Remarks and Replies

Empty Categories Access Their Antecedents during Comprehension: Unaccusatives in Spanish

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Spanish speakers who scan their syntactic representation to find a word from the subject NP in a just-comprehended sentence recognize the word faster in unaccusative-verb sentences than in unergative-verb sentences. This is consistent with an analysis of unaccusatives as raising verbs with a trace: the trace corresponds to an extra mental representation of its antecedent. Spanish speakers who scan their conceptual representation to find the target word recognize it more slowly in unaccusative-verb sentences: this may indicate that the conceptual representation of unaccusatives is more complex than that of unergatives. Overall, the results give experimental support to linguistic frameworks that differentiate conceptual from linguistic levels of representation and to syntactic models that postulate NP-trace.

Keywords: NP-trace, NP-movement, priming, unaccusatives, unergatives

1 Introduction

Understanding a sentence includes interrelating two kinds of representations: a conceptual representation of its meaning, and a syntactic representation of its form. Hence, the study of the final product of sentence comprehension can provide information about both the syntactic and the conceptual forms of sentences computed during comprehension. Laboratory investigations of the syntactic representation assigned by comprehension processes can differentiate between competing linguistic theories of syntactic form.

Structural syntactic theories in the past decade have come to differ on the role of *empty categories* (Fodor 1989). Broadly conceived, empty categories have syntactic form and grammati-

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cal function but receive their lexical and semantic content from other phrases in their sentence; they have some similarities with pronouns in this regard, but no segmental phonological form. A typical example of an empty category is that associated with *wh*-pronouns in (1). The structural effect of the empty category (t_i) is that it fills the grammatical object position of the verb, *like*; in this way, it explains how a verb that ordinarily requires a grammatical object can appear phonologically to lack one. For purposes of meaning, the empty category is coindexed with its antecedent (Chomsky 1981), it is an exact copy of the moved element (Chomsky 1993, 1995), or it is unified with it (Gazdar 1982, Goldberg 1985, Sag and Pollard 1986). In (1) the antecedent of the trace is *book*.

(1) This is the book$_i$ which$_i$ I like (t_i).

Various lines of research in the past decade have demonstrated the relevance to comprehension of empty categories associated with *wh*-movement. For example, the salience of the word *book* in (1) is enhanced after the listener or reader reaches the location of the empty category (Frazier, Clifton, and Randall 1983, Swinney et al. 1988, Nicol 1988, Nicol and Swinney 1989, Garnsey, Tanenhaus, and Chapman 1989).[1]

Such results tend to support any theory that proposes both that *wh*-traces occur at specific points in the sentence and that they access a representation of their antecedent during comprehension. However, the results do not differentiate between syntactic theories that share this structural feature but differ in other important ways. Thus, in Government-Binding (GB) style theories, including the Minimalist Program (Chomsky 1995), the identity of the *wh*-trace and its antecedent is based on movement from one position to another in its derivation (this corresponds in Relational Grammar (RG) to being indexed simultaneously with different grammatical relations). In Head-Driven Phrase Structure Grammar (HPSG) and Generalized Phrase Structure Grammar (GPSG) style theories, the *wh*-location is represented as an unindexed *slash* category, "NP-slash," which is lexically unified with its antecedent elsewhere in the tree. In such models, the relation between the empty category and its antecedent is based on computations on one level of phrase structure rather than on the fact that different phrase structure representations are involved in its derivation. Accordingly, the recent results showing the comprehension salience of *wh*-traces do not differentiate between monolevel and more complex syntactic theories, since *wh*-trace or its unification equivalent exists in both sets of theories.

There are, however, other kinds of empty categories that are proposed in some structural syntactic theories but not in others. In particular, traces left behind by movement of noun phrases during a derivation are a part of GB-type theories but do not have corresponding slash categories

[1] This can be shown in experimental paradigms in which the salience of the critical word can affect the recognition of an associated word. For example, consider a paradigm in which an experimental subject listens to a sentence like (1) and, at some point during the listening experience, sees the word *chapter* on a screen. *Chapter* is recognized faster if it follows the empty category location in the sentence than if it precedes it. Such results have been taken as showing that the empty *wh*-category accesses a representation of its antecedent: since *chapter* is a high associate of its antecedent, *book*, recognition of *chapter* is facilitated (Nicol 1988). However, this particular probe method (also used by Osterhout and Swinney 1993) and the results it gives rise to are not completely understood theoretically and empirically (McKoon, Ratcliff, and Ward, in press, McKoon and Ratcliff, in press, Nicol and Swinney, in press).

in current monolevel theories. Some empirical evidence has been reported for the role of such traces in comprehended representations. Bever and McElree (1988) used a probe word recognition paradigm to study the relative salience of different phrases immediately after they are understood in a sentence. They found that a probe word is recognized as having occurred in a just-read sentence faster when the probe word is part of a phrase that is an antecedent to an empty noun phrase, as in a passive (see (2a)) or a raising construction (see (2b–c)), than when it is not, as in corresponding control sentences (see (3a–b), (4a–b), (5a–b)).

(2) a.	The tall waiter . . . was hit (t-NP) by the angry patron.	Probe: TALL
b.	The tall waiter . . . seemed (t-NP) to be helpful.	Probe: TALL
c.	The tall waiter . . . was likely (t-NP) to be helpful.	Probe: TALL
(3) a.	The tall waiter . . . was standing by the angry patron.	Probe: TALL
b.	The tall waiter . . . had stood by the angry patron.	Probe: TALL
(4) a.	The tall waiter . . . tried (PRO) to be helpful.	Probe: TALL
b.	The tall waiter . . . talked to the patron.	Probe: TALL
(5) a.	The tall waiter . . . was eager (PRO) to be helpful.	Probe: TALL
b.	The tall waiter . . . was nice to the patron.	Probe: TALL

These results and others (e.g., MacDonald 1989, McElree and Bever 1989, Bever et al. 1989) are consistent with the view that the NP-movement constructions do include a trace in their comprehended representation. The trace provides an extra representation of its antecedent compared with the corresponding nontrace constructions; thus, its antecedent phrase is more salient, which is reflected in the relatively short latencies to recognize a word contained in the antecedent.

Discourse-level properties of these constructions may offer an alternative account of many of these results. It is a well-known discourse function of the passive construction to focus the patient noun phrase, by placing it at the front of the sentence; thus, the relative salience of the patient in passive constructions may be due to its discourse focus, not to the presence of a trace.[2]

In general, the previous studies of NP-trace in comprehension characteristically involve contrasting different lexical sequences or different constructions (active vs. passive, raised vs. nonraised versions of sentences) with structural or meaning differences other than just the presence or absence of an NP-trace. Accordingly, it is important to study minimal pairs in which two

[2] For example, the active and passive constructions differ in their impact on the pronominal subject of a conjoined small clause: in each case it is the apparent subject of the first verb that is the agent of the second.

