kind of expression that is derived. This relativization of the generic properties of the operations of the Language Faculty is an optimal mean to meet the interface legibility requirements at for each kind of expression. At the CI interface, morphological and syntactic expressions are different kinds of semantic objects, predicates on the one hand and propositions on the other. At the SM interface, morphological and syntactic expressions differ, including with respect to stress patterns.

The investigation of the properties of I-Morphology leads to a further understanding of the computational procedure of the Language Faculty deriving morphological expressions, viz., the grammatical words. The investigation of E-morphology leads to a further understanding of the properties of the externalized morphological expressions and the factors external to I-morphology reducing complexity. Building on previous work in the Minimalist program and the Asymmetry Theory, I focus on the properties of the computational procedure deriving morphological expressions **as opposed to syntactic expressions**, as well as on the parsing conditions imposed by the external systems that impose limits on their tractability. I discuss them in turn in the following paragraphs.

2. Operations and derivations

The Minimalist program provides important insights for the study of language as a science by reducing the technical apparatus of the grammar to the bare minimum. The operations, the categories and the structural relations of the grammar are reduced to the ones that are required by conceptual necessity. The conditions on internal interfaces postulated in pervious models, for instance the Projection Principle, the Binding Theory, the Case Theory, the Chain Condition, etc. from the Government and Binding Theory (Chomsky 1981) are rethought as legibility conditions at the CI interface. At the semantic interface, the conceptual-intentional (CI) system must be able to read certain kinds of semantic representations and not others; at the phonetic interface, the sensorimotor (SM) system must be able to read certain phonetic representations and not others. The elimination of the internal interfaces of the grammar led to the simplified model of the Language Faculty in (1), where the properties of narrow syntax (NS) are unique to the Language Faculty (FLN) contrary to the properties of the other parts of this architecture, which is part of the Language Faculty in the broad sense (FLB), as discussed in Hauser, Chomsky and Fitch (2002).

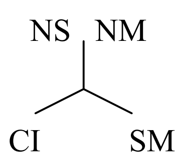
(1)



Given the regularity of form and interpretation of morphological objects, the Minimalism methodology prevents us to consider I-morphology as falling outside of FLN.

Asymmetry Theory relies on the Minimalist architecture and takes morphological and syntactic objects to be derived in different planes of the computational space. Thus, Narrow Morphology (NM) is part of FLN along side NS, as depicted in (2).

(2)



In this model, the operations of I-morphology and I-syntax share basic properties. They build structure bottom-up (Merge) and relate features (Agree). Merge is a *binary* operation, which combines two items into one constituent. This operation is *asymmetrical* in the sense that it combines items whose features are in a proper subset relation.[1] Merge

[1] For Chomsky (1995), Merge is asymmetrical in the sense that either one or the other object projects its label. For Di Sciullo and Isac (2008), Merge is asymmetrical as the sub-procedure SELECT applies to elements in the Numeration whose features are in a proper sub-set relation. Merge is also asymmetrical for Zwart (2011:8): 'At each step of the derivation, then, an asymmetry exists between the two sisters being

is *recursive*, as the output of Merge may subsequently be submitted to Merge with other items yielding a further constituent.[2] The items that are subjected to Merge are drawn from a list called the Numeration. A Numeration is defined as a set of pairs (*LI*, i), where LI is a lexical item and *i* is an index indicating the number of times that *LI* is selected. Every time a lexical item is selected from the Numeration in order to enter the derivation its index is reduced by one. The derivation terminates when all indices are reduced to zero.

The implementation of Merge in Asymmetry theory implies: a) a Numeration: the set of lexical items with their features, b) SELECT: an operation that selects items from the numeration whose set of features are in a proper subset relation and inserts them into the workspace, c) a workspace: the space where the derivation unfolds and which will eventually contain the output of the recursive application of Merge. The operation Agree is a feature matching operation applying to two objects in asymmetrical relation for the checking of uninterpretable features.[3] Feature Checking, enforced by the Earliness Principle (Pesetsky & Torrego 2001) applies as soon as possible in the derivations. In the Asymmetry Theory, Agree and SELECT are both asymmetrical operations applying to two objects whose sets of features are in a proper inclusion relation. Feature asymmetry constrains the order of application of morphological merger and thus provides a restricted approach to morphological computation.

