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ANAPHORA PROCESSING WITHIN ADVERBIAL CLAUSES

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ABSTRACT. *Current models of memory within cognitive psychology try to account for the limited capacity of memory in language processing and generation of stories. In this respect, attentional mechanisms were analysed in order to study the strategies used both (i) in processing ambiguous anaphora within initial adverbial clauses and (ii) in generating references to complete the main clause of the sentence. The reported results suggest that top-down and bottom-up processing took place during reading and writing. It is argued that the possibility for strict referential access in anaphora resolution and generation can be determined by attentional memory capabilities.*

KEYWORDS. *Binding, focus theory, discourse processing, automatic inferences.*

RESUMEN. *Los recientes modelos de memoria dentro de la Psicología Cognitiva intendan dar cuenta de la capacidad de memoria limitada que mostramos durante el procesamiento y generación del lenguaje (i.e., comprensión y generación del discurso). A este respecto, los mecanismos atencionales son analizadas de cara a estudiar las estrategias que utilizan los seres hunanos durante (i) el procesamiento de anáforas ambiguas y (ii) la generación de referencias para completar historias. Los resultados obtenidos indican que se dan tanto el procesamiento arriba-abajo como el de abajo-arriba, y tanto en escritura (generación) como durante la lectura. Finalmente, se discute si el hecho de existir un acceso referencial limitado durante la resolución y generación de anáforas, puede estar determinado de alguna manera por las capacidades atencionales de la memoria humana.*

PALABRAS CLAVE. *Resolución de anáforas, comprensión del discurso, memoria de trabajo, inferencia en comprensión de textos.*

1. INTRODUCTION

There are strong reasons to believe that the whole contextual interpretation of a sentence is elaborated in an incremental way, with an integration process that happens to be very quick, say, as soon as possible. However, it is worthwhile to realize the difference between the immediate resolution of a sentence, from the point of view of the

pragmatic commitments involved in deciding a concrete interpretation rather than another, and the different forms of intermediate pragmatic interpretation. Roughly, experimental data indicate that different types of cohesion markers, such as pronouns or proper names, can serve to address the on-line resolution process in several ways. In this sense, it seems necessary a very detailed analysis about how this wide variety of expressions interacts directly with the discourse representation (that is, with the mental model of the discourse).

During understanding, the inferential activity seems to depend on the continuous control of an unfixed number of input signals (syntactic, semantic, textual, conceptual and probabilistic), being its coding either locally determined by the very text, or globally by more general expectations based on knowledge. For instance, anaphors form part of the general phenomenon of context dependency in natural language understanding, where the lexical input given by anaphoric expressions determines its interpretation in use, requiring an on-line mechanism of selection for identifying its particular value in a given context. This understanding process is facilitated by contextual information, or more specifically, by the common context holding between speaker/hearer or between writer/reader, at a given moment. Recently, psycholinguistic research suggests that understanding processes operate within a time scope that ranges between a few hundreds of milliseconds to a few seconds.

Evans (1989) argued that the interpretation of a problem affects its computation: errors are due to pre-attentional representational heuristics used during the process of language understanding in order to build a representation. This view is compatible with the work that shows the use of inductive inferences during understanding. It is compatible as well with Mental Model's Theory, because it presupposes that models are constructed (mainly) through the use of inductive inferences applied to propositions. Inferences that operate over the resulting representation can be purely deductive, as Johnson-Laird (1983) has suggested, or can also include other inductive heuristics, such as those proposed by Kahneman & Tversky (1982).

On the other hand, memory structure is important for problem solving but also for remembering. The research developed about text understanding shows: (i) that events with a lot of causal links are better remembered than those with few causal links (Trabasso & van den Broek 1985); (ii) that events in a "causal chain" of a story are better remembered than those that aren't present in the chain (Black & Bern 1981; Black & Bower 1979, 1980; Trabasso et al. 1984; Trabasso & van den Broek 1985); and (iii) that well-structured stories (that is, stories with a high number of events connected by causal chains) are better remembered than stories poorly structured (Trabasso et al. 1984). Given the importance of narrations as representations in memory, we can expect that such structural variables have a strong impact on the way events are remembered. Furthermore, in as much as autobiographical memory is organised in a narrative way, similar structural features would affect the remembering of personal events (Brown 1990).

The aim of this paper is to analyse the recent developments in cognitive psychology in the study of memory and to evaluate whether or not they can supply some explanations about the nature of language processing. In this respect, we will analyse the results of a pilot study we have designed in order to account for language understanding and generation of stories based on everyday schemes. In the first section, we will analyse the current models of memory within cognitive psychology, describing how they try to account for the limited capacity of memory (namely, attentional mechanisms). In the next section, we will describe the study mentioned above, trying to examine these attentional memory capabilities and, finally, we will discuss the consequences of our results for the dynamics of focus shifting during both language understanding and language generation.

