NVEO
Natural Volatiles & Essential Oils

Integrated Formalization for Temporal Referentialities

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Abstract

It is common knowledge that natural languages are complex. All utterances are uttered directly by the speaker and are described over the passage of time, which is called “temporal referentiality” (called also the “frame of reference”), which is the axis of time. However, not all utterances are described in “enunciative referentiality,” which is the speaker's time axis. For example, utterances that are not described in the present time, such as utterances with fictional meaning, narrative or historical facts, or indirect speech,are not realized in the speaker's time axis. Rather, they require a new axis of time, such as an axis of time that has not been realized or an axis of indirect speech, or an axis of time that has not yet been realized but contains possibilities. Therefore, to analyze various types of utterances, other types of referentialities are required in addition to enunciative referentiality. In addition, enunciative operations that allow the insertion of predicative relations into the temporal frame of reference should be considered. The purpose of this study is to demonstrate the necessity and applicability of enunciative operations to formally conceptualize various types of situations expressed by predicate relations that form the basis of utterances. For these works, logico-linguistic systems, such as locative detection systems, and the cognitive linguistic theories such as temporal referentiality theory are used. These methodologies can be used to perform enunciative operations, resulting in the most general and canonical abstract schema. This schema is ultimately applicable to any natural language and is the primary abstract form for the computerization of natural languages.

Keywords—Locative detection system, Temporal referentialitytheory, Theory of enunciation, Abstract aspecto-temporal application schema

1. Introduction

The operation of applying an operator to an operand is used as a basic idea for applicative formalisms (such as λ-calculus, combinatory logic, and functional programming). In linguistics, an operator is considered to be an operating process associatedwith incomplete linguistic units. In enunciative theory (in [5], [6]), the object of analysis is a predicative relation that has a subject and predicate (that is, a clause). This theory explicitly differentiatesa clause from an utterance thatis enunciated by means of “taking charge”operators.The function of a predicate of a predicative relation (a clause) is, therefore, the function of an operator, which must construct a clause from a certain number of arguments (its operands); these can be either only terms or nested terms.

To understand the concept of the operator and apply it to linguistic units, it is essential to introduce two approaches: a locative detection system ([4]) and a temporal referentiality theory ([6], [7]). Using this formal theory and the theoretical approach, this study presents an abstract aspecto-temporal applicative schema. The introduction of an abstract schematic form is applicable to any type of

utterance in any natural language, containing all the necessary information. Therefore, human beings can formalize any utterance in the related applicative expressionsthat can be inserted by a machine.

In this study, a locative detection system, which is a logical structure applied to linguistics, is first described. A methodology first studied by French linguists, it is suitable for describing the syntactic structure and temporal relations of verbs. Second, a theoretical introduction to temporal referentiality, which describes verbal time, is described. Using these two methodologies, an abstract aspecto-temporal schema that can represent various types of utterances is presented, and applicability and efficiency are examined through example sentences.

Acomputer program is a complex operator composed of elementary programs.The idea of a compiler must start with the application system, that is, an applicative expression in which an operator is applied to an operand to produce a result.The abstract schema presented in this studywas created by combining the descriptive analysis of linguistics with a logical analysis system (the locative detection system) and linguistic theory (temporal referentialities), and it is possible to have a 1:1 correspondence similar to the process in which an operator is applied to an operand. Therefore, it is a general formula that can be used in the field of computational linguistics, where the processing of linguistic analysis is more explicit.The abstract schema presented in this study can be applied to various types of concrete utterances, and the formula representing the resulting expression becomes an applied expression that a computer program can recognize. That is, natural language utterances (e.g., enunciator's time, narrator's time, fictive time, possible but not yet realized situation time, and so on) including one, two, or several predicate relations can all be expressed in an abstract schema regardless of the type of utterance. This abstract schema eventually has a structure of operators that are applied to the operands, thus taking a machine-readable form. Therefore, this study suggests the necessity and applicability of an abstract schema, and it can be said that it is a common formula that can be applied to all, not specific, natural languages.

2. Locative Detection System

The first theoretical framework for building an abstract schema, the locative detection system ([4]), is a logical operation that generates temporal relations of utterances. It has its origins in French linguistics, in particular, directly inspired by the theoretical considerations of Antoine Culioli ([3]) and later modified to apply to the analysis of the *est* copula in French ([5]).Thissystem introduces three specific types of relations for locative detection, which make it possible to generate different linguistic temporal relations: *identification*, *differentiation*, and *rupture*. "Identification" means that the two temporal relations are exactly the same. "Differentiation" represents the relation of inclusion, simultaneity (or concomitance), anteriority, or posteriority. Finally, "rupture"indicates that different temporal relations are separated into distinct ones. In the domain of temporality, these three locative relations participate in the conceptualization of linguistic time (that is, circular time), which is clearly distinct from non-linguistic time (that is, linear time),such as calendrical and chronological time ([1]). They serve to construct various temporal referentialities, including enunciativereferentiality (also referred to as "enunciative frame of reference").

Before the theoretical description is started, there are several abbreviated symbols used in this locative detection system (in [9], [12], [14], and [16]):

- $PROC_{J0}$: "PROC" is an abbreviation of the enunciative process representing the act of enunciationof a speaker, where"J^0" indicates the topological interval of this enunciative process.
- $PROC_{J1}$: If an utterance or a predicative relation has linguistically an aspectual *process*value(that is, a gradual progress situation), it is expressed by the abbreviation "PROC," and the process is realized in the topological interval "J^1."
- $EVEN_{F1}$: If an utterance or a predicative relation represents linguistically an event aspectual value, it is expressed by the abbreviation "EVEN," and realized in the topological closed interval, denoted as"F^1."
- $STATE_{O1}$: If an utterance or a predicative relation represents a static situation (a state), it is abbreviated as"STATE," and is realized in the topological opened interval, denoted as"O^1."
- T^0: "T^0" is the fixed point that is often used in the enunciative theory. From this point, the realized domain and the unrealized domain of the utterances are divided. T^0 is concomitant with the right boundary line of the enunciative process. Therefore, utterances in the past or present tense are situated on "before T^0," and utterances in the future tense are situated on "after the fixed point T^0."