In the Asymmetry Theory, the operations of I-morphology and I-syntax share basic properties. Notwithstanding shared properties, syntactic and morphological computations cannot be equated without failing to capture the fact that I-morphology and I-syntax combine objects with different featural and configurational properties, as the following paragraphs illustrate

2.1 Features

Suppose that affixes and roots have categorical features as lexical items do. The following derivations show that morphological merger differs from syntactic merger with respect to the operation SELECT.

Consider the derivation of the morphological object *unpredictability*, which is the nominalization of a deverbal adjective *unpredictable*. Given the numeration in (3) and the proper sub-set requirement on SELECT, the theory correctly predicts that *un-* can only merge with *predict-able*, see (4), and the representation in (5). This prefix cannot merge

merged, in that one of the two sisters is already part of a derivation to which the other is newly merged. It follows that the output of merge is inherently asymmetric, except with first merge (assuming binary merge, i.e. involving exactly two elements).'

2 Since Chomsky's (1995) definition of Merge, (i), several variants have been formulated. They differ, for instance, with respect to whether the output of the operation derives a label (LB) or not, Collins (2001), and whether the operation is free with respect to ordering (Boeckx 2006) or not (Kayne 2011). We will not discuss the different formulation of Merge in this paper, as well as the different approaches to morphology integrating Merge, including Distributed Morphology (Hale and Marantz 1993, *et seq*.).

(i) Merge : Target two syntactic objects a and b, form a new object G {a,b}, the label
LB of G(LB(G)) = LB(a) or LB(b). (Chomsky (1995)

3 In Chomsky (2000), AGREE ($\alpha > \beta$), where α is a probe and β is a matching goal, and ' >' is a c-command relation. In Di Sciullo (2005), the proper subset requirement also hold for Agree.

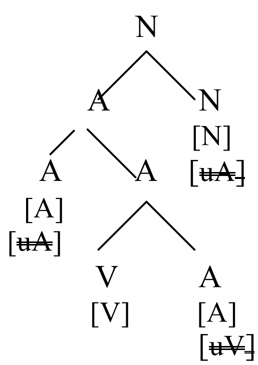
to [[*predict -able*] -*ity*] since there is no proper-subset between the features of -*un*, [A, uA], and the features of [[*predict -able*] -*ity*], [N].

(3) N = { predict: [V], -able: [A, uV], un- : [A, uA] , - ity : [N, uA]}

(4) Step-by step derivation

Step 1. Select an item from Numeration that has interpretable features only
⇒ Select V {[V]}
Step 2. Select an item from Numeration that properly includes V
⇒ Select Num { [uV], [A]}
Step 3. External-Merge V with A to the workspace and check uninterpretable features, as enforced by the Earliness Principle
Step 4. Select an item that properly includes A
⇒ Select {[A], [*u*A]}
Step 5. External-Merge to the workspace and check uninterpretable features, as enforced by the Earliness Principle
Step 6. Select an item that properly includes A
⇒ Select {[N], [*u*A]}
Step 7. External-Merge N to the workspace and check uninterpretable Features, as enforced by the Earliness Principle.

(5)



Consider now the syntactic derivation in (7), given the numeration in (6). The proper subset requirement on SELECT also predicts the 'right' order of Merge for interface legibility.

