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Clausal Arguments and Peripheries in ASD-STE100: The Parsing of Subordination in ARTEMIS [1]

La cláusula argumental y periférica en ASD-STE100: el parseado de la subordinación en ARTEMIS

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One of the main objectives of Natural Language Processing is the simulation of natural language understanding. Within its applications, ARTEMIS (Automatically Representing TExt Meaning via an Interlingua-Based System) is theoretically grounded in RRG, whose linking algorithm lies at the basis of our interlingua-based system. A fundamental component of ARTEMIS is the GDE module, where feature-based production rules and AVMs are stored to allow the generation of natural language expressions. Production rules for phrasal constituents, simple sentences and adverbial subordinates have already been described, but it is now turn to delve into other types of complex structures and generally contribute to the enhancement of parsing rules for clausal subordination in ARTEMIS. Bearing in mind the validation process these production rules should undergo, as well as the common problems that may arise in such parsing applications, our research will concentrate, precisely, on the analysis of these subordinate structures as found in a CNL like ASD-STE100.

Keywords: *subordination; ARTEMIS; production rules; AVMs; ASD-STE100*

Uno de los principales objetivos del procesamiento del lenguaje natural es la simulación de la comprensión del mismo. Entre sus aplicaciones, ARTEMIS se basa en el modelo teórico de la GPR, cuyo algoritmo de enlace fundamenta su proceso de parseado. Componente esencial de ARTEMIS es el módulo EDG, en donde se almacenan las reglas de producción y las MAVs, vitales para el proceso de generación de expresiones del lenguaje natural. Ya se han descrito las reglas de producción para el sintagma, la oración simple y la subordinada adverbial, pero aún quedan por desarrollar otras estructuras complejas y contribuir al enriquecimiento de las reglas de parseado para la oración subordinada en ARTEMIS. Teniendo en cuenta la validación a la que estas reglas deberán someterse, este trabajo se centra en el diseño de reglas de producción para las subordinadas detectadas en el lenguaje controlado ASD-STE100.

Palabras clave: *subordinación; ARTEMIS; reglas de producción; MAVs; ASD-STE100*

0. INTRODUCTION

One of the main objectives of our research project is the validation in the near future of the production rules that will derive from our linguistic analysis. These will be stored in the

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Grammar Development Environment (GDE module) in ARTEMIS (Automatically Representing TExt Meaning via an Interlingua-Based System). In order to do that, we have opted for studying syntactic structures as found in a controlled language, since this will necessarily provide a more constrained grammar to work with and therefore simplify the mechanisms to finally evaluate our prototype.

In this sense, we have structured this paper by first introducing and describing in section 1 the type of simplified controlled language to be used for these matters, ASD-STE100. Secondly, a summary of the most important aspects of complex sentences within Role and Reference Grammar (RRG-Van Valin & LaPolla, 1997; Van Valin, 2005) is considered, since ARTEMIS is inspired on this functionally-oriented linguistic theory. In section 3, we deal with a review of RRG's juncture-nexus combination theory and its three-layered classification of subordination: CORE, CLAUSAL and SENTENTIAL. On the other hand, ARTEMIS and FunGramKB (Functional Grammar Knowledge Base) are two of the computational resources of FUNK Lab, a virtual laboratory for natural language processing (Mairal-Usón and Cortés-Rodríguez 2017), and the influence of the four-level constructional schemata of the Lexical Constructional Model (LCM- Mairal-Usón and Ruiz de Mendoza, 2009) on both of them will be seen in section 4. It is here where we propose discarding the previous tripartite typology of subordinate structures in favor of a more computer-friendly study. Section 5 is devoted to the analysis *à la* ARTEMIS of the subordinate sentences identified in ASD-STE100. That is, we supply the GDE with the necessary tools to carry out a correct parsing of the subordinate sentences under analysis by propounding a series of Attribute Value Matrixes (AVMs) and production rules (lexical and syntactic). Finally, section 6 includes a review of the most pertinent and relevant conclusions to be further evaluated in our prototype. The Appendix 1 at the end includes a representative selection of all the different types of subordinate clauses found in ASD-STE100. These are classified into two subtypes: argumental and peripheral. Likewise, Appendix 2 is a list of the frequently used abbreviations of this paper which will help the reader to follow its line of argument.

1. CONTROLLED LANGUAGES: ASD-STE100

According to Kuhn, a controlled natural language (CNL) can be defined as "a constructed language that is based on a certain natural language, being more restrictive concerning lexicon, syntax, and/or semantics, while preserving most of its natural properties" (2014: 123). Some controlled languages may be intended to solve communication problems among humans, others to improve manual or machine translation. In particular, ASD-STE100 is a CNL developed for the readability of maintenance documentation of the Aerospace and Defence industries of Europe, to make their texts more uncomplicated and less condensed than when full English is used. Its initials stand for AeroSpace and Defence Simplified Technical English, but it is often abbreviated to STE or just Simplified English. It had its origins in 1979, even though it did not receive its current name until 2005 when AECMA (*Asociación Española de Contruction MAnagement*) merged with two other associations to form ASD. According to the authors of their website (http://www.asd-ste100.org/), the success of STE is such that even industries not related to this discipline use it beyond its original purpose thus stimulating a growing interest in academic, scientific and professional circles on the linguistic side.

The ASD-STE100 guide (January 2017 version, or Issue 7) is based on standard English, but the following restrictive general rules constrain the language at the different levels:

a. The lexical level (e.g., "Use approved words from the Dictionary only as the part of speech given").

b. The syntactic level (e.g., "You can use the "-ing" form of a verb only as a modifier in a technical name").
c. The semantic level (e.g., "Keep to the approved meaning of a word in the Dictionary. Do not use the word with any other meaning."). There is a fixed vocabulary consisting of terms common to the aerospace domain. Additionally, user-defined "Technical Names" and "Technical Verbs" can be introduced.

Consequently, these restrictions should have affected the syntax of complex sentences by largely constraining their complexity and use or frequency so as to enable an easy and correct interpretation by parsers like ARTEMIS, especially if the intention behind this is automatic translation.

2. RRG AND ENGLISH COMPLEX STRUCTURES

RRG (Van Valin & LaPolla 1997) accounts for the structure of complex sentences in terms of three types of nexus relation (see Figure 1): coordination, in which independent structures are related, and two more types in which there seems to be a certain dependency: subordination, where we have dependent structural constituents, and cosubordination where there is operator dependence.

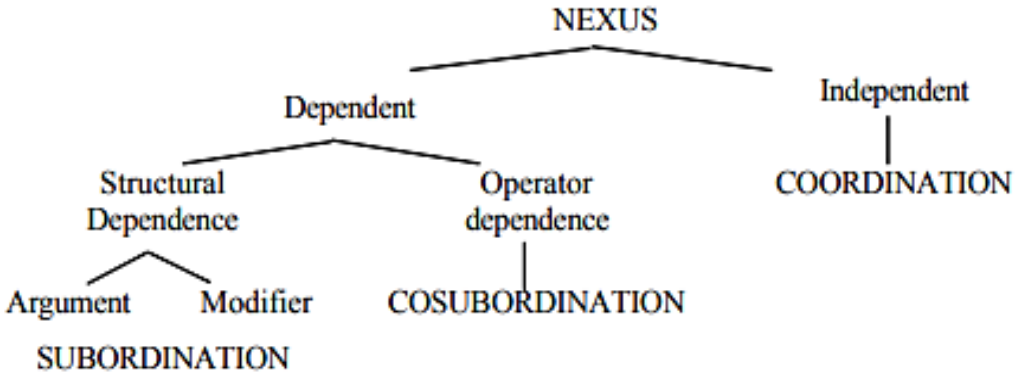

Figure 1: ***Nexus types***[2]

Each of these nexus types can be applied to each of the four levels of juncture that have been identified in RRG: the nuclear level, the core level, the clausal level and the sentential level. The latter involves the linking of whole sentences and differs from the other linkages in that not all nexus types are possible. According to Van Valin & LaPolla (1997: 469), only coordination is admitted at the sentential level, since cosubordination has no sentential operators to share and subordination has no sentential units to be embedded. However, Van Valin (2005: 192-93) claims that sentential subordination is also possible, as will be explained later on in section 3.3.

As a result of these considerations, eleven are the possible juncture-nexus combinations attested in the languages of the world, according to RRG. Out of these, only the nine types below can be found in English, since nuclear coordination and nuclear subordination have been ruled out by the founders of this grammatical model:

[2] Taken from Van Valin & LaPolla (1997: 454).

Nuclear cosubordination
Core coordination
Core cosubordination
Core subordination
Clausal coordination
Clausal cosubordination
Clausal subordination
Sentential coordination
Sentential subordination

A certain ambiguity or disparity in the description of some subordinate juncts in Van Valin & LaPolla (1997) and Van Valin (2005) needs to be elucidated at this point, so as not to render an inconsistent analysis. Such a clarification will be expounded in the following sections.

