Indeterminacy and coercion effects

Minimal representations with pragmatic enrichment*

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Central to the investigation of the biological and cognitive capacities underlying human language is to determine how hypothetically distinct linguistic and non-linguistic computational systems interact to yield the representation of the meaning of a sentence. The focus of our chapter is on the comprehension of "indeterminate" sentences, that is, sentences seemingly semantically incomplete – albeit grammatical – such as "The man began the book". While one might understand such a sentence as referring to an event that the man began doing with the book, the actual event cannot be determined. We contend that the interpretation of indeterminate sentences relies on the identification of structurally determined gaps which function to signal higher, non-linguistic cognitive mechanisms to trigger pragmatic inferences. These inferences serve to enrich the output of the linguistic system to give the sentence a meaning fitting with a particular context. Psycholinguistic and neuroimaging (fMRI) data are discussed supporting the view that the source of sentence enrichment is pragmatic – not analytic lexical-semantic decompositions – beyond linguistic computations per se.

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1. Minimalism and indeterminacy at the interfaces

Discussions on the hypothetical interface between linguistic and non-linguistic representations in the process of sentence comprehension have often been cast in terms of where to draw the line between a formal – syntactic, semantic, or logical – representation of a sentence and the type of content it yields. These discussions have permeated much of the philosophy of language, linguistics, and psychology, at least since Frege and Russell, in modern times, but as far back as Aristotle's *Rhetoric* and *Poetics*.

In psychology, for instance, this long-standing debate has motivated the empirical work bearing on the modularity of language – a hypothesis that set the agenda for much of the psycholinguistic investigations since the 1980's. The key idea – which in our view remains a central one – is that linguistic computations are encapsulated or cognitively impenetrable, much like the perceptual computations in vision (Fodor 1983, 2000; Pylyshyn 2003). According to this view, what the linguistic system makes available, as the product of perceptual hypotheses, is a "shallow output". This output is, by hypothesis, mostly void of content – or perhaps it is a logical form of a sentence, or at most a logical form cum denotation of its constituents.[1] But most importantly this output representation is based primarily on linguistic-specific principles for parsing (i.e. the likes of syntax, morphology, phonology, logical form). The enrichment of this supposedly shallow linguistic representation would come as a consequence of the computations performed beyond linguistic analysis; it would be, by hypothesis, the role of a *Quinean*, i.e. holistic, conceptual central system that takes into account virtually everything one knows.[2]

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1. We say that the output is void of content only insofar as "broad content" is concerned. The output representations of a linguistic module *a la* Fodor might be referential and compositional, and thus have "narrow content". For instance, the shallow output could be a process of identification of the morphemic constituents of a token utterance and their structural relations – and thus what the linguistic input system outputs to other systems is the content of the morphological constituents and their compositional structure. It is also possible that, if the linguistic system is truly modular, what it does is to operate over the forms of the representations, not the content of their constituents. Although several studies have claimed context effects on parsing operations (e.g. Tanenhaus, Spivey-Knowlton, Eberhart & Sedivy 1995), it would be beyond the scope of the present paper to discuss in detail those findings – and why we see modularity as a standing *hypothesis*.

2. We use "enrichment" throughout this paper as a neutral term among diverse approaches: In Jackendoff (1997) and some of his followers, *enriched composition* is a form of semantic composition that relies on sentence constituents and sentence form but with information provided by internal analyses (semantic features) of lexical constituents (see also Pustejovsky's (1995) *co-composition*); in Recanati (2004), enrichment is used to refer to the processes by

In linguistics and philosophy of language, the now classical distinction between *what is said* (*sentence meaning*) and *what is intended* (*speaker's meaning*) has set the agendas for semantic and pragmatic processes, with the former primarily responsible for structuring the basic ingredients of *what is said*, and the latter enriching that information in search of *what is possibly intended* in a given context. Thus, the classical approach postulates that sentences such as those in (1) below, generally speaking, (i) have assigned a context-free *semantic* representation or logical form, and (ii) take the *semantic* representation to be the input to pragmatic processes of enrichment – of implicature seeking (see, e.g. Grice 1989; Searle 1969, for classical examples).