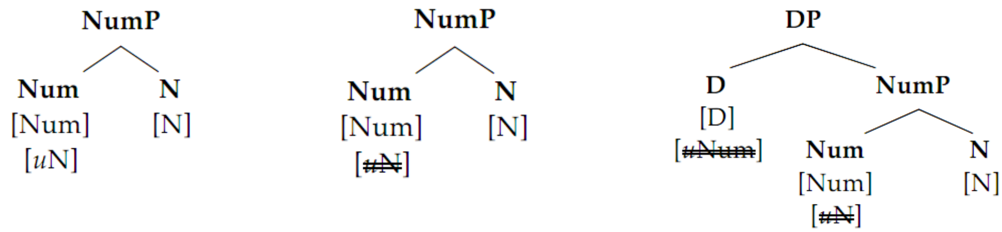
(6) N = {C, T, {D, Num, N, *v*, V, D, Num, N}}

(7) Step-by step derivation

Step 1. Select an item from Numeration that has interpretable features only.
⇒ Select N {[N]}
Step 2. Select an item from Numeration that properly includes N.
⇒ Select Num {[Num], [*u*N]}
Step 3. External-Merge N with Num to the workspace and check uninterpretable Features, as enforced by the Earliness Principle.
Step 4. Select an item that properly includes Num

⇒ Select D {[D], [*u*Num]}
Step 5. External-Merge D to the workspace and check uninterpretable features, as enforced by the Earliness Principle.

(8)



The asymmetry of Merge ensures that morphological and syntactic representations are efficiently interpretable by the external systems at the interfaces. For example, it ensures that the morphological merger of an affixal head and its complement occurs before the merger of a modifier to the head-complement configuration. In the case of a head-complement relation, the head is the superset and the complement is the proper subset; in the case of a modification relation the modifier is the superset while the modified constituent is the proper subset, as detailed in Di Sciullo (2013). It also ensures that the syntactic merger of the constituents of a DP occurs before the merger of the DP as a complement of a V and that the subject of a subject predicate relation is merged to a VP that has been previously built. This also satisfies the strong minimalist thesis in the sense that it provides an optimal solution to the CI interface legibility conditions for the interpretation of the predication relation. The proper subset requirement on the merger of a head and its complement ensures that there is an asymmetric relation between the features of a head and the features of the complement of that head. At each step of a syntactic derivation, the head is the super-set and the complement is the proper subset.

Under the assumption that affixes and roots like LI are specified for categorical features, the comparison between the derivations in (4) and (7) illustrates that Merge combine different sets of categorical features when applied in morphological vs. syntactic derivations. The syntactic feature specifications for the category N, as well as for the categories D, V, tense and C from Di Sciullo and Isac (2008), here in (9), do not extend to morphology. Different sets of features are at play in the merger of affixes and roots.

(9) a. N: [N]
Indefinite D: [Num] [*u*N]
Definite D: [D] [*u*Num]
wh-D: [D] [*u*Num] [wh]

b. UnergativeV: [V]
Transitive V: [V] [*u*D]
Unaccusative V: *v* [*v*] [*u*V] [*u*D] [*u*Tense]
Unaccusative *v*: [*v*] [*u*V], [*u*Tense]

c. Tense : [Tense], [*uv*] [*u*D] [EPP] [*u*ClauseType:]
C_1 : [D] [ClauseType] [*u*Tense]
C_2 : [D] [ClauseType] [*u*Tense] [wh]