(i) a. The patron helped the waiter and [ ] then left. (i.e., the patron left)
b. The waiter was helped by the patron and [ ] then left. (i.e., the waiter left)

Note that a corresponding discourse function approach to explain the reported salience of subjects of raising constructions is not correct. Discourse constraints do not reflect a relative focus for NPs in raising constructions in the same way as in passive constructions; there is no change in the subject of a small clause following a raised or a nonraised construction.

(ii) a. It seemed that the waiter helped the patron and [ ] then left.
b. The waiter seemed (t-NP) to help the patron [ ] and then leave.

(iii) a. It was likely that the waiter helped the patron and [ ] then left.
b. The waiter was likely (t-NP) to help the patron and [ ] then leave.

constructions involve the same words and the same surface order, but in which one has a trace and the other does not. Monadic predicates in Spanish provide such a pair. It is generally assumed that monadic predicates divide into two types: unaccusatives (verbs with a patientlike argument, such as *appear* and *fall*) and unergatives (verbs with an agentive argument, such as *run* and *travel*). Syntactic evidence reviewed below supports the view that Spanish unaccusative constructions with a preverbal argument involve movement of the theme argument to [Spec, IP] (Sanz, Bever, and Laka 1992; also see the evidence for Italian in Burzio 1986, Belletti 1988, and De Vincenzi 1991, among others). In contrast, sentences with unergative verbs show no evidence of trace.

2 Arguments for the Analysis of Unaccusatives as Raising Constructions

2.1 Bare Noun Phrases

Spanish allows NPs with no article when they are grammatical objects of verbs, but not when they are grammatical subjects. Thus, (6a) is grammatical with a determiner in the subject, but (6b), with a bare plural in the subject, is not.

(6) a. Los gatos comen ratones.
the cats eat mice
'Cats eat mice.'
b. *Gatos comen ratones.
cats eat mice

A bare NP can appear only in positions that are commonly assumed to be governed positions, such as the object of a verb or of a preposition (Torrego 1989, Lois 1987, Rodríguez 1992). In (6) the bare NP *ratones* 'mice' is grammatical because it is in the position of complement of the verb.

Torrego (1989) points out that postverbal subjects of unergative verbs cannot be bare, whereas postverbal subjects of unaccusative verbs can. This is illustrated in (7a) and (7b) (from Torrego 1989), which contain an unergative and an unaccusative, respectively.

(7) a. *Anidan cigüeñas.
shelter storks
(*'Storks shelter.')
b. Crecen flores.
grow flowers
'Flowers grow.'

This indicates that the apparent postverbal subject of unaccusatives is actually in the complement position, governed by the verb.

2.2 Past Participial Constructions

Past participles in Spanish can form absolutive constructions (8a). In these constructions, a past participle appears with its subcategorized object, agreeing with it in gender and number (as

adjectives do). If the subject appears in the form of a *by*-phrase, the sentence is ungrammatical (8b). Furthermore, if the subject of the verb in the participial form is the argument that shows agreement with it, the sentence is also ungrammatical (8c). This shows that subjects cannot appear in the absolutive construction and that only objects are allowed to agree in gender and number with the past participle.[3]

(8) a. Examinado el caso en el juzgado, la magistrada
examined-PAST PART-MASC the case-MASC in the court the female judge
pronunció la sentencia.
pronounced the sentence
'Once she had examined the case in court, the judge pronounced the sentence.'

b. *Examinado el caso por la magistrada,
examined-PAST PART-MASC the case-MASC by the female judge
pronunció la sentencia.
(she) pronounced the sentence

c. *La magistrada examinada el caso, pronunció
the female judge examined-PAST PART-FEM the case-MASC (she) pronounced
la sentencia.
the sentence

Accordingly, past participial absolutive constructions do not occur with unergative verbs (see (9a–b)), since these verbs have only one participant in their argument structure, namely, the subject. However, such constructions do occur with unaccusative verbs (see (10a–b)), since these verbs have a complement in their argument structure (see Belletti 1990 for an account of how nominative Case is assigned to the NP in the absolutive construction).

(9) a. *Una vez llorado el niño, vino su madre.
once cried-PAST PART-MASC the child-MASC came his mother
('Once the child cried, his mother came.')

b. *Un niño llorado pintó los dibujos.
a child-MASC cried-PAST PART-MASC painted the paintings
('A cried child made the paintings.')

(10) a. Llegado el ministro, comenzó la reunión.
arrived-PAST PART-MASC the minister-MASC started the meeting
'The minister having arrived, the meeting started.'

b. Un estudiante llegado de Francia inauguró
a student-MASC arrived-PAST PART-MASC from France opened
el congreso.
the conference

[3] Adjuncts can also appear in the absolutive clause; this does not affect the contrast between subject and object.

Following the arguments of Burzio (1986) and Perlmutter (1989) for Italian, Sanz, Bever, and Laka (1992) propose that these facts support the claim that unaccusative "subjects" in Spanish are actually grammatical objects. Further evidence comes from participials stranded by deletion of the auxiliary verb along with an object pronoun in a relative clause, as in (11b), derived from (11a).

(11) a. Un estudiante que había sido sobornado suspendió el examen. →
a student who had been bribed failed the exam
b. Un estudiante sobornado suspendió el examen.
a student bribed failed the exam

Such derivations cannot occur if the relative pronoun is a subject.

(12) a. Un estudiante que había sobornado al profesor suspendió el examen. →
a student who had bribed (to)-the teacher failed the exam
b. *Un estudiante sobornado al profesor suspendió el examen.
a student bribed (to)-the teacher failed the exam

Thus, relative pronoun subjects of unergative verbs cannot be deleted.

(13) a. Un estudiante que había dormido por la mañana suspendió el examen. →
a student who had slept in the morning failed the exam
b. *Un estudiante dormido por la mañana suspendió el examen.
a student slept in the morning failed the exam

However, such constructions can occur with unaccusative verbs.

(14) a. Un estudiante que había llegado por la mañana suspendió el examen. →
a student who had arrived in the morning failed the exam
b. Un estudiante llegado por la mañana suspendió el examen.
a student arrived in the morning failed the exam

Again, the unaccusative verb patterns as though its apparent subject is actually a structural object (see Perlmutter 1989 for evidence of this phenomenon in Italian, Bosque 1990 for the aspectual properties of past participles of unaccusatives in Spanish, and Sanz, Bever, and Laka 1992 for more evidence concerning past participles of unergatives and unaccusatives).

2.3 Nominal Derivations

Agent suffixes (i.e., *-dor*) in Spanish specify that the argument of the nominalization is the agent of the action (15a); patient suffixes (i.e., *-ión, -ada/-ida, -aje*) specify that the argument of the nominalization is the patient of the verb (15b).

