



ANTECEDENT ACTIVATION BY EMPTY PRONOMINALS IN SPANISH

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ABSTRACT

A cross-modal priming technique was used to look for activation of discourse antecedents by three kinds of subject pronominals available in Spanish. Despite strong pragmatic clues there was no indication of antecedent assignment to PRO, subject of a nonfinite verb. Little *pro*, by contrast, while also a phonologically null element, induced a significant plausibility effect, indicating activation of the pragmatically plausible antecedent, and exhibiting a pattern similar to that of overt pronouns. These data support a modular model of language processing in which the influence of pragmatic inference does not precede that of syntactically-driven information, where available.

I. INTRODUCTION

The ongoing debate about the best model of the human language processor has inspired a surge of experimental work designed to address issues of cognitive architecture. Much of this work has attempted specifically to address the question of whether the language processor operates in a modular or an interactionist manner.

Unlike a modular model, an interactive model of the processor need ascribe neither autonomy nor priority to a syntactic or any other component of the machine. Marslen-Wilson and Tyler [4] have described such a model which, at least in instances of ambiguity in the input string, is free to appeal to clues inferred from the discourse context, without particular deference to any structural levels. They report experimental results which suggest that pragmatic implications drawn from the discourse are used alongside of and equally as fast as syntactic clues in the assignment of an antecedent to the pronominal subject of a verb.

A modular model of language processing is one in which part of the cognitive system is specifically assigned to syntactic information. This module, by Fodor's hypothesis [2], is characterized as being cognitively autonomous and encapsulated. Furthermore, processing is strictly bottom-up, so that syntactic principles, where applicable, are always the first to operate.

If there is to be any discussion at all about whether the human mind processes syntax in an encapsulated module, we must begin work with some clarification of what belongs inside that capsule. The most likely definition of that can be borrowed from syntactic theory, and I will be assuming here some fairly well-established tenets of the Government and Binding (GB) theory of syntax [1].

We report here on a decidedly ambitious project designed to address two issues simultaneously. First, we ask whether or not and under what conditions people appeal to context in their unconscious processing of referentially-dependent subjects. Further, we explore the extent to which the parser respects theoretically-defined distinctions between two kinds of phonologically empty pronominal categories. Specifically, we are comparing the influence of discourse context on antecedent activation for PRO (aka big PRO), the phonologically null subject of a nonfinite verb, with activation for *pro*, (aka little *pro*), a phonologically null pronoun which is licensed by many of the world's languages, including Spanish, as subject of a finite verb.

II. SYNTACTIC BACKGROUND

A pronoun is constrained by Principle B of the Binding Theory, which states that it must be free in its governing category. For our purposes here, this means simply that a pronoun cannot be preceded by an antecedent in the same sentence. In a typical sentence, including all the sentences discussed here, the syntax provides no positive clues about the referent of a pronoun. Hence a pronoun is free to find its antecedent in the discourse.

Spanish has a set of overt subject pronouns, similar to the English paradigm, specified for number and for gender in the third person. The syntax of Spanish, which is a so-called "null subject" language, also licenses the use of a phonologically-null pronoun, known as little *pro*, as the subject of a finite verb. Little *pro* gets its person and number features from the inflected verb. It, like any other pronoun, is syntactically free to pick any discourse referent with appropriate person and number features.

Nonfinite (gerundive or infinitival) verbs may not have lexical NP subjects because this is not a position in which an NP can receive Case. Every clause, is required, nonetheless, by Chomsky's Extended Projection Principle, to have a subject. The subject of a nonfinite verb, in Spanish as in English, is a phonologically-empty element called PRO. It is defined as a pronominal anaphor whose occurrence is restricted specifically to ungoverned positions.

PRO is an abstract syntactic element with no lexical content of its own. When PRO is the subject of an adverbial clause, as in the cases to be discussed here, it is antecedent-controlled by, and co-indexed with, the subject NP of the main clause, from which it inherits its referent. In the case of a preposed adverbial clause, PRO will precede its controller linearly:
PRO, Estudiando demasiado, María, se enfermó.
PRO, Studying too much, María, got sick.

Assuming that GB theory is correct in its characterization of referentially-dependent elements, we would expect a modular processor to respect the distinctions it makes. If encapsulation of processing is contingent upon structure, then we would expect to see differential treatment of these two different phonologically-empty subject pronominals. Given the same discourse and parallel sentence structures, a processor that respects the encapsulation of syntax would treat PRO and *pro* in distinct manners since the former, but not the latter, has a syntactic controller. On encountering PRO, the processor should look first to the syntactic controller to identify the antecedent, whereas the antecedent for *pro*, just as any other pronoun, can - indeed must - be found in the discourse.