2. WORKING MEMORY CAPACITY

Within traditional accounts of memory, the two different parts of the memory system proposed by William James –Short Term Memory (STM, primary) and Long Term Memory (LTM, secondary)– have been related to the immediate processes and to the storage of knowledge structures, respectively. This distinction was the core of information processing approaches to memory that dominated memory research during the sixties. Nevertheless, approaches of this kind were finally abandoned. One of their main problems did arise with the notion of STM storage. STM was considered a passive intermediate memory where the information remains until it is finally processed. Its capacity was conceived as essentially static, reflecting the ability for passively storing non-structured information, for instance, chains of random digits or words. The classical study of Miller (1956) estimated the short-term storage capacity at seven, plus or minus two, items of information. The surprising fact was that the size of the items was never determined, seeming to vary according to the kind of processed information. Research showed later that subjects were able to remember seven familiar sentences as easily as seven random words. This variability suggested that the active processing also plays a role in STM storage. Furthermore, and this aspect is important for the research on individual differences, static STM capacity (say, memory of lists of random words or digits) has brought about very poor predictions about reading ability and other higher cognitive processes (Perfetti 1985).

"Working memory" conception, on the other hand, emphasizes processing and storing functions. According to this view, working memory serves as a "computational arena" where processing is performed and its partial products are stored for further processing (van den Broek 1995). A central assumption of this account is that processes and knowledge structures compete for this shared limited capacity. Information can be missed because of the decay of the activation strength or by removal, when other additional structures that are coded, activated or constructed, exceed its capacity. Accordingly, a task requiring expensive processing will decrease the capacity for retaining additional information, because it needs to pay more attention to the requiring

processes. In other words, in this case it is employed a capacity for processing that, otherwise, would be available for storage. In contrast to short-term storage, that was defined in terms of spatial units for static storage, working memory capacity is defined in terms of an operational capacity in respect to some specific domain of cognitive processing, serving as an index of the relative processing efficiency.

The elasticity of the working memory capacity is measured by means of a concurrent processing task designed to unfold both the processing and storage functions during immediate processing. Ordinarily, the subject performs a primary memory task, while at the same time she has to perform a task of simple processing that also needs resources. The work of Daneman & Carpenter (1980) is illustrative in this respect. In this study the subject is asked for reading aloud a set of sentences while having to remember the last word of each sentence. At the end of each set of sentences, the subject has to remember the whole number of the last words of the sentences in the set. The number of sentences in a set -and the number of last words to be remembered- increases uniformly, resulting in a higher demand of processing in the subject. Thus, the working memory capacity of a subject is indicated by the number of last words correctly remembered.

The relationship between reading span and reading ability has been extensively examined (Johnson, Rugg & Scott 1987; Baddeley et al. 1985; Vallar & Shallice 1990). The different types of reading spans have a positive correlation with the measures of reading understanding, as well as with other specific reading abilities, such as the one to pick up the referent of a pronoun. The differences in working memory capacity have been related to discourse processing, specifically to the ability to perform elaborative inferences that facilitate understanding. These capacity differences are also involved in syntax processing during reading. In the research into syntactically ambiguous sentences (garden path), eye movements data show that readers with higher reading spans are able to maintain activated alternative syntactic representations for more time than readers with lower reading spans. The latter select quickly a particular interpretation, often erroneous, at the early stages of the processing of the sentence.

The correlational nature of the evidence linking working memory capacity and reading ability demands a careful interpretation. The behaviour in diverse reading tasks can depend on working memory capacity, but it may also be that this capacity reveals just a higher level of reading capacity -even it is possible the existence of a third factor as responsible for the performance level in both cases. Although the relationship between working memory and reading seems quite strong, other aspects of discourse have to be considered as well.

In the attempts of modelling text understanding, some problems arise when just purely structured rules are employed. For example, it has been used a propositional *coherence graph* for representing the text, where propositions are connected whenever they share an argument (see Kintsch & van Dijk 1978; Kintsch 1988). Relevant features of this repetition model of concepts are the strategies that select the propositions to be retained in the STM, which has a limited capacity, in order to process the next input. Although such strategies are grounded on an evaluation of the relative importance of

propositions, the model does not specify *how* the most important or *thematic* propositions are selected. This evaluation turns out to be also relevant for the construction of the macro-structure, that consists in an abstract representation of the original coherence graph. The propositions of lower importance are deleted from the representation and the abstractions and generalizations are constructed from the most important propositions. In this concern, some mechanism to evaluate the relative importance of propositions becomes again necessary.