(1) a. It is raining
b. I am here now
c. John had breakfast
d. Mary is not going to die

But in recent years, there have been many attempts to blur this divide – and in particular (even *contra* Grice) to show that semantic representation says little about what sentences actually mean (e.g. Recanati 2004). The general idea is that one cannot evaluate a sentence such as (1a) unless one determines the context *C* of the utterance at time *t*. A similar state of affairs comes up with a sentence such as (1b), which requires moreover that the pronoun be assigned a proper referent – namely, whomever utters (1b). In (1c) and (1d), however, what the sentences *say* appears to require some sort of hidden modifier such as *today* for (1c) and *because of this* or *despite that* for (1d). The suggestion is that a sentence such as (1d) cannot possibly assert Mary's immortality (for we are supposed to know somehow that Mary is not immortal) so its very content comes enriched with what Recanati (2004) calls *unarticulated constituents* – which exert their effects not *after* a literal interpretation has been entertained, but at the expense of it.

A variety of semantic minimalists (e.g. Cappelen & Lepore 2005; Stanley 2000; Borg 2004; Bach 2006) have argued against the view that unarticulated constituents or any other context sensitive properties have an effect on the initial, literal representation of sentences such as (1c) and (1d). In fact, some minimalists assert that "[t]he semantic content of a sentence S is the content that all utterances of S share…no matter how different their contexts of utterance are"

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which the meaning of sentences such as (1) below are represented together with "unarticulated constituents" standing for the intended meaning of a sentence (see below). In the sense we will argue for, enrichment comes from pragmatic processes which do not affect sentence meaning but which are triggered by it, as in Grice (1989), where enrichment is attributed to *implicatures*.

(Cappelen & Lepore 2005: 143). What they have rather proposed is that the only allowable *context-sensitive* properties of a sentence are those licensed by linguistic structure, i.e. syntax proper, and overt *indexicals* (Kaplan 1977), such as the pronoun and adverbs in (1b).

While there are many nuances on what would count as the content of a sentence – and certainly the many schools of thought dealing with semantics in cognitive science and philosophy have attested to that – we can establish that at its lowest boundary, content is a function of the form of a sentence and the denotations of its constituents. It is with this in mind that we focus, in the present chapter, on a phenomenon that has gained prominence mainly in computational linguistics and psycholinguistics, but which to us better embodies the tension between *what is said* and *what is communicated* by a given sentence. Typical sentences appear in (2).

(2) a. The man began a book
b. The woman wants a beer

These sentences, which we call *indeterminate*, have been used to illustrate the phenomenon known as *coercion* or *type-coercion* or even *logical metonymy* (Briscoe, Copestake & Boguraev 1990; Pustejovsky 1995; Jackendoff 1997; Godard & Jayez 1993). We call them indeterminate because, following Gillon (2004), we assume that sentences such as those in (2) do not allow for a truth-value judgment *if* such a judgment is parasitic on a specific event performed by the man with the book. The idea is that a judgment might be deferred until appropriate contextual information determines the type of event that, e.g. the man began doing with the book or what the woman wants to do with the beer. Alternatively, we may judge the sentence based on whether or not there was anything that John began doing with the book.[3]

There is, to be sure, something we know about the content of sentence (2a). It says something like (3a) – or even (3b), following Davidson (1967), if we want to acknowledge that *begin* introduces an event variable (*w*).[4]

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3. To clarify, we use *indeterminate* (Gillon 2004) to refer to these sentences rather than an alternative theory-neutral term such as *underspecified* simply because the very activity performed with the object noun cannot be determined from the linguistic material per se. Although it may be suggested that the meaning of such sentences can be determined via coercion, it is generally agreed that the output of the coercion operation is distinct from the overtly specified linguistic content of sentences such as (2). Thus, the term indeterminacy can be taken to apply specifically to the content of such utterances as they are, prior to the deployment of special mechanisms of enrichment – whatever they might be.

