# Syntax in Performance: Minimalist Derivation in the Late Assignment of Syntax Theory*

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## 1. Introduction

This paper presents an account of how Minimalist derivation (as described in Chomsky 1995) can be embedded in a model of comprehension, the Late Assignment of Syntax Theory (LAST) model (Townsend & Bever, 2001). The issues addressed concern the interface between the first step of the LAST model, in which heuristic "pseudo-syntactic" strategies apply to the utterance, and the second step, Minimalist derivation. Two questions about the interface are addressed: 1) How are features in the numeration needed to begin a Minimalist derivation chosen? 2) What dictates which lexical and functional heads Merge in the derivation? Chomsky (1995:226-227) claims that we do not need to ask either of these questions. I discuss his reasons in sections 4 and 5. I argue that we can and should answer these questions in a workable comprehension model. In response to the first question, I demonstrate how pseudo-syntactic strategies applied to the surface form of the utterance determine the features in the numeration. In response to the second question, I discuss how pseudo-syntactic strategies combined with subcategorization information from the lexicon determine which items Merge in the derivation.

In section 2, I briefly summarize the LAST model of comprehension. In section 3, I review the basics of Minimalist derivation. Section 4 focuses on how features enter the numeration, and section 5 addresses how pseudo-syntactic strategies and subcategorization information direct the Merge operation.

## 2. The LAST Model of Comprehension

The LAST model (Townsend & Bever, 2001) is a three step "analysis by synthesis" model of sentence comprehension. The first step, "pseudo-syntax", involves applying heuristic strategies to the surface form of the utterance. The second step is a grammatical derivation. The third step is a comparison between the phonological output of the grammatical derivation and the initial input, the surface form.

In the first step, pseudo-syntactic strategies based on statistical properties of the surface form of language apply passively to the input. Three examples[1] of pseudo-syntactic strategies are given in (1) below.

(1) Some pseudo-syntactic strategies

- Word recognition: The surface input (the short term memory representation of the utterance) is broken down into words that match up with entries in the lexicon.

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[1] Only three pseudo-syntactic strategies are mentioned; this list is not meant to be exhaustive.

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- Phrase segregation: The surface input is broken down into phrases, especially by the identification of function words that typically occur at the edge of a phrase. For example, Determiner phrases (DPs) or Noun Phrases (NPs) may be identified by an initial[2] determiner, such as *the*. Prepositional Phrases (PPs) may be identified by an initial preposition, such as *for* or *of*.

- Assigning a configurational syntactic structure and a likely conceptual interpretation: A preliminary guess about argument structure and thematic roles is made by identifying canonical sentence patterns. For example, the sequence *NP Verb NP* (henceforth referred to as the NVN pattern) most often corresponds to the conceptual structure *agent action patient*.

The preliminary conceptual interpretation revealed through the pseudo-syntax provides an initial representation of the meaning of the utterance. The comprehender may access this meaning.

I assume that the second step of the model, the grammatical derivation, is (mostly) as described in The Minimalist Program (Chomsky 1995). Townsend and Bever (2001) discuss the Minimalist Program as a kind of grammatical derivation that could occur in the second step of their model, but they also say that the LAST model is compatible with other syntactic theories.

The input that a Minimalist derivation begins with is called the numeration. The numeration consists of lexical items, each of which is associated with phonological, semantic, and syntactic features.[3] In section 4, I explain how the pseudo-syntactic strategies described in (1) above select which features are included in the numeration.

The second step of the LAST model has two outputs. One is called Phonological Form (PF), and the other is called Logical Form (LF). PF is a representation of the pronounced surface structure. LF is a representation of the utterance's meaning. In the LAST model, the first representation of the utterance's meaning is provided by the pseudo-syntactic strategies. The LF representation gives the comprehender a second and possibly more developed representation of the utterance's meaning.

The third step of the LAST model, the "comparator", compares the PF output of the Minimalist derivation to the initial surface representation of the utterance. If they match, comprehension has been successfully completed. If they do not match, pseudo-syntactic strategies must apply to the initial surface form again, and another grammatical derivation will follow. The three steps of the model will repeat until the comparator finds a successful match between the initial input and the PF representation.

### 3. The Basics of Minimalist Derivation

The model of a Minimalist derivation (Chomsky 1995) which will be explained in the following paragraphs is depicted in (2) below.