2.1. *Topic and Focus*

The function of the topic in discourse has been usually conceived as the one that defines the connection of the sentences with the discourse coherence. Such topics must be defined in terms of propositions, sets of propositions and/or propositions carried out by such sets. Recently, another notion of topic at the sentence structure level has been used in linguistics, often in combination with the notion of *comment* and *focus*. The definition of such structures is specified in semantic and pragmatic terms of information and distribution of information in sentences. The intuitive idea behind the assignment of such structures in a grammar is that in a sentence we can distinguish between what is being said (affirmed, asked, and so forth) and what is being said about *what*, a distinction that clearly parallels the classical distinction subject-predicate in Logic and Philosophy.

The notions of topic and comment possibly do not correspond to particular syntactic categories, but they must possess at least a semantic status. Such a semantic status should reveal that a topic is some function that determines the item about which something is being said currently. Analogously, topics are usually associated to what is already known (by the hearer) in some particular context of discourse, or to what is presupposed by any sentence. On the contrary, the comment is associated with what is unknown (to the hearer), but nonetheless affirmed. A sound explanation of the preceding notions should be framed in a referential semantics and in a pragmatic component.

Therefore, noun phrases with topic function can or should be typically pronominalized. In this way, the topic can be associated with the logic category of *binding variable*, in the case of individuals and properties or relationships. Roughly, we can think about topics as those elements of a sentence that are bound by the text or previous context. From a cognitive point of view, topicalization of certain phrases consists probably in a process by means of which the knowledge of certain individuals is foregrounded, namely, carried from LTM stores to some working memory where the stabilised information can be combined with new information. But, what are the consequences for discourse structure and interpretation? The first point to emphasize is that, according to the adopted assumptions, some sentences at the commencement of a discourse or a discourse section (for instance, a paragraph) can lack topic in some occasions, as turns out to be in the cases where an individual object or a property known by the reader/hearer is not selected for commentary.

3. ANAPHORA PROCESSING

The several theories on discourse processing proposed for the last decade, as well as the empirical results supporting them, suggest that a lot of ingredients are involved in anaphora resolution. This seems to be so, specially if we take into account the facility (speed) to read sentences containing anaphors which are preceded by sentences where antecedents have been manipulated.

Making use of referential terms is crucial for written text comprehension. These terms bring coherence that allows a sequence of sentences to remain united as a text. In general, studies about reference have focused on pronoun comprehension and have examined the role of general knowledge for understanding them. On the other hand, it has been shown that heuristic strategies are also employed in pronoun resolution. For instance, subject assignation strategy has been analysed (Crawley 1986), as well as parallel function strategy (Caramazza & Gupta 1979). Furthermore, Sanford & Garrod (1981) reckon several heuristic strategies that include current topic assignation, assignation to close expressions and assignation to concepts previously referred in a reiterative way. Some of these strategies, concretely, the former two, are valid just for sentences, while the remaining ones are valid for texts (topic assignation strategy). In the present paper, we will analyse the relationship between these types of strategies.

Topic assignation is a heuristic based on text that requires knowledge of the text structure. Empirical evidence suggests that stressing an entity as more salient than others, namely, as a discourse topic, affects text comprehension in general, and pronoun resolution in particular. There have been found higher reading times for non-topicalised antecedents *versus* topicalised antecedents and, for sentences containing a reference to an antecedent introduced as grammatical object of a previous sentence *versus* as its subject (Hudson, Tanenhaus & Dell 1986). These results are consistent with the idea that antecedent topicalization serves to install in focus the antecedent referent, thus affecting the ease of anaphora resolution.

In texts, a topic becomes indexed by several structural features. Among them, are title, initial mention, frequency of mention and the employment of a name instead of a noun phrase. All these structural features are important because of their contribution to the salience of the items in a text. Given that it turns out to be that pronouns usually refer to salient entities, it is probable that these features are relevant for the reference obtained by means of their use.

Up to date, research has investigated the comprehension of reference terms or the production of such terms (Anderson et al. 1983; Garrod et al. 1994; van den Broek 1995; Hobbs 1976), but not both together. Research in comprehension has offered some evidence showing that there is an effect of a factor at the sentence level (i.e., the position of the antecedent in the sentence) during pronoun resolution in texts. On the other hand, some investigations on production of reference terms have found that the subject of the sentence and discourse structure affect the selection of an antecedent in a text. For instance, Hobbs (1976) examined pronouns of several texts finding that about 90% of

pronouns referred to the subject of the previous sentences. Other investigations, using a completion task, have shown also the importance of discourse topic. For instance, Anderson et al. (1983) found that pronouns were generally reserved for statements about the main actor rather than about secondary actors. However, these studies have been centred just on texts without examining in detail the relationship between processes at sentence level and processes at text level. The functional and psychological dimension involved here alludes to the measure of topic accessibility by the reader, according to the distance from the previous mention in the discourse, amount of semantic redundancy available in the proposition and amount of thematic redundancy available in the text.