(15) a. El general destruyó la ciudad. → el destructor de la ciudad
the general destroyed the city → the destroyer of the city

b. El general destruyó la ciudad. → la destrucción de la ciudad
the general destroyed the city → the destruction of the city

When these suffixes are applied to monadic predicates, the proposed analysis predicts that the agent suffixes will attach only to unergative verbs (16), whereas the patient suffixes will attach only to unaccusative verbs (17) (see Sanz, Bever, and Laka 1992, Varela 1993).[4]

(16) a. Mario habla mucho. → Es muy hablador.
Mario talks a lot → (he) is (a) great talker
b. Mario lloró mucho. → *La llorada de Mario fue larga.
Mario cried a lot → the crying of Mario was long

(17) a. Mario llega siempre muy temprano. → *Es buen llegador.
Mario arrives always very early → (he) is (a) good arriver
'Mario always arrives very early.' → ('He is a good arriver.')
b. Mario llegó a tiempo. → La llegada de Mario fue muy esperada.
Mario arrived on time → the arrival of Mario was very much awaited
'Mario arrived on time.' → 'Mario's arrival was very much awaited.'

This is further proof that the argument of an unaccusative bears the role of patient, and it confirms the agentive nature of the subjects of unergatives.[5]

2.4 Present Participles

The *-ing* forms in phrases like *the walking man* or *the dancing doll* are present participles. In Spanish the suffix used to form these participles is *-ante/-ente*; the Spanish expressions corresponding to the English examples are *el caminante* and *la muñeca danzante*. The former is a nominalization that incorporates the noun *man;* in other words, *el caminante* means literally 'the walking one'. The noun in such an expression, whether overt or implicit, is interpreted as the agent of the action expressed by the derived form of the verb in the present participle. When the present participle is derived from a transitive verb, it refers to the subject and the object is included as a PP.

(18) el fabricante de muñecas
the manufacture-PRES PART of dolls
'the manufacturer of dolls'

[4] Not all unergative predicates accept this derivational suffix (e.g., **sonreidor* 'smiler'). Although an exhaustive analysis of these facts does not concern us here, we observe that verbs like *sonreir* 'smile' can be considered similar to verbs denoting involuntary bodily functions (closer to unaccusative predicates). The fact that one cannot "not smile" in some situations indicates this. The suffix *-dor* (or its allophone *-tor*) implies that the person performing the action does so willfully. A detailed analysis of the types of thematic roles that each of these predicates subcategorizes for would be necessary in order to fully understand this morphological process.

[5] We are not considering here the type of ergative verbs that allow transitivization (e.g., *break, open*). In their monadic use in Spanish, they require the presence of the clitic *se*, an analysis of which is beyond our goals in this article. See Sanz 1996 for a discussion of *se* and unaccusativity in the minimalist framework.

The prediction is that this participial suffix will be ungrammatical with unaccusative verbs, which lack an external argument. The prediction is borne out.

(19) a. *el llegante
the arrive-PRES PART
'the arriving man'
b. *el muriente
the die-PRES PART
'the dying man'
c. *el apareciente
the appear-PRES PART
'the appearing man'

By contrast, most unergative verbs are grammatical with this suffix.

(20) a. el cantante
the sing-PRES PART
'the singing man, the singer'
b. el viajante
the travel-PRES PART
'the traveling man, the [commercial] traveler'
c. la bella durmiente
the beautiful sleep-PRES PART
'the sleeping beautiful woman, (sleeping beauty)'

This is further proof that the argument of an unaccusative in Spanish differs substantially from the argument of an unergative. Whereas the latter is an external argument, the former acts as an internal one.

2.5 Conclusion: Unaccusatives and Unergatives Constitute a Minimal Pair for Research on Empty Categories

The previous tests demonstrate that the argument of an unaccusative behaves syntactically like a D-Structure complement. This supports an analysis in which the theme of an unaccusative verb appears in preverbal position as a result of movement, leaving a trace in its original postverbal position.[6]

[6] The structure of sentences with postverbal subjects is controversial. Contreras (1991) assumes that the VSO order in Spanish results from V-to-I movement. He also assumes that nominative Case can be assigned within VP, on the assumption that I in Spanish is lexical and governs the NP position. Therefore, no trace is posited in the case of unergatives with a postverbal subject (ia). On the other hand, we assume that definite DP arguments of unaccusatives cannot remain in their base-generated position (Belletti 1988). Consequently, they move to a VP-adjoined position (ib). Our experiment contained only definite NPs.

(i) a. unergative: $[_{IP}[_{VP}[V]\ NP]]$
b. unaccusative: $[_{IP}[_{VP}[_{V'}\ V\ t_i]\ NP_i]]$

An anonymous *LI* reviewer has pointed out to us the possibility that Spanish preverbal subjects are extrasentential

Prima facie, these constructions allow for a complete set of minimal pairs, with a trace for unaccusatives with preverbal subjects and no effective trace for all the other constructions. If the trace facilitates recognition of its antecedent, it should do so only in constructions with unaccusative verbs in which the subject is preverbal. Thus, recognition times can be expected to differ in two ways: preverbal subjects of unaccusatives should be recognized faster than those of unergatives, and faster than postverbal subjects of either type of verb; and there should be no latency difference for postverbal constructions. Any overall discourse differences due to pre- vs. postverbal subjects are neutralized by the fact that the experimental materials include both.

3 Behavioral Interlude: Accessing Different Levels of Representation

A separate issue concerning previous studies of NP-trace processing involves the exact behavioral assumption linking the presence of a trace and the probe recognition task. In general, previous research has assumed that the salience of a recognized word reflects the presence of a representation of it in the stimulus sentence. The corresponding "trace facilitation hypothesis" interpretation of the extra salience of the antecedent of the NP-trace is that the mental representation of NP-trace provides a separate instance of its referent and therefore increases recognition speed.[7,8]

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and coindexed with a pro in either the subject position (in the case of unergatives) or the object position (in the case of unaccusatives). Were this true, no trace would be involved in any of the constructions. The differences in reaction times we report later in this article would have to be explained with regard to other properties of the verbs or the relative distance between the two coindexed representations of the subject (see section 6.1).

[7] A possible objection to this is that the surface structure merely contains two coindexed terms and that the trace does not necessarily reinstantiate its antecedent. But note that constructions with PRO involve precisely that: two coindexed elements. Prior research has not found consistent facilitation with this empty category. This suggests that there is a difference between a trace and mere coindexation of an empty category with an antecedent.