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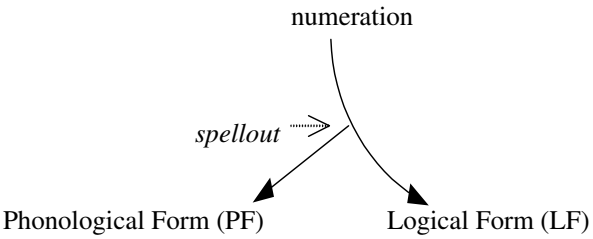
[2] Determiners and prepositions typically begin Determiner Phrases and Prepositional Phrases in English. Of course, in other languages, the statistical patterns and hence the pseudo-syntactic strategies may differ. For example, in a language with postpositions, a Postpositional Phrase will be identified by the postposition at its right edge.

[3] The numeration consists of lexical items with phonological, semantic, and syntactic features in Chomsky's (1995) version of Minimalism. In another popular version of Minimalist theory, Distributed Morphology (Halle & Marantz 1993, Harley & Noyer 1999), the numeration consists of syntactic features only (no phonological or non-formal semantic features), and the features are not grouped as lexical items.

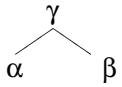
(2) The "T-model" (or "Λ-model") of the Minimalist Program




As mentioned in section 2 above, a Chomskyan Minimalist derivation starts out with the numeration, an inventory of items from the lexicon that make up an utterance. Syntactic, semantic, and phonological features are associated with each lexical item.

The sentence is derived through two basic operations: Merge and Move. Merge, defined in (3) below, joins two linguistic units[4] and their associated features together.

(3) Merge (Chomsky 1995:226): Given any two structures α and β in Σ, project a new node γ which dominates both:




The Merge operation in (3) above is elegant in its simplicity; however, without any constraints on which structures can be Merged, the operation is too powerful. Proposed constraints on which structures can be Merged and arguments for why they are needed are discussed in section 5.

Once a lexical item with its features has been Merged with the structure being derived, it is a node in what may be considered a tree. Specifically, a lexical item is associated with a node referred to as a "head". Other nodes in the tree, such as the one indicated by γ in (3) above, are not heads. Nodes in the tree may be moved. Movement occurs in order to Check features, as described in (4).

(4) Check: Compare two value-specifications A, B for the same feature F. If A and B are identical, delete them.

It is apparent from the definition of Check that Checking succeeds when two linguistic units have the same value-specifications for the same feature. This usually occurs because in addition to lexical (content) heads, there are also functional heads, which often have no phonological features (they are often unpronounced). For example, if a noun phrase, such as *the horse*, has the feature [Accusative], the numeration will also include a functional head with the feature [Accusative].

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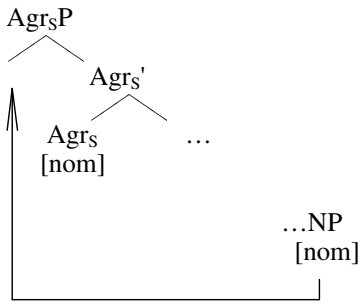
[4] The items that may be Merged, as defined in (3) are lexical (content) heads and functional heads. Lexical heads are morphemes or words that have a meaning and are generally always pronounced. Functional heads have a syntactic function, carry no meaning, and are often unpronounced. I consider both of these to be stored in the long term memory of the language user. I see no reason why functional heads (such as $Agr_s$, which bears the Nominative feature) should not be stored in the lexicon. The lexical heads and functional heads could be thought of as stored in separate "bins".

Checking occurs when two features occur in the same phrasal projection. For example, [Nominative] is checked when a Noun Phrase with the feature [Nominative] moves into the Specifier position of $Agr_SP$,[5] as shown in (5) below.

(5)




Movement occurs through two sub-operations, Copy, defined in (6) below, and Delete, defined in (7) below.

(6) Copy (Chomsky 1995:252): Given α in Σ, select β, where β is a subtree of α. Copy β into Σ, and Merge α and the new β.

(7) Delete (Chomsky 1995:202): Given α in Σ, select β, where β is a subtree of α. Delete β if the features of β are redundant.

All syntactic features must be Checked and deleted, as described in the definition of Check in (4), before the point marked "Spellout" in the model shown in (2) above. Spellout is the point in the derivation where phonological features are sent to the level of Phonological Form (PF). At this point, if any syntactic features have not been deleted by the Check operation, the derivation "crashes". In other words, in any grammatical sentence of a language, all syntactic features will have been checked by the Spellout point.