Later on, we will present an study aimed at analyzing the nature of some conditions for focus shifting. In doing so, we will try to show how the introduction of a new entity in the discourse affects the salience of a previous entity in the "mental representation" of the text. When designing it, we have believed that it is worthwhile to examine the use of discourse markers. In this respect, we try to emphasize the fact that markers play an essential role along discourse development, because phenomena such as topic shifting appear generally preceded by markers whose function is just to point out and inform the reader/hearer about the phenomenon that is going to happen. Analyzing the role played by these markers in the framework of discursive coherence, Schiffrin (1987) considered that markers play several functions at each level of discourse, in addition to their proper role in the integration of the discourse as a whole. In this work, we will deal with two concrete types of markers: when a new entity can appear in a subject or no-subject position and when a subsequent ambiguous pronoun appears in an adverbial clause that is the first part of the final sentence. The task for the subjects is to interpret this ambiguous anaphora and write the final part of the last sentence.

4. FUNCTIONAL DISTRIBUTION OF ADVERBIAL CLAUSES

Givón (1982), based on examples constructed with a minimal context, suggested that adverbial clauses are "topics" or "pragmatically presupposed" just when they precede the main clause. However, they are "focus" or "stated information" when they follow the main clause. Later studies tried to refine these results. Thompson (1985) concluded that initial and final clauses perform different functions in discourse. Initial clauses guide the attention of readers by pointing out how the following material has to be associated with preceding material. Final clauses do not have the same function but a different and more localized one: they serve just for consigning the purpose by which the mentioned action in the main clause is developed. On the other hand, Chafe (1984) suggested that the role of adverbial clauses varies according to two conditions: one is related with the position in respect to the main clause, while the other with the amount in which adverbial clause is linked to main clause.

The studies above bring us some worthy intuitions about the behavior of the different types of adverbial clauses, suggesting that their position is established by the organization of the information in the discourse. Therefore, initial clauses depend

largely, for their interpretation, on the preceding thematic context. Typically, thematic links are broader, more abstract, and connect with higher thematic nodes. In this way, it is possible that they appear in the important thematic breakdowns of discourse. Following Givón (1987), they function as a combination of the anaphoric and cataphoric grounding mechanism. The anaphoric connection is primarily thematic (A), while the cataphoric connection is mainly semantic (B). Nevertheless this does not exclude a parallel thematic grounding function in relation to subsequent discourse (see Figure 1).

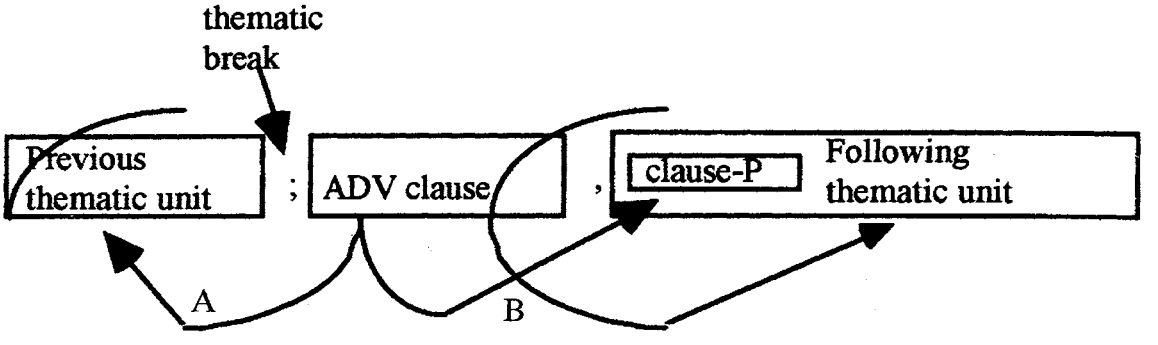

Figure 1. *Diagram proposed by Givón (1987)*

Research on topic continuity, in connection with pragmatically controlled word order, suggests the following general principle: "Topic noun phrases more predictable/continuous follow verbs; while topic noun phrases less predictable/continuous precede verbs". A similar ordering principle can be involved in the order of adverbial clauses: initial clauses are used in situations of great thematic discontinuity. In fact, the results obtained by Ramsay (1987) showed several refinements concerning referential and thematic continuity. In respect to referential continuity, these clauses exhibit a lower referential continuity than final clauses in relation to main clauses, but nonetheless a higher referential continuity than main clauses with previous discourse. With respect to thematic continuity, they exhibit their discourse coherence -or continuity- in relation to the preceding discourse in more abstract, thematic terms.

As we will see below, the task employed in our study is a completion task that allows comprehension and production of reference terms to be examined. The proposed task consists in completing a sentence fragment (an initial clause) making reference to one of the two entities mentioned in text. This fragment of the last sentence contains an ambiguous pronoun that subjects should interpret (with respect to the two entities of the text) in order to perform the completion task. Subjects have to choose a reference term as well as a referent. They have to assign the pronoun and then produce a completion compatible with such an assignment.