3. SUBORDINATION IN RRG

RRG characterizes subordination as a structural dependence that can be of two types: i. argumental subordination (also referred to as daughter subordination), syntactically represented by a *that*-clause that functions as either a subject or an object argument of the main verb; ii. peripheral subordination (or adverbial subordination), structurally characterized by a peripheral clause that modifies the main verb. It is within the latter, peripheral subordination, that a certain disparity has been observed.

In Van Valin & LaPolla (1997), adverbial subordination is generally regarded as a clausal subordinate juncture-nexus type. However, Van Valin (2005: 194) distinguishes between three types of peripheral subordinates:

a. Temporal clauses classified as "[…] 'ad-core subordination' where the subordinate clause is regarded as a modifier of the matrix core and therefore in the periphery$_{CORE}$".
b. Other types of adverbials except temporals (i.e., reason, concessive, conditional, …), "which express the reason or a condition for the event expressed by the clause as a whole", and consequently housed in the periphery$_{CLAUSE.}$
c. Any type of adverbial subordinate (temporal, reason, concessive, conditional) occupying the extra clausal slot labelled as Left Detached Position (LDP) and therefore concerning the sentential layer.

In the present account of RRG's subordination, we will follow Van Valin (2005) because, as shown below, it is in this volume where the author takes into consideration cases of sentential subordination, like the ones offered in 3.3 below, and those found in our own corpus (see section 5)[3].

3.1 *Core subordination*

Two nexus subtypes of CORE subordination are distinguished: CORE daughter subordination and CORE peripheral subordination. In the former, subjectless gerund structures (e.g., *Washing the car today would be a mistake*) and *that*-subject clauses (e.g., *That she arrived late shocked everyone*) are involved. However, two facts lead us to discard this first subtype of CORE

[3] Even though the analysis of adverbial subordinate cases found for ASD-STE100 in section 5 is in line with the proposals derived out of the research offered in this paper, some of them can still be regarded as good examples of RRG's sentential subordination.

subordination: on the one hand, the fact that the restrictions observed in our CNL prevent the use of subjectless gerund clauses (see section 1 above); on the other, the evidence that no examples of subject-*that* clauses have been found in the data-gathering process.

The second subtype of CORE subordination is the PERIPHERAL one, which can be illustrated with examples like the one below, where an adverbial clause in the periphery$_{CORE}$ (an Ad-CORE junct) expresses the temporal setting of the event. This is so because "the relationship of the adverbial subordinate clause to the core it modifies is the same as that of a peripheral PP modifying a core" (Van Valin 2005: 194), as illustrated in Figure 2.

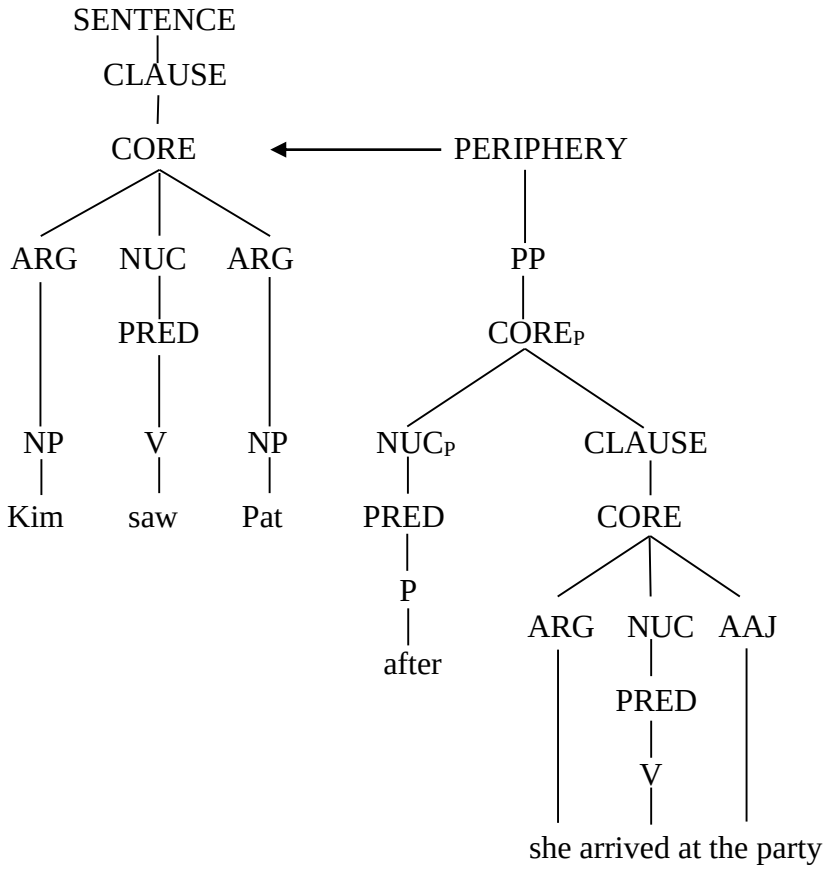

Figure 2: ***Ad-CORE subordination***

RRG includes, within Ad-CORE subordination, temporal subjectless gerund structures like *Max brushed his teeth after drinking a cup of coffee* (VanValin, 2005: 196). But as mentioned above, adverbial clauses such as these are not available in ASD-STE100 because the only *-ing* forms allowed in our controlled language are those involving the modification of a technical name (see section 1).

3.2 *Clausal subordination*

As it happens in CORE subordination, clausal juncts can be further classified into two subtypes in English, the CLAUSE daughter subordination, and the CLAUSE peripheral subtype.

The former expresses propositional attitude, cognition and indirect relations. As Van Valin (2005: 199-200) himself admits, this type of juncture is an example of a "syntax-semantics mismatch" that "violates the basic principle that arguments in the logical structure of the verb are realized as core arguments". Accordingly, in a sentence like *Kim told Pat that she will arrive at the party late*, the embedded clause *that she will arrive at the party late* is

semantically an argument of the matrix verb *told*, but syntactically it occurs outside the CORE, since in English peripheral elements cannot occur between two core elements and therefore the *that*-clause "must be outside of the clause and a daughter of the matrix clause node".

The other subtype of clausal subordination, that of adverbial clauses, is used to indicate, unlike CORE peripheral subordination, "the reason or a condition for the event expressed by the clause as a whole" (Van Valin, 2005: 194), as for example is the case of clauses introduced by conjunctions like *because*, *if*, *despite* or *although* in English.

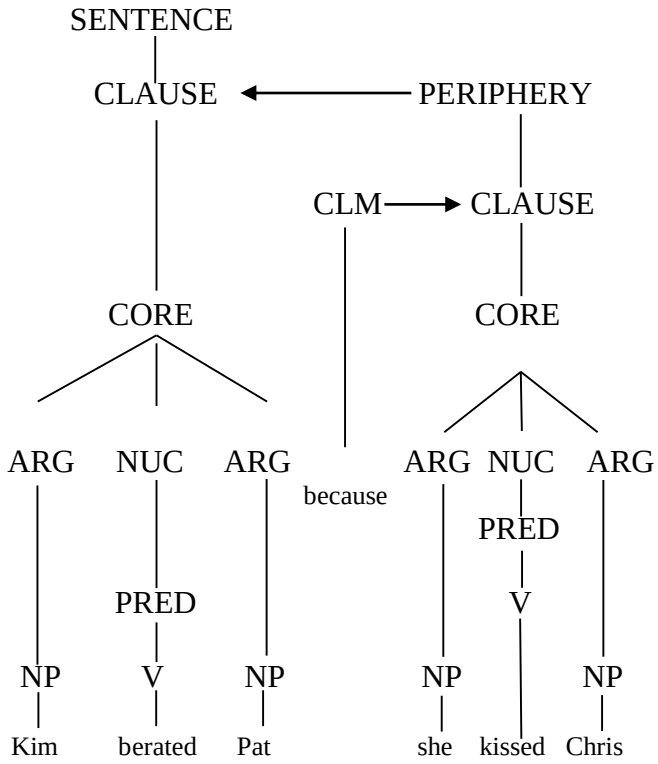

Figure 3: ***Ad-CLAUSAL subordination***

As we can see in Figures 2 and 3 above, the PERIPHERAL element in both, CORE and CLAUSE subordinate juncts, is represented marginally in RRG's tree scheme, and linked to the main hierarchical structure using an arrow. In any case, it sounds curious that the burden of distinguishing between these two junctures falls on the grammatical nature of a peripheral trigger, because in CORE subordination, a predicative preposition introduces the peripheral clause, whereas in CLAUSAL subordination it is a Clause-Linkage-Marker (or CLM) that triggers the adverbial subordinate (Van Valin, 1997: 470).

Perhaps an approach more similar to that offered in Van Valin & LaPolla (1997) would be preferred in this case in which the distinction above could hardly be justified and adopted by an interlingua-based syntactic parser like ARTEMIS. This assumption comes to be somehow reinforced in section 3.3, where a single juncture-nexus combination (sentential subordination) is proposed for both, LDPs introduced with either predicative prepositions or CLMs.