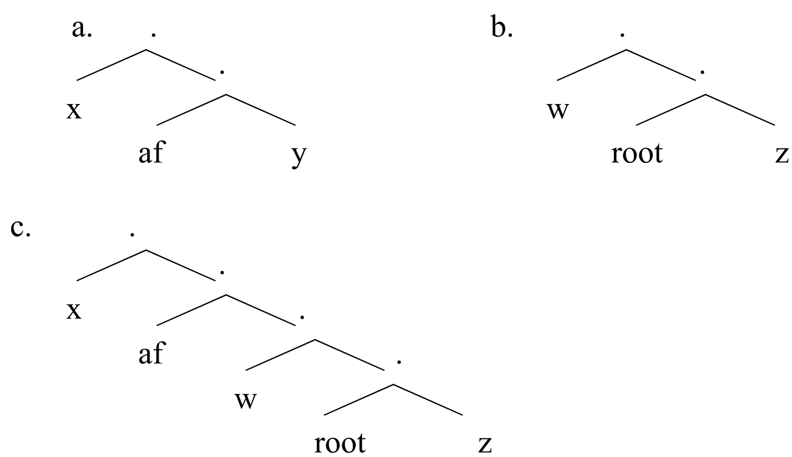
For example, N affixes (e.g., *-ity, -ion, -ade*) would be specified for [uA], [uV], [uN], which is not the case for syntactic Ns, see (9a).. V affixes (e.g., *-ize, -ify*) would be specified for [uN] (e.g., *union-ize*) and [uA] (e.g., *formal-ize*), but not [uD] and [uTense], as it is the case for syntactic Vs, see (9b). Tense affixes, (e.g., *-ed*) would not be specified for [*u*D] [EPP] and [*u*ClauseType:], (e.g., f*ormalized*), as it is the case for the syntactic category Tense, see (9b). Thus, SELECT applies to elements with different sets of features in morphological derivations as opposed to syntactic derivations.

According to the Asymmetry Theory however, affixes and roots are not specified for categorial features, but with arguments, aspect and operator-variable features. According to this theory, the set of features of the objects undergoing morphological merger is distinct from the set of features of LI, which undergo syntactic merger.

2.2 Structure

Merge applies to different kinds of structural objects in I-morphology vs. I-syntax. According to the Asymmetry Theory, Merge applies to elements that are part of minimal trees, that is, trees with one complement and one specifier in morphological derivations. This is not the case in syntactic derivations, where Merge applies to lexical Items (LI) whose morphological configuration is not accessible to syntactic derivation. The central operation of I-morphology combines trees, as argued in Di Sciullo (2005a *et seq*.). Morphological merger is akin to TAG's substitution operation, which substitutes a tree to the complement position of another tree. The merger of an affix with a root is sensitive to the configurational argument structure, aspect and operator-vatiable of the root and the affix, as in (14), where x and y may host arguments, Aspect or Operator-variable features. These features are located in the specifier and the complement positions of the minimal trees including affixes and roots. The predictions of this theory of restrictions on the combinations of affixes and roots as well as for their linearization in a variety of languages, including English and the Romance languages, Turkish and Yekhee, a North Eastern Niger Congo Language, as discussed in Di Sciullo (2005a, b).

(10)



The Asymmetry Theory focuses on the asymmetry of morphological relations. The strict asymmetry of morphological relations is evidenced by the fact that symmetry breaking is observed in the derivation of syntactic expressions (Moro 2000), but not in the derivation of morphological expressions. Consequently, symmetrical orderings of constituents can be found in syntactic expressions but not in morphological expressions. Evidence that asymmetrical relations are core properties of morphological expressions comes from the fact that while scope ambiguity is attested in syntactic expressions, it is not attested in morphological expressions. The notion of 'minimal word' defined in terms of the morphological shell, (10c), where each constituent is part of an asymmetrical c-command relation, expresses the strict asymmetry of morphological expressions.

Summarizing, asymmetry is a core property of the operations of the FLN. The computational procedure associated to Merge, namely the operation SELECT applies pairs of elements in morphological numerations whose features are in an asymmetrical proper subset relation. The fact that different features are assembled to form lexical items on the one hand and syntactic phrases on the other provides evidence that I-Morphology cannot be equaled to I-Syntax. Moreover, the fact that the objects undergoing Merge are minimal trees in the case of I-morphology and structurally unanalyzed objects in the base of I-syntax points to the same conclusion.

3. Merge and not Proto-Merge

In the Minimalist Program, it is assumed that Merge is the central operator of the Language Faculty. In recent works however, it is argued that more primitive form Merge, that is Proto-Merge, as defined in (11), is also part of the operations of the Language Faculty for the derivation of word-like expressions.

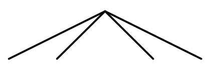
(11) Proto-Merge: a recursive n-ary operation concatenating n elements and deriving a flat/adjunction structure.