The locative detection structural expression is<**X rep Y**>[2]; itmeans that "X is locationally detected with respect to Y." In [4], the symbolic notations are designated according to its meaning and usage as follows:

Notation of locative detection: 1. rep (generic term): =, ≠, #

- 2. $rep\text{-}_{ING}$ (mereological ingredient, part of): ε
- 3. $rep\text{-}_{loc}$: =, ⊂, <, >

- The first generic symbol "rep" is used in the <X rep Y>expressionto indicate a general locative detection, where X is identified with respect to Y and takes three values (*identification*, *differentiation,* and *rupture*).
- The second notation "$rep\text{-}_{ING}$" is used for the belonging relation, which is a sub-branch of *differentiation* while keeping the characteristic property of "non-symmetry." "X $rep\text{-}_{ING}$ Y" means that "X is identified as the ingredient or part of Y." In the linguistic formalization, this notation is used to indicate that a temporal interval belongs to a certain referentiality. For example, [J^0 $rep\text{-}_{ING}$ REN] expresses that theenunciative process ("J^0" is an abbreviation for the topological interval of an enunciative process) belongs to the enunciative referentiality (abbreviated as"REN").
- The third symbolic notation "$rep\text{-}_{loc}$" is used for the temporal relation between topological intervals. This notation specifies the discrimination oftemporal location, which is also a sub-branch of the relation of *differentiation*, by maintaining the characteristic property of non-symmetry. "X $rep\text{-}_{loc}$ Y" means that "X is located relative to the location of Y." This symbol contains four locational values (in [8]).
- (3.1) Concomitance or simultaneity (symbolized as =),for example, the right temporal boundary (symbol "δ") of the enunciative process J^0 is concomitant with the fixed point T^0: [(J^0) = T^0].

[2]The technical term "rep"is used in locative detection theory. This term means *repérage* in French. ([4], [5])

- (3.2) Inclusion (symbolized as ⊂),for example, in a sentence such as *Last Monday Paul asserted his innocence*, the linguistic event (symbol "F^{1}") *Paul asserted his innocence* is included in the static situational value, state (symbol "O^{1}") *Last Monday*: [$F^{1}\subset O^{1}$].
- (3.3) Anteriority (symbolized as <),for example, the sentence *Paul asserted his innocenceto the police* represents the linguistic aspectual value, event F^{1}, and it is situated before the enunciative process J^{0} in the enunciative referentiality; therefore [$F^{1}< J^{0}$].
- (3.4) Posteriority (symbolized as >),for example, for the same example as (3.3), the native process J^{0} is located after the event F^{1}; therefore [$J^{0}> F^{1}$].

For a better understanding, the classification of the symbolic notations described above can be tabulated as in Table I.

Table I. Classification Of Locative Detection Schema

<table>
<tr><th colspan="3">X rep Y</th></tr>
<tr><td>1. X = Y</td><td colspan="2">X is identified with Y</td></tr>
<tr><td rowspan="3">2. X ≠ Y</td><td>2.1. X rep_{-ING} Y</td><td>X is mereological ingredient of Y</td></tr>
<tr><td rowspan="3">2.2. X rep_{-loc} Y</td><td>2.2.1. X = YX is concomitant with Y</td></tr>
<tr><td>2.2.2. X < YX is situated before Y</td></tr>
<tr><td>2.2.3. X > YX is situated after Y</td></tr>
<tr><td>3. X # Y</td><td colspan="2">X is in rupture relation with Y</td></tr>
</table>

In linguistic analysis, such as aspecto-temporal analysis or modal analysis, most linguistic structural algorithms can be expressed as a function of the locative detection system. Using this locative detection system, not only the relations of temporal boundaries, but also the relations between different temporal axis (referential ties) can be represented. Therefore, in this study, the locative detection system is used to describe the various temporal relations that the utterances mean.

3. Temporal Referential ties in Linguistic Time

Languages are a system of semiotic representations that can represent not only current situations directly perceived, but also past, targeted, imagined, possible, and even counterfactual situations ([6], [7], [10], [11] and [16]). The different temporal referencing mechanisms represent each time axis of different types of situations; therefore, they are one of the most important fields of study in cognitive linguistics. To account for these mechanisms, cognitive linguistics refers to epistemological research on physics that explicitly distinguishes what is observed and what is referenced. The representations of different types of linguistic situationsmust, therefore, identify different referentialities, especially the referentiality of an observer and that of facts described. Galileo's reflection showed that temporal referentiality can be in motion with respect to another type of

temporal referentiality. In an enunciative approach, the enunciator becomes comparable to an observer who must organize what he or she observes and utters in a temporal referentialitythat has become detached from the external frame of reference (physical, cosmic, or calendrical time). This ability to detach from the external world is one of the deepest abilities of a human, and is reflected in that person'sown language (in [7: p.96]).

Temporal referentiality (also called a"temporal frame of reference") is an ordered set of temporal continuous instants that can be structured by the locative detection system,that is, the relations of *concomitance* (=) and *differentiation* (≠,anteriority, or posteriority). Each moment is identified in relation to another instantusing thesethree relations. Because the set of instants is continuous, it is represented by the topological intervals of the instants with open and closed boundaries.Temporal referentiality can also be determined by a *rupture* relation (#) from another referentiality. The definition oftemporal referentialityis as follows.For any instant of a temporal referentiality REF1, there is an instant "t" of another temporal referentiality REF2, and hence this instant "t" cannot be identified by the *concomitance* or *differentiation* relation in the REF1 referentiality. Instead, this instant "t" establishes a *rupture* relation with any instant "t1" ofREF1; hence, expressed by [t # t1].