III. SPANISH EXPERIMENT

3.1 Background

Experimental data based on materials such as the following [4] pose a challenge to the strict encapsulation that earmarks Fodor's modularity:

"As Philip was walking back from the shop he saw an old woman trip and fall flat on her face in the street. She seemed unable to get up again. Running toward ..."

Following the oral presentation of the incomplete discourse, subjects responded to a visually-presented object pronoun (*him* or *her*); naming response time to *him* was longer

than to *her*. If the processor had assigned *Philip* as the implicit subject of the gerund (*running*), then *him* would be an ungrammatical completion of the fragment (under the assumption that there are only two people in the world). Such a decision could have been based solely upon the pragmatic implications of the verb. The fact that the effect was not significantly greater when fragments were presented with overt subject pronouns (*s/he ran toward ... him/her*), suggests that the effect of pragmatic inference is comparable to that of the gender disambiguation provided by overt pronouns.

3.2 The Cross Modal Priming Paradigm

A paradigm that supplies data only about fragment completion does not allow one to determine the exact locus of antecedent activation. Unlike a fragment completion task, the cross-modal priming (CMP) paradigm provides the means to precisely track the course of antecedent priming for a referentially-dependent NP. With this task there is no need to run any syntactically ungrammatical controls. There is also no need to wait for a resolution point at which to look for overload. If referential assignment is made immediately upon encountering a pragmatic clue, then at that point - immediately after the verb - there should be priming for only the pragmatically preferred subject.

The employment of CMP in studies of lexical ambiguity [6] has been extended in several recent studies to the interpretation of referentially-dependent elements [see 5 for review]. The combined results of these studies suggest that unless the antecedent for a referentially-dependent NP is uniquely selected by the syntax, all potential referents are re-accessed, without regard to real-world knowledge.

To examine and compare discourse context effects on processing of PRO with *pro*, and with the goal of incorporating our findings into a larger program of empty category processing studies, we ran an experiment employing a variant of the cross-modal priming technique with a word naming task.

3.3 Materials and Design

Experimental tokens consist of 48 two-sentence discourses. The first sentence (S1) provides the context, introducing one male and one female, identified by occupation or human relation term. In order to eliminate any possible discourse topic effects, they form the conjoined subject of the first sentence. (Note that every Spanish noun is marked for gender by the definite article.)

S1. La arrogante millonaria y el huérfano abandonado llegaron al mismo tiempo a la puerta del restaurante.
'The arrogant millionaire(f) and the abandoned orphan(m) arrived at the same time at the door of the restaurant.'

In the second sentence (S2), the verb in the initial clause provides a pragmatic clue which, given the discourse context, points to one of the characters in the discourse (*la millonaria* or *el huérfano*, in this example) as the plausible antecedent of its subject. There are three different versions of S2.

- S2. (a) PRO
Mendigando lastimeramente una comida caliente, se desmayó.
'Begging sorrowfully a hot meal, fainted.'
- (b) *pro*
Mientras mendigaba lastimeramente una comida caliente, se desmayó.
'While begged sorrowfully a hot meal, fainted.'
- (c) overt pronoun
Mientras él mendigaba lastimeramente una comida caliente, se desmayó.
'While he begged sorrowfully a hot meal, fainted.'

For each discourse used there are four corresponding probe words: plausible experimental (*huérfano*), plausible control (*orificio*), implausible experimental (*millonaria*) and implausible control (*medicación*). The experimental probes are the human identity nouns heard in S1 (without articles or adjectives). Control probes are inanimate nouns which do not appear anywhere in the discourse and are not semantically related to either the context or the experimental probe. Each control probe is matched with its respective experimental probe for gender and number of graphemes. Onset phones are, when not identical, at least of the same phonological class; this was done to remove any effect of acoustic differences on the triggering of the RT measurement.

The three versions of S2 were counterbalanced across three tape-recorded scripts so that each tape contained one version of each of the discourse materials and 12 tokens of each S2 version. Cueing tones were manually inserted at the syllable peak following the initial verb. The four probe words were rotated through four word lists. The three within subjects factors (pronominal type, antecedent, and probe) yielded a 3 x 2 x 2 design with 12 subject groups. Experimental items were padded with 54 filler items of similar length and style design. Tones were inserted at random positions in the filler items; probe words were randomly chosen nouns, some of which had appeared in the filler discourse.