3.3 *Sentential subordination*

Sentential junctures involve the linking of whole sentences. In particular, the subordination type "involves sentences or clauses occurring in the right- or left-detached positions" (Van

Valin, 2005: 192). There are two syntactic realizations in English that can illustrate this type of juncture: the use of direct discourse complements[4], and the fronting of adverbial clauses to the LDP, a slot outside the clause but within the sentence. The following sentences extracted from VanValin (2005: 192 and 195 respectively) illustrate the second of these syntactic structures:

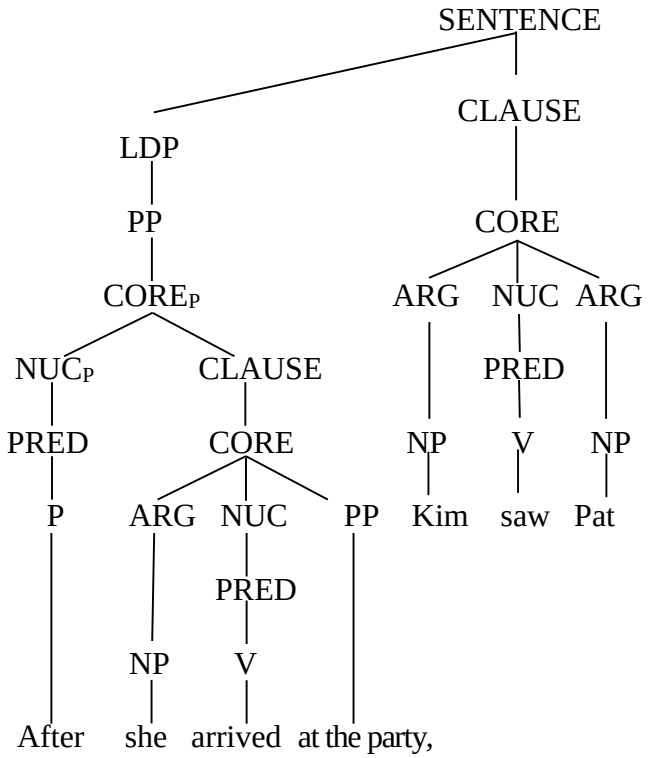

Figure 4: ***Sentential subordination with a PP in the LDP***

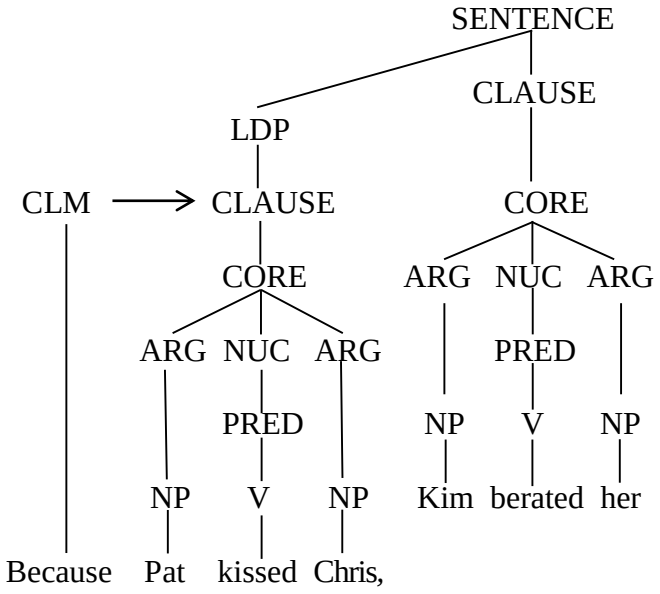

Figure 5: ***Sentential subordination with a CLM in LDP***

[4] As an example, see Van Valin & LaPolla (1997: 469): "Amy said, 'As for Sam, I saw him last week'". This type of syntactic structure is inexistent in our CNL.

In these tree diagrams, an LDP lodges both, a predicative preposition taking a clausal argument to "express the spatial or temporal setting" of the core event (Figure 4), and a subordinating conjunction that introduces an adverbial modifier (Figure 5) to indicate "the reason […] for the event expressed by the clause as a whole" (Van Valin, 2005: 194).

On the other hand, subjectless cores similar to those in section 3.1 for core subordination could also participate in these sentential junctures (*After arriving, Kim saw Pat*). For obvious reasons already mentioned in section 1, STE has no examples for this type of complementation.

4. ARTEMIS AND THE PARSING OF CLAUSAL SUBORDINATION

Within the applications designed for the simulation of natural language understanding in Natural Languge Processing (NLP), ARTEMIS follows the paradigm of unification grammars (Sag, Wasow & Bender, 2003), and unlike other trending computational resources, it is theoretically grounded in RRG whose linking algorithm lies at the basis of our interlingua-based system. This application is a prototype designed within FUNK-Lab's resources to enable the understanding of natural languages within the paradigm of RRG. In this process the knowledge base FunGramKB comes to provide ARTEMIS with a "large-scale repository of fine-grained morphosyntactic, semantic and pragmatic knowledge" on which to base an effective parsing (Periñán-Pascual & Arcas-Túnez, 2014: 181).

In ARTEMIS, powerful tools such as the CLS constructor[5], the COREL-scheme Builder[6] and the GDE module contribute to encode natural language sentences into machine-readable expressions. In particular, the GDE consists of a repository of production rules (lexical, syntactic and constructional rules) and AVMs, which facilitates the grammar building process. In it, lexical and syntactic rules for phrasal constituents, simple sentences and adverbial subordinates have already been described (Cortés-Rodríguez, 2016; Cortés-Rodríguez & Mairal-Usón, 2016; Díaz-Galán & Fumero-Pérez, 2016; Fumero-Pérez & Díaz-Galán, 2017; Martín-Díaz, 2017, 2018 and 2019), but it is now turn to delve into other types of complex structures and contribute to the enhancement of parsing rules for clausal subordination.

Production rules in ARTEMIS are computationally enriched rules derived from the original RRG's Layered Structure of the Clause (LSC). Within construction rules, a clear distinction between kernel (intransitive or kernel-1, monotransitive or kernel-2 and ditransitive or kernel-3) and non-kernel L1constructions [7] was established in Periñán-Pascual (2013). This kernel/non-kernel distinction involved two important modifications for RRG's LSC: firstly, the introduction of a new constituent in this hierarchical structure, the CONSTR-L1 node; and secondly, the subsequent redefinition of RRG's Precore slot (PrCS) position as a Preconstruction-L1-position, the PrC-L1 node "where constituents triggered by a construction can also intervene" (Cortés-Rodríguez & Mairal-Usón, 2016). Both adjustments are shown in Figure 6.

[5] A tool for the generation of a Conceptual Logical Structure (CLS).

[6] A tool to transform a CLS into a COnceptual REpresentation Language (COREL) and make ARTEMIS useful for NLP tasks.

[7] The LCM promotes this constructionist linguistic view in FunGramKB where a four-level hierarchy in its Grammaticon allows ARTEMIS to distinguish different types of constructional meaning (argumental, or L1; implicational, or L2; illocutionary, or L3; and discursive, or L4) (Mairal Usón and Ruiz de Mendoza 2009).

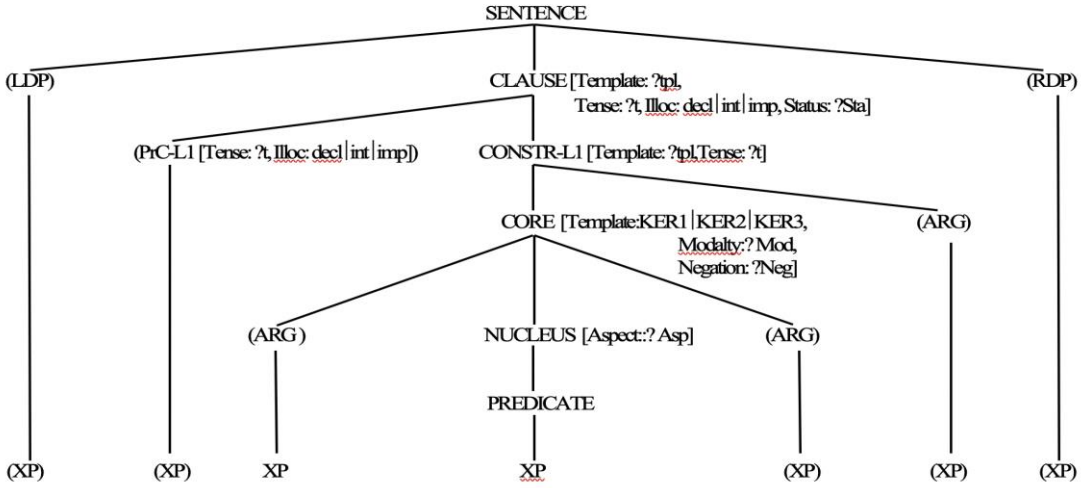

Figure 6: ***Modified LSC in ARTEMIS***

The CONSTR-L1 node for L1-constructions halfway between the CORE and the CLAUSE nodes implied that the clause was now seen as a layer configured "as one or more L1-constructions which are recursively arranged" and where "the innermost construction introduces the core, which can be modeled by other L1-constructions, typically contributing with a further argument" (Periñán-Pascual, 2013: 222). This modification also implied the redistribution of original peripheral modifiers in Van Valin (2005) to its own periphery$_{\text{L1-CONSTRUCTION}}$, as shown in Figure 7.