4. Notice that in the standard (Davidson 1967) treatment, the variable that the verb *begin* introduces is not the action/event that *x* began doing with *y*, but *begin* itself. We are reluctant to

(3) a. ∃x(=man), ∃y(=book) (*begin* (x, y))
b. ∃*w* (*begin* (x, y, *w*))

But we do not know its intended meaning, nor do we think it has a default one – no matter how much one is tempted to think about *reading*. Sentence (2a) is so designed that it leaves us wondering what the man began doing with the book. In fact, as observed by Culicover (1970), this sentence has an "infinite ambiguity", for what it communicates cannot be resolved by appealing to its linguistic structure. Contrary to Culicover's early intuitions, however, we argue here that we *can* postulate "hidden" linguistic material which might allow for an interpretation of (2a) that goes beyond what (3) specifies, even if we are *still* to be left wondering about what (2a) communicates.

2. "Coercion" and content

The very idea of nominal coercion came about as an attempt to resolve the "ambiguity" in (2a) by assuming that, because what the verb does is to specify the temporal properties of an event, whatever is in its object position ought to be understood as an event or a process (Pustejovsky 1991). Prima facie, understanding the complement as an event requires that the standard, denotational lexical properties of the noun be deemed unfit for semantic composition, i.e. be deemed as violating the verb restrictions. As the story goes, because the verb specifies an event for its internal argument, an entity (rather than an event) in that position will result in an anomalous representation. Clearly, the sentences in (4) are well formed syntactically and do not violate semantic restrictions, for their gerundial (4a) and infinitival (4b) complements denote events.

(4) a. The man began reading a book
b. The man began to read a book

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treat a sentence such as (2a) as (3b) tout court because this representation may run into problems accounting for adverbial modification. For instance, *John began a book slowly on Saturday* would be represented as '∃*w* (*begin* (x, y, *w*)) & (*w* was slow) & (*w* was on Saturday)' which might lead to an ambiguity as to what *w* picks out: It might be the case that what John began doing with the book is slow, but the beginning was on Saturday, that is, *slow* does not necessarily predicate the aspectual property of the event, while the time adverbial does predicate *begin*. In short, it is possible that what *w* picks out is different in the two adverbial clauses (see Fodor 1972; Lepore 2003). In the syntactic analysis of (2a) that we discuss below (Section 3), the variable *w* would, by hypothesis, pick out the empty *V* head, not *begin*.

And even when there are no such clear events as gerundial or infinitival phrase complements but a so-called event nominal (5a) or a derived nominal (5b), there is no need for coercion.

(5) a. The man began the fight
b. The man began fighting

These examples suggest in fact that whether or not coercion of the complement occurs – i.e. whether or not the complement is understood as an event – is tied to the properties of its host VP and how the complement disposes information to compose the meaning of the phrase. This view carries two assumptions, which drive much of the coercion work in linguistics and psycholinguistics. The first is that a verb such as *begin* does select for a particular event complement. The second is that nominals that do not conform to the verb's specification need to be "read as", "coerced" or "type-shifted" in order to comply. While we will accept the general thesis of verb restrictions – and in this particular case, there is ample evidence that aspectual verbs combine with events and other complex VPs, as seen in (4) – we are suspicious of the validity of the second assumption.

We turn now to a brief discussion of three alternative accounts of the *coercion* phenomenon, including some of the experimental evidence offered in support of these different accounts.

2.1 Three views on "coercion effects"

In psycholinguistic experiments (mostly employing self-paced reading, and eye-tracking; de Almeida 2004; McElree, Traxler, Pickering, Seely & Jackendoff 2001; Traxler, Pickering & McElree 2002; McElree, Frisson & Pickering 2006) as well as in studies employing neuronal recording (event-related potentials, ERP; e.g. Kuperberg, Choi, Cohn, Paczynski & Jackendoff 2010; and magnetoencephalography, MEG; e.g. Pylkkanen & McElree 2007) and neuroimaging (de Almeida, Riven, Manouilidou, Lungu, Dwivedi, Jarema & Gillon 2012) researchers have attempted to tackle experimentally what constitutes the content of sentences such as (2). These studies, for the most part, have found a behavioral as well as a functional-anatomic difference between indeterminate (e.g. (2a) repeated below) and otherwise fully-determined event sentences such as (6).