Non-syntactic semantic features may be further moved and checked after the Spellout point to yield the Logical Form (LF) representation of the sentence. At LF, the meaning of the sentence is represented.

**4. The Interface between Pseudo-syntax and Minimalist Derivation, Part 1: How Pseudo-syntactic Strategies Determine Which Features Enter the Numeration**

Chomsky (1995:227) says that we do not need to ask how the numeration is formed. He says this is like asking "a theory of the mechanisms of vision or motor coordination (to) explain why someone chooses to look at a sunset or reach for a banana." He acknowledges that "the problem of choice of action is real, and largely mysterious, but does not arise within the narrow study of mechanisms." This argument may be tenable for a theory of competence or of production. The LAST model, as I am concerned with it here, is a model of comprehension. We do not want Minimalist derivation to derive all (or most) of the grammatical sentences in the language before it happens by

5 The label $Agr_sP$ is mnemonic for "subject agreement phrase".

chance to output a Phonological Form that matches with the input surface sentence. The LAST model can and should account for where the input to the Minimalist derivation comes from.

Here, I explain how the first step of the LAST model, pseudo-syntax, provides the needed input. As explained in section 3 above, the input to a Minimalist derivation, the numeration, contains the lexical items (bundles of phonological, semantic, and syntactic features) that make up an utterance. An example of lexical items in the numeration for the sentence in (8) is given in (9) below. Each lexical item is represented as a list of its features. Separate lexical items are delimited by semicolons. The number 1 near the end is an index that specifies the number of times that the lexical item is used in the utterance (following Chomsky 1995:225).

(8) Sparta attacked Athens.[6]

(9) {<phonological: [spartə],[7] syntactic: [Nominative], semantic: [definite],[8] .., 1>;
<phonological: [ətækt],[9] syntactic: [Past], semantic:.., 1>;
<phonological: [æθɳz], syntactic: [Accusative], semantic: [definite], .., 1>}

Pseudo-syntactic strategies are critical in forming a numeration, such as the one in (9) above. After the strategy of word segmentation applies, the phonological, semantic, and syntactic (past tense, for example) features of activated lexical entries enter the numeration. Some syntactic features, such as [Nominative] and [Accusative], cannot be stored in the lexical entry, because in English most noun phrases (NPs), such as *Sparta,* can have either nominative or accusative case. The strategy of assigning a preliminary argument structure based on canonical sentence patterns, explained in (1) above, can be used to determine whether an NP has the feature [Nominative] or the feature [Accusative]. If the preliminary argument structure is *agent action patient*, the *agent* NP will be associated with the feature [Nominative], the feature that syntactic subjects must bear. The *patient* NP will be associated with the feature [Accusative], the feature that syntactic direct objects must bear. The pseudo-syntactic strategy of phrase segregation is used to determine that [Accusative] must be associated with an NP following a preposition.

Recall from the review of Minimalism in section 3 that all syntactic features must be Checked with another instance of the same feature before Spellout. This suggests that the numeration in (9) above does not include all of the features that must occur in a grammatical sentence. The Nominative feature on *Sparta* must be Checked with a functional head bearing the feature Nominative. The Past tense feature on *attacked* must be Checked with a functional head bearing the feature Past. The Accusative feature on *Athens* must be Checked with a functional head bearing the feature Accusative. In English, these functional heads are unpronounced. Therefore, the numeration for the sentence in (8) above must be as in (10) below.

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6 The example sentence in (8) is from Townsend and Bever (2001).

7 Here I give a phonological representation of the lexical items to show that phonology is represented in the numeration. The phonology actually should be represented through phonological features, such as [strident], [sonorant], etc.

8 Identifying all of the semantic features that specify the meaning of a lexical item is outside the scope of this paper. The semantic features included in the numeration (both formal and non-formal) should exactly specify the meaning of the word (except in Distributed Morphology, see footnote 2).

9 In the Minimalist Program, words enter the numeration fully inflected (Chomsky 1995).

(10) {<phonological: [spartə], syntactic: [Nominative], semantic: [definite], …, 1>;
<phonological: [ətækt], syntactic: [Past], semantic: [telic], …, 1>;
<phonological: [æθ̩nz], syntactic: [Accusative], semantic: [definite], …, 1>;
<phonological: [∅], syntactic: [Nominative], 1>;
<phonological: [∅], syntactic: [Past], 1>;
<phonological: [∅], syntactic: [Accusative], 1>}

The functional head with the feature [Nominative] in the numeration in (10) above is usually referred to as $Agr_S$. The functional head with the feature [Past] is referred to as Tense. The functional head with the feature [Accusative] is referred to as $Agr_O$ (Chomsky 1995:121).