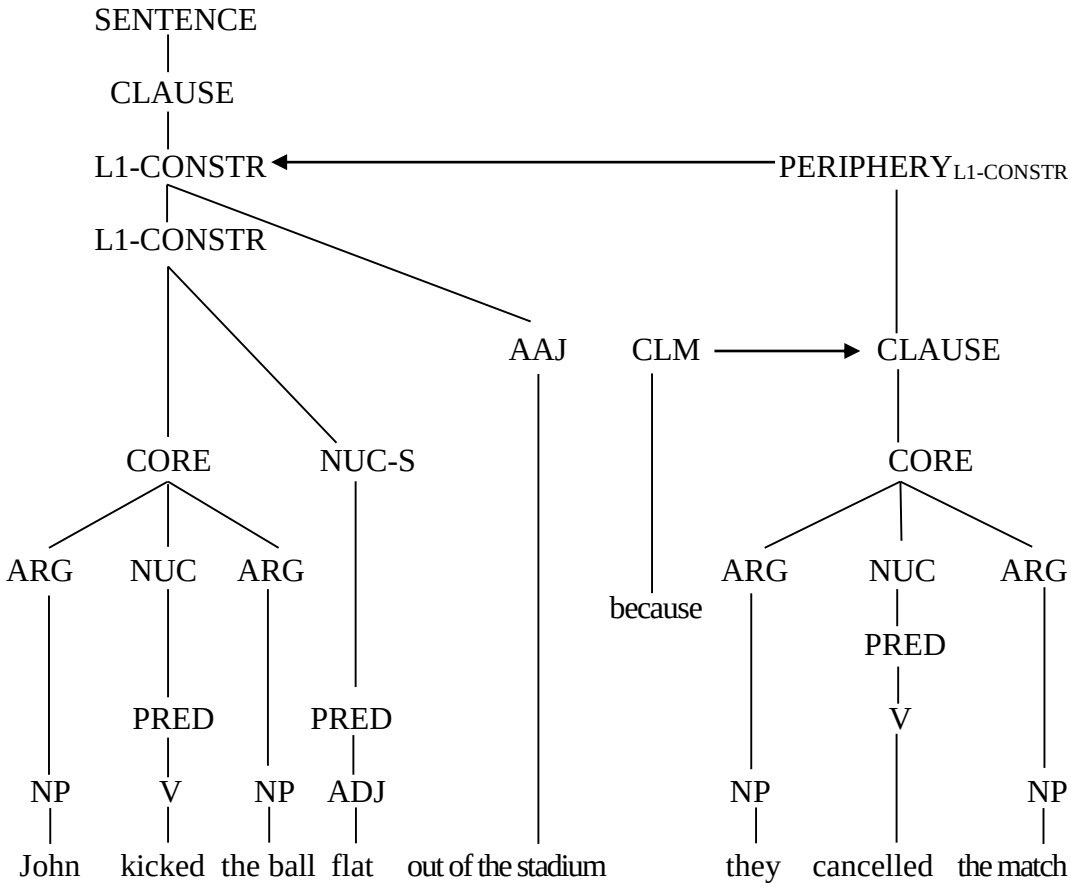

Figure 7: ***Tree-diagram of an adverbial modification of a caused-motion and resultative L1-construction (adapted from Martín-Díaz 2019)***

The sentence in Figure 7 above is further complemented by an adverbial clause in the periphery, whose optional attachment as an adjunct is represented by means of an arrow in RRG. This representation poses a dual problem for ARTEMIS: firstly, because we can infer from it that its optionality is not as relevant as to deserve the slot a structural constituent does; and secondly, because in RRG "the linear order of the core arguments and the predicate is irrelevant to the determination of whether an element is in the nucleus, core or periphery" (Van Valin & LaPolla, 1997: 32).

As a computational parsing application, ARTEMIS must follow a linearity of processing so that a tag or label can be assigned to each of the constituents in the sentence, and the machine can analyze them in a strict sequential order, as proposed in Martín-Díaz (2019). Besides, as advanced in section 3.2, the adoption of single representation for adverbial subordinate juncts that Van Valin (2005) regards as belonging to different layers could also favor this computer adaptation.

In line with this, Cortés-Rodríguez (2019) admits that the syntactic relation established between the periphery and its modified node needs redefining so as "to describe the type of dependent unit that is conjoined". In other words, the peripheral constituent in our complex structures is now reinterpreted as a clausal subordinate, because the dependent unit that modifies the L1-Construction is a clause.

This periphery has been relabeled PER-L1 in Cortés-Rodríguez & Rodríguez-Juárez (2019), where they also offer a scale of positional preferences in case several adverbial components participate of the LSC (see Figure 8).

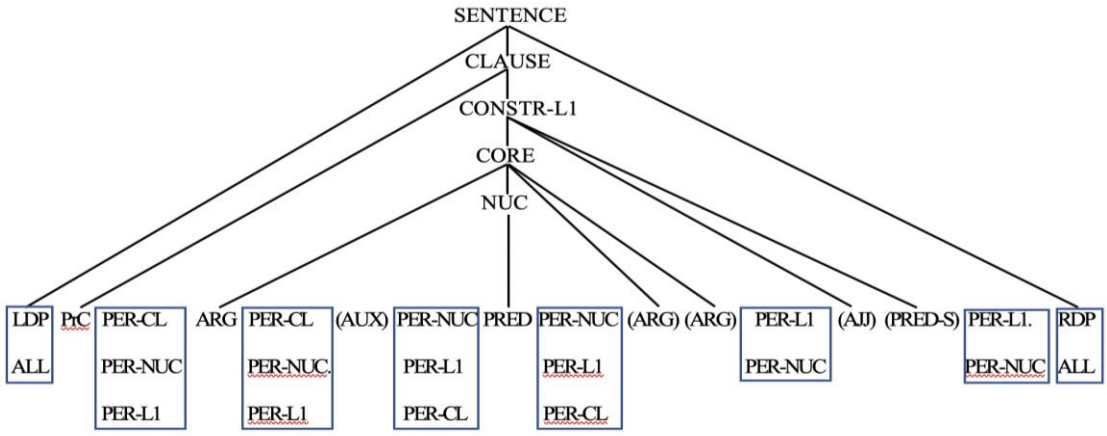

Figure 8: ***Peripheries and positional preferences in the abstract LSC***

As opposed to RRG's juncture-nexus analysis for adverbials, ARTEMIS will not further distinguish then between layers (Ad-CORE, Ad-CLAUSE and SENTENCE subordinate juncts), but it will just take into consideration a PERIPHERY constituent modifying the L1-CONSTRUCTION node (or PER-L1 node). Such a PERIPHERY could either occupy a fronted (initial) position or a final position, as will be shown in section 5, and it will always be saturated by an ADJUNCT with a possible dual realization: i. a predicative preposition encoded in the FunGramKB lexicon[8]; ii. a CLM (see Figures 10-16 below to show these two types of adjuncts).

For the sake of facilitating also the linear parsing process within ARTEMIS, Martín-Díaz (2019) proposes the inclusion of a CLM-node as a constituent in the LSC. Such a node has now been renamed as LM, dropping the first initial in the original label in order not to restrict its linkage to the CLAUSE level (González-Orta & Martín-Díaz, 2022 forthcoming), and has

[8] See Hernández-Pastor and Periñán-Pascual (2016).

been stored in the lexical rules repository in the GDE. Three types of LMs have been generally observed: a *that*-complementizer (COMP); a coordinator (COORD), that is not going to be considered in the present research since here we are only concerned with subordination; and a conjunction (CONJ). This LM-node will consequently need an AVM to be associated with in the parsing process, as will be developed in section 5.

5. CLAUSAL SUBORDINATION IN ASD-STE100

Once the three-layered classification for subordination has been reinterpreted in ARTEMIS as a single type, i.e., clausal subordination, we propose a further distinction between argumental and peripheral subtypes.

5.1 *Argumental clausal subordination*

In ARTEMIS, we recover the ARG label used in Van Valin & LaPolla (1997) to discriminate between an argumental and a peripheral type of subordination. A syntactic optionality between a single CLAUSE and an LM-CLAUSE must be encoded in the corresponding syntactic rule for this type of ARG node stored in the GDE, as shown in the syntactic rule (1). In it, the first subrule (ARG -> CLAUSE) is not found in ASD-STE100 given that *-ing* clauses do not form part of this CNL; as for the second subrule (ARG -> LM-COMP CLAUSE), this can only apply when the dependent unit is an object *that*-clause (see González-Orta & Martín-Díaz, 2022 forthcoming[9]).