(2a) The man began a book

(6) The man read a book

With the exception of a few studies manipulating context (de Almeida 2004; Traxler et al. 2005) as well as those investigating the neural basis of indeterminate versus determinate sentences, most studies have found that it takes longer to

process (2a) than (6) at post-verbal positions. This general finding – albeit controversial on methodological grounds (de Almeida & Dwivedi 2008; de Almeida et al. 2012) – is far from illuminating on how a sentence such as (2a) licenses an enriched interpretation, one which follows our intuitions that (2a) communicates something about *reading*. It is this empirical observation – i.e. longer reading times for post-verbal positions in (2a) contrasted to (6) – that we refer to throughout this paper as a "coercion effect". Because we do not support the idea that there is coercion, nor that there is type-shifting of the complement noun, we will use "coercion effect" simply to refer to the experimental finding as well as to linguistic intuitions about what goes on in indeterminate sentences such as (2a).

There have been at least three main types of explanations for why coercion effects occur: lexical-semantic decomposition of the complement noun, type-shifting rule operating over the complement noun, and the one we further extend in the present paper, the verb structural-gap account.

2.2 Lexical-semantic decomposition

The idea that information that enriches the representation of a sentence comes from the decomposition of a verb's complement noun is by far the most popular, at least in psycholinguistics and in computational linguistics (e.g. Briscoe et al. 1990; Godard & Jayez 1993; Pustejovsky 1991, 1995). This view has been discussed extensively in the literature so here we are interested only in providing some of the key arguments for how this approach accounts for coercion effects. Some of the views put forth by the lexical decomposition approach to coercion are often conflated with the semantics rule approach, as we will see in Section 2.3, below.

The main proposal for resolving the indeterminacy of sentences such as (2a) – articulated by Pustejovsky (1995; but also Briscoe et al. 1990) – is that interpreting the nominal complement as an event relies on interpreting it as a *token event*. More importantly, the token event is extracted from the lexical-semantic representation of the nominal and interpolated in the sentence producing an enriched composition (or *co-composition*). This process relies on the nature of the lexical representation for nominals, as proposed by Pustejovsky. In essence, his proposal specifies that lexical representation is an amalgamation of many properties ranging from structural (e.g. argument structure) to meaning-constitutive such as telic role (the purpose and function of the item's referent) constitutive role (the "relation between the object and its constituent parts"; Pustejovsky 1991:418), and others. Regarding the constitutive role, for instance, Pustejovsky (1991, 1994) notes polysemy even in cases such as *door* (as in *paint the door* – a "physical object" sense – and *pass through the door* – an "aperture" sense), suggesting that nominal interpretation is sensitive to its use in different phrasal contexts. What is more

important in the present context is that the representation of nominals are supposed to *contain* information such as the *telic* properties of their referents. The telic properties of a nominal such as *book* specify, say, *reading* as a default (Briscoe et al. 1990) or as the most prominent among other rank-ordered candidates (e.g. Lapata & Lascarides 2003) for things we do with books; thus, it is *reading* that most likely becomes available for interpolation in the "enriched" semantic structure of the sentence.

Early psycholinguistic studies on the coercion phenomenon (e.g. McElree et al. 2001) have sided with this view, assuming that reading delays in post-verbal positions for a sentence such as (7a), when contrasted with (7b) were due to the process of necessary interpolation of the activity information (*read*) extracted from the internal analysis of the complement noun (*book*).

(7) a. The student began the book late in the semester.
b. The student read the book late in the semester.