In these cases, it is probable that antecedent selection turns out to be affected by the salience of entities in the subject's working memory, in particular, by the salience of a new entity previously introduced in the discourse. Nevertheless, antecedent selection

can also be affected by any of the assignation strategies previously mentioned. Some of these strategies can be used, such as the one of subject assignation, given that the second entity of the text can appear in different grammatical positions of the previous sentence. In written text, we can expect that discourse topic turns out to be a salient entity able to modify the subject effect of the previous sentence.

In understanding situations, our prospects are oriented to check whether the effect of the subject and/or topic shall be more marked, or may be modified, by the undertaken strategies in presence of an ambiguous pronoun. In production situations, it is also possible to examine the reference terms (for instance, ellipsis, pronouns or proper names) used to refer to the subject and object of the sentence and to the topic and no-topic of a text. Some evidence suggests that the less explicit referential forms are used to refer to the more salient items in texts.

4.1. *Study*

In the study we used texts based on everyday schemes. Each text mentioned two individuals of the same sex. The first entity always appeared at the beginning of each discourse, while the second one could appear with different syntactic roles: subject (condition A) or in some grammatical position of the verb phrase (condition B) of the previous sentence. The last sentence contained two parts neatly separated. In the first one, an ambiguous pronoun was introduced in an initial adverbial clause, whereas the second one was a dots open line to be filled by the study subjects. For example,

Ann inherited a lot
She wanted to build a detached house
Finally, the Town Council gave license
Texts A] *She ordered the job to Louise*
Texts B] *Louise took charge of the job*
When she had the plan,.....

The task to be accomplished by the study subjects (30 volunteers, students of Psychology) consisted in reading 22 texts built with this same structure, eleven corresponding to condition A, and the remaining ones to the condition B. After reading each text, subjects had to complete the last sentence. Next, they had to answer two control questions in order to check, firstly, which of the two entities the ambiguous pronoun was assigned to in the first part of the last sentence; and secondly, to specify which of the two entities was referred to during the sentence completion task (for instance, subject could employ a pronoun referring to one entity different from the one assigned by the pronoun). Therefore, the tasks consisted in assigning the pronoun to one of the preceding actors (understanding) before producing a text continuation.

4.2. *Results*

In order to analyze the results of the subjects performance in the target task, we have considered two complementary ways. The first one consists in analyzing the

references assigned by the subjects according to their answers to control questions. We have called 'A' to the first actor of each text and 'B' to the second one. As a second way, we have used a similar analysis for completions of the last sentence made by the subjects according to the referred actor, and how this reference was obtained (the reference term). In both cases, we have performed an analysis of frequencies (crosstab) in order to examine the activation degree of the text entities in subjects' working memory.

Table I shows the results of the subjects' options obtained in each (type A and B) text, in relation to the references performed in both questions. The four conditions have been grouped as A1, A2 and B1, B2, respectively. The references have been grouped as 'Reference A' (first entity), 'Reference B' (second entity), 'Reference A&B' (reference to both) and 'Other' (references to other elements).

	TEXTS A		TEXTS B	
	1st question Gr. A1	2nd question Gr. A2	1st question Gr. B1	2nd question Gr. B2
Ref. A	17 56.7	11 36.7	13 43.3	13 43.3
Ref. B	13 43.3	8 26.7	17 56.7	12 40
Ref. A&B	–	8 26.7	–	3 10
Other	–	3 10	–	2 6.7

Table I. *Group average table*

A rough examination of the references performed by the subjects in each condition, shows the existence of different selections between the answers given to the first questions (A1, B1) and the ones given to the second ones (A2, B2). In condition A1 and B1, all references are focused on references to A and references to B; while in conditions A2 and B2, subjects also make references to other entities or to both together. The results obtained concerning the ambiguous pronoun seem to support our initial hypothesis: there are more references to the first entity in those texts where the second entity happens to be in no-subject position. However, when the second entity plays a role as subject, the amount of references to it increases notably. Concerning reference production during the completion task, the distribution in texts pertaining to condition A runs parallel to the distribution exhibited in the interpretation of the ambiguous pronoun. In text pertaining to condition B, there is not such parallelism of distributions between B1 and B2. In the

completions of both types of texts, there are more references to the first entity than to the second one.

There is, however, a surprising fact in the results of the study: it happens to be a great variance in the standard answers given by the different subjects to the first and second questions. Far from coinciding, the standard answers differ to a great extent depending on each type of text. In completion tasks, references to the second entity increase inasmuch as it appears in a subject position, whereas reference to both decreases. In texts completion in which the second entity appears in a non-subject grammatical position, the reference to both entities is very high. It seems that in the former texts the second entity is considered in completions, however either slightly or together with the first entity. In texts where it appears as subject, study subjects do prefer either one or other interpretation, that is to say, the subject position seems to produce a topic shifting. Because of this reason, it becomes necessary that an examination is in order to check the dynamics of attentional mechanisms (antecedent activations) both in anaphora resolution and in sentence completion. Table II shows crosstab tables performed for each experimental condition: type of text and type of reference to each question.