[8] There is another interpretation of the previous effects, based on the view that experimental subjects scan their conceptual representation of the sentence to determine whether or not it contained a probe word. On this view, the critical NPs in trace constructions are more salient conceptually because their conceptual roles have been reassigned during comprehension. This follows from a comprehension theory that phrases are assigned probable conceptual roles as they are encountered, based on their serial position, animacy, and other factors. For example, initial animate NPs in English are immediately assigned agent status, even before the verb is perceived; this follows the statistical regularity that agents tend to be animate, and tend to occur before their inflected verb. The idea of immediate assignment of conceptual roles derives from a general theory of the role of probabilistic information in comprehension. On this view, many statistical properties of colloquial language with high cue validity (Brunswik 1956) are embedded in comprehension templates, "perceptual strategies," that are used at an early stage in sentence comprehension (Bever 1970; for recent implementations of related ideas, see Tanenhaus, Carlson, and Trueswell 1989 and MacDonald, Pearlmutter, and Seidenberg 1994).

This idea has often been proposed to account for the relative difficulty of passive constructions. For example, in (2a) the initial phrase, *the tall waiter*, is at first assigned "agent" status, awaiting a main verb; it is then reassigned to "patient" status when *was hit* is perceived. Thus, passive sentences involve an extra computation, compared with active sentences, because the initial phrase must be reassigned to a different thematic role. Several researchers have noted that it may be the reassignment process itself that makes the initial phrase of passives more salient; that is, more perceptual operations are performed on the phrase, which increases its salience (Clifton and Frazier 1986, Fodor and Swinney 1992, Janet D. Fodor, personal communication, Michael Tanenhaus, personal communication, Bever et al. 1989). On this "conceptual recoding hypothesis," it is the semantic reassignment that causes faster recognition, not the presence of the trace in the linguistic representation.

Note that the conceptual recoding hypothesis is a bit obscure as an explanation for the facilitation of recognition of initial NPs in raising constructions. In those cases (e.g., 2b–c)), the initial NP is in fact the agent of a verb, so its essential status as "agent" does not need to be reassigned later in the sentence; from the standpoint of processing, the raised NP is in a position typical of agents. But it is not the agent of the VP with which it apparently agrees (*seemed, was likely*).

The differences between unergative and unaccusative verbs in Spanish are felicitous with respect to differentiating between syntactic and conceptual explanations of prior results. At the linguistic level, unaccusatives with preverbal subjects involve an additional NP-trace, compared with unergatives. If the NP-trace facilitates recognition, then preverbal subjects of unaccusatives should be recognized faster. At the conceptual level, the argument of an unergative bears the agent θ-role, whereas that of an unaccusative bears the theme θ-role (Hale and Keyser 1986). One result of this is that unaccusatives are conceptually more complex (Grimshaw 1990, Levin and Rappaport Hovav 1992). They correspond to a state or change of state, which requires a hidden locative or an external cause in the conceptual representation, whereas unergatives denote an activity and have a simple argument structure with a unique argument. In addition, unaccusatives permit both animate and inanimate arguments, whereas unergatives permit only animate arguments and thus are more constrained. In a general sense, both conceptual differences suggest that unaccusatives are more complex: thus, if meaning factors affect recognition time, unaccusative subjects should be recognized more slowly. It is possible that some aspect of these conceptual differences will determine probe recognition speed.

It is important to find a positive way to contrast empirically the trace facilitation hypothesis with facilitation due to conceptual factors. This can be done by exploiting the idea common to most comprehension theories: that understanding a sentence results in both a surface linguistic representation and a conceptual representation. A surface representation is a representation of the grammatical relations between the participants of a sentence; it is a string of hierarchically organized elements, including syntactic elements, such as traces. The trace constitutes an extra representation of an overt element of the surface structure. A conceptual representation, on the other hand, is a mental representation of the event that is not necessarily expressed in linguistic terms. Therefore, it does not contain traces or word order information.[9]

Experimental subjects have the choice of searching for a probe word in a just-understood sentence by scanning the surface structure representation of the sentence or the conceptual representation of its meaning (or both). On the trace facilitation hypothesis, an experimental subject who searches a linguistic sequence will show faster recognition to probes from preverbal subjects in unaccusative sentences; these constructions present a trace of the relevant type. An experimental subject who searches the conceptual structure will not show that effect, since the conceptual structure does not include any pure syntactic entities, such as traces. Thus, if experimental subjects

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As pointed out to us by an anonymous *LI* reviewer, Noam Chomsky has suggested that the raised subject of a raising construction exhibits some superimposed agentivity. However, even if it acquires an increased notion of agentivity when raised, it is still not an actual agent (see the discussion of (ii) and (iii) in footnote 2). This suggests that the conceptual recoding hypothesis for apparent trace effects may require considerable elaboration to deal with the existing literature, and may not be consistent when it is more elaborated. Thus, it may not be a viable alternative to the trace facilitation hypothesis, even in accounting for prior research.

[9] We are not taking a stand on exactly what a conceptual representation is. Our argument crucially depends only on the premise that it is a complete nonlinguistic representation of the meaning of a sentence. Examples of conceptual representations proposed in the literature range from mental imagery (Kosslyn 1980) to propositional types (Pylyshyn 1973, 1981). Furthermore, it is possible that the implementation of conceptual representations varies across individuals, and that it even varies within an individual, depending on the task to be performed.

who search their conceptual representation for a probe word can be differentiated from those who search their linguistic representation, it will be possible to discover specific evidence for the presence of NP-trace.

4 A Technique to Differentiate Syntactic from Conceptual Scanners

The different probe search strategies make different predictions about probe recognition with unaccusatives and unergatives. This raises the question of how to control what kind of search strategy an experimental subject will use, so that the predictions can then be assessed. A typical technique to induce a conceptual search strategy is to emphasize meaning, by asking content questions after every sentence; however, this might have the effect of deemphasizing syntactic processes in an arbitrary way, because experimentally usable content questions tend to be homogeneous. If each sentence in the study were followed by a content question, the experimental subjects could develop a problem-solving strategy specific to the task at hand. For example, if the questions always referred to a small number of elements of the sentence—say, the predicate or the subject-predicate-object—the experimental subjects would concentrate only on them and pay no attention to other constituents. The whole process of answering could become automatic and meaningless for our purposes. Also, experimental subjects who would otherwise arrive at the conceptual representation through a syntactic analysis might be less inclined to do so if answering homogeneous content questions were such an important part of the task.[10]

It would also be difficult to arrange a sensible contrasting situation in which we induce a surface syntactic search, for example, by deemphasizing the meaning and putting weight only on recognizing the probe word correctly. In the latter case, experimental subjects could adopt an arbitrary behavioral strategy for the experiment that might ignore meaning altogether. We decided to emphasize both meaning and probe recognition by including occasional content questions and by using data only from experimental subjects who performed well on both tasks. The content questions were simple and unambiguous yes-no questions about the relative clause separating the NP from the verb (see (22a) and (22b)).