For the linguistic analysis of utterances, it is indispensable to clearly distinguishthe temporal frames of reference organized by the enunciator that constitute the "cyclical linguistic time" and the chronological frames of reference organized from an external cosmology that is linear. This linguistic time can be expressed by several temporal referentialities organized by the enunciator (or speaker). The notion of temporal referentiality is essential for organizing temporal and linguistic aspectual references. This notion is necessary for the conceptualization of temporality and the aspectuality of languages.

It is necessary to consider, in the modeling of linguistic time, different registers underlying any aspecto-temporal reference verbalized in a text. An enunciative referentialityis directly linked to the act of enunciation, and different types of referentialities are relatively independent of the enunciation but are always linked to the enunciative process by the relations of locative detection. The linguistic grammatical category, aspect refers to the aim of predicative relation that an enunciator verbalizes, often represented by the progressive form or the preterit. Time refers to relations that situate either in the enunciative referentiality, in another referentiality, or in relation to the enunciationoften represented by past tense, present, or future tense. To account for the aspecto-temporal values observed in languages, it is essential todistinguish different types of temporal referentiality (in [13], [15]).

- External referentiality (external frame of reference): it represents the cosmic or calendar time and is abbreviated as"REX."
- Enunciative referentiality (enunciative frame of reference): it represents the enunciator's time axis and is abbreviated as"REN."
- Other referentialities identified by the rupture relation (#) with respect to the present utterance: RNA (non-actualization referentiality), RPOS (referentiality of possible situations), RGT (referentiality of general truth), and REN-DR (referentiality of reported discourse).

Temporal referentiality can be determinate relative to other referentialities. The enunciative referentiality, designated as"REN," is the required first frame of reference for any type of utterance. Through her or his enunciation, the enunciator constructs his own autonomous referentiality detachable from the external world. In this constructed enunciative referentiality, the enunciator can specify the "enunciative coordinates" of predicative relations that the enunciator takes charge ([15]). This referentiality should not be confused with the external referentiality designated as"REX,"because the REN presents the point of view of the enunciator, while the REX can ignore it.

Each enunciator builds her or his own enunciative referentiality. In the enunciative referentiality, predicative relations are identified directly or indirectly in relation to the act of enunciation, which represents an enunciative process, symbolized as"$PROC_{J0}$." This referentiality is, therefore, organized by the enunciator and oriented from the fixed point T^0,and the right boundary of the enunciative process coincides with T^0 andis expressed by ($[\delta(J^0) = T^0]$), where $T^0$is the last instant of the actualized temporal domain. The definition ofT^0 is:

- The continuous cut between the first moment of the unrealized (T^0, therefore, does not belong to it) and the last moment of the realized temporal domain.
- Considered as a fixed point (or benchmark) in the enunciative frame of reference, and it therefore serves as a fundamental temporal benchmark for all the other temporal benchmarks implied by an enunciation.
- Often considered as the "very moment of enunciation," but this should not be done in an approach of linguistic temporality because enunciating consumes time.

If this fixed point T^0 is projected in the REX, it becomes a moving reference point "t_m"thatchanges with the flow of time. Therefore, it cannot be considered as an original. Each enunciator builds her or his own enunciative frame of reference, which can be the "certain" or "realized" domain, that is, the domain where all the instants have already passed and already been realized. All the situations identified in the REN are events that have happened or are in the process of happening.They belong to the past or present tense. In contrast, situations that will arrive or those that arrive remain "unrealized" in the temporal domain (which situate after T^0) and they belong to the future tense.

When an utterance (in the form of a predicative relation) is represented in the REN, first, the act of enunciation is grammatically aspectualized in the form of an unaccomplished process (which is the enunciative process), and then the predicative relation is expressed by the enunciator in the form of one of the linguistic aspectual values (state, process, event) in the REN, or in another suitable referentiality in relation to the REN (for more theoretical explanation of aspects, in [2],[15]).

There are many linguistic situations that cannot be realized semantically on the enunciator's time, even if the enunciator has uttered it directly, and thus, various references other than REN and REX are required. In other words, there are referentialitiesthat are linked to the temporal relations (by the relations of identification, differentiation, and rupture) with the REN but cannot be identified directly in relation to the act of enunciation: non-actualization referentiality (also called "narrative

referentiality,"abbreviated as"RNA"), referentiality of possible situations (RPOS), referentiality of general truth (RGT), referentiality for comments (RCOM),referentiality for reported discourse (REN-DR), and so on. Here, some representative temporal referentialities are introduced.

- Non-actualization referentiality, also called "narrative referentiality"(RNA), expresses and represents narratives or fictitious situations that are not part of the enunciator's realized world but are linked to the REN. The distinction between REN and RNA is presented in the literature and is expressed through different concepts or terminologies, for example, the linguistic works of Emile Benveniste between "discourse" and "history" ([1]), and those of Antoine Culioli between "enunciative" and "aoristic" ([3]). Many narrative situations cannot be located either in the past, present, or future of enunciator's time axis. Linguistic markers such as *That day*, *Once upon a time,* and *One day* effectively underline a non-reference in the REN—more precisely, a rupture relation with the current utterance. They require the creation of RNA into which the verbalized situations fit. All the instants of RNA are in a rupture relation,symbolized as "#," with all the instants of REN—in particular, with T^0.
- Possible situations referentiality (RPOS) represents situations that cannot be directly related to the act of enunciation and are not taken care of by the enunciator. The hypothetical *if* is the linguistic mark for constructing the RPOS of possible situations. In this referentiality, situations themselves and relations between situations are only considered possible; therefore, they are not necessarily realized in the REN. With this possibility frame of reference, the following situations can be represented: potential of the present (*If you take one more step, I shoot*), counter-facts such as unrealistic present (*If he has money, he gives it to you* or *he will give it to you*) or unrealistic past (*If Paul had money, he would give it to you*), or inferential reasoning (*If, at that time, he had money, he would give it to you*).
- In reported discourse referentiality (REN-DR),the enunciator can support statements of another enunciator. At each indirect narration, the main enunciator creates a new enunciative frame of reference for the second enunciator who uttered the statement of indirect narration, designated as the reported discourse referentiality "REN-DR," which is distinct from REN.All event situations, static, and processual situations uttered by the second enunciator are located in this referentiality.

