Grammar in 3D: on linguistic theory design
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2 DISTRIBUTION

2.1 INTRODUCTION

Distribution is the first dimension considered in this study in relation to the architecture or design of any theory of grammar. If one were to see a grammar as a city, this dimension would capture the number, type and relative position of all districts, areas, blocks and houses of the city, as well as how to get from house x in block y in area z into house a in block b in the c district. Within this term are thus subsumed all notions related to the formalization of information throughout the various layers, sub-levels, levels, modules, components, etc. constituting the map of a certain model of grammar. In this dimension, “the first D” or Distribution, a certain number of sub-features are to be considered. The first feature is the number and type of levels of representation. These levels, in turn, are a consequence of the number and type of formation rules (whether they are independent or not) and restrict inter-level mapping processes, whose number and nature are the direct outcome of the number and nature of levels. Accordingly, the following sections set out to examine all previously mentioned features: number and type of formation rules; number and type of levels of representation; number and type of inter-level mapping processes.

This chapter offers an account of the series of features that determine the map of a model’s grammatical component, i.e. its Distribution. It is divided into three further sections: formation rules; levels of representation; and inter-level mapping processes. Each of the models is explained through three different Figures (one for each architectural feature) so that, by superposing each model’s three Figures, one can obtain the full picture of the models’ Distribution. The complete pictures obtained by superposing all three features (formation rules, levels, inter-level mapping processes) for all the three
models are displayed in this chapter and lead to a comparison of the models’ distributional properties in pairs.

2.2 FORMATION RULES: NUMBER, TYPE

In general terms, a formation rule is a one that determines which formations are correct and which are not, i.e. which sequences of symbols can be combined in a given model. In a grammar, rules and principles operate with symbolic data structures and primitives (see Pinker 1991: 530, see also Lasnik 2000 for rule systems) such that correct combinations can be yielded. To the extent that the number and nature of formation rules determine the number and nature of levels of representation in a theory of language, the first feature that is to be analyzed when approaching the map of a grammar is the number and type of formation rules. On the one hand, the number and type of independent levels of representation is obviously restricted by the number and type of independent formation rules, and so are the number and type of non-autonomous levels, since their lack of autonomy is defined in opposition to independent levels and formation rules. On the other hand, and since the number and type of independent formation rules are at the core of the number and type of dependent and independent levels and these, in turn, determine the number and type of inter-level mapping processes, the number and type of independent formation rules are also inherently linked to the number and type of mapping processes. In what follows, Figures 9-11 illustrate the number and type of independent formation rules for TGG, PA and FDG.

In this section, it is illustrated that: TGG possesses one single type of independent formation rules, namely syntactic; PA possesses three types of independent formation rules, syntactic, semantic and phonological; FDG possesses four different types of independent formation rules, syntactic, semantic, phonological, pragmatic. This, in turn, means that TGG will have one independent syntactic level, PA three
(syntactic, semantic and phonological) and FDG four (syntactic, semantic, phonological and pragmatic). There may however be more levels than those that directly originate from independent formation rules but, in that case, these cannot be predicted from formation rules and they will depend upon another grammatical level. This is illustrated in sections 2.3 and 2.4. Furthermore, the number and type of formation rules will have an impact upon the number and type of inter-level mapping processes such that the source of interfaces will be restricted to those levels that are independent i.e. born from independent formation rules. This is illustrated in section 2.5.

Accordingly, TGG possesses one type of independent formation rules, namely syntactic. In the generative tradition, “a grammar contains a syntactic component, a semantic component, and a phonological component. The latter two are purely interpretive” (Chomsky 1965: 141). This means that semantics and phonology “play no part in the recursive generation of sentence structures” (ibid) and are therefore not born from independent formation rules. Figure 9 below illustrates independent formation rules in TGG.

**Figure 9. TGG and independent formation rules**

![Syntactic rules](image)

In contrast to TGG, PA possesses three different types of independent formation rules. “The consequence is that phonology and syntax are properly viewed as independent generative systems, each of which characterizes an unlimited set of structures” (Jackendoff 1999: 395). This is illustrated in Figure 10 below.
Finally, FDG possesses four types of independent formation rules for formulation and encoding. The different rules or grammatical operations that create the four levels of representation in FDG make use of sets primitives serving as the building blocks for their respective levels of application. For formulation, formation rules make use of primitives containing frames, lexemes and operators. For morphosyntactic encoding, formation rules make use of templates, grammatical morphemes and morphosyntactic operators. For phonological encoding, formation rules make use of templates, suppletive forms and phonological operators. The various primitives are then combined by formation rules in order to produce the various levels of representation (Hengeveld & Mackenzie 2008: 12-13, 19). This is illustrated in Figure 11 below.

**Figure 10. PA and independent formation rules**

![Phonological rules](image1) ![Syntactic rules](image2) ![Semantic rules](image3)

**Figure 11. FDG and independent formation rules**

![Pragmatic rules](image4) ![Semantic rules](image5) ![Morphosyntactic rules](image6) ![Phonological rules](image7)
2.3 **LEVELS: NUMBER, TYPE**