We then differentiated experimental subjects who *spontaneously* habitually search the sequential representation from those who search the conceptual representation. The overall paradigm has a large number of filler sentences in which the probe word does not occur (that is, the experimental subject must always be prepared to answer that the probe word was not in the sentence). In all the negative probe cases, the probe word is not a synonym of any of the terms in the sentence. This allowed us to develop a separate measure of whether a person is sensitive to the surface sequence of a sentence or not. If an experimental subject is scanning the surface sequence to find the probe word, then the longer the sentence, the longer the reaction time to correctly respond that the probe word was not in the sentence (Sternberg 1969). Conversely, if

[10] The reader may wonder how one can arrive at a conceptual representation of a sentence without having computed the syntax. Our claim here is that it is possible to create a conceptual representation without having necessarily accessed a complete or correct syntax of the sentence.

an experimental subject is scanning the conceptual representation of the sentence, there should not be a strong positive relation between the length of the sentence and the reaction time to correctly respond that the probe word was not in it.[11]

In brief, we carried out an experiment using three interleaved kinds of stimuli: (a) a set of unaccusative and unergative sentences, in which the recognition probe word was drawn from the subject phrase; (b) a heterogeneous set of sentences of varying length, followed by a probe word that was not in the sentence; (c) a heterogeneous set of sentences of varying length, followed by a probe word that was in the sentence. We used the relative positive correlation between sentence length and reaction time in set (b) to classify experimental subjects as *sequence-sensitive* and *sequence-insensitive*. As we outline below, the two groups of experimental subjects gave categorically different results on the critical sentences: sequence-sensitive experimental subjects' performance is facilitated by unaccusative trace; sequence-insensitive experimental subjects are affected by the conceptual complexity of preverbal subject location in unaccusative sentences.

5 Method

5.1 Materials

Eight pairs of frequency-matched unaccusative and unergative verbs were selected. The unaccusative verbs used in this study were *crecer* 'grow', *aparecer* 'appear', *desaparecer* 'disappear', *aterrizar* 'land', *morir* 'die', *caer* 'fall', *llegar* 'arrive', and *arribar* 'arrive by boat'. The unergatives were *caminar* 'walk', *pasear* 'stroll', *viajar* 'travel', *correr* 'run', *dormir* 'sleep', *hablar* 'speak', *cantar* 'sing', and *llorar* 'cry'.

Since Spanish allows postverbal subjects, we included two versions of every sentence in the materials: with a preverbal and with a postverbal subject phrase (see footnote 6). We did this to test all the possible environments that included a trace corresponding to an unaccusative theme argument. The shape of the sentences is exemplified in (21).

[11] An *LI* reviewer points out that the conceptual representation of a long sentence should also be more complex than that of a short sentence. If this is the case, we would expect that the correlation between length and reaction time should also be positive for those experimental subjects who try to find the probe word in the conceptual representation. This is a legitimate concern and requires further experiments specifically to test it. However, the fact that our results pattern as they do is prima facie evidence that we have partitioned relatively sequence-sensitive from relatively sequence-insensitive experimental subjects. Moreover, intuitive considerations indicate that sentence length may be related to relevant kinds of conceptual complexity only in extreme cases. Sentences can be lengthened by adding material that does not necessarily add participants to the conceptual representation. It would probably be gratuitous to assume that the conceptual representation related to a predicate adjective clause is more complex than that related to the same adjective in prenominal position. It is also the case that even adding more content words may not affect the time to decide that a probe word is not present in the conceptual representation. For example, consider searching for the word *often* in the sentences *A boy kicked the can* and *A very tall boy kicked the bright red can with his foot*. The conceptual representations for the longer and shorter sentences have the same two main entities, neither of which is *often*. Of course, it might take more processing to *construct* the more detailed conceptual representation of the longer sentence, but the additional detail might even make it *easier* to reject the probe word *often*.

(21) a. [determiner-adjective-noun [relative clause] verb-prepositional phrase]
b. [verb-prepositional phrase, determiner-adjective-noun [relative clause]][12,13]

The experimental sentences were judged for "colloquialness" by 32 native speakers of Castilian Spanish who had the same characteristics as the experimental subjects. Sixteen speakers rated how colloquial the sentences were, presented individually as in the experimental lists, including fillers. Sixteen different speakers were presented with the sentence trials in pairs, one with a preverbal and the other with a postverbal subject, and were asked to indicate which member of the pair was more colloquial. The results from both studies show that constructions with preverbal subjects are rated as more colloquial than those with postverbal ones. However, this does not differ for unaccusatives and unergatives, and differences in naturalness between the sentence constructions therefore cannot account for any difference in results between the constructions.[14]

Each unaccusative-unergative pair of verbs corresponded to two structurally similar sentence frames, constructed so that the same experimental subject could be exposed to both verbs without seeing lexically identical surface frameworks. Accordingly, the design consisted of 16 experimental trials (corresponding to the eight pairs of verbs). The two sentences in each pair contained subject nouns matched for frequency and length. Each of the two sentences also contained an adjective from a frequency-matched pair of concrete and abstract adjectives.[15] This way, the nouns, verbs, and adjectives in one sentence of a pair could be exchanged with the corresponding nouns, verbs, and adjectives in its counterpart.

[12] The adjectives in the subject phrase were either concrete or abstract members of a pair matched for length and frequency. Since many words did not appear in the *Frequency Dictionary of Spanish Words* (Juilland and Chang-Rodríguez 1964), frequencies were assessed based on a survey of 20 native speakers of Castilian Spanish. The speakers were asked to rank words, on a scale of 1 to 10, on the basis of how frequent they are in daily speech. Previous research suggests that inflectional morphology can be used to guide comprehension, independently of word order and trace effects (Frazier, Flores D'Arcais, and Coolen 1993, Elías-Cintrón 1994, Sanz, Bever, and Laka 1992). Adjectives in Spanish agree in number and gender with the nouns they modify. To neutralize the effect of this morphology, each experimental sentence contained both nouns and adjectives that were univocally masculine or feminine (50% of each).

[13] Torrego (1989) argues that a locative argument in preverbal position makes unergative verbs behave like unaccusatives in accepting a postverbal bare NP as a subject. Even though the experimental constructions never contain a preverbal locative, we tried to avoid any kind of locative argument in the materials. That is why all the PPs in the experimental sentences are manner and not spatiotemporal expressions.

[14] The experimental subjects were asked to rank the sentences for colloquialness on the assumption that *colloquial* meant 'not literary-sounding'. The scale was from 1 to 7, 1 being not colloquial at all and 7 perfectly colloquial (i.e., in everyday use). In the first study, the averages were 3.8 for unaccusatives and 3.8 for unergatives. In the second study, sentences with initial subjects were preferred for both unaccusatives (4.9) and unergatives (5.4). The difference between these was not significant. The reason why the scores are not very high in either case may lie in the fact that these sentences all contained a prenominal adjective. At least for certain types of adjectives, this is in itself a literary-sounding way of modifying a noun.