(1) ARG -> CLAUSE || LM-COMP CLAUSE

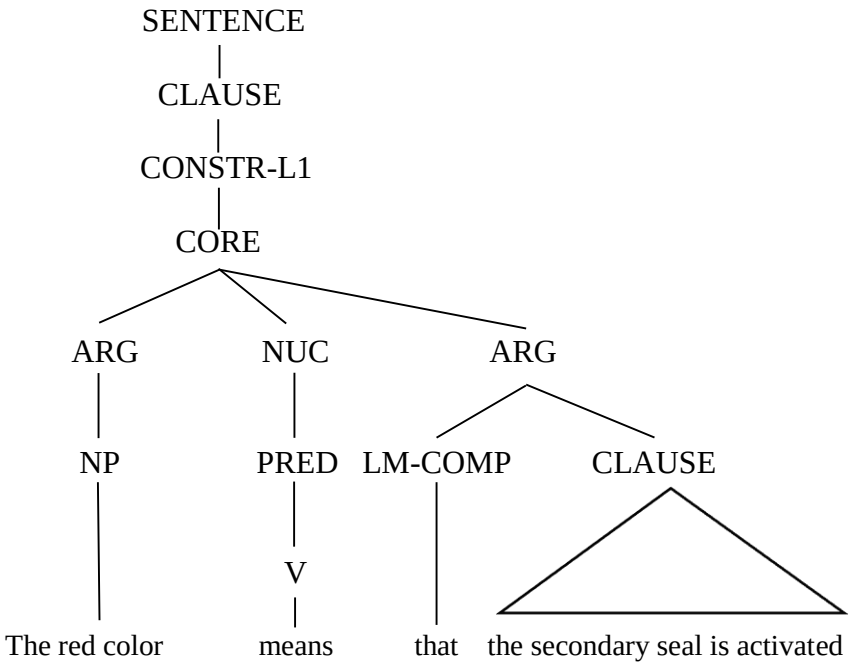

Figure 9: ***Argumental subordination with an LM-COMP CLAUSE structure in STE***

Given the tree representation of an argumental subordination in Figure 9 above, it is easy to infer from it the attributes the LM-COMP should encode in its corresponding lexical rule (2) in the GDE: the type of juncture (junc) to which it is associated, a clause; the mother node

[9] The order of subrules in the referred article is different because here we are following an alphabetical order.

(mthr) it derives from, the node ARG; the type of nexus it establishes, subordination; and the semantic information (sem) it provides, Ø:

(2) That LM-COMP [junc=cl, mthr=arg, nexus=sub, sem=null]

Other examples of this subtype in ASD-STE100[10]:

(3) Make sure that you apply the correct torque values.
(4) Loaded means that the aircraft is on-ground.
(5) The hub caps prevent that unwanted material goes into the axle nut, bearings and internal hole of the axle.
(6) This result shows that the brakes are not hot.
(7) The loadmaster controls show that it is dangerous to operate the Kneeling System when the highest brake temperature is more than +300.

5.2 *Peripheral clausal subordination*

In ARTEMIS the syntactic rule for PER-L1 (8) is formed by four possible subrules in which, following Cortés-Rodríguez & Rodríguez-Juárez (2019), up to four ADJUNCTs can occur. Two modifications to the rule offered by these authors need to be contemplated, nevertheless, in order to account for the spelling out of the rule for the ADJUNCT constituent (9) in peripheral clauses:

(8) PER-L1 -> ADJUNCT || ADJUNCT ADJUNCT || ADJUNCT ADJUNCT ADJUNCT || ADJUNCT ADJUNCT ADJUNCT ADJUNCT
(9) ADJUNCT -> LM-CONJ CLAUSE || MP || PP || RP

On the one hand, the clause-node in the first subrule in (9) must be preceded by an LM-CONJ constituent. On the other, the PP subrule in (9) will imply a further modification to the syntactic rule for PPs offered in Cortés-Rodríguez (2016) and repeated in (10):

(10) PP-> PER-PP CORE-PP || PREP RP[11]

A distinction between non-predicative (e.g., *I showed the pictures to my neighbor*) and predicative prepositions (e.g., (*The farm) right behind the house*) is shown in (10)[12]. However, this author does not take into account cases in which the predicative preposition is not preceded by a PERIPHERY node, as it happens in our examples for adverbial subordination in ASD-STE100 (see 13-16 below). In turn, a second subrule to the one proposed in Cortés-Rodríguez (2016) for CORE-PP needs to be included so as to contemplate, precisely, the possible presence of peripheral subordinate clauses, and not only that of referential phrases (RPs). After the suggested modifications, the syntactic rules propounded here for both PP and CORE-PP are:

(11) PP-> CORE-PP || PER-PP CORE-PP || PREP RP
(12) CORE-PP-> NUC-P CLAUSE || NUC-P RP

Examples in ASD-STE100 for peripheral subordination with a NUC-P CLAUSE are:
(13) Do a functional test after you install the component.

[10] See Appendix 1 for more examples.
[11] See the previous footnote.
[12] Examples taken from Cortés-Rodríguez (2016).

(14) After the engines stop, none of the two functions, antiskid or differential braking, are available from the brake-accumulator pressure-source.
(15) Let the brakes and the wheels become cool before you go near the landing gear.
(16) Before a new autobrake mode engages, the active selection disengages.

Coming back to the other modification proposed for the ADJUNCT constituent in (9), the clause-node in the last subrule is now preceded by an LM constituent, i.e., an LM-CONJ. As it happened in the lexical rule for the LM-COMP *that* (see (2) above), the LM-CONJ should also encode four attributes: juncture (junc), mother node (mthr), nexus, and semantic information (sem). Out of these, the attributes *junc* and *nexus* coincide in value for both types of LMs (those introducing argumental and peripheral subordination). However, the attributes *mthr* and *sem*[13] characterize the type of subordination involved. That is, in the case of LM-CONJ, the value for the *mthr* attribute is ADJUNCT; and that for *sem* depends on the semantics provided by the corresponding CONJ, as shown in the following catalogue of lexical rules (17-24) where only the subordinating conjunctions found in ASD are described[14]:

(17) Although LM-CONJ[junc=cl|L1, mthr=adj, nexus=sub, sem=Λ]
(18) As LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem=reason]
(19) Because LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem=reason]
(20) If LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem= ->]
(21) So LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem=consequence]
(22) Until LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem=time span]
(23) When LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem=time position]
(24) While LM-CONJ[junc=cl, mthr=adj, nexus=sub, sem=time simultaneous]

The following sentences show examples for each of these conjunctions in ASD-STE100:[15]

(25) Although the pressure decreases, the valve must stay close.
(26) And, as the rotors are connected to the wheels, the rotors decrease the wheel speed.
(27) Nose wheels stay at a fixed position because the axle nut prevents axial movement.
(28) A spring holds the valve at the center if the solenoid is de-energized.
(29) Do this until you see no air bubbles in the fluid.
(30) Do not bend the electrical harness too much when you release or tighten the clips or clamps.
(31) Hold the upper and lower torque links while you remove or install the apex pin.

As the examples (13) to (16) and (25) to (31) above illustrate, our peripheral clauses (PER-L1), whether saturated by a NUC-P CLAUSE or an LM-CLAUSE, can occupy two main positions, fronted or final. In ASD, ADJUNCTS syntactically realized by LM-CLAUSEs appear to show a preference for the final position, whereas those realized by NUC-P CLAUSEs do not seem to present such an inclination. These two positions will be represented in the tree diagrams below (Figs. 10-16) and their corresponding syntactic rules in (32) and (33). In the latter, the a-rules codify the NUC-P CLAUSE subordinates, and the b-rules, the LM-CLAUSE juncts.

[13] In line with this, Van Valin & LaPolla themselves claim in their Interclausal Relations Hierarchy that "the burden of expressing the semantic relations" among the units of a complex structure really "falls on the clause-linkage markers" (1997: 477).
[14] The values for the attribute *sem* in both CONJs *although* and *if* are by means of the logical operators "Λ" and "→" respectively.
[15] Only one case with the conjunction *so* (e.g., The Parking Brake System does not have a differential braking function, so the system does not adjust the supplied brake hydraulic-pressure), presumably not accepted in STE, has been found.