A grammar is a structured, formal description of a natural language (Bryant, Johnson & Edupuganty 1986), a whole made up of several parts of which syntax is only one part. There are thus different parts in a grammar that organize different types of contents and that are constituted by different units (Bosque & Gutiérrez-Rexach 2009: 11). These parts are called levels of representation. A level of representation is thus a module that expresses a certain content and certain hierarchical and/or non-hierarchical, structural relations. The number and type of these levels partly depend upon the number and nature of independent formation rules. Firstly, the number of levels of representation depends on the number of independent formation rules, since there is a minimum number of independent grammatical levels that corresponds to the number of independent formation rules. Secondly, the type of levels of representation also corresponds with the type of formation rules (whether they are semantic, pragmatic, etc.). These are the independent grammatical levels, and their nature corresponds to that of the formation rules from which they originate. All other grammatical levels that are present in a model are bound to be at least partly dependent on other levels since, lacking their own independent formation rules, they necessarily originate from another grammatical level to which they owe their existence. This, in turn, means that any level of representation to which another level owes its existence has to formally account for any phenomenon that takes place in the latter. Figure 12 below illustrates the equation from which the number of independent levels of representation (the minimum number of levels in a given grammar) can be obtained. The minimum number of compulsory grammatical levels corresponds to the number of independent formation rules. The type of these levels (semantic, syntactic, etc.) is also a direct consequence of the formation rules from which they are born.
Figure 12. Independent levels of representation

\[ I = FR \]

Whereby

- **I**: Minimum number of levels within grammatical component or independent levels
- **FR**: Number of independent formation rules within grammatical component

Figures 13-15 below illustrate the number and type of obligatory, independent grammatical levels (corresponding to the number and nature of independent formation rules) for TGG, PA and FDG. These constitute the minimum number of autonomous levels.

Figure 13. TGG and independent levels of representation

As illustrated in Figure 13 above, the fact that TGG has independent syntactic rules means that the syntactic component is independent and therefore “[t]he infinite generative capacity of language resides in the syntactic component of the grammar” such that “[p]honology (the sound system of language) and semantics (the meaning system) are purely ‘interpretive’. That is, syntax creates sentence structure, from which sound and meaning are then ‘read off’ ” (Jackendoff 1999: 395). The fact
that the only independent formation rules are of syntactic character means that, throughout the history of TGG, the semantic and the phonological levels are dependent upon the syntactic one (see for a study of the levels of representation in GG May & Koster 1981).

In *Syntactic Structures* (Chomsky 1957), the independence of the syntactic level was made clear by the fact that the rule-centered system was based on phrase structure rules determining the category and lexical form of the various parts of the sentence to which two other types of rules were later on applied: morphophonemic rules in order to change the form of lexical items, and transformational rules in order to change the order of lexemes. In *Aspects of the Theory of Syntax* (Chomsky 1965), the syntactic base component (phrase structure rules, lexical insertion rules) gave birth to the deep structure (syntactic, related to the semantic component – projection rules, semantic representations), which then underwent transformations (syntactic, the transformational component, transformational rules) and gave birth to the surface structure (syntactic, related to the phonological component). In *Lectures on Government and Binding* (Chomsky 1981), the D-Structure (movement rules) gave birth to the S-Structure, from which both the Phonetic Form and the Logical Form were born. Although D-Structure and S-Structure can be considered as two different levels (see Hornstein, Nunes & Grohmann 2005: 73), they are both syntactic in nature (they may be seen as sub-levels). In *The Minimalist Program* (Chomsky 1993, 1995), the base syntactic component contains lexical items that are accessed (operation Select) and used to build syntactic structures (operations Merge, Move, overt syntax) leading to the operation Spell Out, which splits the derivation into PF (syntax-phonology interface) and LF (covert component or covert syntax). PF and LF are the two linguistic levels that interface with A-P and C-I (Hornstein, Nunes & Grohmann 2005: 15, 73), thus of a syntactic nature. All these versions of TGG depart from a main syntactic level from which both the semantic and the phonological
interpretations are derived since the syntactic rules or operations (be it phrase structure and transformation rules in 1957 and 1965, movement rules in 1981 or selection, merging and movement rules in 1993, 1995) are at the core of the derivation, as illustrated in Figure 13 above.

The Parallel Architecture offers a different view of the grammatical component because language is thought of as a group of three independent generative components (phonological, syntactic and semantic structure) linked by interface components (Jackendoff 1999). If there are three independent generative levels of representation, there must necessarily be three different types of independent formation rules, one for each level. This is illustrated in Figure 14 below.

**Figure 14. PA and independent levels of representation**

![Diagram of PA and independent levels of representation](image)

Finally, FDG possesses two levels of formulation and two levels of encoding such that “the underlying representation of an utterance contains four levels of organization: an Interpersonal Level (pragmatics), a Representational Level (semantics), a Morphosyntactic Level (morphosyntax), and a Phonological Level (phonology)” (Hengeveld & Mackenzie 2008: 5). The model is conceived in such a way that, “though there are regular correspondences between the Interpersonal Level and the Representational Level, the two are basically independent of each other, allowing for a wide variety of interactions between them” (*ibid*: 16). In practice, this means that all four levels of representation are independent, thus they may be mismatching. A further conclusion is that they are all
born from independent formation rules and use separate sets of primitives (see *ibid*: 12-13). This is illustrated in Figure 15 below.

**Figure 15. FDG and independent levels of representation**

Figures 13-15 above illustrate two main facts. On the one hand, they show that any theory of language has a minimum number of independent grammatical levels whose number and nature are determined by the number and nature of independent formation rules. Accordingly, TGG is bound to have a minimum of one independent, syntactic level, PA a minimum of three independent levels (syntactic, semantic, and phonological) and FDG a minimum of four independent grammatical levels (syntactic, semantic, phonological, and pragmatic). On the other hand, these Figures show that the total number of grammatical levels is calculated by a simple addition of the number of independent formation rules and a variable that depends on the grammatical model (X). This variable corresponds to the
number of levels that are not directly originated from independent formation rules, therefore dependent upon another level and non-autonomous levels. Figure 16 below illustrates the relation between independent formation rules, the said variable X and the total number of levels of representation in a given theory of language.