[15] The use of adjectives as probes instead of nouns is motivated by two considerations. On the one hand, we were using the methodology of the previous research on NP-traces cited in section 1. On the other, adjectives do not appear as separate entities in the conceptual representation, whereas nouns do so in both the conceptual and the syntactic representations. If there is any difference in the way experimental subjects approach the task based on different levels of representation, adjectives would elicit it more clearly than nouns (see footnote 11).

It is often reported that abstract words are harder to process than concrete words. We expect this difference to occur more for sequence-insensitive than for sequence-sensitive experimental subjects. Such a difference would confirm our classification of experimental subjects into these two groups. However, this measure itself cannot be used to classify them, because reaction time to the probe words (always the adjectives in the experimental trials) is the primary dependent variable.

Each sentence of a pair had eight major variants (unaccusative vs. unergative verb; pre- vs. postverbal subject; abstract vs. concrete adjective). The different versions were balanced throughout eight lists, each of which contained a total of 16 experimental trials. The sentences were presented in four fragments. In the version of the sentence with a preverbal subject, the first fragment consisted of an NP (an article, an adjective, and a noun); the second and third consisted of a relative clause; and the fourth consisted of the entire VP (a V and a manner PP). In the version of the sentence with a postverbal subject, the first fragment consisted of the VP; the second consisted of the subject NP; and the third and fourth consisted of the relative clause.[16]

(22) a. El apuesto/severo crítico
que visitaba
el museo
habló/llegó con cuidado
the handsome/strict critic
who visited
the museum
spoke/arrived with care
PROBE: *APUESTO*/*SEVERO*
QUESTION: ¿Visitaba el crítico una catedral? ('Did the critic visit a cathedral?')

b. El apuesto/severo árbitro
que actuaba
en el encuentro
habló/llegó con recelo
the handsome/strict referee
who officiated
at the game
spoke/arrived with suspicion
PROBE: *APUESTO*/*SEVERO*
QUESTION: ¿Estaba el árbitro de vacaciones? ('Was the referee on vacation?')

[16] As pointed out by an anonymous *LI* reviewer, the use of the verbs in the relative clause could affect the results. For instance, in (i) *entrenar* 'train' was intended as an intransitive verb (meaning that the player trained himself and not someone else).

(i) El robusto/tímido jugador que entrenaba en el estadio corrió/apareció sin permiso.
the robust/timid player who trained in the stadium ran/appeared without permission

This use of *entrenar* could be argued to be quasi-unaccusative (it passes the tests only marginally). We did not control ahead of time for the nature of the verbs in the relative clauses. Of the relative clauses in the 16 sentence trials, 5 contained a transitive verb and its direct object, 6 contained an unergative verb followed by a PP, 2 contained a transitive verb with a null object and a locative PP, 1 contained a transitive verb with a prepositional selected object, and 2 contained a verb (one of them being *entrenar*) that was questionable between the unergative and unaccusative readings. However, any effect due to the nature of the verbs in the relative clauses would be neutralized by the fact that the relative clause was held constant across all sentence versions.

The experiment also contained 80 filler sentences, 40% of which were followed by a probe that was not in the sentence. The fillers consisted of either a simple or a complex sentence. The negative probes were all fairly frequent words that had no obvious relation to the meaning of the whole sentence or to the meaning of any single word in the sentence.

5.2 Procedure

Experimental subjects were asked to perform two tasks: to decide if a probe word occurred in the sentence, and to answer content questions about the sentence. On each trial the experimental subject read a sentence, accessing one phrase at a time by pressing the space bar on a keyboard. When the experimental subject finished reading the sentence and it was no longer visible, the probe word, by itself, appeared in capital letters and between asterisks. Experimental subjects responded as quickly as possible whether the probe was or was not contained in the sentence, by pressing one of two keys: the right hand activated the "yes" key, and the left hand the "no" key. In the critical cases, the probe was an adjective that had modified the noun subject of the sentence. After 40% of the filler probes, a content question appeared on the screen, and the same two keys were used in making a forced-choice response.

In 25% of the cases, the correct answer to the content question was "no." All the experimental trials were followed by content questions, which were straightforward questions about the meaning of the relative clause in the sentence. In 5 out of the 16, the correct answer was "no."

The study was carried out in a small experimental room at the School of Psychology of the Universidad Autónoma de Madrid. The stimuli were displayed on a CRT roughly 35 centimeters from the experimental subject, so that each letter in the display took up approximately 0.5 degrees of vision. No punctuation mark appeared at the end of the sentences, unless the filler consisted of more than one clause, in which case the clauses were separated from each other by a period. The fillers that did not contain the probe word ranged from 15 to 58 syllables.

5.3 Experimental Subjects

Thirty-two right-handed undergraduates (16 men and 16 women) were selected from volunteers to participate in this experiment. Four experimental subjects responded to each experimental list. The experimental subjects had no family history of left-handedness. They were native speakers of Castilian Spanish with no history of bilingualism.[17]

5.4 Results

For each experimental subject, a correlation was calculated between the length of each negative filler sentence and the time to respond correctly that the probe word was not in the sentence.[18]

[17] No universal tests are available that assess the verbal ability of university students in Spain, but we should note that the entrance exams are generally perceived as quite difficult. Nine other experimental subjects participated in the study, but their data were discarded because they recognized fewer than 80% of the experimental probes correctly. All of the 32 experimental subjects whose data were used for analysis also responded correctly to the content questions in at least 80% of the experimental trials.

[18] Only correct probe recognition trials were used in the analysis. Overall, 2.3% of the experimental probes were

Table 1
Reaction time to probes in seconds

	Position of argument			
	Preverbal		*Postverbal*	
	Sequence-sensitive	*Sequence-insensitive*	*Sequence-sensitive*	*Sequence-insensitive*
Unergative subject	1.07	.96	.92	.91
Unaccusative subject	.95	1.07	.90	.89
Difference unergative-unaccusative	.12	−.11	.02	.02

The 16 experimental subjects whose results correlated positively with the length of the stimulus sentence are hereafter referred to as *sequence-sensitive;* the 16 whose results correlated negatively are hereafter referred to as *sequence-insensitive.*[19] The difference in reaction time to abstract and concrete adjectives was significantly larger for sequence-insensitive than for sequence-sensitive experimental subjects. This is an independent confirmation of our classification of experimental subjects. The abstract-concrete difference is marked only at the conceptual level of representation, not at the syntactic level. Accordingly, the sequence-insensitive experimental subjects show the largest difference in reaction time to abstract and concrete words.[20]

The results are summarized in table 1. The different types of comprehenders show opposite reaction time effects for unaccusative and unergative verbs when the position probed was the preverbal subject: sequence-sensitive experimental subjects showed shorter probe recognition latencies with unaccusatives than with unergatives; sequence-insensitive experimental subjects

missed. Reaction times to correctly recognized probes were truncated to $2\frac{1}{2}$ standard deviation based on all the correct positive recognition probes for each experimental subject (including both experimental and filler trials); 2.4% of the responses were truncated for this reason. Because of a mistake in the design, one of the probe adjectives appeared twice for some experimental subjects. The second occurrence of that adjective was removed from all analyses.