4. Aspecto-Temporal Schema

The application schema for the linguistic formalization of aspecto-temporal analysis, represented in the form of a linear or tree-based applicative expression, has become complex through the theoretical development of the enunciative theory that is applied to various types of utterance (in [16]). The aspecto-temporal applicativeschema proposedin this section takes an abstract shape and makes it possible to process a wide variety of utterances. It offers the possibility of accountingfor several predicative relations as well as the synchronization betweenreferentialities.

4.1. LINEAR AND SYNTACTIC TREE FORMS

An enunciator naturally takes care of all the information, including the temporal relations between statements. For an utterance represented in a certain referentiality REF different from the REN, it is necessary to have a linguistic marker that makes it possible to create a new referentiality, and this marker (either an adverbial expression or another predicative relation) itself becomes a benchmark

interval in the REF. The following aspecto-temporal applicative schema I (Fig.1) contains all the information necessary for any utterance: The main idea of schema I is to deal with several types of utterance, and it ultimately helps in the analysis of inferences as well as the implementation in an adequate functional programming language.

Presentation of temporal relations in a single block divided into four sub-parts

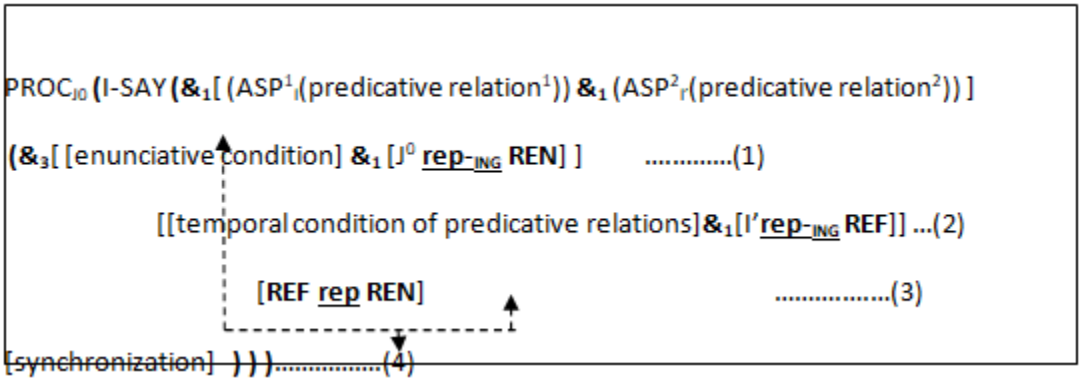


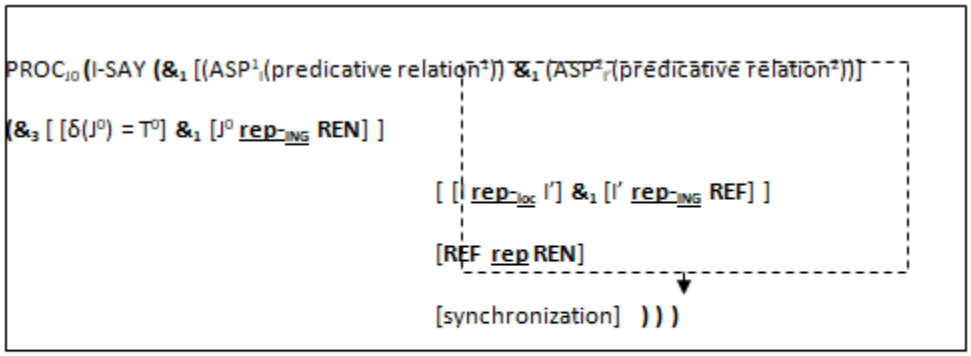
Fig. 1General abstract form of schema I

In the general schema in the above abstract form, PROC$_{J0}$ is a metalinguistic symbol of the enunciative process, indicating that the enunciator is uttering. In this enunciative process, the actual enunciator is responsible for what he or she says (predicative relation 1 and 2), and thus, it forms the largest group. "I-SAY" is also a metalinguistic symbol, meaning that "I," an abstract enunciator, is uttering, "SAY."In addition, the content of the utterance is composed of two predicate relations, and information about the temporal relations of these predicate relations inevitably follows.The conjunction connector is "&," and the number of its occurrences is expressed as a numerical exponent, for example, "&$_1$" means that there is a single occurrence of the conjunction by connecting two contents (or arguments),"&$_2$" means two instances of the conjunction '&' by connecting three contents contained in the block (parentheses), and"&$_3$" means that there are three instances of the conjunction '&' in the block by connecting four contents. The indices for each aspectualized predicative relation, for example,(ASP^1_I(predicative relation^1)) and (ASP$^2_{I'}$(predicative relation^2))),are added to distinguish them clearly.In particular, in this schema, all the temporal conditions are distinguished into four sub-parts.

- The first part concerns information on the enunciation, that is, both "the right boundary of the enunciative process being concomitant with T^0," expressed by [δ(J^0) = T^0], and "the enunciative process belonging to the REN,"expressed by [J^0 rep-$_{ING}$ REN].
- The second concerns the temporal conditions between the topological intervals. Specifically, a temporal condition between the interval of the aspectualized predicative relation I and the related interval I', and the interval I' is situated in any type of referentiality (REF) other than REN.
- The third expresses the relation between two different referentialities with the rupture relation (denoted as #).[REN # REF] means that the two referentialites are distinct from each other.
- The fourth part represents synchronization, provided that it exists, between the benchmark interval of

REF and T^0.

Fig. 2 shows the entire concrete version of schema I, which is a simplified abstract form. Fig. 1 is an abstract form to help the understanding of the schema introduced for the first time, and Fig. 2 shows a concrete expression of all temporal condition relations using metalinguistic symbols.