**Figure 16. Total number of levels of representation**

\[ L = FR + X \]

Whereby L: Total number of levels within grammatical component  
FR: Number of independent formation rules within grammatical component  
X: Number of extra, non-autonomous levels within grammatical component

Following Figure 16 above, the mismatch between the number and type of levels of representation and independent formation rules equals the variable X, i.e. non-autonomous grammatical levels. Figures 17-19 below illustrate both independent formation rules and the total number of levels for TGG, PA and FDG. Non-autonomous levels are those lacking corresponding independent formation rules.

**Figure 17. Independent formation rules and levels in TGG**
Figures 18-19 below show the mismatch between independent formation rules and the total number of levels of representation (i.e. non-autonomous levels) for the three models. Independent grammatical levels are distinguished from dependent levels in that they are born from their own
independent formation rules. Dependent levels are shown in a lighter shade in Figure 20. The formula in Figure 16 above for the calculation of the total number of levels of representation by adding the number of independent formation rules plus the number of non-autonomous levels (X) is also applied for TGG, PA and FDG.

Figure 20. Autonomous and non-autonomous levels in TGG

![Diagram of TGG levels]

Whereby

- \( L \): Total number of levels within grammatical component
- \( FR \): Number of independent formation rules within grammatical component
- \( X \): Number of extra, non-autonomous levels within grammatical component

\[ L = FR + X = 1 + 2 = 3 \]

Figure 21. Autonomous and non-autonomous levels in PA

![Diagram of PA levels]
Figures 20-22 above illustrate the number and nature of non-autonomous levels in TGG, PA and FDG. As shown in Figure 20, TGG has a total of three grammatical levels and only one type of independent formation rules (syntactic) from which the one grammatical level that is independent (syntax) is born. Therefore, the two remaining levels within the grammatical
component (semantic, phonological) depend upon the former (syntactic), since they lack their own independent formation rules. The X variable in this case is therefore = 2. Regarding semantics, syntactic structures are given a semantic interpretation but are not accorded autonomy (see e.g. Katz & Postal 1964; cf. Jackendoff 1972). Regarding phonology, “[o]nce the speaker has selected a sentence with a particular syntactic structure and certain lexical items […], the choice of stress contour is not a matter subject to further independent decision” (Chomsky & Halle 1968: 25). Both semantics and phonology are thus deprived of autonomy. This leads to the postulation that syntax operates rules that, even in the minimalistic versions of the generative tradition, lead to a derivation that splits into phonology and semantics as in earlier versions of the theory.

Contrarily, as shown in Figures 21 and 22, neither PA nor FDG have more independent levels than independent formation rules such that the X variable corresponding to the number of levels that do not have their own formation rules (see Figure 16) is 0. All grammatical levels in PA (phonological, syntactic and semantic) are born from their own independent formation rules (phonological, syntactic and semantic). This is so because phonology and semantics are not derived from syntax but syntax rather appears as the bridge element between both phonology and semantics (see e.g. Jackendoff 1997, 2002).

In FDG, all levels of representation (pragmatic, semantic, morphosyntactic and phonological) are also born from their own independent formation rules (pragmatic, semantic, morphosyntactic and phonological). This means that there is no difference between the nature and number of independent formation rules, on the one hand, and the number and nature of both independent and the totality of grammatical levels, on the other, for FDG. All levels within the grammatical component are thus independent. This independence is reflected in a two-fold manner: firstly, a single constituent acquires different representations at the various levels making use of different sets
of primitives (Hengeveld & Mackenzie 2008: 22); secondly, only those aspects that are relevant to build up a certain level or an aspect of an utterance are used for the representation in order to avoid the vacuous specification of levels of representation, as specified by the principle of Maximal Depth (ibid 2008: 25).

2.4 FORMATION RULES AND LEVELS

Tables 1 and 2 below offer an overview of the relation between the number and nature of independent formation rules, on the one hand, and the number and nature of non-autonomous grammatical levels, on the other. Firstly, note that TGG shows a quantitative and qualitative mismatch between formation rules, on the one hand, and its total number of grammatical levels, on the other. Whereas there is only one independent type of formation rules, syntactic (which means that there is a compulsory minimum of one, syntactic level), there is a total of three levels (syntactic, semantic, and phonological). This means that all those levels which are not born from independent formation rules of their own type are bound to depend upon the level that does have its own independent formation rules, the syntactic one. This is the case for the semantic and phonological levels. For this reason, the syntactic level has to representationally account for any phenomena that may arguably take place within the semantic or phonological levels. Such an architectural choice has been named “syntactocentrism” (Culicover & Jackendoff 2005).

As opposed to TGG, PA shows the same number and type of independent formation rules as of grammatical levels, namely three (syntactic, semantic, and phonological). The same goes for FDG, although this theory, having one more type of independent formation rules, also has one more grammatical level. The total number of independent formation rules and of independent grammatical levels in this case is four, namely syntactic, semantic, phonological, and pragmatic. This means
that PA and FDG, in the absence of quantitative or qualitative mismatches between the number and type of independent formation rules, on the one hand, and grammatical levels, on the other, are only comprised of levels that are autonomous such that no level fully depends upon any other level.

Table 1. Autonomous and dependent levels in TGG, PA and FDG: number

<table>
<thead>
<tr>
<th>LEVELS: DEPENDENCY VS. AUTONOMY</th>
<th>TGG</th>
<th>PA</th>
<th>FDG</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEPENDENT FORMATION RULES</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>INDEPENDENT</td>
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<td>3</td>
<td>4</td>
</tr>
<tr>
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<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
2.5 INTER-LEVEL MAPPING PROCESSES

2.5.1 NUMBER

An inter-level mapping process is an interface process taking place between two different levels of representation. Thus, an interface consists of a set of rules that relate different representations (Van Valin Jr. 2005) and express the exchange between such levels. In a sense, the whole grammar could be defined as a series of mappings such that “grammar is mapping between sound and meanings not via one step but via several intermediate steps or data structures” (Pinker 1991: 530).