Proto-Merge would be active for word-like expressions such as VN expressions in English such as *dare-devil*. Jackendoff (1999, 2002) suggests that the relatively flat (non-hierarchical) structure of adjuncts, as well as the raw concatenation of compounds, still retain a bit of proto-linguistic flavor, and can be analyzed as syntactic 'fossils' of a previous stage of syntax. The notion of Proto-Merge is related to the gradualist view of the origin of language (Bickerton 1990, 1998, Jackendoff 1999, 2002, 2011). In a gradualist perspective, Proto-Language would be intermediate step in the historical development of language, (12).

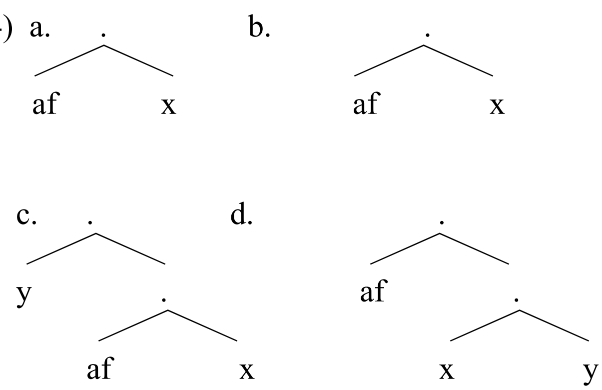
(12) pre-syntactic (one-word) stage > proto-syntax (two-word) stage > modern syntax

This view is opposed to the emergent view of the origin of language (Chomsky 2008, 2011, a.o.), there is no Proto-Language, or a preceding pre-syntactic (two word) stage in language evolution. To claim that a language includes expressions from a pre-syntactic stage is to assert that both Proto-Merge and Merge contribute to the derivation of linguistic expressions. By Minimalist assumptions, complexity in design would arise from the co-presence of Merge and a more primitive form of Merge. Given that the Language Faculty consists of a small set of operations generating syntactic and morphological expressions, then for economy considerations, I-morphology and I-syntax do not differ with respect to the core properties of their operations: binarity, asymmetry and recursion. If it were otherwise, that is, if the operations of I-morphology were completely different from the operations of I-syntax, different operations, concatenation and structure building, would be needed to derive binary branching structure. This would contravene to the Minimalist methodology, which reduces to the minimum the formal apparatus of the grammar. A model including only one generic operation deriving syntactic and morphological expressions is preferable to a model where these objects are generated by two different rules.

Moreover, the flat structure derived by Proto-Merge fails to account for the internal constituency of morphological expressions. If the core operation of I-Morphology were not a binary operation, and could derive ternary or n-ary structures, (13a,b), it would be impossible to account for the fact that morphological expressions, such as *re-formul-ate* for example, have a hierarchical binary-branching structure, as can be seen by the fact that *formul-ate* can be isolated within the larger structure *re-formul-ate*.

(13) a.  b. 

Binary branching alone is not sufficient to derive the configurational properties of morphological expressions. There are two basic binary branching configurations in which affixes and roots are part: configurations where the affix is a head and configurations where the affix is an adjunct. Assuming that there are no intermediate projections, such as X' projections, the binary branching structures in (14a,b) are indistinguishable however with respect to the 'head of' and 'adjunct of' relation. Assuming that an adjunct occupies the specifier position (Cinque 1999), the configurational asymmetry emerges in (14c,d) however, where in (14c) the affix is the head and x is its complement and in (14d) where the affix occupies the specifier position. The configurations in (14c,d) are the minimal configurations anchoring affixes in morphological expressions in the Asymmetry Theory.

(14)


The structures in (14c,d) are binary branching hierarchical structures, and thus they provide representations for the configurational properties of morphological expressions, contrary to ternary or n-ary branching structures. They unambiguously distinguish affixes that head their projections, from affixes that modify the projection of which they are part. These representations are the minimal representations identifying different kinds of affixes. They satisfy the strong minimalist thesis, as it is the best solution to the interface CI legibility conditions regarding the 'argument of' relation and the 'modifier of' relation between affixes and roots.