Presentation of temporal relations in a single block divided into four sub-parts

Fig. 2 Application schema I: entireconcrete form

The abstract enunciator (I-) utters something (-SAY(…)) in the form of an unaccomplished enunciative process ($PROC_{J0}$). This part of "something,"—that is, the contents of the utterance,—means the following.

- First, there exists a main "predicative relation 1" of the utterance that is aspectualized in a topological interval "I"; therefore,it is expressed as"ASP^1_I (predicative relation 1)."There exists another secondary "predicative relation 2" or an adverbial expression or even a linguistic marker, which makes it possible to create another reference frame REF as a marker interval, which is aspectualized in a topological interval I'.Therefore,it is expressed as $ASP^2_{I'}$ (predicative relation 2). These two predicative relations are linked with the connective connector "$\&_1$."
- Next, the temporal relations between intervals, as well as between referentialities, must be indicated.
- (2.1) All the temporal information that takes place in the REN must be bound by the & connector (often $\&_1$ because, in most cases, the & connector only takes two arguments). The first information concerns the right boundary of the enunciative process, which is concomitant with T^0; the second is that this native process J^0 is located in the REN, which is identified as the ingredient of the REN, and thus, [[$\delta(J^0)=T^0$] $\&_1$ [J^0 rep_{-ING} REN]].
- (2.2) It is necessary to provide information, especially on the relationship between two topological intervals I and I', and indicate where they are located in a certain type of referentiality. This information must be linked together by the $\&_1$ connector operator.
- (2.3) The rupture relation between two referentialities is indicated.
- (2.4) If synchronization between referentialities exists, it can be expressed in the schema.

This bundle of temporal conditions (2.1-2.4) is grouped together by the conjunction operator &.Because there are four arguments to connect, the operator & becomes $\&_3$.

For a more concise and abstract schema, it is also possible to substitute the operator of taking charge by the enunciator,"$PROC_{J0}$ (I-SAY (...))" (form of above schema in Figs) by the enunciative operator "$ENONC_{J0}$" ([6], [7])(Fig. 3).

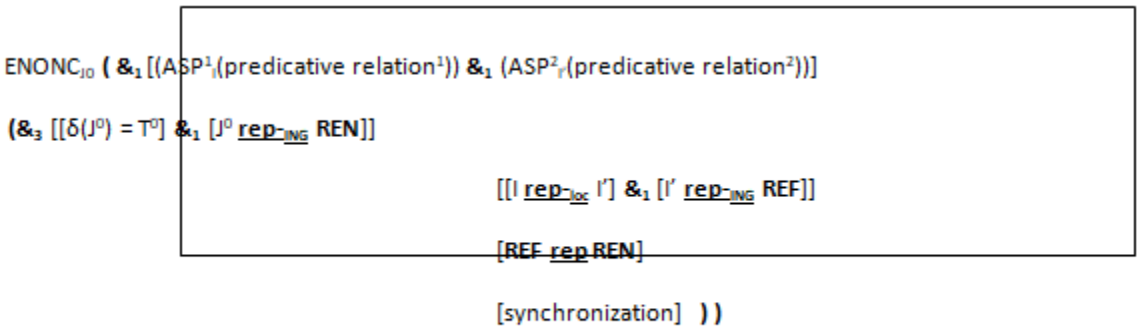


Fig. 2 schema I': notational variation of the schema I

The main manage mental operator "$PROC_{J0}$ (JE-DIS (…))" can be reinterpreted using the combinator of functional composition **B** of the combinatory logic (for more explanation, in[5],[8],[16]),and this combinatorex changes these condargument for the third. Therefore, it can be rewritten as the definition [$ENONC_{J0}$ = $_{def}$**B** $PROC_{J0}$ JE-DIS].This main operator can then bere placed by the abstract enunciative operator"$ENONC_{J0}$,"which contains at the same time the enunciative process, the complex operator of the enunciator "JE-DIS," and the compositive combinator **B**.

The representation of visual comfort in the form of a syntactic tree is shown inFig. 4.

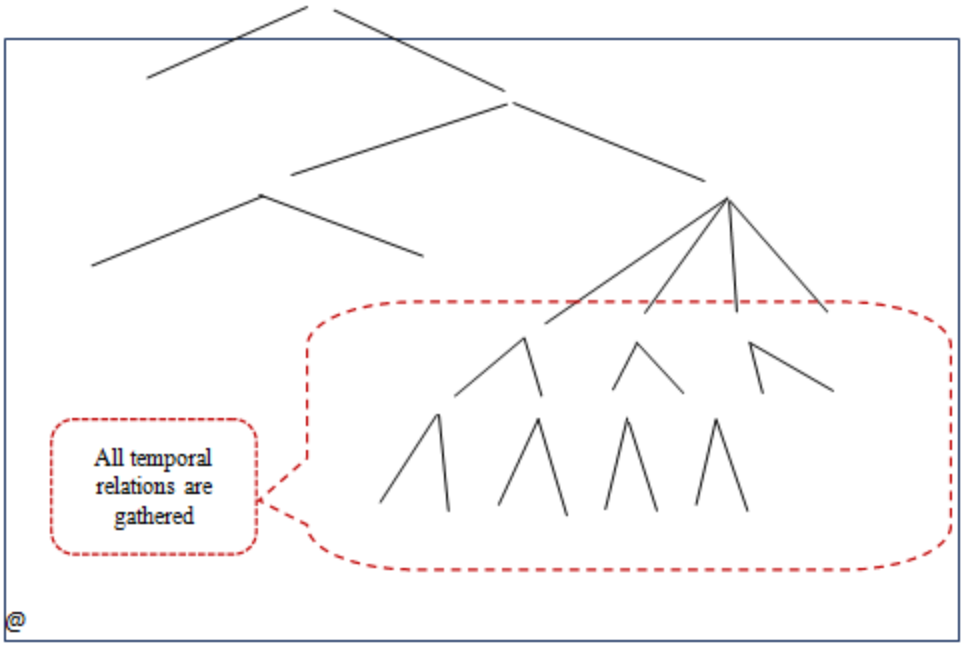


Fig. 2Syntactic tree form of the Representation of Schema I′

@

ENONC$_{J0}$&$_1$

&$_1$&$_3$

ASP^1_I(predicative relation^1) ASP^2_I(predicative relation^2)