It is possible to calculate the number of potential inter-level mapping processes in a certain grammar—the maximum number of interfaces a grammatical model can have, given its
distributional restrictions. The quantity of possible interfaces is linked to the number of grammatical levels, since it is always between two levels that interface processes are established. Although some grammatical models may allow for the simultaneous activation of several interface processes or may even tolerate the activation of an inter-level interface process before any other mapping process feeding it has been completed, interface processes always take place between two and not more levels.

The calculation of the maximum number of interfaces that can be formalized in a certain model of grammar results from the application of a simple combination rule. If the grammatical component possesses only 3 levels, then the maximum number of potential interfaces will not possibly be higher than the dual combination of 3 (levels), since interfaces only link 2 levels. The maximum number of potential interfaces will then be \( I = 3 \times (3 - 1) = 3 \times 2 = 6 \). Note that this number is calculated taking into account two factors: the two levels involved in the mapping process; and the sense in which the process takes place between those two levels (directionality).

Figure 23 below offers the formula for calculating the maximum number of potential (vs. actually implemented) interfaces (definition factors: levels involved, directionality).

**Figure 23. Maximum number of inter-level mapping processes (directionality)**

![Formula](image)

Whereby:
- \( I \): Maximum number of potential interfaces, directionality involved
- \( L \): Number of levels within grammatical component
Interfaces always take place between two levels and are therefore a combination of a maximum number of two. If directionality is not a factor for the distinction of interfaces, their number is reduced to a half. This is so, since the combination rule (see Figure 23 above) applies in such a way that the order (in this case directionality) is taken into account. The formula for the calculation of the maximum number of potentially implemented interfaces (definition factor levels involved, no directionality involved) is shown in Figure 24.

**Figure 24. Maximum number of inter-level mapping processes (no directionality)**

\[ I = \frac{L \times (L - 1)}{2} \]

Whereby I: Maximum number of potential interfaces, no directionality involved
L: Number of levels within grammatical component

Following the calculation of the maximum number of potential interfaces considering directionality, TGG and PA have a maximum number of 6 interfaces (3 x (3-1) = 6) whereas FDG has 12 (4 x (4-1) = 12) (see Figure 23). The maximum number of interfaces disregarding directionality is in turn 3 for TGG and PA ((3 x (3-1)) / 2 = 3) and 6 for FDG ((4 x (4-1)) / 2 = 6) (see Figure 24). Note that a difference is established between the potential number of interfaces that a model may formalize according to the formula in Figures 23 and 24, on the one hand, and the number of interfaces that a model of grammar actually implements. Figures 25-27 show that the number of interfaces that TGG, PA and FDG actually implement is lower than the number of interfaces which their distributional constraints (their number of levels) could have allowed for. The
lines between the levels represent mapping processes (i.e. which are the two levels involved in the inter-level mapping process) and the sense of arrows represents the direction in which those mapping processes take place (i.e. which is the directionality or, in other words, which is the source and which the target level). Figure 25 below shows the number of interfaces that are actually implemented in TGG. Note that the number of possible interfaces is 6 (3 levels x (3-1)) = 3 x 2 = 6) whereas the number of interfaces that are actually implemented is 2.

Figure 25. TGG and inter-level mapping processes

Figure 26 below shows the number of interfaces implemented in PA. In this case, the number of possible interfaces is also 6 (3 levels x (3-1)) = 3 x 2 = 6), which coincides with the number of interfaces that is actually implemented. The richness of the interface system in PA is of great importance, since the representations of all three levels are otherwise relatively encapsulated. This is called “representational or structure-based modularity”, a grammatical system in which “[e]ach separate form of representation has its own particular autonomous (i.e., domain-specific) structure, and its own interfaces to other structures” and in which “[o]ne form of representation is relatively informationally encapsulated from another to the degree that one can influence the other only through a series of interfaces, or through a narrowly specialized interface” (Jackendoff 2010b: 44)
Thus, in a parallel grammar there exist those constraints that are level internal, i.e. intra-level, and also those regulating relations among levels, i.e. inter-level: “[t]he structures of each component are licensed by simultaneously applied component-internal constraints. The relationships among structures in different components are licensed by interface constraints” (ibid: 588) that impose restrictions on the ways in which the various parts of the semantic, syntactic and phonological structures interact with each other. These are the ‘correspondence rules’ or ‘interface component’” (Jackendoff 1999: 395).

**Figure 26. PA and inter-level mapping processes**

![Diagram showing PA and inter-level mapping processes]