The only viable account of how these functional heads enter into the numeration is that each one is selected when the lexical item with the matching feature is selected. For example, when *Sparta* with the feature Nominative is selected, $Agr_S$ will also be selected. When *Athens* with the feature Accusative is selected, $Agr_O$ will also be selected. All complete grammatical sentences must have Tense, so the Tense functional head should always be in the numeration. However, the selection of the feature Past (rather than Present or Future) must be dictated by the selection of the lexical item *attacked* with its Past feature.

In this section, I have explained how the pseudo-syntactic strategies of the LAST model determine which lexical heads, functional heads, and features enter a Minimalist numeration based on properties of the surface form of the utterance.

In the next section, I consider a second issue about the interface between pseudo-syntax and Minimalist derivation: how information provided by pseudo-syntactic strategies directs which items Merge.

## 5. The Interface between Pseudo-syntax and Minimalist Derivation, Part 2: Argument Structure, Subcategorization, and Constraints on Merge

Here I restate and discuss a claim made in section 3: the Merge operation is too powerful. I begin by addressing Chomsky's claim that we do not need to ask how Merge [10] is directed. I demonstrate that Merge unconstrained makes NP movement unnecessary in sentences that have been shown to have NP-traces in a psycholinguistic experiment (Sanz 1996). I then discuss how pseudo-syntactic strategies and subcategorization information provide the necessary direction for the Merge operation.

Chomsky (1995:226) says that asking how Merge can go wrong is like asking 'proof theory (to be) concerned with a sequence of lines that does not satisfy the formal conditions that define 'proof', or a chess-playing algorithm with evaluation of improper moves." The problem is that the Merge operation, as defined in (3) above, can Merge any two units. A theory of language competence (what Chomsky intends Minimalism to be) can allow derivations that Merge inappropriate units as long as the derivation will be ruled out later. Such a filtering mechanism could not be used in the LAST model, because the comprehension process would have to repeat until the derivation happened by chance to generate the correct PF representation. (Recall that the third step involves comparing the PF output of the Minimalist derivation to the initial surface form of the utterance held in memory. If the comparison fails, the entire process must repeat.) It is more psychologically plausible that the Merge operation

[10] Chomsky does propose the operation Select which formally determines which item Merges with the structure being built. Select is defined as follows: "Select a lexical item from the numeration, reduce its index by 1, and introduce it into the derivation" (Chomsky 1995:226). Since Select can choose any item in the numeration, it does not solve the problem that I address in this section. Throughout this paper, I consider Select to be a suboperation of Merge. In other words, I use the term "Merge" to mean "Select then Merge".

is directed or constrained. I give an example of how Merge undirected can go wrong below. Then I explain how pseudo-syntactic strategies and subcategorization information can prevent this from happening.

Consider the unaccusative Spanish sentence in (11) below.

(11) Mi hermano llegó.[11]
My brother arrived.

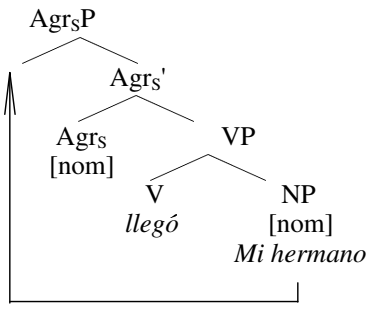
Sanz (1996) provided psycholinguistic evidence that unaccusative verbs such as *llegó* 'arrived' have an internal argument which moves and leaves an NP-trace in its direct object position (following the verb). The evidence is from a priming study: subjects are faster to say that *bonita* 'beautiful' occurred in the sentence immediately after being presented with (12b) below than after (12a). This finding is interpreted as evidence for an NP-trace of *La bonita criada* following the unaccusative verb *desapareció* 'disappeared'. No NP-trace should occur following the unergative verb *lloró* 'cried'.

(12) a. La bonita criada que limpiaba la posada lloró con tristeza.
The beautiful maid who cleaned at the inn cried with sadness.

b. La bonita criada que limpiaba la posada desapareció con tristeza.
The beautiful maid who cleaned at the inn disappeared with sadness.