3.4 Pretests

In order to verify the existence of a clear plausibility bias towards one or the other of the discourse referents as antecedent, we ran an off-line experiment asking for conscious judgments as to who was the most probable subject of the verb. 60 high school seniors in Madrid completed printed questionnaires. For each item, S1 appears as it does in the final scripts and S2 appears as a fragment in one of the following two formats:

- a) MENDIGANDO ... _____
b) Mientras MENDIGABA ... _____

Participants were instructed to indicate who was the subject of the verb by writing in either the masculine or feminine pronoun, as appropriate. They were also given the option of choosing "I don't know," "both," or "someone else." Based on the results of this pretest we rejected any materials that had over 10% total of incorrect responses, where incorrect was anything other than the "appropriate" pronoun. Thus we are assured that for each of the discourses used in the main experiment, there is one clearly preferred antecedent, at least to the conscious mind, for both of the null pronominals.

Unconvinced by the available lists of Spanish word frequencies, we matched these word pairs in a two-step process. The first was a far-from-definitive intuitive rating by six native speakers, which we used to narrow our selection. Next, we ran an on-line experiment in which 20 subjects read the words aloud as they were presented on a cathode ray tube (CRT) one after the other, in a randomly-ordered list format. Naming times were measured; for each probe word we then took a mean baseline RT. All data reported here are based on what we will call the BARTs (baseline-adjusted reaction times), namely raw RTs from which the respective baseline scores have been subtracted, representing, for each word, the latency caused by the experimental conditions. (Corresponding analyses performed on the raw data show the same trends.)

3.5 Subjects

Seventy-two students at the Universidad Complutense de Madrid were paid the equivalent of US\$6 for their participation in the experiment. All were unaware of the purpose of the experiment.

3.6 Procedure

Subjects listened through headphones to pre-recorded instructions, which explained that their main task would be to listen attentively to a series of unrelated paragraphs. Simultaneously, they were to monitor the CRT in front of them. At some point during each paragraph, a word would be flashed on the screen and they were to say the word aloud as quickly as they could, while continuing to listen to the paragraph. After five practice items, the experiment ran for 15 minutes after which there was a 3-5 minute rest period, and then another 10 minutes to completion. The interval between visual presentation of the probe word and onset of naming were measured and recorded by a computer program.

3.7 Predictions

At presentation of the probe, the subject has heard both the pragmatic clue as well as the evidence for having passed a subject position, and hence a silent, if not overt, subject pronominal. If referential assignment is made immediately upon encountering a pragmatic clue, then naming times immediately after the verb should reflect activation for only the pragmatically plausible antecedent. We expect that a repetition effect will make BARTs for the experimental probes faster than those for the control probes, which are unrelated to anything in the discourse. Hence our planned measure of antecedent activation is a comparison of the BARTs for plausible versus implausible experimental probes, after they have been subtracted from the BARTs for the respective control probes. It is this interaction that will reveal the pure effect of plausible versus implausible antecedent.

Because PRO is a syntactically-controlled element, we predicted that there would be no plausibility effect (interaction between antecedent and probe word) for the PRO condition. Little pro, on the other hand, is syntactically free. Since the ambiguity of its referent cannot be resolved by the syntax, we would not be surprised if pragmatic clues were engaged immediately; hence we predicted the likelihood of an interaction effect. Since the overt pronoun is gender-specific, there is only one human in the discourse that could be its antecedent. The gender marking and the contextual plausibility select the same antecedent; hence we expected to see a significant interaction in the overt pronoun condition.

3.8 Results

Several subjects were excluded from the final analysis, either due to equipment failure or a large number (>5) of missing or wrong responses. The data reported here are from 60 subjects. Outlying RTs were normalized to ± 2 standard deviations from the mean. Recall that the data we report here are the BARTs - differences remaining after subtracting the respective baseline RT (from the word list experiment) from each RT measured in this experiment.

An overall analysis of variance demonstrated no significant effect for any of the subject groups or materials counter-balancing conditions (tapes and lists). An uninteresting significant effect was for probe type, where, as expected, the experimental probes were always faster than the control probes ($F(1,59)=51.76, p<.000$). There was also a significant interaction of antecedent by probe ($F(1,59)=5.04, p<.028$), but no 3-way interaction of pronoun by antecedent by probe.

Further ANOVAs were performed separately for each pronominal type, with antecedents (plausible, implausible) and probes (experimental, control) as within subjects factors. There was the still uninteresting continued significance ($p<.000$) of probes in each pronoun condition. An analysis of variance for the PRO condition shows virtually no interaction of antecedent by probe ($F(1,59)=.01, p<.916$). The same test in the little pro condition revealed a significant interaction of antecedent by probe ($F(1,59)=6.58, p<.013$). In the overt pronoun

condition, while there is a main effect of antecedent ($F(1,59)=4.49, p<.038$), the interaction of antecedent by probe does not reach significance ($F(1,59)=2.13, p<.150$).