Finally, Figure 27 below shows the number of interfaces implemented in FDG. In this theory, the number of possible interfaces is also 12 (4 levels x (4-1)) = 4 x 3 = 12), whereas the number of interfaces that are actually implemented is 9 (Hengeveld p.c.). Although interface conditions are not dealt with in depth in the book, their nature allows for the model to commit to “multiple orthogonal representations of linguistic phenomena” (Hengeveld & Mackenzie 2008: 31).
Table 3 below offers an overview of the maximum number of potential inter-level mapping processes for TGG, PA and FDG as well as an overview of the number of interfaces that are actually implemented in each of the models. It also illustrates the number of inter-level mapping processes that could in principle be formalized in each of the theories (i.e. there is no distributional restriction for their formalization) but are not. Note that there may be a quantitative difference between those processes that an architecture of grammar may potentially implement and the actual implementation of processes, and that such difference may be influenced by whether directionality (source and target levels of mapping process) is considered or not. Table 3 illustrates that PA makes use of all its distributional resources as far as the number of interface processes which its formalism allows for is concerned, i.e. it formalizes all inter-level mapping processes that its remaining distributional properties allow for (formation rules, levels). Thus, all possible combinations between its three levels are formalized regardless
of whether directionality is involved or not. This means that there is communication between all three levels and this in all ways so that the grammar formalizes and tolerates the flux of information from and into any of the three levels. TGG, on the other hand, lacks one interface, four if directionality is involved (both directions of the lacking interface, plus one direction for the two interfaces it does formalize). Finally, regarding FDG, all potential interface processes are formalized when directionality is not taken into account such that all four levels are dually linked among themselves in some way. However, when directionality is concerned, a lack of three potential interface processes is to be observed in the formalism of the grammatical component. This is so because no bottom-up mapping processes are allowed for within the formalism implying the skipping of any intermediate level.

2.5.2 TYPE

The type of interface processes that a given model of grammar chooses to implement in its formalization is a direct consequence of its architectural design. This is so, since such processes show the emphasis which each grammar chooses to put upon each type of information flux (type being understood as the nature of the two levels involved) and, most importantly, which are the source and target levels of information flux processes. The number and type of interface processes are restricted by the number and type of levels which a grammar decides to formalize such that inter-level mapping processes are only a more restricted presentation card as to a model’s architectural preferences (where the relevant or necessary information is, where it comes from). It is therefore of great importance to analyze the nature of those interface processes which could be implemented in a grammar, the nature of those interfaces which actually are implemented, and why those interface processes which could be implemented are not. Table 4
below offers an overview of the type of those interface processes that could be implemented in TGG, PA and FDG and those which are. A difference is made regarding directionality (whether it is involved or not). It also illustrates those inter-level mapping processes that are not implemented in the models.

Table 3. Potential vs. implemented and non-implemented inter-level mapping processes in TGG, PA and FDG: number

<table>
<thead>
<tr>
<th>Levels within grammatical component, number</th>
<th>TGG</th>
<th>PA</th>
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<tr>
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Table 4. Potential vs. implemented and non-implemented inter-level mapping processes in TGG, PA and FDG: type

<table>
<thead>
<tr>
<th>LEVELS WITHIN GRAMMATICAL COMPONENT, TYPE</th>
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<th>PA</th>
<th>FDG</th>
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<td>INTERFACES, TYPE</td>
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Table 4 illustrates the difference between those interfaces that could be implemented in TGG, PA and FDG and those that are actually formalized or those which are not. Whereas Table 3 focuses on the number of such interfaces, Table 4 focuses on their type. Starting off with TGG, it is to be observed that both directions of the semantics-phonology interface are formally ignored, so that no flux of information takes place between these two levels. This means that all information flux processes will occur with syntax as one of the
levels involved, the overall number of levels being just three and interfaces taking place between only two levels. Nor is there flux of information taking place from semantics or phonology into syntax, which means that all flux between the two permitted interfaces (syntax-semantics and syntax-phonology) takes place from syntax and into semantics and phonology but not the other way round. This being so, all phenomena accounted for within the grammar will have to be accounted for within syntax first, since it is syntax that is at the core of all other possible grammatical phenomena (semantic as well as phonological). For some authors, the fact that the conceptual-intentional interface (C-I) is derived from syntax amounts to claiming that “babies and apes cannot think combinatorily” (Jackendoff 2010b: 594).

Regarding PA, it is to be noticed that all types of potential interfaces are actually implemented within the model. This means that the flux of information will take place from and into each of the levels involved, thus from and into any combination (directionality involved) of syntax, semantics and phonology. This being so, the model clearly opts for a view of grammar in which any level can be the source of information processing, which may take place into any of the levels. There is no level which fully restricts or is fully responsible for any other level, and interfaces can not only take place from and into any level but, furthermore, they can do so at any time and simultaneously. Since there is no single source of computation, there is no fixed order as to which interface should be processed first, nor is there a restriction as to whether a new interface process may commence before some other is fully finished. In contrast to TGG, in PA semantics and phonology are not derived from syntax. Rather, phonology and semantics appear at both ends and syntax in the middle of the representation such that the default mapping is phonology > syntax > semantics for speech perception and phonology < syntax < semantics for speech production (Jackendoff fc.; see also section 4.4.2). In the bigger picture, the interfaces that obtain are hearing, gestures, music < > phonology < > (syntax) < > semantics < > perception,
action. The parentheses in syntax mean that phonology and semantics can also interact without having to go via syntax (see e.g. Jackendoff 2002: 125).

Finally, the presence of a pragmatic level in FDG obviously broadens the potential number and type of interfaces up to a maximum of six (no directionality involved). In a dynamic implementation of FDG, the different levels of the model are related by means of formulation and encoding rules (Bakker 2001, 2005). In this respect, all potential interfaces are formalized, thus information flows between pragmatics and semantics, pragmatics and morpho-syntax, pragmatics and phonology, semantics and morpho-syntax, semantics and phonology, and morpho-syntax and phonology. Now, if directionality is taken into account, three potential interface processes seem to be absent in the model. These are: phonology into semantics, phonology into pragmatics and syntax into pragmatics. This is so because the model has not as of today formalized bottom-up processes that imply the skipping of any intermediate level (intermediate as in any level between the source and target levels of computation). In this case, the interface process from phonology into semantics would skip the morpho-syntactic level, the process from phonology into pragmatics would skip the morpho-syntactic and semantic levels and the process from syntax into pragmatics would skip the semantic level. Notice that, as opposed to TGG and PA, FDG makes a further distinction as to the type of interface processes taking place in an inter-level fashion. Thus, inter-level processes in FDG are distinguished according to whether they involve hierarchical or non-hierarchical relations between the units involved. Top-down interface processes are assumed to involve hierarchical relations whereas non-hierarchical relations are captured by bottom-up processes, whereby the restriction of non-skipped levels applies. These relations take place in non-hierarchical mappings e.g. in the mapping of a predicate’s arguments into morphosyntactic units (referred to as “alignment”, see ibid: 316), whereby the ordering of
morphosyntactic units determines the ordering of their corresponding semantic units.