Given their configurational properties, morphological expressions are not flat structures. This view contracts with approaches that do not exclude this possibility, as it is the case for recent works on exocentric VN compounds in English, such as *dare-devil*, which have been argued to be derived by concatenation in Jackendoff (1999, 2002, 2011), and thus have a flat, non hierarchical structure. According to Jackendoff, exocentric compounds in English are living fossils of the very beginning of syntax or Proto-Merge. VN exocentric compounds are found in English as well as in other languages, as exemplified in Progovac and Locke (2009). According to these authors, VN exocentric compounds raise biolinguistic questions on the origin of language, on language variation and evolution, on whether languages carry living fossils of Proto-language, on whether Proto-language exists at all. They also raise specific questions on Merge, whether there is a more primitive operator alongside full-fledged Merge.

Progovac (2011) argues that exocentric VN compounds have a flat structure on the basis of the following properties of these constructs: i) they are not recursive, which would suggest that they cannot be derived by Merge; ii) the nominal element may in some cases be interpreted as the complement or the subject of the predication, which would suggest that no hierarchical structure is derived that structurally differentiates the complement from the non-complement. However, the analysis of similar expressions in Romance languages suggests that these forms have an internal phrasal structure, as evidenced in Di Sciullo and Williams (1987) and Di Sciullo (2009). Exocentric compounds in French may include bare nouns, e,g, *creve-faim*, as well as determiners, creve-la-faim, and prepositions, *crève-de-faim* (half-starved wretch), indicating that the V takes a DP complement. Exocentric compounds may also include a PP adjunct, e.g. *monte-en-l'air* (cat-burglar), which provide additional evidence that they have an internal phrasal structure and thus are not derived by concatenation or Proto-Merge.[4]

Summarizing, Minimalism leads to consider basic questions on the development of language, emergence vs. evolution, as well as the properties of the core operation of FLN. While exocentric compounds seem to be natural candidates for the evolutionist view of language development and Proto-Merge, in fact, they provide evidence for Merge and the emergent view of the origin of language. The emergent view of the Language Faculty prevents us to take Proto Merge to be evolutionary prior to Merge and to co-exist with Merge in FLN.

3. Recursion and complexity

Complexity, defined as the property of an operation to reapply to its own output, is brought about by the recursive property of Merge. By Minimalist assumptions, the

[4] A reduced restricted relative clause analysis for exocentric compounds is found in Panini's work on Classical Sanskrit (Gillon 2007), and in Tollemache (1945), Coseriu (1978), Bok-Bennema and Kampers-Mahne (2005), Franco (2010), a.o. The merger of an unpronounced nominal constituent with a CP derives a reduced relative clause analysis for these compounds. If the structure of exocentric compounds is that of a reduced relative clause, and thus is derived by the recursive application of Merge, it is expected that phrasal complements and adjuncts can be generated in these constructs.

unbounded recursion of Merge is limited by constraints imposed by systems external to the Language Faculty. Is it possible to equate the complexity brought about by the recursive application of the operations of I-Morphology and the one that is brought about by I-Syntax? Is the complexity generated by recursive application of Merge limited by the same constraints?

The discussion on complexity in Generative Grammar goes back to Chomsky's (1956) hierarchy of formal grammars, according to which grammars are ranked according to their generative capacity to generate languages of increasing complexity.