The main – and perhaps the most damaging – of the criticisms one can wage against this view stems from the fact that it depends on an analytic-synthetic distinction which many consider a dead-end in affairs of lexical-semantic analysis (Quine 1953; Putnam 1970; Fodor 1970; Fodor & Lepore 2006). Simply put, without a principled distinction, one cannot determine what goes into *lexical* representation and what does not – i.e. what is true in virtue of linguistic (viz., lexical) properties, and what is true in virtue of shared or private knowledge, beliefs, and so on. This distinction would be necessary if coercion were to occur at a *semantic* linguistic level that is separate from general knowledge (akin to what Katz 1972 proposed). And even if one could stipulate what in fact determines the content of lexical representations – viz., limited feature sets or definitions – one would have to (i) specify which properties are made available when the word is used in a given context (for instance which *constitutive role* is accessed); and (ii) determine which, among all possible *telic roles*, is the one to be chosen (and why). Perhaps a no less ambitious project would be to determine (i) and (ii) for all lexical items. Although some see this as necessary for lexical-semantic research (Jackendoff 2002), we see no viable solution in sight vis-à-vis the problem of analyticity: neither definitions for *all* lexical items are feasible, nor would they work without a set of primitive semantic/conceptual constituents.

2.3 Type-shifting rule

A semantic type-shifting rule (e.g. Partee 1986; Partee & Rooth 1983; Heim & Kratzer 1998) in principle does away with lexical-semantic decomposition by imposing constraints on the semantic *types* that enter into well-formed representations. This

view of coercion phenomena assumes that a complement of a given semantic type (say, *entity* [*e*]) might turn into another type (say, *proposition* [⟨*e*⟨*e,t*⟩⟩]), as in (8), following verb demands.

(8) a. Mary$_{\langle e \rangle}$ began a book$_{\langle e \rangle}$ →
b. Mary$_{\langle e \rangle}$ began a book$_{\langle e\langle e,\, t\rangle\rangle}$

In essence, this type of operation is supposed to be sensitive to verb-argument structure; for, by hypothesis, the argument structure of each verb has to either encode the types of the categories it licenses (or with which they compose) or has to have access to the rules that yield a given predicate composition valid. That is, the proposal is that the verb *begin* (or any other verb of the same class) specifies a type ⟨*e*⟨*e,t*⟩⟩ for its VP. In processing terms, when the parsing system detects a mismatch in the verb-noun complement – i.e. when the complement nominal is of type ⟨*e*⟩ – a type-shifting rule applies.

Of course, this view also assumes that there is a type taxonomy that cuts across grammatical categories and in fact supervenes on operations of semantic composition and interpretation. A shifting rule is supposed to operate at the "linguistic level" on the output of or concomitant with syntactic-structuring computations – if semantic rules are in effect during language comprehension, as we might assume they are. In addition, besides serving for translating syntactic into semantic categories and thus complying with classical-compositional processes, a semantic rule operating on *types* does not rest on an account of the analytic/synthetic distinction, assuming that *types* are symbolic primitives. The resulting categorical type representations are at the basis of an intensional logical representation of the event that the sentence denotes, i.e. of the logical form of the sentence, which provides the basic *form* for enrichment without actually enriching the sentence.

Insofar as accounting for *coercion effects*, we see the semantic-rule approach as heuristic at best for it does not specify the source of information that enables the reading of *book* as an event of a certain type, i.e. a particular activity performed with the book. What it does is to specify that a particular event reading of the nominal book should be made without determining what it is – thus without supplying the content of the event itself. It is possible then that coercion effects are simply effects of the *entity* → *proposition* shift itself, that is, the computational process of changing types, thus without the necessity of reading the changed *type* as a *token activity*. If so, this process thus preserves a separation between linguistic and non-linguistic computations to yield a non-enriched logical form.

It is in this context that the lexical-semantic decomposition proposal arose:

Pustejovsky's (1995) solution to account for the content of a given event while holding the basic type-shifting idea was to rely on *qualia* information as the source

of coercion operations, thus yielding for a sentence such as (2a) a representation such as (9) where the NP complement is read as an event *of a certain kind*.

(9) λ*e*, λ*x* [read (e, *x*, a_book)]

The type-shifting approach *sans* lexical decomposition (see also Fodor & Lepore 2002) can be conceived as a "semantic minimalist" account of coercion effects, for it complies with the idea that the content of *S* is only sensitive to the linguistic properties of *S*, regardless of contextual factors. But as we show below, the structure of the sentences employed in coercion research is deemed to have hidden linguistic structure, which, we argue, might be the basis for pragmatic enrichment. We take our view to be semantic-minimalist as well, for enrichment is structurally determined.