(32) PER-L1 in final position

a. CLAUSE -> CONSTR-L1 PER-L1, where
PER-L1 -> ADJUNCT, where
ADJUNCT -> PP, where
PP -> CORE-PP, where
CORE-PP -> NUC-P CLAUSE

b. CLAUSE -> CONSTR-L1 PER-L1, where
PER-L1 -> ADJUNCT, where
ADJUNCT -> LM-CONJ CLAUSE

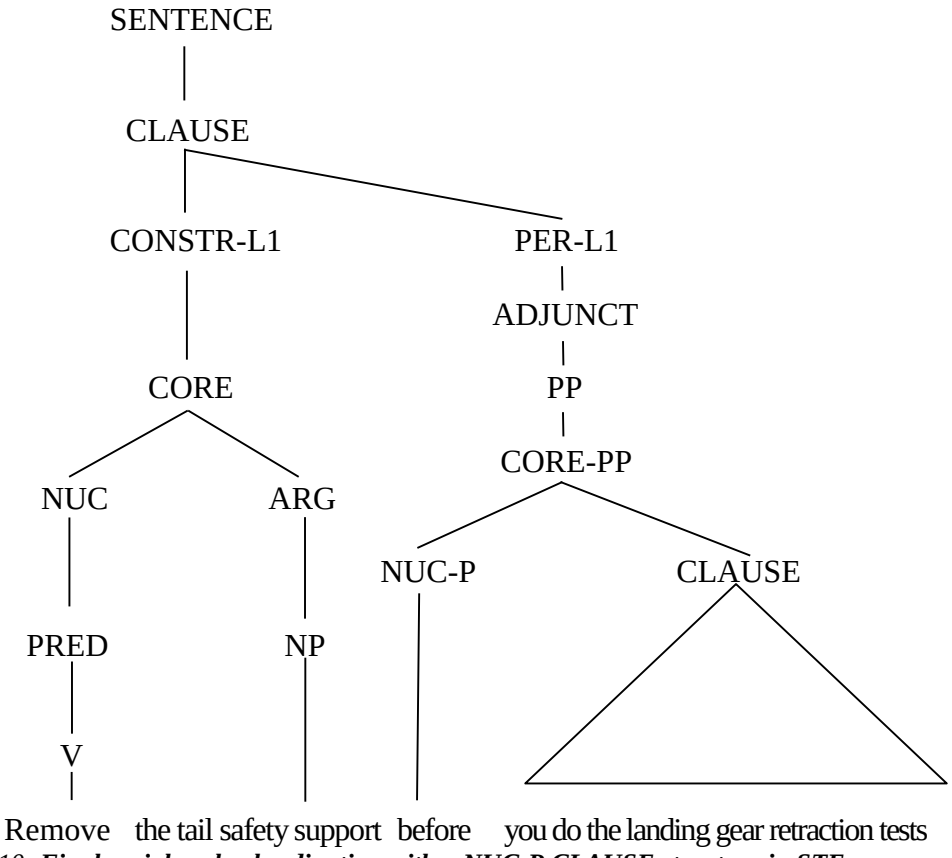

Figure 10: ***Final peripheral subordination with a NUC-P CLAUSE structure in STE***

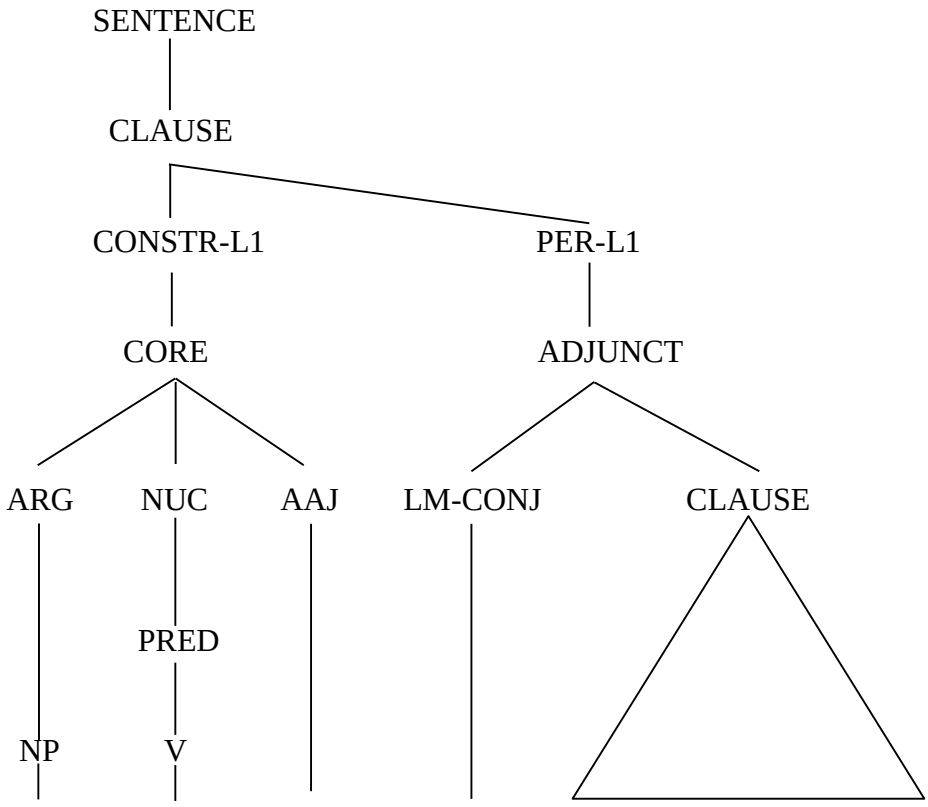

Figure 11: ***Final peripheral subordination with an LM-CONJ CLAUSE structure in STE***

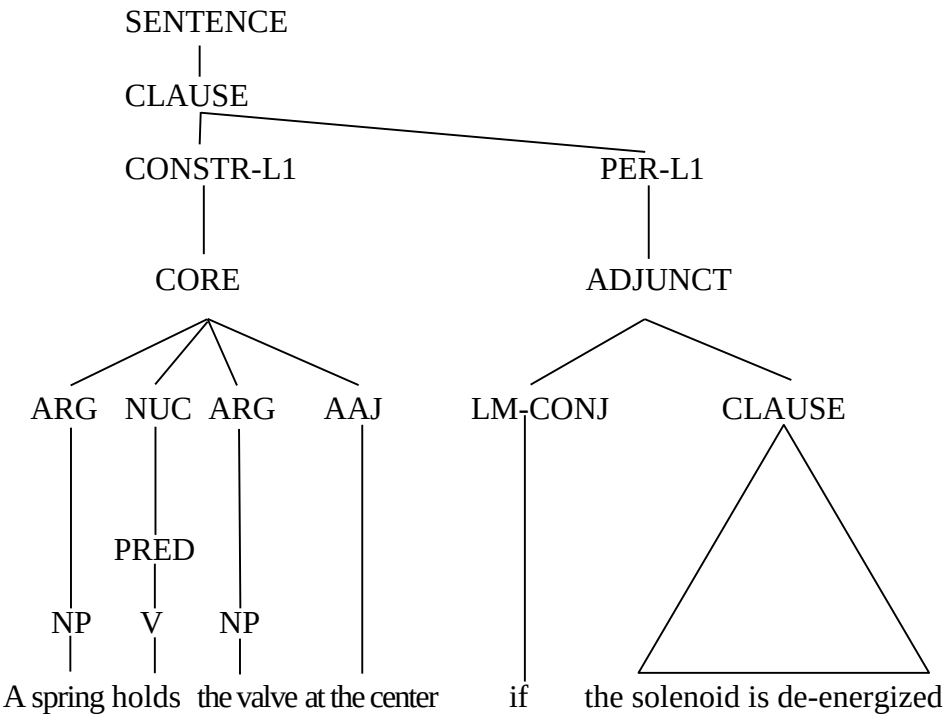

Figure 12: ***Final peripheral subordination with an LM-CONJ CLAUSE structure in STE***

(33) PER-L1 in fronted position

a. SENTENCE-> LDP CLAUSE, where

LDP -> PER-L1, where
PER-L1 -> ADJUNCT, where
ADJUNCT -> PP, where
PP -> CORE-PP, where
CORE-PP -> NUC-P CLAUSE

b. SENTENCE->LDP CLAUSE, where
LDP -> PER-L1, where
PER-L1 -> ADJUNCT, where
ADJUNCT -> LM-CONJ CLAUSE

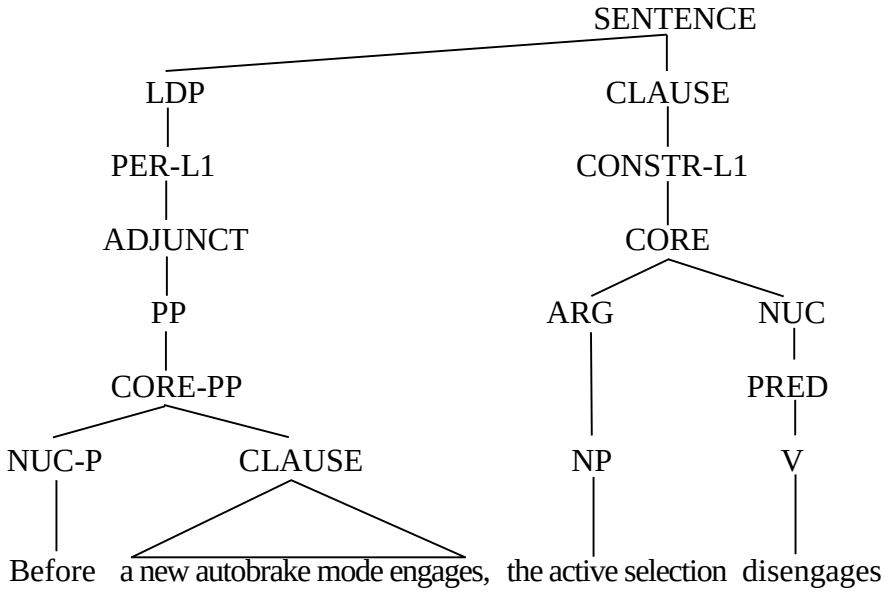

Figure 13: ***Fronted peripheral subordination with a NUC-P CLAUSE structure in STE***