[19] The mean correlation for the 16 sequence-sensitive experimental subjects was $r^2 = 0.22$ ($p < .01$); for the 16 sequence-insensitive experimental subjects, it was $r^2 = -.10$ (n.s.). This is as expected, since we are hypothesizing that the former group is actively performing a syntactic task.

[20] The effect of experimental subject group in the analysis of the abstract-concrete difference was significant at $p < .04$ ($F = 1.68$). The mean of the abstract-concrete difference in all the conditions was 0.09 for sequence-insensitive and −.003 for sequence-sensitive experimental subjects.

showed shorter probe recognition latencies with unergatives than with unaccusatives. No differences were found for the two verb types with postverbal subjects.[21]

6 Discussion

6.1 Sequence-Sensitive People

The data confirm the hypothesis that there is a trace in the comprehended representation of a Spanish unaccusative sentence with a preverbal subject: experimental subjects who scanned the linguistic sequence to find a probe word recognized the word faster in preverbal position in an unaccusative than in an unergative verb construction. This result is consistent with the trace facilitation hypothesis, on which the NP-trace in the comprehended representation of the sentence makes its referent more available for recognition. The difference between unergative and unaccusative verbs with postverbal subjects is not significant.

Postverbal subjects in the unaccusative constructions used in the experiment may also involve raising, whereas postverbal subjects of unergatives do not (see footnote 6). There are several reasons why recognition of postverbal subjects may not differ significantly for unaccusative and unergative verbs. First, in the experimental sentences *all* postverbal sentences may contain a trace. All the verbs were immediately followed by a PP; thus, the postverbal NP is moved around the PP, leaving a trace both in unaccusatives and in unergatives. This may account for the lack of difference between the two types of verbs for postverbal subjects.

Second, there may be a "minimal distance" effect for the impact of NP-trace on probe recognition, which could be the reason why the recognition of postverbal subjects of unaccusatives was not facilitated in comparison with recognition of postverbal subjects of unergatives. That is,

[21] There was considerable variability in the means (the range of mean responses was from .76 to 1.45 seconds). The smallest standard deviation was .13 seconds and the largest 1.12 seconds. The size of standard deviations was highly correlated with the mean reaction time ($r^2 = .76, p < .01$). This means that the slow experimental subjects' reaction times could have determined most of the effects on absolute reaction times in the different conditions. Therefore, for statistical analyses, we transformed the data into z scores, which factor out individual differences in means and standard deviations. A z score expresses each of an experimental subject's absolute reaction times in terms of its variation from the mean, with the standard deviation for that experimental subject as the measure of variation.

An overall analysis of variance (ANOVA) revealed that postverbal subject positions were responded to faster than preverbal subject positions (main effect of position significant at $p < .01$, $F(1, 433) = 22.66$). There was a three-way interaction between type of experimental subject (sequence-sensitive vs. sequence-insensitive), type of verb (unaccusative vs. unergative), and position (preverbal vs. postverbal) ($F(1, 433) = 3.83, p = .05$). Taking each group of experimental subjects separately, the difference between the response times to pre- and postverbal subject constructions was significant only with unaccusatives for sequence-insensitive experimental subjects ($F(1, 15) = 9.12, p < .01$, for the difference between 1.07 and .89), and only with unergatives for sequence-sensitive experimental subjects ($F(1, 15) = 8.69, p < .01$, for the difference between 1.07 and .92). An ANOVA for the initial cases revealed a significant two-way interaction only between type of comprehender and type of verb ($F(1, 199) = 5.98, p < .03$). Finally, sequence-sensitive experimental subjects considered alone showed a significantly shorter recognition time for preverbal-subject unaccusative than preverbal-subject unergative constructions ($F(1, 100) = 4.74, p < .03$).

We also performed an items-based ANOVA. The entire sentence containing the mistakenly repeated adjective was dropped from the analyses. The three-way interaction Type of Subject × Type of Verb × Position was significant ($F(1, 448) = 5.39, p < .02$). The two-way interaction Type of Subject × Type of Verb was also significant, at $p < .04$ ($F(1, 448) = 4.41$). The items-based analysis on initial cases resulted in only one significant interaction: Type of Subject × Type of Verb ($F(1, 214) = 9.01, p < .01$).

a trace may be effective in increasing recognition speed only when it is far enough from its antecedent to work as a distinct representation. An analogy with visual processes illustrates how the trace may actually facilitate probe recognition for those experimental subjects who scan the linguistic representation of a sentence to find a probe word. Imagine an array of numbers scattered on a screen. Suppose a number is repeated twice in the array. The experimental subject looks at the array and subsequently reports whether that number was present. If the two instances of the number are far apart, the likelihood that the experimental subject notices it quickly will increase, since a random search is likely to focus on it early. On the contrary, if the two instances of the number are close together, there is only one chance of detecting it: the moment when the experimental subject looks at that particular corner of the screen.

The sequence-sensitive experimental subjects in this study do not focus on an entire sentence at once; if they did, their reaction time to reject probes correctly would not be a positive function of the length of the sentence. Suppose these experimental subjects move from one search "focus" to another, whether they scan the sentence backward or forward: if the probe word is in a search focus, the experimental subject recognizes it. This means that if a word is represented twice in a sentence, it will be found more quickly than if it is represented only once. But that increase in recognition speed will occur only if the two representations are far enough apart to be in different search foci. On average, the farther apart two representations are, the more likely it is that the existence of two representations will facilitate recognition speed. On this view, the trace in the postverbal unaccusative subject is within the verb's maximal projection, too close for it to count as a representation effectively distinct from its antecedent.

The role of effective distance between the trace and the antecedent also allows us to integrate our results with recent developments in syntactic theory. So far we have referred to the traditional GB analyses of unaccusatives and unergatives to account for the structural differences between them. In the last few years, the VP-internal subject hypothesis (Kuroda 1988, Kitagawa 1986, Koopman and Sportiche 1991) has gained support among syntacticians within the GB and Minimalist Program frameworks. At first, this hypothesis might seem to be inconsistent with our results: it entails that *all* locations of subjects with *all* verbs involve some kind of movement. Thus, in both types of verb constructions we studied, the subject is moved to its phonological position and a trace copy is left in its original position.