2.4 Structural gap

The third view on why coercion effects occur – even if not consistently so – is the one we develop more thoroughly in the next section, following up on a proposal put forth by de Almeida and Dwivedi (2008) for the distributional properties of the verbs implicated in the *coercion* literature. In summary, the idea is that *coercion effects* are by-products of structural gaps in the host predicates, mostly aspectual verbs. To advance a bit what we further develop below, the idea that there is a *gap* in the structural, linguistic representation of the predicates involved in coercion studies follows from the very idea of syntactically active null elements (as in Chomsky 1981) or an unexpressed argument for which a syntactic position is specified. As in de Almeida and Dwivedi (2008), we do not take this position to be specified only in the logical form of the sentence, but to be specified syntactically as a place-holder for a verb (see also Wurmbrand 2004).[5] The discussion that

5. There is possibly a major difference between proposing that (a) logical form is simply a representation of syntactic relations as determined by the overt and covert syntactically active constituents of the sentence and (b) that logical form is free to include non-syntactically but *semantically* determined constituents. Thus, a sentence such as (1c), *John had breakfast*, would have a logical forms such as '∃*w* (*had* (x, y, *w*))' under alternative (a), and '∃*w* (*had* (x, y, *w*))& (*today* (*w*))' under alternative (b). In essence the distinction amounts to determining whether or not, say, *today* is an *unarticulated constituent* (as in Recanati 2004). We will assume, without much contention that (a) is the null hypothesis – that only syntactically active (phonologically null or not) positions contribute information to logical form. Of course, it is an empirical question whether or not there is a syntactically active but phonologically null position in sentences such as *John began a book* – some believe there is (de Almeida & Dwivedi 2008), others believe there isn't (Pylkannen & McElree 2006) – see below.

follows elaborates on the linguistic evidence for this view as well as on how the effect arises as a function of *structurally-licensed* pragmatic inferences.

3. Linguistic evidence for the *gap*

In this section, we discuss some linguistic evidence for a structural *gap* in predicates said to produce coercion effects. Some of our discussion is a follow-up on the analysis presented by de Almeida and Dwivedi (2008); thus we begin by briefly recasting some of their arguments.[6] We then present some new evidence for the structural gap in predicates used in coercion studies.

3.1 Restructuring verbs

In a paper discussing the nature of the verb phrases involved in studies investigating *coercion*, de Almeida and Dwivedi (2008) proposed that sentences such as (2a), repeated here as (10a) have a VP structure as represented in (10b).

(10) a. The man began a book
b. [VP [V^0 *began* [V^0 *e* [OBJ *a book*]]]]

This structure assumes that the phrase has an empty *V* head, motivated by the so-called restructuring verbs idea developed by Wurmbrand (e.g. Wurmbrand 2004). We recast below some of the key types of evidence presented by de Almeida and Dwivedi in support of the analysis in (10b).

First, de Almeida and Dwivedi argue that VP modifiers such as the adverb *again* in (11) can have scope over an empty V within a VP. This is the case of sentences often used in coercion studies – with verbs like *prefer* and *attempt* – but also the case of aspectual verbs.

(11) I read *War and Peace* and now I'll start [VP [VP [VO *e*][NP *Ulysses*]] again].

The idea is that *again* has scope over the event that is to be performed, not over *start*, for there is no *start* in the first clause. This sort of elliptic reading of the lower predicate works even better with two aspectual verbs marking the end points of the same event, thus forcing instrumental PPs to modify an empty

6. Some of the arguments for and against the structural complexity of verbs that yield coercion effects were discussed in two papers – de Almeida and Dwivedi (2008; originally submitted in 2005) and Pylkannen and McElree (2006) – which reached different conclusions. We follow most of the argument by de Almeida and Dwivedi (2008) for reasons presented therein.

lower V head which is anaphorically bound to the main V in the antecedent clause, as in (12). That is, the empty V head works as the site for the VP ellipsis of *reading/to read*.