TABLE 1
Mean (baseline-adjusted) reaction times for probe and antecedent type by pronominal type, in milliseconds

	CONTROL	EXPERIMENT	DIFF.
BIG PRO			
IMPL (medicacion)	178	134	44
PLAU (orificio)	167	121	46
LITTLE PRO			
IMPL	159	141	18
PLAU	191	128	63
OVERT			
IMPL	154	129	25
PLAU	186	133	53

Paired t-tests comparing the plausible experimental directly with the implausible experimental probes showed no significant effect in any of the pronoun conditions. A paired t-test comparing plausible controls with the implausible controls reached significance for little pro ($t(59)=2.25, p<.028$) and overt pronouns ($t(59)=2.00, p<.051$) but not for PRO ($t(59)=-.71, p<.483$).

IV. DISCUSSION

For the PRO condition, where the verb in the first clause of S2 is nonfinite, we see no significant effect of plausibility. By way of contrast, in the case of little pro, there is a significant effect of the interaction between antecedent and probe word, as predicted. This differential treatment of these two phonologically-null pronominals suggests an architecture in which the processor recognizes the difference in status between the subject of a finite and that of a nonfinite verb. The former, which is syntactically free, proceeds immediately to access its antecedent in the discourse, and employs pragmatic clues available in the discourse to that end. The latter is syntactically linked to a controller in the same sentence, even if that controller is yet to appear in the string; despite the presence of pragmatic clues in the discourse, these clues are - at least temporarily - not employed in the search of an antecedent for PRO.

We were initially surprised to discover that the significant interaction we see in the little pro condition is due largely to an inhibition of the plausible control word, rather than an activation of the plausible experimental probe. In fact, paired t-tests comparing the plausible with the implausible control words show that this is true for the overt pronouns as well. In this way, the two syntactically-free pronouns are classing together, as we would expect. (While the predicted interaction does not reach significance for the overt pronouns, there is a clear trend in this direction.)

Although we do not have any citeable evidence to explain this inhibition, we propose that it is due to the similarity between the experimental and control words. That is, an excitation of the plausible antecedent results in an inhibition of its phonologically and graphemically similar control word. Further research will be needed to clarify this issue.

In an English experiment using similar discourse materials [FGS], colleagues have found a significant effect of discourse antecedent priming by overt pronouns, and again, no effect for PRO. Similarly, in an unpublished pilot study in

Spanish we found an effect for overt pronouns and neither PRO nor pro. As a group, these experiments lend support to the modularity thesis. Wherever we see some effect of discourse pragmatics, it is in the processing of a syntactically-free pronoun. In none of these experiments do we see any indication of PRO responding to pragmatic clues.

We do have to ask why we in the current study we get an inhibition effect on the controls but fail to see the same activation, particularly for the overt pronoun, as we see in the other two. A possible explanation lies in the different designs. In the other studies, activation is a measure of the difference between the post-clue test position and a baseline position earlier in the discourse. The current study uses naming latencies to unrelated probes as a comparable control. It may be that the repetition effect is diluting the positive activation effect that we otherwise see for the correct antecedent to the unambiguous pronoun. Moreover, whereas the postverbal position is the first one in which the processor can know it has passed a phonologically null pronominal, by then there has been a time lag since passing an overt pronoun. Perhaps an earlier probe position - after the gender-disambiguating pronoun, but before the context-biasing verb - would yield a positive activation effect.

Having anticipated instead the opposite situation - where the effect for either or both of the null pronominals would be delayed - we have already completed a second run of this experiment testing at a later probe position. We used the same tapes and lists and procedures on another group of subjects. In this run there was a 300 msec computer-timed delay between the cueing tone and the visual presentation of the probe word. These data have not yet been analyzed.

In summary, we have presented evidence that while there are at least some conditions in which people do appeal to discourse context in the processing of pronominals, there is no across-the-board effect. In the English and Spanish studies where we do find a facilitation effect, it is only for pronouns. We continue to see the absence of a priming effect for PRO, the syntactically-controlled implicit subject of a nonfinite verb. This has been shown to be in contrast with pro, the syntactically-free subject of finite verbs in Spanish. The processor's differential treatment of these two elements suggests a modular architecture which makes fine distinctions between syntactically-encapsulated and syntactically-free language phenomena.

References

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