Although bottom-up feedback between levels is allowed for, the model of FDG is strongly top-down (Hengeveld & Mackenzie 2008: 1-3). The most relevant interfaces are thus pragmatics > semantics, semantics > morpho-syntax and morpho-syntax > phonology. The mapping from pragmatics to semantics takes place through the Communicated Content (C). If there is no Communicated Content (in expressives such as “oh!” or interactives such as “thanks”, in which the meaning is expressed directly by the illocution ILL), there is accordingly no semantic level of representation (ibid: 87). Regarding the mapping from the pragmatic and the semantic levels into the morpho-syntactic level, this is kept as simple and stable as possible thanks to iconicity, domain integrity and functional stability (ibid: 287). This preference for a one-to-one relation also applies to the mapping from the morpho-syntactic level into the phonological level (ibid: 288).

Note that, for the three models, inter-level mapping processes are a direct consequence of the previously analyzed features within Distribution, namely the number and type of grammatical levels and the number and type of formation rules. This is so, since formation rules determine the autonomy of certain grammatical levels, and these are in turn those potential source levels from which inter-level mapping processes may take place. On the contrary, those levels lacking their own independent formation rules are bound to be non-autonomous and may only appear as potential target levels in mapping processes. In PA and FDG all levels are born from their own independent formation rules and possess therefore certain autonomy - they may all be activated as the source level of computation in inter-level mapping processes. In TGG, however, only the syntactic level is born from its independent formation rules. The phonological and semantic levels are dependent upon the syntactic one and may only be activated as target levels of computation in inter-level mapping processes.
2.6 A GRAMMAR, A PATCHWORK

The grammatical component of a theory of language is like a patchwork and the architectural features belonging to the first D or Distribution, the pieces of cloth. Take formation rules, dependent and independent levels, uni and bi-directional inter-level mapping processes, sew them all together, and the grammar is ready. These three distributional features are closely linked. Firstly, the number and type of formation rules determine the number and type of independent grammatical levels (see Figure 12). The number of extra, non-autonomous levels is the choice of a particular grammar (see Figure 16). Secondly, the nature of a given level, itself determined by the absence or presence of independent formation rules (from which it is born), determines which interfaces may be allowed for in a formalism. That is, if a grammatical level is dependent because it has been born from its own independent formation rules, then it may be activated as the target as well as as the source level of linguistic computation. If a level, however, has not been born from its own independent rules and it is therefore non-autonomous, then it may only be activated as a target but never as a source level of linguistic computation (see Tables 3-4).

In what follows, an explanation is offered, firstly, of the link between the various distributional features and, secondly, between those distributional features and a model's full architectural picture or map of grammar. Figures 28-30 show how such patchwork mechanism works for the construction of the three formalisms under study. For each of the Figures, the relation between formation rules (short, thick arrows), grammatical levels (filled boxes) and inter-level mapping processes (longer, thinner arrows between empty boxes) is shown, as well as how these behave as the inter-dependent pieces of a puzzle that constitutes the formal overview of a grammatical model of language.
Figure 28 offers the visual representation of how all distributional features add up in order to obtain a whole picture of the TGG formalism.

**Figure 28. TGG, a patchwork**

Formation rules

\[ + \]

Syntactic rules

\[ + \]

Levels

Phonological structures

Semantic structures

Syntactic structures

\[ + \]
Figure 28 illustrates that TGG has one type of independent formation rules, namely syntactic. This means that the minimum number of grammatical levels is one, also of syntactic nature. This in turn means that the maximum number of independent levels is one, syntactic level. The TGG formalism has however two further levels, a phonological and a semantic level. These
two levels, lacking their own independent formation rules, behave as non-autonomous levels (in a lighter shade). This, in turn, has consequences upon the number and nature of inter-level mapping processes. Since the syntactic level is born from its own independent formation rules and is therefore independent, it may theoretically be activated as a target as well as as a source level of linguistic computation. The phonological and semantic levels are not born from their own independent formation rules, thus they are dependent and unable to be activated as source levels of linguistic processing. As a consequence of this, no information flux can take place from the semantic and phonological levels but only into them. This in turn implies that all information flux has to take place from the remaining level, syntax, so that the interfaces syntax>semantics and syntax>phonology are activated. Now, the syntactic level could theoretically also be activated as a target level, but since neither the semantic nor the phonological level may be activated as the source level, then the syntactic one cannot possibly receive information from the other two levels as a target level of computation. Regarding the interface semantics-phonology, none of these two levels may be activated as a source level of linguistic computation, so both interfaces are formally impossible (see Tables 3 and 4).

Figure 29 shows a full picture of the PA formalism that is also obtained by a simple patchwork-like addition of formation rules, (in)dependent gramatical levels and inter-level mapping processes.