(12) I started reading with my contacts but finished [VP [VP [VO *e*][PP with my glasses]]]

Second, V-*able* structures allow for VPs (with overt or empty Vs) to raise to subject position. This type of construction might work particularly well with adjectives derived from event verbs (*writable, watchable*, etc.), but, following de Almeida and Dwivedi, we believe the grammaticality of constructions with adjectivized aspectual verbs is also warranted. Thus, for (13a), one can conceive of a complex external argument with an embedded VP structure, as in (13b), yielding a sentence such as (13c) grammatical.

(13) a. This chapter may be finishable
b. [VP [VO *e*][NP this chapter]] may be finishable
c. [VP [Writing][NP this chapter]] may be finishable
d. NP may be able to finish *V* this chapter

We suppose that adjectives such as *finishable* are morphologically decomposable (and thus paraphrasable) as in (13d). We also suppose that *writing*, as in (13c), might be licensed from an internal-argument position within the aspectual verb's matrix before the adjective derivation.

The third argument put forth by de Almeida and Dwivedi is that VPs (with overt or empty Vs) cannot raise to subject position in so-called unaccusative structures. They argue that we can form unaccusatives with event nominals (such as *war*) but not with entity nominals (such as *book*). However, we have a slightly different view with regards to why this happens. While (14a) as well as (14b) are allowed, a sentence such as (14c) cannot license an unaccusative construction when it has a VP in subject position, as shown in (14d).

(14) a. We began [NP this chapter] in June, well after the deadline
b. [NP This chapter] began in June, well after the deadline
c. We began [VP to write this chapter] in June, well after the deadline
d. *[VP to write this chapter] began in June, well after the deadline

But the ungrammaticality of (14d) arises, in our view, because the VP structure is broken, i.e. the V head is supposed to *stay* within the VP as one of its constituents, allowing its internal argument to move to subject position, thus yielding a so-called middle construction, as the sentences in (15) show.

(15) a. This chapter began to write in June, well after the deadline
b. This meat began to cut smoothly only after it was defrosted

In the next couple of sections we extend these ideas by also briefly discussing two other tests – middle formation and compounding.

3.2 Middles

We have seen in (15) that it appears that middle constructions with aspectual verbs can be formed when the VP structure is full. Middle formation can be a good test of the VP structure discussed above because in middles the surface subject comes from the internal argument position of the main verb. Thus, if the VP of an aspectual verb has a structure such as (10b), it should block middle formation because the nominal complement is the internal argument of an empty verb. For example, it is widely accepted that we can form middles such as those in (16), with rough paraphrases in (17).

(16) a. This chapter reads easily
b. The meat cuts perfectly
c. The bread slices smoothly

(17) a. One can read this chapter easily
b. One can cut the meat perfectly
c. One can slice the bread smoothly

As can be seen in (17), what appears to be the subject of the verb is in fact the object, with structures like in (18), whose internal arguments moved to subject position (see Keyser & Roeper 1984; Stroik 1992).

(18) [NP$_1$ This chapter] reads [NP$_1$___] (easily)

But as it turns out, with an aspectual verb (but not with other verbs that produce coercion effects such as *prefer*, *attempt*, and *manage*), middle formation appears to lead us in a different direction. The sentence in (19a), for instance, does not seem to license paraphrases such as those in (19b)–(19d).

(19) a. This chapter begins easily
b. ? One can begin this chapter easily
c. ? The beginning of this chapter is easy
d. ? It is easy to begin this chapter

If (19a) does indeed license one of these paraphrases, it is because its structure is that of an unaccusative (as in *The chapter began*; *The movie commenced*), *not* a middle. Crucially, the felicity of (19a) does not depend on the adverb *easily*, for (19a) can be a statement about the creation of a chapter (as in *writing the chapter*).