&$_1$&$_1$rep [synchronization]

= **rep-$_{ING}$rep-$_{loc}$rep-$_{ING}$** REF REN

δ(J^0) T^0 J^0REN I I′ I′ REF

Schemas Iand I′ are the most abstract versions of the development and complexity of the aspecto-temporal application schema. They can be applied diverse semantic values and different forms of utterances, for example, one sentence having several clauses, a sentence describing a fictive narration, a sentence with universal truth such as a proverb or an apothegm, a conditional sentence, or an indirect discourse. With these schemas, various types of utterance, even having one, two, or several predicative relations, can be formulated.

4.2. Application to Different Types of Utterances

The aspect-temporal application schemas I and I′can treat different types of utterances as formal and logical expressions. In this section, examples of three types of utterances are applied to the abstract schema: (1) an utterance having one predicative relation realized in the enunciative

referentiality, (2) an utterance having two predicative relations realized in the enunciative referentiality, and (3) an utterance identified in the non-actualization referentiality, with two predicative relations.

- An utterance with only one predicative relation is situated on the temporal axis of the enunciator,that is, on the enunciative referentiality.

Representative examples are*John arrived in Seoul*, *He is tall*, *We are reading a book,* and so on. Each utterance can have a linguistic aspectual value,such asan *event, state,* or*process*. If a predicative relation is realized before the act of enunciation (which is the enunciative process), it represents the past tense.If it is being realized at the same time, it represents the present tense. If this is realized later, it represents the future tense.To treat these examples, schemes I and I′ can be reduced to a simplified one because there is only one predicative relation (Fig. 5).

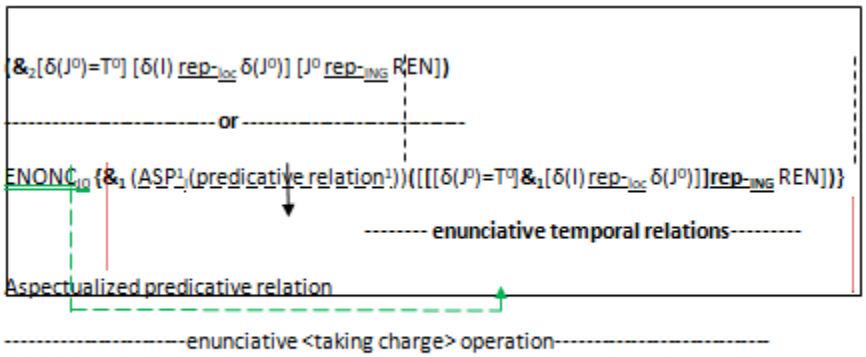


Fig. 3 Simplified reduction of schema I and I′ for a simple utterance

The utterances directly uttered by the enunciator are located in the REN.If an utterance occurs in the REN, the information about the REN (such as [J^0 rep-$_{ING}$ REN] in schemas I and I′) is redundant and implicitbecause the interval J0 is the ingredient of REN, and this referentiality REN is needed when another referentiality REF is presented.Accordingly, relations related to REN were deleted to avoid duplication of unnecessary information. For the case of a simple utterance presentin the REN, schemas I and I′ can be simplified (for visual comfort, see Fig. 6).

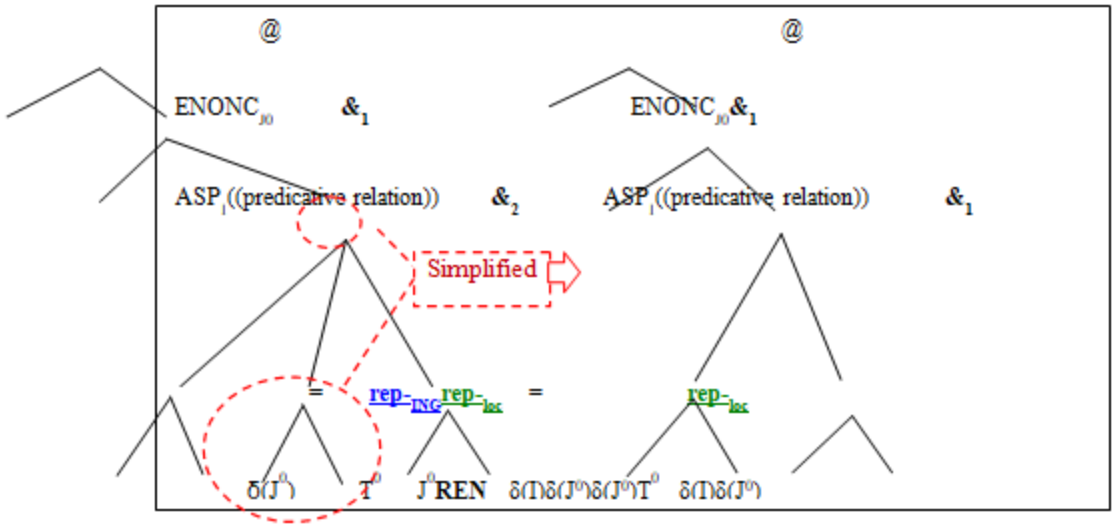


Fig. 3 Representation Tree of an Utterance having a Ssingle Ppredicative Relation in the REN

To formalize a simple utterance, this study takes a past event example *He arrives in Seoul*, whichmust be started from schema I. Because the example is present tense in the REN, all the information concerning two referentialities([REF rep REN] and the synchronization) is deleted. Furthermore, because this example contains only one predicative relation, the second predicative relation (or an adverbial expression)realized on an interval of instant I′ (expressed as $ASP^2_{I'}$ (predicative relation 2) and [[I rep$_{-loc}$ I′] &$_1$ [I′ rep$_{-ING}$ REF]])is also deleted. Then, an enunciative temporal condition concerning the predicative relation "[δ(I) rep$_{-loc}$ δ(J^0)]" is added. Finally, it must provide corresponding linguistic values.The operator of the aspectualized predicative relation ASP$_I$ is substituted with the linguistic aspectual *event* value, EVENT$_{F1}$, so the topological temporal interval "I" is replaced by F1.The predicative relation is substituted with (*arrive-in-Seoul*, *He*), the value of the locative detection system "rep$_{-loc}$."Depending on the time of the example (past perfect), the anteriority (<) value is assigned because this example takes place before the enunciative process.