According to Burzio (1986) and others, the NP must move in order to receive nominative case, because the unaccusative verb cannot assign accusative case. Under Minimalism, this means that the NP, e.g. *Mi hermano* in (11) above, has the feature [Nominative] in the numeration. In order to Check the feature [Nominative], the NP in (11), *Mi hermano,* must move to the subject position (the specifier position of $Agr_SP$, according to Chomsky 1995:121). The matching Nominative features may be Checked, as defined in (4) above, when one is in the specifier position of the projection headed by the matching feature. For example, in (13) below, the functional head $Agr_S$ has the feature [Nominative]. The NP, *Mi hermano*, Checks this feature when it moves to the specifier position of $Agr_SP$.

(13)




[11] This example sentence is borrowed from Sanz 1996.

Now consider how the derivation could occur if Merge was undirected: nothing would dictate that the NP *Mi hermano* should Merge with the verb *llegó.* The NP could Merge directly with $Agr_S'$ . If this were the case, there would be no NP-trace following *llegó*, but Sanz's results show that there is.

Here, I discuss two forces that dictate which items Merge: pseudo-syntactic strategies and subcategorization information from the lexicon.

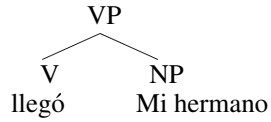
First, reconsider the sentence in (11), repeated as (14) below. According to Sanz (1996), Burzio (1986), and others, subcategorization information from the lexicon specifies that the verb *llegó* 'arrived' has an internal argument (direct object) but not an external argument (subject). This subcategorization information can be represented in the numeration as shown in (15) below.

(14) Mi hermano llegó.
My brother arrived.

(15) {<llegó, phon: [yego], syn: [Past, Telic], sem..., subcat: (Ø[NP]), 1>;...}

The subcategorization frame (Ø[NP]) indicates that the verb *llegó* has ∅ (nothing) for an external argument and an NP for an internal argument. This information can be used to determine that *llegó* should Merge with an NP on its right, as shown in (16) below.

(16)




From (16), the derivation will continue as in (13) above. *Mi hermano* will move to the left of the verb *llegó*, leaving the NP-trace that Sanz (1996) provides psycholinguistic evidence for.

Thus far, I have explained how subcategorization information from the lexicon directs Merge. Next, I show how the pseudo-syntactic strategy of identifying canonical sentence patterns also directs Merge.

Reconsider the sentence in (7), repeated as (17) below.

(17) Sparta attacked Athens.

Subcategorization information in the entry of the verb *attacked* reveals that *attacked* may have both an internal and an external argument, as shown in the numeration in (18).

(18) {<phonological: [ətækt], syntactic: [Past], semantic:…, subcat(NP[NP]), (NP[ ∅]),[12] 1>;
<phonological: [æθn̩z], syntactic: [Accusative], semantic: [definite], …, 1>;
<phonological: [∅], syntactic: [Nominative], 1>;
<phonological: [∅], syntactic: [Past], 1>;
<phonological: [∅], syntactic: [Accusative], 1>}

[12] Note that *attacked* may also be intransitive, as in *Sparta attacked.*

The subcategorization information does not specify which NP, *Sparta* or *Athens*, should be merged as the internal argument (direct object) of the verb *attacked.* The pseudo-syntactic strategy of identifying the canonical NVN sentence pattern, described in (1) above, can inform the Merge operation, so that *Athens* will be the internal argument and *Sparta* will be the external argument.

The final case that I want to consider is one in which pseudo-syntactic strategies misdirect the Merge operation. Consider the frequently discussed reduced relative clause sentence in (19) below.

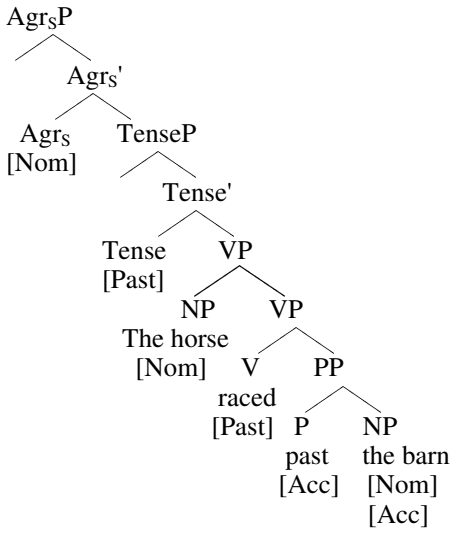
(19) The horse raced past the barn fell.