(15) (Turing (context sensitive (context free (finite state))))

For example, the complexity of context-free grammars is higher than the complexity of finite state grammars. The latter include abstract categories in addition to terminal elements, and derive hierarchical structures. They allow for recursive (both direct and indirect) and center embedded constituent structures. Several works from the 70s and the 80s discussed the generative capacity required to describe the complexity of the English vocabulary and the morphological complexity of other vocabularies, including for instance the vocabulary of Bambara (Culy 1985).[5]

Unbounded recursion is a distinctive property of the core operation of FLN (Hauser, Chomsky and Fitch 2002). It is usual to distinguish the basic recursive property of Merge, viz., the application of this operation to its own output, from the recursive application of Merge bringing about the replication of the same categorical structure. Different kinds of recursion are observed in phrasal syntax, including tail recursion and center embedded recursion. Tail recursion is also observed under the word level, as it is the case with evaluative affixes, e.g. *redishish*, and higher aspectual affixes, e.g. *rerewire, reunwire*.

While Merge is potentially unbounded, recursion is limited by independent properties the human brain, including the properties of short-term memory. Recursion is part of the internal system (I-Language) and the limits on recursion come from the external systems (E-Language). For example, sentential multiple center embeddings are difficult to parse, as the examples in (16) illustrate.

(16) a. The book [$_{CP}$ the students read] is interesting.
b. ##The book [$_{CP}$ the students [$_{CP}$ the professor knew] read] is interesting.

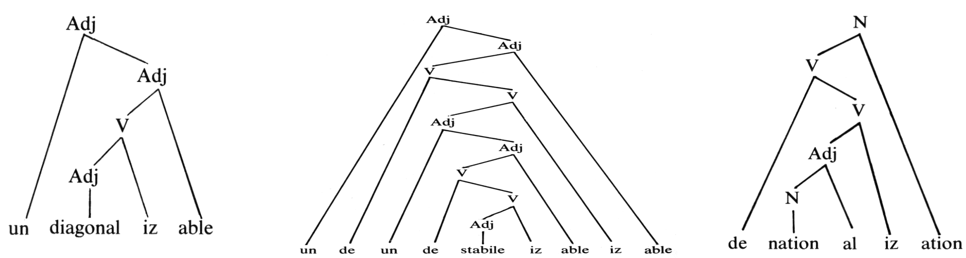
Chomsky and Miller (1963) suggest that a perceptual principle that can be formulated in terms of a parsing constraint is at stake: sentence production cannot be interrupted more than once. Kimball (1973) argues that the problem of unbounded center embedding is due to limitations on working memory: working memory cannot process two sentences at once. For Chomsky and Miller (1963), any perceptual principle may not interrupt its own operation more than once. Sentences are parsed from left-to-right, and

[5] Morphological complexity has been discussed in several works starting from the sixties in the generative framework (Bar-Hillel & Shamir 1960, Langendoen 1981, Carden 1983, Culy, 1985, a.o.) as well as more recently in the statistical framework (Moscoso del Prado Martin, Kostic & Baayen 2004, Bane 2008, Milin, Kuperman, Kostic & Baayen 2009, a.o.).

human processing mechanism cannot be interrupted more than once. Multiple center embedded structures are difficult to process because they require more than one interruption of the subject-VP relation.

The question arises whether multiple center embeddings are arrested in morphological expressions. If this were the case, empirical evidence could be provided that unbounded recursion is also part of the property of the operations of I-Morphology. Based on Chomsky's Hierarchy of formal grammars (Chomsky 1956), several works from the beginnings of generative grammar showed that the derivation of morphological expressions required the power of structure building context-free grammars (Bar-Hillel and Shamir 1960, Langendoen 1981, Carden, 1983, Shieber, 1985). Multiple center embedding is observed in morphological expressions, as the following examples from Carden (1983) illustrate.

(17) a. b. c.



Chomsky and Miller's (1963) perceptual principle can be extended to account for the difference in acceptability between simple and multiple center embeddings in morphological expressions, assuming however that the parsing of a morphological expression of a given category cannot be interrupted more than once by an intervener of a different category, as the following examples illustrate.