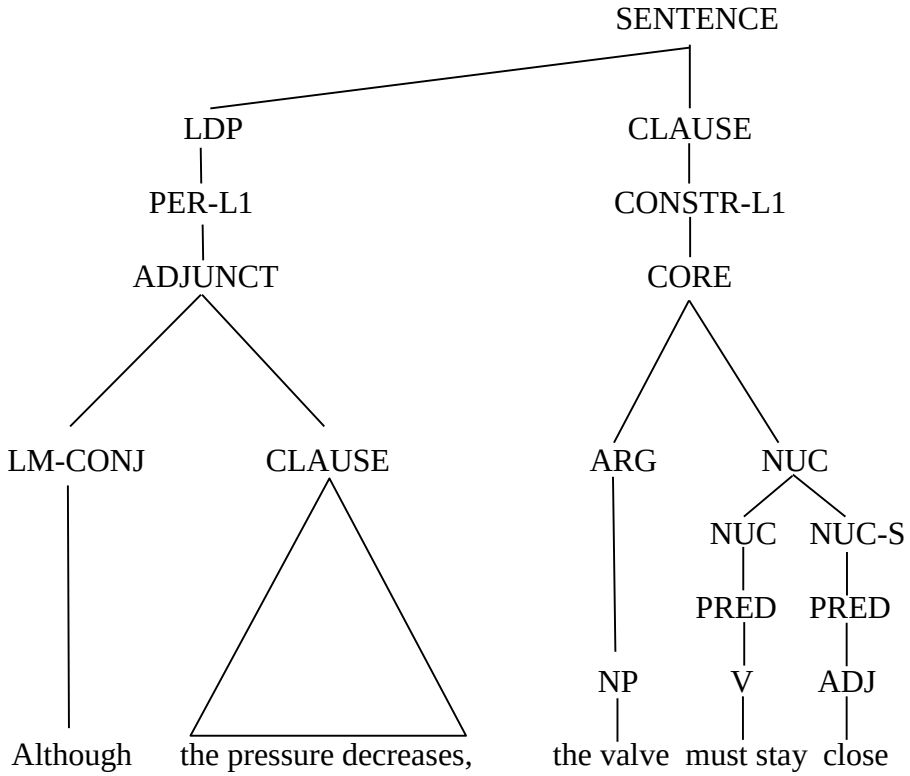

Figure 14: ***Fronted peripheral subordination with an LM-CONJ CLAUSE structure in STE***

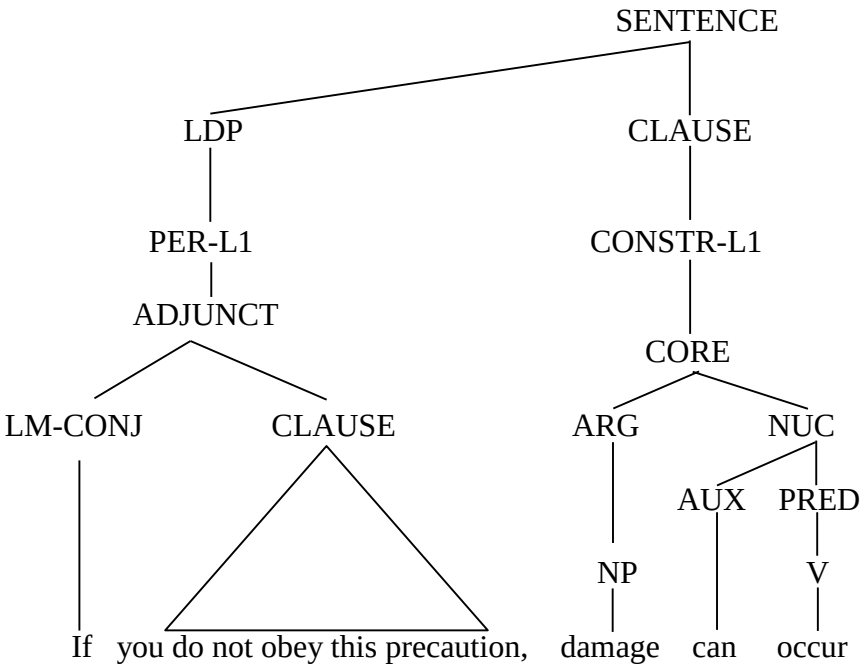

Figure 15: ***Fronted peripheral subordination with an LM-CONJ CLAUSE structure in STE***

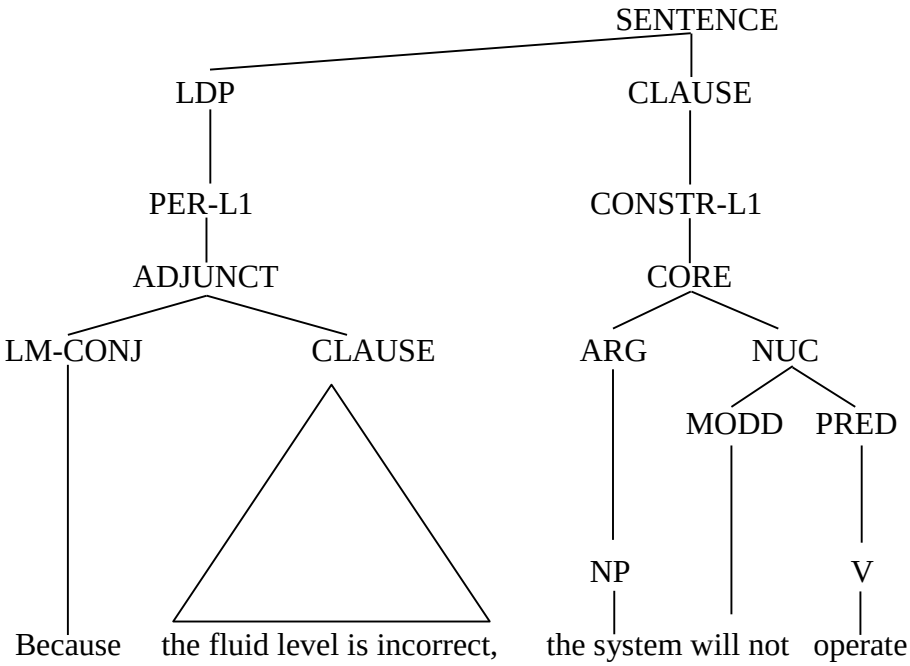

Figure 16: ***Fronted peripheral subordination with an LM-CONJ CLAUSE structure in STE***

6. CONCLUSION

The analysis *à la* ARTEMIS of subordinate structures in ASD-STE100 has taken us to introduce some modifications to RRG's theory of linkage relations. Mainly, they have involved: i. the redefinition of some of RRG's juncture-nexus combinations and consequently, the distinction of two types of subordinate juncts; ii. the necessary adaptation of this grammatical

model to the linearization principles observed in our parsing application; iii. the design of various lexical and syntactic rules, as well as some new AVMs for the GDE that enable the processing of these subordinate juncts in ARTEMIS.

Following Martín-Díaz (2019) and González-Orta & Martín-Díaz (2022 forthcoming), RRG's PERIPHERY and CLM have been given the status of constituent nodes of the LSC, and in particular, the latter has been relabeled as LM so as to show its multilevel ability in the linking process. Out of the three possible LMs identified in ARTEMIS, only the LM-COMP and the LM-CONJ are relevant for our subordinate juncts. The modification in this case arises from the proposal in the present paper of the corresponding attributes for its AVM: junc, mthr, nexus and sem; as well as the lexical values suggested for both LMs, the LM-COMP and the LM-CONJ found in the analysis of ASD-STE100. Besides, in the case of peripheral subordination a dual positional behavior is evidenced: final or fronted peripherals. In both cases, predicative prepositions and conjunctions trigger this adverbial subordinate for which the corresponding syntactic rules have been designed.