Finally, from the abstract schema, the concrete schema of the example *He arrives in Seoul* is completed.

ENONC$_{J0}$ (&$_1$ (EVENT$_{F1}$(*arrive-in-Seoul He*)) ([δ(J^0) = T^0]))

- An utterance including two predicative relations in the REN.

If an utterance situated on the enunciative temporal axis contains more than one predicative relation (often two predicative relations), such as *He was sleeping when I arrived at home* or *Jean ate at the restaurant and the went to the movies with his friends*, the notational and conventional simplifications of schemas I and I′ change again differently compared with the first of a simple utterance because it is necessary to add information on the second predicative relation.

The first step removes all the information on the referentialityREF and synchronization, such as [I'rep-$_{ING}$ REF], [REF rep REN], and [synchronization].However, it must keep everything concerning the enunciative conditions, such as [[$\delta(J^0) = T^0$] &$_1$ [J^0 rep-$_{ING}$ REN]], but also the temporal relation between two topological intervals, [I rep-$_{loc}$ I'].Second, given that the utterance is in the REN, adds (as in the previous case of the simple utterance) an enunciative condition between the topological interval of the main predicative relation and the enunciative process: [δ(I) rep-$_{loc}\delta(J^0)$]. As seen in the example above, both predicate relations are located in REN, and the information between the enunciative process and the referentiality expressed as[J^0 rep-$_{ING}$ REN] can be omitted, because the temporal relation [$\delta(J^0) = T^0$] already represents the location and existence of the REN. After these modifications, another linear form of the conventional and notational simplification of the schema can be represented as shown in Fig. 7.

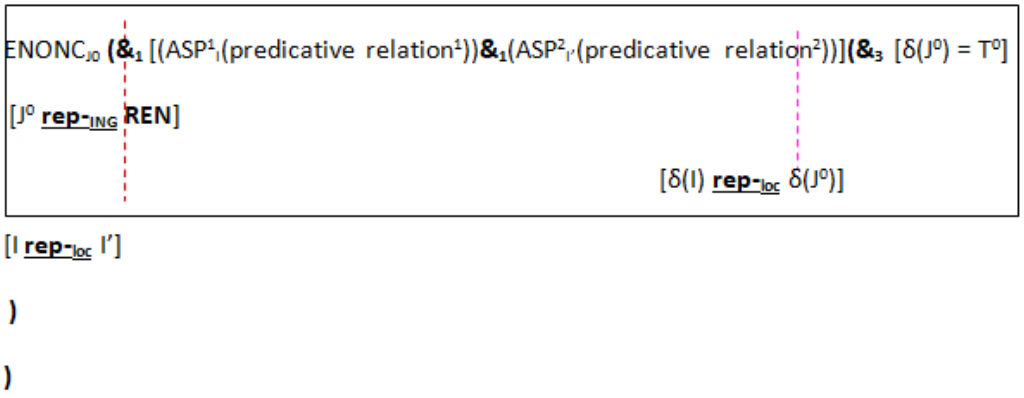


Fig. 4 An utterance containing two predicative relations in the REN

For example, *He was sleeping when I arrived at home* takes two predicative relations in the form of an applicative expression (*sleep He*) and (*arrive-at-home I*). Each predicative relation has an individual aspectual value *process* and *event*; thus, metalinguistic operators ASP^1_I and ASP$^2_{I'}$are substituted with PROC$_{J1}$ and EVENT$_{F1}$. The temporal interval of the first predicative relation J1 represents the past progressive form, and F1 represents the past perfect. The right boundary of J1 and the left boundary of F1 are concomitant; therefore, expressed as [$\delta(J^1) = \gamma(F^1)$] because, when the event occurred, it could not be determinedwhether the process had progressed.

With this necessary information, from the abstract schema, the concrete schema of the example *He was sleeping when I arrived at home* is completed.

ENONC$_{J0}$**(**&$_1$**[**(PROC$_{J1}$ (*sleep He*)) &$_1$(EVENT$_{F1}$(*arrive-at-home I*))**]**

(&$_1$ [$\delta(J^0) = T^0$]**[** [$\delta(J^1) = \gamma(F^1)$]&$_1$ [$\delta(F^1) < \delta(J^0)$]**]))**

- An utterance identified in the non-actualization referentiality (narrative referentiality), RNA, for example, *once upon a time, a beautiful princess lived in a water castle* or*Julius Caesar crossed the Rubicon,* etc.

A fictive or historical narration is not part of the world realized by the enunciator linked in the REN, and it is no longer identifiable in relation to the enunciative act (except for explicit indications indicated by synchronization). Therefore, the narrative situation must be inserted into another referentiality, RNA. All that is necessary is to assign the value of the RNA to each occurrence of REF and, automatically, the relation between REN and RNA is rupture (#), (Fig. 8). Synchronization between a left or right boundary of an interval and a referentiality would occur, if it exists, depending on the given context.