Figure 29. PA, a patchwork
Figure 29 illustrates the construction of PA as though it were a patchwork. Starting off with independent formation rules, PA has three different types of independent formation rules, namely syntactic, semantic and phonological. This means that there is a minimum number of grammatical levels, namely three, syntactic, semantic, and phonological. Since these levels are born from their own independent formation rules, they are autonomous. Now, the grammar could formalize some extra levels that would be of a dependent nature—since they would lack their own formation rules. However, PA does not add any extra, non-autonomous level. Since all three existing levels are autonomous, they may all be activated as the source and target level of linguistic computation. Indeed, all levels are actually allowed to do so in the formalism. The syntactic, semantic, and phonological levels are activated as both source and target levels of computation, all possible source-target level combinations being thus implemented: phonology > semantics, phonology > syntax, semantics > phonology, syntax > phonology, semantics > syntax, syntax > semantics. That is, all potential inter-level mapping processes are actually implemented within the model (see Tables 3 and 4). Finally, Figure 30 below illustrates the way in which the same additional, patchwork-like process with distributional features is used in order to obtain a full picture of FDG.
Figure 30. FDG, a patchwork
Figure 30 illustrates the addition of the various architectural features of Distribution that make up FDG in a patchwork manner. FDG has four different kinds of independent formation rules, namely pragmatic, semantic, morpho-syntactic, and phonological. This means that the theory must at least have four different kinds of grammatical levels, namely pragmatic, semantic, morpho-syntactic, and phonological. Since they are born from their own independent formation rules, all four levels are autonomous. The theory does not account for any other level than for these four autonomous ones, thus the number of non-autonomous levels is 0. Since they are all independent, they could all theoretically be activated as the source as well as the target level of linguistic computation. All four levels are indeed activated as the source and as the target level of different inter-level mapping processes. Implemented top-down mapping processes are, for hierarchical relations within the formalism’s representations: pragmatics > semantics, pragmatics > morpho-syntax, pragmatics > phonology, semantics > morpho-syntax,
semantics > phonology, morpho-syntax > phonology. As far as bottom-up non-hierarchical relations are concerned, observe that not all potential interface processes are implemented within the model but only those involving two adjoining levels: phonology > morpho-syntax, morpho-syntax > semantics, syntax > pragmatics (see Tables 3 and 4).

2.7 COMPARING PATCHWORKS

2.7.1 INTRODUCTION

In the previous section it has been argued that a visual representation of a grammatical model can be obtained by adding the various architectural features categorized under the label Distribution in a patchwork-like manner. This section sets off to compare the patchworks that obtain for TGG, PA and FDG, i.e. the choices which each of the three theories make as to their distributional features. Table 5 below offers an overview of all architectural features analyzed in the preceding sections and classified as distributional features: formation rules (number and type), levels (number and type), and inter-level mapping processes (number and type). Levels are subdivided into autonomous and non-autonomous ones, and mapping processes according to their uni- or bi-directionality.

In what follows, a comparison of distributional features is offered for TGG, PA and FDG. Firstly, TGG is compared to PA. Secondly, TGG is compared to FDG. Finally, PA is compared to FDG. For all Figures given, dotted lines indicate a shared feature between the two models under comparison. A cross indicates that a given feature that is implemented by one model is not permitted by the other model. When comparing TGG with FDG and PA with FDG, there are features that TGG and PA allow for which FDG forbids, and vice versa. In order to make it easy to identify which model forbids what, a lighter shade is used for those features which TGG and PA forbid and
of which FDG makes use, and a darker shade is used for those features which FDG forbids and of which TGG and PA make use.

Table 5. Comparing patchworks

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Whereby FR: independent formation rules within grammatical component
2.7.2 TGG vs. PA

Figure 31 illustrates the architectural features shared by TGG and PA and those in which they differ. TGG and PA share several distributional features. Firstly, regarding formation rules, both models possess independent syntactic formation rules and, therefore, an independent syntactic level. As a consequence, both theories share an autonomous syntax. Another common distributional feature regarding levels is the presence of two other levels, namely one semantic and one phonological level, though their autonomy status differs. As far as inter-level mapping processes are concerned, the interfaces syntax-semantics and syntax-phonology appear in both formalisms, although their directionality is also different.

Regarding the differences between TGG and PA, and starting off with formation rules, it is to be noted that TGG only has one set of independent formation rules, syntactic, while PA has three sets of independent formation rules. These are syntactic, semantic, and phonological. Non-dotted lines indicate that this is no shared feature. Crosses indicate that TGG forbids the presence of independent semantic and phonological formation rules. Regarding levels of representation, a subsequent difference is that, although both models represent the same number and type of levels (three, syntactic, semantic and phonological), their autonomy status is different. Whereas in TGG both the semantic level and the phonological level are dependent upon syntax, in PA they are independent (as the syntactic level is). A consequence of the former regarding inter-level mapping processes is that, whereas in TGG only the syntactic component is a theoretically potential source and target
of interface processes (since it is autonomous), in PA all three levels (the three being autonomous) can be both source and target levels of linguistic computation. This is clearly seen in Figure 31 below, whereby crosses upon the interfaces semantics $\langle \rangle$ phonology show that none of the directions of such mapping processes (allowed for in PA) are allowed for by TGG. Regarding the interface syntax-phonology, the direction syntax $\rangle$ phonology is allowed for by both TGG and PA, although the direction phonology $\rangle$ syntax is only allowed for by PA. This is so, since PA represents an independent phonological level from which interface processes can be born, whereas TGG represents a dependent phonological level from which no mapping processes can take place. This is why such process appears crossed. The same can be said for the interface semantics-syntax. Note that the arrow marking the mapping process with direction semantics $\rangle$ syntax is crossed for TGG. This is so, similarly, because TGG represents a non-autonomous semantic level from which no mapping processes can take place. TGG represents therefore the syntactocentric position that assumes that “everything begins with syntax” in the model whereas PA represents “a radical dethronement of syntax from its ruling position” (Burling 2003).