(18) a. stablil$_{A}$ -iz$_{V}$ -able$_{A}$
b. ##un$_{A}$- de$_{V}$-stabil$_{A}$ -iz$_{V}$-able$_{A}$
c. marked$_{A}$ -ness$_{\mathbf{N}}$ -less$_{A}$
d. ## marked$_{A}$ -ness$_{\mathbf{N}}$ -less$_{A}$ -ness$_{\mathbf{N}}$ -less$_{A}$

The examples in (18) illustrate that the parsing of a complex adjectival expression cannot be interrupted more than once by a verbal or a nominal intervener. In (18a) and (18c) only one constituent intervenes between two adjectival constituents, and the structure can be parsed from left to right. However, left to right parsing efficiency decreases with (18b) and (18c) when there is more than one intervener.

Interestingly, categorically distinct constituents may center embed in the derivations of morphological expressions on the one hand, and in syntactic derivations in the other, suggesting again that these derivations take place in different workspaces. The fact that unbounded center embedding is limited by parsing constraints indicates that both morphological and syntactic complexity are limited by systems external to the language Faculty. This complexity, due to the recursive application of the operations of FLN, can be measured in terms of length of the derivations. It may be distinguished from the complexity that is occurrence-dependent and that can be measured on the basis of externalized data. In Di Sciullo (2012), I isolated two approaches to morphological complexity: the statistical information theoretic approach, or E-complexity, and the shortest derivation that relates morphological complexity to the length of a form's derivation i.e. the number of applications of morphological merger (Kolmogorov 1965, Chaitin 1987, Fodor, Bever Garrett 1974), I-complexity. I showed that languages, such as French and English, differing in E-complexity according to Bane's (2008) metrics, have a similar I-complexity with respect to morphological structures, and I reviewed experimental works that relate morphological I-complexity to processing.[6]

The results of psycholinguistic experiments on prefixed verbs reported in Tsapkini et al. (2004) and in Di Sciullo and Tomioka (2011) on compounds provide evidence that the mind/brain processes differences in hierarchical relations, which may not be associated with overt morphological material. If hierarchical representations are legible at the CI interface but not at the SM, it is natural to assume that the complexity brought about by the computations of I-Morphology is processed at the interface between the language faculty and the CI interface. This complexity is not occurrence-dependent and it cannot be measured on the basis of externalized data. The complexity of E-Morphology, however, is a function of the density of externalized data, or string sets, and it is natural to assume that it is processed at the interface between the language faculty and the SM system.

6. Summary

Minimalism leads to raise basic questions on the properties of the biologically grounded operations of FLN, to revisit issues on the development of language, emergence vs. evolution, as well as to consider the role of the factors external to the Language Faculty limiting the complexity.

Minimalism prevents us to consider morphological operations as falling outside of the operations of FLN, to view issues related to the evolution of language in terms of gradualist theories, where words were evolutionary prior to syntax and to view morphological complexity as complexity brought about by the actual occurrences of morphological expressions. Minimalism leads us to distinguish internal/intentional properties of morphological expressions from their external/extensional properties. It leads us to articulate further the properties of morphological derivations, their legibility at the cognitive interfaces, and to sharpen what are the properties of FLN and what falls outside of FLN.

I discussed the properties of the operations deriving morphological expressions, and provided evidence that the computational procedure of I-morphology is the best solution to interface legibility conditions for morphological expressions. The dual nature of morphological complexity can be viewed as a consequence of the Minimalist

[6] Assuming that morphological derivations may yield structures where no phonetic features are associated with terminal nodes, as in Di Sciullo (2005a), morphological complexity, understood in terms of the number of applications of morphological merger, may give rise to expressions that are not distinct with respect to the number of affixes and roots, but are distinct with respect to the number of applications of morphological merger. I-complexity is a function of the iterative application of the operations of FLN. These operations derive hierarchical structures, which may include zero-morphology.

architecture of the language faculty, where the generative operations of FLN derive interface representations interpreted by the external systems. The complexity brought about by the computations of I-complexity is processed at the CI interface, while E-complexity is processed at the SM interface. Internal complexity and external morphological complexity are related to the extent that the CI and the SM interfaces are part of FLB.

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