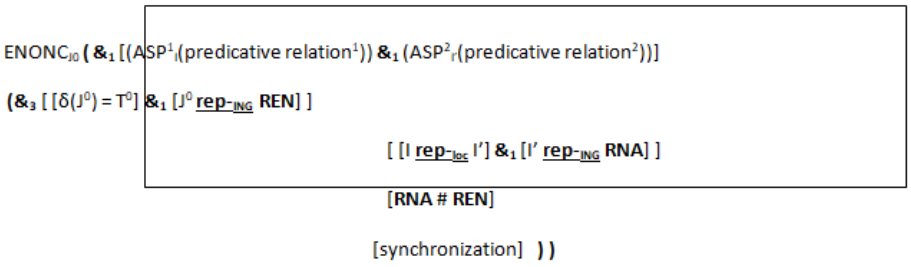


Fig. 4 An utterance situated in the RNA

The third type of utterances takes the following example:*Once upon a time, a beautiful princess lived in a water castle*for analysis. In linguistics, especially in the field of the applied analysis of natural language, only adverb expressions and predicative relations (which clearly have a subject and predicate) are analyzed. This is because the analysis object of linguistics is a clause unit having a predicate and a subject (a single noun or adjective is excluded from the analysis). In addition, adverbial expressions indicating time are also objects of analysis, even if they do not include the subject or predicate. This examplehas two objects to analyze: *Once upon a time* for an adverbial expression and *live-in-a-water-castle a-beautiful-princess* as a predicative relation.The adverbial expression represents a static situation in time; therefore,it is expressed as $STATE_{O1}$ (*Once-upon-a-time*).The predicative relation represents an event (a perfect aspectual value) and is included in the static situational interval O1, and is thereforerepresented as [$EVENT_{F1} \subset STATE_{O1}$]. These two analysis objects are both situated in the non-actualization referentiality because they cannot be referred to the enunciative time that the enunciator who uttered this example takes charge of,represented as [O1 ⊂ RNA]. Two different referentialities have a rupture relation, and there is no synchronization between them (it can thusbe deleted).

With theseanalyses, the concrete schema of the example *Once upon a time, a beautiful princess lived in a water castle* is completed as follows.

$ENONC_{J0}$**(**$\&_1$**[**($STATE_{O1}$(*Once-upon-a-time*))$\&_1$($EVENT_{F1}$(*live-in-a-water-castle a-beautiful-princess*))**]**

($\&_2$ [δ(J^0) = T^0] **[**[$EVENT_{F1} \subset STATE_{O1}$]$\&_1$ [O1 ⊂ RNA] **]** [REN # RNA]**))**

For the other types of referentiality, their schema forms would be identical to the form of the RNA, giving different values of the aspect, referentiality(I, I',and REF), and synchronization.Their

application to specific examples is planned for a later study.

Here, it is argued that the notion of temporal referentialityis necessary for a conceptualizing the temporality apprehended by languages. Temporal referentiality is made up of continuous instants identified by relations, either by *identification* (concomitance or simultaneity) or by *differentiation* (anteriority or posteriority). As previously noted, REN enunciative referentiality must be distinguished from the external referentiality REX. The enunciative frame of reference is organized from the enunciative process, and its right unaccomplished boundary is concomitant with instant T^0. For the analysis of different utterances and even the text, different referentialities must be considered,—particularly the RNA for non-actualized situations that are identified with respect to each other but independently of any reference with respect to their utterance. Thus, the RNA is constructed in relation to rupture with respect to the REN. Certain analyses (historical present and reportable present, for example) require not only the relation of *rupture*, but also a relation of synchronization between instants of two referentialities. Other referentialities, such as the referentialityof comments, the referentiality of possible situations introduced by *if* (*si* in French) andreferentiality for indirect discourse, have already been implemented in an analysis of specific examples of French (in [6], [7], [16],[17]). Because these different types of referentiality were introduced into the aspecto-temporal analysis of utterances, this study can lead to coherent analyses thatmake it possible to relate the analysis of time (more specifically, tense and grammatical aspects) apprehended through its categorizations by natural languages.These linguistic analyses are relatively simple and naturally instinctive to the analyses undertaken by physics (time of the universe), biology (time of life), and psychology (time of consciousness). The study ofreferentialities is one of the major pieces of a general theory of aspecto-temporal representations in several languages (for examples of referentialities in other languages: in French [7], [16], in Bulgarian [7], in Korean [16], and in Russian [17]).

5. Conclusions

In this article, a locative detection system that makes it possible to generate the identified relation of linguistic elements, in particular temporal relations of a given utterance, was described. Then, the introduction of referentialitiesand their conceptsare presented, in which aspecto-temporal analyses of utterances can be represented. Next, an applicative abstract schema is constructed using a locative detection system and the theory of referentiality.The presented abstract form schema is applicable to any type of utterance, including all the necessary information. Finally, three types of enunciative formsare applied to the completed abstract schema to verify its applicability and effectiveness.

The main idea of the schema is to deal with various types of utterances for computational formalization because their applicative expression form is highly adequate for a computing process in which all input units are operators applied to operands. Therefore, the presented abstract schema is the most canonical form to be applicable to different kinds of natural languages, andit can ultimately help in the inferential analysis of languages, as well as the implementation in a functional programming language.

The concept of referentiality is the "unifying concept" because temporal relations (concomitant or non-concomitant to the enunciation) and grammatical aspectual relations are all represented on the temporal axis—the referentialities. This unifying concept makesthe conceptual economypossible because it transcends the diversity of languages. It can be used to teach,learn, and even compare languages. The concept of referentiality is ultimately a function that makes it possible to analyze orunderstandmany natural languages.

This study was conducted only in the phase of analysis, indicating linguistic tense and grammatical aspects. However,the formalization of utterances integrated in the referentialities should not remain solely at the level of aspecto-temporal analyses. It canandshould further extend the scope of its analysis, that is, toward the junction with the integration of semantic-cognitive schemas (which is often presented in the domain of cognitive linguistics) of verbal predicatesin the formalization. Using the concepts and theory presented in this study, the abstract schema can be applied to a computer implementation based on formularization and algorithm work. The computational implementation can deal with concepts related to notions of referentialities because,by using the abstract schema, various types of utterances can be analyzed in the form of an applicative expression that is machine readable.

Acknowledgments

This work was supported by Hankuk University of Foreign Studies Research Fund of 2021.

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