According to Cortés-Rodríguez (2019) original RRG cases of CORE, CLAUSE and SENTENCE subordination, are now considered CLAUSE subordination since the status of the embedded constituent, a CLAUSE, is what matters. Therefore, two grammatical types have been identified as a result of the present analysis: argumental or daughter subordination, syntactically realized by LM-COMP CLAUSEs (i.e., *that*-clauses where the complementizer introduces the subordinate clause); and an L1-peripheral subordination, in which two grammatical subtypes are distinguished: clauses introduced by predicative prepositions (NUC-P), or by means of conjunctions (LM-CONJ). Both of them have been found in the analysis of this aeronautical controlled language, even though not with the same diversity as that generally seen in English, and with a higher percentage of peripheral over argumental structures. Within the former, the prepositions *after* and *before*, and the conjunctions *if* and *when* are the most frequently used in the corpus. However, the number of examples using these LM-CONJs outnumber those cases with NUC-Ps in both, fronted and final positions.

The final step in this process will be testing all these production rules in our prototype so as to confirm its adequate parsing as well as to evaluate its success rate after comparing it to similar computational resources.

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Appendix 1

A. Argumental subordination in ASD-STE100
Make sure that all the fitting elements are installed before you apply the torques.
Make sure that each P-clip is attached at the center position of the sleeve.
Make sure that no objects hit the brake unit.
Make sure that the adaptation brake of the handling trolley is on.
Make sure that the axle of the damaged wheel is not damaged.
Make sure that the bonding value is correct.
Make sure that there are no leaks on the hydraulic pressure line that you disconnected.
Make sure that there are no leaks, corrosion, missing parts, chafing or flammable material on the structure, system and equipment.
Make sure that there is a good flow of air through the work area.
Make sure that there is no damage on the components and on the protective treatments of the area.
Make sure that they are correctly aligned.
[…] make sure that they are aligned with the aircraft centerline.
Make sure that you connect each electrical connector to its related receptacle.
Make sure that you correctly align the wheel with the axle.
Make sure that you correctly install the cotter pin.
Make sure that you hold the electrical harness along its full length during removal and installation procedures.
Make sure that you isolate the power supply a minimum of three minutes before you do work on the engine.
Make sure that you remove all hydraulic fluid, fuel, oil and grease from the tire.
Make sure that you use the hand-operated grease gun to lubricate the greasing nipples.
To prevent that the body subassembly turns, it has two open lugs to set its position with a cross-bolt.

B. Peripheral subordination in ASD-STE100

1. Final peripheral subordination with an LM-CONJ CLAUSE structure in STE
The main wheels stay at a fixed position because the axle nut prevents its axial movement.
The two links do the same function as a panel, because there is no panel attached to the top part of the forward leg.
This is because shock absorber fluid can absorb nitrogen.

The crew members can operate the park-brake switch to use the parking brake system if pedal jamming and global braking failure occur.
The hitch pin can only be installed if the kneeling lock valve is correctly closed.
The hydraulic flow moves the spool if a metering hole finds a pressure drop.
The hydraulic fuses prevent the discharge of hydraulic flow if there is a downstream leakage.
The rolling selector valve pressurizes the kneeling manifolds if the kneeling selector valve is energized to the kneeling down position.

Damage to the fuselage can occur if the aircraft moves during the tests.
Damage to the harness can occur if you bend it too much.

Wait until the end of the emergency extension procedure.
They are in tension until the tool is removed.
Continue to drain hydraulic fluid until flow is constant.

Be careful not to put too much load on the shock absorber when it is at the end of its travel range while you use the compression fixture.
All the autobrake mode labels come into view when none of the autobrake modes are armed.
All the indications are off when all the related legs are uplocked.
All the labels are off when all the kneeling chamber indicators are in the static position.
By default, the Normal Braking System is the active system that hydraulically operates the brake units when the aircraft moves.
Check of the Inflation Valve Be careful when you use consumable materials.
Be also very accurate when you apply the torque value.
Be careful not to cause damage to the seal rings when you install the changeover valve.
Be careful when the retraction actuator is unlocked.
Be careful when you connect and disconnect the nose wheel steering system.
Be careful when you do work near the electrical and hydraulic installations on the fuselage.
Be careful when you remove the changeover valve.
Be careful when you use consumable materials.
Be very careful when you turn the changeover valve nut to prevent internal damage to the valve.
Functions of the deactivation steering electrical-box disconnects the Steering System when the towing of the aircraft is necessary.
It changes to amber when a minimum of one engine is started.

The check valve lets hydraulic fluid flow in one direction, while it causes a blockage of the flow in the opposite direction.
Be careful not to cause damage to the seals and back-up rings while you install the anti-shimmy valve.
Be careful not to put too much load on the shock absorber when it is at the end of its travel range while you use the compression fixture.

2. Final peripheral subordination with a NUC-P CLAUSE structure in STE

Let the tires become cool before you measure the pressure.
Make sure that all the fitting elements are installed before you apply the torques.
Make sure that the electrical connectors are clean and in the correct condition before you connect them.
Make sure that the tire is fully deflated before you remove the wheel.
Make sure that you isolate the power supply a minimum of three minutes before you do work on the engine.
On hydraulic connections, tighten the nut with your hand before you use the wrench.

3. Fronted peripheral subordination with an LM-CONJ CLAUSE structure in STE

If you get one of these materials: On your skin or in your eyes, flush it away with a flow of clean water.

If you remove two or more sensor shims or target shims at the same time, identify the position and orientation in which they must be installed.
If you do not stay aft of the gear leg, this can cause injury or kill you.
If you do not use the correct tester, the result of the hardness check can be incorrect.
If you can not lift the aircraft, do the operational test of the Emergency Extension system on ground instead of this operational test.
If you do not connect the electrical connectors to their related receptacles, damage to equipment can occur.
If the visual examination does not give a fault: Contact the Airbus Defence and Space support.
If the problem continues the operation mode changes to the inhibited mode.
If the problem continues the operation mode changes to the inhibited mode.
If the downlock mechanism is not correctly pressurized, there is a risk that the mechanism suddenly closes.
If only one motor operates, then the time necessary to unlock the related uplocks will be two times more than that with two motors.
If the Yellow hydraulic system is not pressurized, the fuse in the mechanism will break.
If a position indication is not correct, repeat the steps in Para.
If burns occur, put the burned areas in cold water for ten minutes and get medical aid.
If it is necessary, adjust the pressure again.
If it is not, do the pressurization of the kneeling chambers.

When the Normal Braking System is unserviceable, the Alternate Braking System operates the brake units.
When the aircraft is stopped, the Parking Brake System can brake the aircraft through the brake accumulator.
When the deactivation steering electrical-box is at the tow position, the Steering System operates the inhibited mode.
When the fluid becomes stable in the container, it shows its normal color.
When the shortening function operates, the Kneeling System sends a signal to the Braking System to release the forward brake units.
When the steering isolation valve pressurizes the hydraulic circuit, the Steering System operates.
When the target moves away from the sensor, the sensor is in the "target far" position.
When this occurs, the hydraulic fluid goes into the floating separator-piston zone of the hydraulic chamber.
When you connect the electrical wires, make sure that you connect each wire to its related pin/socket.
When you do the lift-up of the shock absorber, make sure that the retraction actuator spacer is installed.
When you engage the carbon brake unit on the torque pin, be very careful to prevent damage.
When you inflate the tire, make sure that the pressure is not more than the maximum limit of the normal pressure range.
When you operate the Parking Brake System, it supplies hydraulic-pressure to the brake units.
When you release the handle, the handle comes back to the tow position.
When you twist the handle more clockwise and hold it, the aircraft changes from the towing condition to the test condition.

While you remove the pin, hold the spacer and torque link.

4. Fronted peripheral subordination with a NUC-P CLAUSE structure in STE

[…] after you remove or disconnect components, install protective covers and caps to prevent contamination.
[…] after the parking brake is applied, this will not have an unwanted effect on the parking brake.
Before you do a check of the Yellow hydraulic system, make sure that the Blue hydraulic system is depressurized.
Before you open the outer mobile panel, make sure that the two wing jacks are in the correct position.
Before you start the kneeling procedure, make sure that there are no objects or persons below the aircraft.
Before you start to depressurize the kneeling chambers, make sure that there are no objects or persons around the aircraft.

Appendix 2

AAJ Argument-adjunct
ADJ Adjective
ADVR Relative adverb
ARG Argument
AUX Auxiliary verb
AVM Attribute-Value Matrix
CL Clause
CLM Clause Linkage Marker
CLS Conceptual Logical Structure
CNL Controlled Natural Language
COMP Complementizer
CONJ Conjunction
CONSTR-L1 Level 1 Construction
COORD Coordinator
GDE Grammar Development Environment
LCM Lexical Constructional Model
LDP Left detached Position
LM Linkage Marker
LSC Layered Structure of the Clause
MODD Modal verb (deontic)
MODST Modal verb (epistemic)
NP Noun Phrase
NUC Nucleus
NUC-S Secondary Nucleus
PER Periphery
PER-L1 PERIPHERY modifying the L1-CONSTRUCTION
PP Prepositional Phrase
PrCS PreCore Slot
PreC-L1 Pre L1 Construction Slot
PRED Predicate
RRG Role and Reference Grammar
S Sentence
V Verb