Texts A

A1 \ A2	Ref. A	Ref. B	Ref. A&B	Other	Total
Ref. A	7	5	4	1	17 56.7
Ref. B	4	3	4	2	13 43.3
Total	11 36.7	8 26.7	8 26.7	3 10	

Texts B

B1 \ B2	Ref. A	Ref. B	Ref. A&B	Other	Total
Ref. A	5	5	2	1	13 43.3
Ref. B	8	7	1	1	17 56.7
Total	13 43,3	12 40	3 10	2 6,7	

Table II. *Distribution frequencies between pronoun referent and completion reference*

In order to know the differences that exist between the several strategies of reference assignation, we have proceeded by analyzing separately each of the two types of text. In those texts where the new entity appears as subject, the main entity remains as topic in the completion, and rarely a topic shifting takes place. Notwithstanding, there do happen to be some similar reference shifting between pronoun resolution and completion. That is to say, if a pronoun is interpreted as A (main actor), the completion makes reference to B and vice-versa. When references to both in completion are analyzed, similar results are obtained if pronoun refers to A as well as B. Roughly, it can be considered that the main entity remains as topic, whereas the introduction of a new entity as focus, in a non-subject position, yields a sort of balance in the activation of both entities.

On the contrary, in those texts in which the new entity appears as subject, it is regarded as the referent of the ambiguous pronoun, although during completion the two entities are considered again, and the same turns out to be when a pronoun is interpreted as making reference to the main entity. Finally, references to both entities in completion is lower than it is in texts of condition A. Thus, there seems to be some mechanism for focus shifting between the reference to the ambiguous pronoun appearing in the initial adverbial clause and the reference used in completions. In the last section of this paper, we will guess at some possible causes of such a dynamics of focus shifting. One of them could be the attempt of adjusting the text as a whole system involving the two entities for its completion. In this concern, it seems interesting to ask for the referential terms employed by the study subjects to write completions. Concretely, we will check the referential terms used in order to build the subject of the main clause. In this way, references to A, B, and A&B have been divided in three possible types: (1) explicit mention of proper name, (2) pronominal reference and (3) nominal ellipsis (see Table III).

Texts A

A1 \ A2	A1	A2	A3	B1	B2	B3	AB2	AB3	Total
Ref.A	–	1	6	4	1	–	2	2	16
Ref.B	1	–	3	1	–	2	2	2	11
Total	1	1	9	5	1	2	4	4	
	3.3	3.3	30		16.7	3.3	6.7	13.3	13.3

Texts B

B1 \ B2	A1	A2	A3	B1	B2	B3	AB2	AB3	Total
Ref.A	–	–	5	4	–	1	1	1	12
Ref.B	5	–	3	1	–	6	–	1	16
Total	5	–	8	5	–	7	1	2	
	16.7	–	26.7	16.7	–	23.3	3.3	6.7	

Table III. *Distribution frequencies between pronoun referent and the referential terms employed by the study subjects to write completions*

In Table III the chief type of referent was the subject of the main sentence concluding the text. Moreover, there were types of reference to both entities (direct object and indirect object), ambiguous references (it was not clear which the referent was) and other references (in the case of completions in which either other entities or none were mentioned). These categories did not bear any relevance for the purposes of this study and thus they are not reflected in the final analysis. This work just reflects three types of reference terms: ellipsis (3), pronouns (2), and nouns (1). The term "ellipsis" was used to indicate that the subject had been moved from the completion sentence, not representing thus a clear linguistic category. Pronominal category attended to personal pronouns and definite nominal phrases, and nominal category attended to proper names.

In our study, it can be considered that subject was easily accessible, as a referent in readers' working memory, in order to complete the final sentence. In this way, in texts of condition A, if the ambiguous pronoun refers to the main entity, the following possibilities happen to be in completion: (i) all subjects that refer to the main entity use ellipsis and (ii) if the secondary entity is referred, then its proper names are used. When the pronoun is interpreted as making reference to the secondary entity, then it happens the following with the subject of completion: both referring to himself or making reference to the topic, it uses ellipsis.

In texts of condition B, if pronoun is interpreted as making reference to the main entity, then the subject of the completion can also refer (i) to the main entity by using ellipses, or (ii) to the secondary entity by using the proper name. On the other hand, if pronoun is interpreted as making reference to the secondary entity, the subject of completion refers to (i) himself by means of ellipses, (ii) the main entity by using the proper name and (iii) the main entity by using ellipses. In general, the continuity of reference makes use of ellipses while a focus shifting makes use of proper names.

