Introduction

We introduce a ubiquitous linguistic construction, Verb-Phrase Ellipsis (VPE), in which the verb phrase in the second clause (CL2) is phonetically unrealized (___):

(1) *The pharmacist bought a house and the electrician did __ too, according to the real estate agent.*

VPE allows the study of some fundamental issues in spoken language processing. For instance, how do listeners understand covert material? What is the categorical nature of VPE? How is its meaning determined? When are different sources of information integrated to build an interpretation? VPE does not involve movement of an argument and hence, does not require the reconstruction of an initial, underlying word order to be understood. This property is useful to distinguish two interpretive processes: word-order recovery and co-indexation (in which an antecedent-seeking element is linked to its referent). This distinction is especially important in studying disordered language. In effect, a given deficit might be attributable to one of the processes, but not to the other. So far, the two have been confounded, blurring the picture. This paper is organized as follows: we begin by presenting linguistic analyses of VPE. We then review the processing literature on VPE, and finally present the first of a series of experiments we are currently running on VPE processing in aphasia.

Theoretical linguistics background

The categorical nature of VPE is still debated in linguistic theory. We will present herein only two proposals: VPE as a trace-like element or as a pro-form. The first (Ross 1967, Sag 1976) postulates that the VPE site is an unfilled position. To be interpreted, it must be linked to an antecedent, and reconstructed (see below). The second approach (Chao 1987, Hardt 1993, Lobeck 1995) considers VPE a pro-form, that is, a silent, pronoun-like syntactic form that requires an antecedent to be semantically interpreted. Research has shown that the pronoun/trace distinction has processing implications (in normal and disordered language). An important concept is syntactic reconstruction. The elided material is syntactically reconstructed (in [3]) by 'copying' the antecedent -the VP in the first clause - in CL2, creating an ambiguity:

(2) $Eric_i$ [defended himself $_i$]$_{vp}$ and Aron did too.

(3) $Eric_i$ [defended himself $_i$]$_{vp}$ and $Aron_k$ did [defend himself $_{i/k}$]$_{vp}$ too.

Sloppy reading: Aron defended Aron
Strict reading: Aron defended Eric

Omitting important technicalities here, note that the strict reading is a possible interpretation, although it is generally dispreferred by speakers (Fiengo & May 1994, Hestvik 1995, Shapiro & Hestvik 1995, Frazier & Clifton 2000; but see Vasi• et al., 2005).

Processing of VPE

Shapiro & Hestvik (1995) tested the prediction that the strict reading would immediately be computed online, despite the preference for the sloppy reading (which is immediately computed online, see Shapiro et al, 2003,Experiment2). They looked for activation of the first clause (CL1) subject at the elided position in CL2 using cross-modal lexical priming (CMLP) with healthy adults. Participants were performing a lexical decision task on visually presented probes while listening to sentences such as:

(5) The policeman defended himself and the fireman did too.

Reaction times were faster to probes that were semantically related to the subject of CL1 (SCL1; *policeman)* at, but not right before, the elided position. That is, SCL1 was re-activated at the elided position, suggesting the strict reading (the fireman defended the policeman) was computed online. The authors conclude that the interpretation of VPE is computed following syntactic constraints.

Koeneman, Baauw & Wijnen (1998) revisited this conclusion and suggested that the activation of the SCL1 at the elided position was not due to the reflexive at all. They argue the listener goes through a memory search of the preceding clause to find a 'filler' for the ellipsis. This search results in the unintended activation of the subject in CL2. To test their hypothesis, Koeneman et al. used a probe recognition paradigm to compare elliptical and non-elliptical constructions, with or without a reflexive. The stimuli were visually presented phrase-by-phrase (self-paced), with the probes presented at the end of the sentence. For the experimental stimuli, the probes were the adjective to SCL1. The participants' task was to decide whether they had seen that word or not. Reaction times indicated that processing VPE involved reactivating SCL1, even without a reflexive. However, no main effect of reflexivity was found, in contradiction with other findings that showed reactivation of the subject with reflexives (Nicol & Swinney, 1989). Koeneman et al. conclude that these results support the view that processing a VPE implies searching in memory, not syntactically reconstructing the elided material.

Shapiro et al (2003,Experiment 3) addressed the question of whether or not the SCL1 is activated

in the absence of a reflexive. Again using CMLP, they looked for the activation of SCL1 in sentences such as:

> (6) The mailman bought a tie for Easter and his brother […] did ___ too, according to the salesclerk.

Contrary to Koeneman et al., Shapiro et al presented their probes at the elided position, a few seconds before the end of the sentences ('Wrap-up effects' have been shown to occur at the end of sentences, where previously encountered noun phrases are re-activated with no syntactic trigger (Balogh et al,1998)). The results showed that SCL1 was not activated in CL2 without a reflexive; that is, reaction times to semantically-related and to control probes were equivalent. The authors conclude that the memory-search hypothesis is not tenable, and that not all arguments of the verb are re-activated at the elided position. Other studies of VPE have shown that the initial, syntactically-driven computations are impermeable to other factors such as lexical properties (Shapiro et al, 2003).

Finally, a single study has looked at offline VPE comprehension in aphasia. Vasi• et al. (2005) investigated the ability of Dutch Broca's and Wernicke's aphasics to assign reference to pronouns in VPE. The patients were aurally presented with VPE containing a pronoun, and then asked to choose one out of three pictures that corresponded best to the sentence they had heard. Broca's aphasics scored above chance when the pronoun could be linked to a local antecedent, indicating that they can represent a dependency. They performed at chance when the only possible interpretation presented to them was the strict reading, in which the antecedent is non-local. Wernicke's aphasics performed at chance on both conditions. Vasi• et al. concluded that dependencies are available on time for Broca's (but not Wernicke's) aphasics, at least for local antecedents. They attributed patients' limitations to the lack of processing resources. Briefly, we are investigating whether aphasics can interpret VPE *online* such as (6) above using picture priming. Following previous findings in the online processing of dependencies in aphasia, we predict that Broca's aphasics will reconstruct the VPE online, but after a certain delay (thus, after the elided position), whereas Wernicke's aphasics will not be able to compute this dependency online at all. We are currently testing these predictions, and hope to shed light on what interpretive processes are affected in aphasia, and how. Finally, we note that it is uncommon to prepare an abstract that is devoid of data from aphasics for this conference. Nevertheless, we have much data from control subjects (some, described above), and will indeed have several aphasic patients' data by the time of the conference.

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