Consider what happens if we accept this idea that all verbal subjects involve movement. It is still the case that the distance between the preverbal subject and its source trace position is greater for unaccusative than for unergative verbs. This is true whether one counts the number of phrase structure nodes traversed or the number of head nodes traversed. Thus, if we take the Minimal Distance Principle seriously, we can derive exactly the same predictions for preverbal subjects under this analysis as under traditional analyses. This would explain the previous findings that the subjects of constructions involving movement to an A-position—such as passive, raising, and *tough*-movement constructions—are recognized faster (McElree and Bever 1989).

We think the notion that traces facilitate recognition most effectively when they are "distant" from their antecedents makes sense. At the same time, we are cautious about which metric of distance is correct. Candidates include longer serial distance, greater number of nodes, greater

number of heads, and greater number of lexical heads (as opposed to functional ones) that a trace movement spans. This question is a topic for future research.

A separate fact is that postverbal subject probe recognition for both kinds of verb constructions is relatively fast. Since this result is true for both groups of experimental subjects, we return to it below.

6.2 Sequence-Insensitive People

Sequence-insensitive experimental subjects recognize the probe word more slowly in unaccusatives with preverbal subjects. This may be because the conceptual analysis of unaccusative sentences is more complex: an agent or instrument must be inferred, which means there are more entities in the conceptual representation to be scanned for the probe word. Whatever the reason for the effect, the results cast doubt on a conceptually based interpretation for the trace facilitation results of both our study and previous studies: those experimental subjects who show evidence of scanning their conceptual representation are just the ones who show a selective *inhibition* of probe recognition time in the critical cases with unaccusatives, not a facilitation.

The relatively slow response of sequence-insensitive experimental subjects to unaccusatives is limited to preverbal subject position. In fact, both groups showed fast and undifferentiated recognition times for all sentences with postverbal subjects (around .9 seconds). An explanation may be that the grammatical subjects in the experimental sentences are all of the form [[NP] [relative clause]]. That is, even though the probe word in postverbal constructions is in the third-to-last presentation fragment, it is in the last phrase of an argument of the sentence. Our materials were not designed to test the hypothesis that recognition of words from a final argument phrase is facilitated. However, in a number of filler sentences, probe words occurred in the second- and third-to-last presentation fragments. The response time to those in which the major phrase containing the probe word also ended the sentence was .938 seconds, close to the reaction time for experimental postverbal subject cases. The response time to those in which the major phrase containing the probe word was not within the final phrase of the sentence was .993 seconds.[22] Thus, the uniform rapid reaction times to postverbal subjects may be due to a "final-phrase reaction time" floor effect.

6.3 Integration with Prior Research

We found opposite results for two types of people, dependent on how sensitive they are to the linguistic sequence. Yet previous research on empty category processing has not differentiated people in this way. Why do prior studies of passive and raising in English show that the grammatical subject is recognized more easily, by all types of people? One explanation is that passive and

[22] For sequence-insensitive experimental subjects, the means were .94 seconds for the group in which the three fragments formed a phrase and .99 seconds for the one in which they did not. For the sequence-sensitive experimental subjects, the means were .95 and .97 seconds, respectively. A paired t test performed on the mean z score for each of the two groupings was significant at $p < 0.001$ ($t = 9.12$).

raising variants of English sentences are no more complex conceptually than the corresponding traceless sentences; thus, in prior studies, sequence-insensitive experimental subjects would have shown no difference in their response pattern and only been a source of random statistical noise.

Our results are not consistent with the hypothesis that conceptual factors cause facilitation: experimental subjects who independently show that they are searching their conceptual representation to find the probe word do *not* show the facilitating effect of trace.[23]

6.4 Conclusions for Psychologists and Linguists

For psychologists, these results highlight the importance of attending to a behavioral theory of probe word recognition in sentences, and how people can differ in the way they approach the task; previous research on the psychological reality of all traces must be reconsidered in light of our finding that individuals differ in whether they scan the syntactic or the conceptual representation in probe recognition tasks. Our results do not dictate the exact details of the ongoing comprehension process, but an integrated interpretation depends on the idea that both conceptual and linguistic representations can be assigned to sentences during comprehension.

For linguists, these results add to the growing evidence that NP-trace is part of the mental representation of the structure assigned to sentences when they are understood. Our materials provide crucial minimal pairs that test and reject alternative accounts of the selective facilitation of recognition of NP-traces based on discourse prominence or other conceptual differences. Thus, it is increasingly the case that experimental studies support those theories that assume that NP-traces or their structural equivalent are included in the mental representation of comprehended sentences. This is not compatible with monolevel theories of language structure (e.g., GPSG and HPSG). However, our results are consistent with GB-style theories, including some variants of RG and the Minimalist Program. In fact, our results are most compatible with the minimalist theory of traces (Chomsky 1993, 1994, 1995). Whereas in the GB framework a trace was considered to be an empty category that was merely coindexed with its antecedent, minimalist syntax proposes that elements that move leave behind exact copies of themselves. At the point of Spell-Out, all copies but one are deleted (for a detailed account of these and related issues, see Sanz 1996).[24]

[23] We did perform a post hoc analysis of a previous experiment comparing adjectival and syntactic passives in English that had been carried out in Bever's lab (Bever et al. 1989). Syntactic passives have a trace in their syntactic representation that adjectival passives lack. Dividing the experimental subject pool into sequence-sensitive and sequence-insensitive groups, we found that it was the sequence-sensitive group that showed facilitation with syntactic relative to adjectival passives. For the sequence-insensitive group, however, there was no difference in response time between the two.

[24] To account for reconstruction phenomena, Chomsky (1993) introduces the "copy theory" of movement. This theory states that the trace left behind by movement is a copy of the moved element, which remains at LF (although it may have been deleted at Spell-Out). Chomsky (1994) claims that reconstruction is a phenomenon that affects Ā-movement, and never A-movement. The latter point is controversial and has been argued against by Barss (1986, 1994), among others. If reconstruction effects are a property of A-chains as well as Ā-chains, and the general principles of the Minimalist Program are to be maintained, then NP-traces (not just *wh*-traces) should be copies of their antecedents. We endorse this conclusion here.

Our assumption in investigating movement experimentally was that a trace acts as an extra exact representation of the moved constituent. Furthermore, we probed with adjectives that were part of the subject NP, under the assumption that the representation of the trace also includes the adjective. The fact that priming can be found with adjectives of a moved NP suggests that traces are structured copies of their antecedents, including all the elements of the antecedent. This is a necessity within the premises of the Minimalist Program, in which elements not belonging to the numeration cannot enter the derivation, once the latter is underway. On this view, it is difficult to justify the existence of syntactic elements like traces in the linguistic representation. The copy theory of traces overcomes this problem and makes predictions with regard to processing of traces that our research corroborates.

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