5. DISCUSSION

The analysis of completions confirms that there are more references to the subject than to the no-subject (direct object or indirect object). The initial clause seems to interact with the reference to subject or no-subject. There is an influence of the topic of each text in the selection of the referent and the type of referential term used. However, the selection of a referential term is affected by the position the new entity occupied and by the interpretation of the ambiguous pronoun inserted in the subordinate clause.

It is plain that completions in which the new entity was mentioned in a subject position were more frequent than those in which the new entity appeared in a no-subject position. It seems that the fact that topic or no-topic were attached to the adverbial clause, does not bear an important effect, although this factor interacts with the type of assignment made to the ambiguous pronoun and with the type of referential term employed in the construction of the main clause. Our remarks about the frequency tables above suggest that this interaction is due to the fact that the participants in the study did

infer with more probability that the ambiguous pronoun makes reference to the new entity when appearing in a subject position, thus becoming the new text topic. Nevertheless, the selection of the referential term was affected by the grammatical position of the new entity and by the assignment given to the ambiguous pronoun. Altogether, our results suggest that the subject of the sentence is a salient item in working memory. This salience increases if the subject of the sentence is also the textual topic. On the other hand, it seems that the presence of an ambiguous pronoun activates a specific strategy in order to assign the pronoun to the (salient) subject of the sentence.

These results show that people refer more often to subjects than to objects, both in understanding references as well as in production. This preference increases when the pronoun has to be understood, instead to be produced. Other factors at sentence level (subject) are important both in top-down processing (production) and bottom-up processing (comprehension). The subjects of the antecedent sentences are selected as referents more often than no-subjects (objects). This suggests that subject is also important both in top-down processing (production) and bottom-up processing (comprehension). The production of completion can be considered as reflecting top-down processing, given that the referred entity has a high probability of being accessible from working memory. On the contrary, comprehension not only reflects such top-down processes, but it requires bottom-up strategies as well, that become activated in presence of pronouns.

The results suggest not only that subject is, in general, salient during reading, but also that pronouns can activate specific heuristic strategies involving assignment to the subject of the antecedent sentence. Given that all pronouns in the study did appear in a subject position, these results could be explained by subject assignment or by the parallel function strategy. This view is consistent with previous research showing the saliency of the subject of the sentence in isolated sentences and in texts (see, for instance, Kieras 1980; Hobbs 1986; Crawley 1986).

Production results also indicate that text topic affects the selection of referent and the type of referential term employed in production. The textual topic is employed together with the subject of the sentence to establish a salient entity in working memory. Nevertheless, in completion productions this salience is also affected by the easiness with which the salient entity can be distinguished from the non-salient one, that is to say, by whether or not there is a focus shifting.

Comprehension results show that a meaningful effect of topic underlies top-down processing. This idea is compatible with those presented by Sanford and Garrod (1981). However, other conditions that also point strongly to the topic cannot be discarded. For instance, introducing a title referring to one of the entities, or introducing a pragmatically ambiguous sentence previous to the initial adverbial clause. The pronoun of such a sentence would refer to the new introduced entity, even though it could be assigned to the antecedent entity given that it is highly topicalized (for instance, when it turns to be the subject of the antecedent sentence). We should analyze as well the way these entities behave when they are referred to by other types of referential terms such as definite noun phrases. In this concern, inasmuch as the target texts are based on schemes, we could ask

for the interaction between definite references to entities that belong to the schema and those to particular entities that only fill a role in the schema (see, Garrod et al. 1994). Therefore, the effect brought about by the subject of the sentence, specially in conditions of comprehension where top-down processes also operate, can have been strong enough as to conceal some top-down processes resulting from a weakly marked topic. In our study, even when topic had some effect in production, the effect of the subject did not seem to be cancelled, but only modified.

It seems thus worthwhile to suggest that the selection of the referential term in completion also supports the idea that both subject and textual topic contribute to the salience of an item in working memory. Previous work on spoken language supported the claim that people usually prefer inexplicit reference terms for making reference to salient items, and it seems that something like that turns out to be in the case of written language. However, when in the present study the reference stood for the object of the sentence, it was observed a preference to employ the name of the entity as reference term. This fact seems to indicate a preference to use explicit terms for non-salient referents. Anyway, there have been pointed out some quandaries concerning whether salience effect is due only to the subject of the sentence or may be due to the presence of a textual topic as well.

Finally, there exists a common agreement concerning the claim that adverbial clauses tend to codify previously given information rather than new information. In narratives, the preferred strategy is to link relative clauses containing new information to indefinite NPs, and those with given information to definite NPs. On the other hand, adverbial clauses usually appear in the more important parts of discourse, as a breakdown in (a) referential continuity, (b) temporal continuity, (c) spatial continuity, (d) sequential action continuity and (e) thematic continuity. In this concern, Ramsay (1987) showed that initial clauses exhibit weak referential continuity with respect to the main clause, that is to say, the subject of the initial clause is usually different from the subject of the main clause. Furthermore, sometimes it turns out to be that the subject of an initial clause is the same as the one of the closest antecedent clause, but there are frequent cases where the reference for the subject of an initial clause is located in one of the several clauses that appear in the previous discourse. For instance, initial clauses (if and when) seem to be thematically linked to the main clause as well as to the previous discourse, even more frequently in the latter case. In terms of Chafe (1984), an initial adverbial clause introduces a constraint on focus: it indicates a path through which the following information shall be comprehended.