The pseudo-syntactic NV(N) strategy would assign *The horse* to be the subject of *raced* and would likely also assign *the barn* to be the subject of *fell*. This would cause *The horse* and *the barn* to be associated with the feature [Nominative]. The pseudo-syntactic strategy of phrase segregation described in (1) above would associate *the barn* with the feature [Accusative] also, since it follows a preposition, *past.* The pseudo-syntactic strategies and subcategorization information would give us the numeration in (20) below.

(20) {<*The*, phon: [ðə], syn: [Definite], sem…, subcat ([NP]), 2>;
<*horse*, phon: [hors], syn: [Definite, Nominative], sem…, 1>;
<*raced*, phon: [resd], syn: [Past], sem…, subcat (NP[ ∅]), (NP[NP]), 1>;
<*past*, phon: [pæst], syn: [Accusative]…, sem…, subcat ([NP]), 1>;
<*barn*, phon: [barn], syn: [Definite, Nominative, Accusative], sem…, 1>;
<*fell*, phon: [fɛl], syn: [Past], sem…, subcat (NP[ ∅]), 1>;
<Tense, phon: [∅], syn: [Past]>;
<$Agr_S$, phon: [∅], syn: [Nominative], 2>;

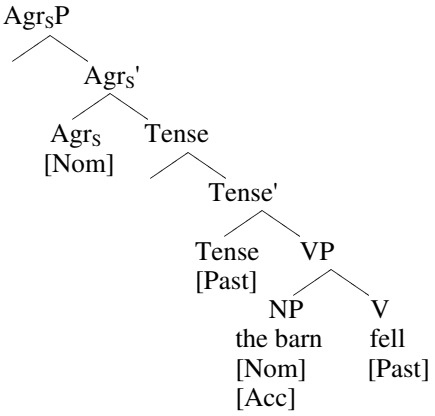
Pseudo-syntactic strategies and subcategorization information would direct Merge to produce structures like the ones in (21) and (22) below.

(21)




A grammatical derivation cannot result from the numeration in (20). The derivation may fail when subcategorization prevents *fell* from being integrated. Alternatively, *the barn fell* could be merged as in (22), but the derivation will still fail because the structures in (21) and (22) are incompatible. The structures in (21) and (22) cannot be Merged together, because subcategorization information does not allow it. The preposition, *past*, cannot take the sentence, *the barn fell*, as an argument.

(22)




There is one other issue with respect to directing Merge that needs to be discussed. In most of the syntax literature, the hierarchical structure of phrasal categories is considered constant at least within a language if not universally. For example, an ordering that is frequently assumed is, from top to bottom, IP, $Agr_SP$, TenseP, $Agr_OP$, VP (Chomsky 1995:120). This hierarchical structure is usually proposed in order to account for word order in a language. The Merge operation is powerful enough that it could have combined the phrasal categories in any order. If Merge is undirected, there is no reason for the operation Move to occur ever, because lexical items can Merge directly into the positions where their features are checked. The discussion surrounding the derivation in (13) above provides an example of this problem. One way to account for this ordering is through subcategorization information

in the lexicon. For example, if $Agr_S$ is stored in the lexicon (or somewhere in the knowledge of the language user, as discussed in footnote 4), it can be stored with the specification that $Agr_S$ subcategorizes for TenseP.

In this section, I have argued that the Merge operation needs to be constrained or directed, and I have proposed that pseudo-syntactic strategies and subcategorization information provide the necessary direction.

## 6.0 Conclusion

In the previous sections, I have explained how Minimalist derivation can be embedded in a model of sentence comprehension, the LAST model. In order to explain the interface between the first step of the model, pseudo-syntax, and the second step, Minimalist derivation, I have dealt with two questions that Chomsky (1995) says need not be answered by a syntactic theory. These two questions are the following: How do lexical items, functional heads, and their features enter the numeration that begins the derivation? What determines which syntactic structures are Merged in the derivation? I have argued that these two questions should be answered if Minimalist syntax is to be embedded in a comprehension model. I have proposed that the pseudo-syntactic strategies in the first step of the LAST model, in conjunction with information from the lexicon, can provide the items and features that enter the numeration and can direct the operation Merge.

More broadly, this paper demonstrates that the LAST model is aptly suited for having a Minimalist grammar embedded in it. The pseudo-syntactic strategies provide the exact information that the grammatical derivation needs to begin.

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