Figure 31. TGG vs. PA
2.7.3 TGG vs. FDG

Figure 32 below illustrates the architectural features shared by TGG and FDG and those in which they differ. TGG and FDG share some distributional features. Firstly, both TGG and FDG possess independent syntactic formation rules, which means that they both argue for an independent syntactic level. A further similarity is that both models also share the existence of one semantic and one phonological level, although their autonomy status is different. As to inter-level mapping processes, note that only one is represented with a dotted line, since it is only the interface syntax>phonology that is shared by TGG and FDG.

Regarding differences between TGG and FDG, FDG possesses four types of independent formation rules (pragmatic, semantic, syntactic and phonological) whereas TGG possesses only one type (syntactic). This leads to further differences regarding grammatical levels. Firstly, whereas FDG shows four independent grammatical levels corresponding to the four different types of independent formation rules (pragmatic, syntactic, semantic, and phonological), TGG possesses only one independent grammatical level (syntactic). Secondly, the presence of independent pragmatic rules in FDG also leads to the creation of an independent pragmatic level that is not formalized in TGG. Finally, regarding the semantic and phonological levels, and although both models account for them, the way in which they do so is different and is also a consequence of the number and type of independent formation rules. Whereas in FDG they are born from their own independent formation rules (thus they are independent), TGG possesses no independent semantic or phonological rules (thus they are dependent upon the sole independent grammatical level, the syntactic level). This means that arguably semantic or phonological phenomena will have to be accounted for first of all within the syntactic level. Thirdly, regarding inter-level mapping processes, only the interface syntax > phonology is shared by both models. Note that, although an interface syntax >
Since TGG only possesses one independent grammatical level, the syntactic one, all mapping processes need be born from it (syntax > semantics, syntax > phonology), the syntactic level thus being the only potential source level of computation. This means that the interfaces semantics > syntax, phonology > syntax and semantics > phonology that are accounted for within FDG are not formalized in TGG. Finally, all interface processes born from the pragmatic level present in FDG are crossed on a lighter shade, since TGG possesses no such level.

Although semantics is present in both formalisms, its nature is different in TGG and FDG. FDG distinguishes between hierarchical and non-hierarchical interface relations within the model, and these have therefore been considered as belonging to two different distributional features: hierarchical inter-level mapping processes (to the left of formation rules in Figure 32 below) and non-hierarchical processes (to the right of the model in Figure 32 below). Since the syntax > semantics interface in FDG is of a non-hierarchical nature and in TGG of a hierarchical one, a darker cross indicates FDG’s lack of a hierarchical syntax > semantics interface whereas a lighter cross indicates TGG’s lack of a non-hierarchical syntax > semantics interface (since it lacks any kind of distinction between inter-level mapping processes). Note that none of the non-hierarchical inter-level mapping processes represented by FDG is represented by TGG. Note also that not all potential processes are represented within the former but only those ones that link two immediately subsequent levels.

2.7.4 PA vs. FDG

Figure 33 below illustrates the architectural features shared by PA and FDG and those in which they differ. PA and FDG share several distributional features. Firstly, both PA and FDG possess independent syntactic, semantic, and phonological formation rules. This means that they both possess independent syntactic,
semantic, and phonological grammatical levels that may potentially be activated as both the source and target level of linguistic computation. Regarding inter-level mapping processes, several interfaces are shared: syntax-semantics (both directions)\(^8\), syntax-phonology (both directions) and semantics > phonology.

Regarding the differences between FDG and PA, FDG possesses, altogether with independent semantic, morpho-syntactic and phonological rules, independent pragmatic formation rules. This means that it also advocates for and represents an independent pragmatic level. This in turn implies that the pragmatic level can be activated as a target and as a source level of linguistic computation. Regarding inter-level

\(^8\) Note that hierarchy relations in the syntax > semantics interface in PA and FDG may differ.
mapping processes, the addition of a pragmatic level amounts to adding six new potential interfaces (pragmatics \(\rightarrow\) semantics, pragmatics \(\rightarrow\) morphosyntax, pragmatics \(\rightarrow\) phonology). Note however that, whereas PA implements all potential bidirectional interfaces that its posited levels allow for (syntax \(\rightarrow\) semantics, syntax \(\rightarrow\) phonology, semantics \(\rightarrow\) phonology), FDG does not. This is so, because the model imposes a restriction as to the distance between levels involved in the bottom-up mapping processes such that no interfaces are allowed for whenever the two levels involved are not two immediate ones. Accordingly, the following bottom-up, non-hierarchical processes are not allowed for: phonology>semantics, phonology>pragmatics, and syntax>pragmatics. Since PA lacks a pragmatic level, the only difference between the two models regarding the latter processes is the presence of the interface phonology>semantics in PA and its absence in FDG.

**Figure 33. PA vs. FDG**
2.8 SUMMARY

In this chapter, I have introduced the concept of Distribution as a model’s layout or map of grammar and applied it to TGG, PA and FDG. I have further analyzed the set of architectural features comprised within this first architectural dimension, Distribution, that together with Derivation and Direction account for the 3D lay-motif of this work. In particular, I have started with an analysis of the distributional features that make up the grammar of language, namely formation rules, dependent and independent levels of representation, and uni and bi-directional inter-level mapping processes. These I have discussed firstly from a general perspective and then with regard to TGG, PA and FDG. After considering each of these features separately, I have discussed the way in which they relate to each other and add up in order to make up a model’s full picture of grammar in a patchwork-like fashion. Finally, I have compared TGG, PA and FDG regarding all above-mentioned distributional features.