It can be considered that initial clauses operate as topics, in such a way that they bring up frameworks in order to guide the processing of the subsequent text. In this respect, their role would be to organize the text, by breaking it into meaningful units. 'When' clauses are used in narratives almost continuously in initial positions. We could conclude that this 'location' turns out to be determined by the organization of discourse. Nevertheless, this phenomenon is also related to other factors, in addition to the goal of connecting or sequencing the information. Because of this reason the study subjects tried

to organize the story and to use the information attending to all these factors in order to generate a coherent ending.

5.1. *Referent Access*

As mentioned above, there are lots of different ways of performing a reference in texts. In the present paper, we have examined several factors underlying the selection of these different forms, and have tried to account for this selection. In this concern, Ariel (1990) considers the notion of "givenness" as a chief factor for explaining the selection of referential form, rejecting what could be denominated a geographical account. According to this later approach, the different forms of reference reflect the origin of a given information from which an antecedent can be retrieved. While proper names and definite descriptions help to recover antecedents by means of the hearer's general knowledge, demonstratives serve to work with the inmediate physical context and pronouns and ellipses with the inmediate linguistic context. Nevertheless, as Ariel pointed out, it is easy to find counterexamples to this simple correspondence between referential form and retrieval function.

On his part, Ariel adopts the notion of contextual accessibility proposed by Sperber & Wilson (1986) in order to account for the distribution of the different referential forms. The basic idea is quite simple. On the one hand, antecedent information is ordered according to the accessibility degree for readers in some point of the understanding process; on the other hand, noun phrases are marked according to the accessibility of its antecedents. This way, a noun phrase marked for a high accessibility, for instance an ellipse or a pronoun, will retrieve just an easily accessible antecedent; instead, one marked for an middling accessibility, such as a demonstrative pronoun, will retrieve just a moderately accessible antecedent, and so forth.

Nevertheless, this theory has some shortcomings. The reason is that it doesn't establish clear principles to define antecedent accessibility independently of the preferred reference form. As it happens with focus theories, it is very difficult to go beyond some apparent rules, such as the amount of text involved, antecedent topicality, and so foth. Therefore, it is necessary a more accurate psychological account of processing including accessibility. Ariel has the intuition that these considerations could be treated in a representation theory of distributed type (PDP), where accessibility could be represented in a unidimensional way (cf. van den Broek 1996). However, the hearer's ability to retrieve antecedent information may involve a complex interaction between reference form and the representational form of the antecedent, that is to say, it surely involves inferential processes.

6. CONCLUSION

As we have seen, our information processing system is affected by a wide range of constraints that must be accounted for when trying to design a cognitive architecture for

text comprehension. Among them, we can point out that our STM has a limited capacity and a huge flexibility if compared to the proposed computational systems. Furthermore, those systems would have large difficulties, as well to account for many of the experimental results carried out both in processing and in understanding.

In our study, comprehension of ambiguous pronouns crucially depends on the salience of discourse entities. Its presence seems to activate a specific strategy in order to assign the pronoun to the more salient entity of the discourse. That is, in our study, the largest part of references was rendered to the main actor, exception made of those texts where the secondary actor did take over an important grammatical role, i.e., a subject position in the previous sentence. Something like that turned out to be the case concerning production of references during the completion task, thus suggesting that subject position in the antecedent sentence brings about a focus shifting. Finally, the continuity of the reference assigned in the adverbial clause was achieved by means of ellipses, while a reference change normally involved the employment of proper names. Roughly, our results suggest that a sentence subject is a salient item in the reader's working memory. Besides, this salience increased when the subject was also the textual topic.

According to the mentioned results, factors at sentence level (for instance, subject) turn out to be key elements both in comprehension and in language generation. Completion task can be considered as a mirror of top-down processing given that the referred entity has a high probability of being easily accessible in working memory. On the contrary, comprehension also reflects bottom-up strategies that are activated by the presence of an ambiguous pronoun.

This variety of cognitive processes involves several levels of intermediate processing ranging from stimulus perception to problem solving. Such processes take place in hundred milliseconds and as such have been so far computationally intractable from the classical viewpoint (Shastri & Grannes 1995). On the second hand, connectionism does not bring about a clear solution. In this concern, it has been severely criticised by its shortcomings for carrying out some inferential processes and there the matter rests whether or not neural networks can exhibit a systematic behaviour while keeping psychological plausibility (Ezquerro & Iza 1995).

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