Thus, while it appears that a middle can be formed, the usual meaning that arises from having the NP in the subject position moved from its original internal argument position cannot be preserved. Our suggestion is that this change

in meaning is due to the NP becoming the surface subject of a verb (*begin*), after moving from its original position as the object of another – covert – verb.

3.3 Compounds

A key characteristic of verbs that supposedly allow for coercion – particularly aspectual verbs – is that they do not obey what has been called the *First Sister* (FS) principle (Roeper & Siegle 1978) for forming verbal compounds. According to this principle, a verbal compound is formed by the incorporation of a word in first sister position of the verb. Briefly, FS assumes that in cases such as those in (20), compounds can be formed because they incorporate adjectives ((20a)–(20b)), adverbs ((20c–20d)), nouns understood as direct objects ((20e)–(20f)), among other lexical categories.

(20) a. grim-acting
b. nice-sounding
c. fast-mover
d. late-bloomer
e. trend-setter
f. bell-ringing

However, other compounds with similar categories are ungrammatical because their modifiers cannot appear in the internal argument (or as modifying adjuncts) of their heads (Roeper & Siegel talk about subcategorization frames). Thus, as we can see (21a) and (21b), the different structures of the predicates *think-e* and *make-N* show the contrast between, e.g. **peace-thinking* and *peacemaker* (from Roeper & Siegel 1978).

(21) a. *She thinks peace → *She is peace-thinking
b. She makes peace → She is a peacemaker

We will not discuss in detail all the arguments for forming verbal compounds, as presented by Roeper and Siegle. We are interested here in focusing on the aspectual cases, as well as in other predicates used to support coercion effects. Thus, for instance, compound formation with predicates such as those in (22a) are allowed because *book* is in the first sister position of the V (or the V selects for the complement N).

(22) a. He reads books → He is a book-reader
b. He makes films → He is a filmmaker

But the cases in (23), we suspect, do not work because the compound needs to be formed with a lower verb which by hypothesis is internal to the aspectual predicate, as predicted by the VP structure discussed above (Section 3.1).

(23) a. He usually begins books on Saturdays →
*He usually is a book-beginner on Saturdays
b. I heard that the man starts the movie at 8 o'clock sharp →
*I heard that the man is a movie-starter at 8 o'clock sharp

If the FS principle is at work in these cases, as we think it is, and assuming the VP structure of verbs such as those in (23) take an internal empty V head, then forming a verbal compound is allowable only when the internal V head is filled, as in (24a).

(24) a. He began to read/reading a book → He is a book-reader
b. He began [VP [VP [VO *e*][NP a book]] → *He is a book-beginner

The compounding and middle cases presented here, together with the de Almeida and Dwivedi's (2008) analyses, further support the idea that coercion effects found in the psycholinguistic literature as well as linguistic intuitions about coercion might be structurally determined, i.e. an effect of a "hidden" verbal position. Thus we take the cases we discussed in the present section to strengthen the case for a view of coercion effects as triggered by linguistic form rather than by semantic decomposition or even, as it might be, by a type-shifting rule.

3.4 Event nominal complements?

A residual issue in our analysis is that of so-called *event* nominals. If it is the case that there is no type-shifting or that there is no coercion via semantic decomposition, why is it that event nominals do not appear to produce the same coercion effect as entity nominals do (see, e.g. Traxler et al. 2002)? Take for example cases such as (25): it appears that there is no coercion of the complement nominal because it is an *event* nominal, which supposedly provides the necessary information to *fill-in* the interpolated structure. It would seem that sentences in (25) mean something like those in (26).

(25) a. John began the fight
b. Mary started the lecture

(26) a. John began to fight
b. Mary started to lecture

We have at least two arguments against the view that event nominals constitute separate cases – thus that the contrast between entity and event nominals as complements of aspectual verbs can be used in favor of either a type-shifting or a lexical-semantic coercion approach. Our arguments are mostly against the latter approach.

The first is that we do not think sentences in (25) are synonymous with those in (26). In fact, we are sure they are not. There are many ways in which one can start *x* without actually engaging in *x*. We can cause a lecture to start without actually being the lecturer, and we can do the same with a fight – provoking it without getting into it. And it is not clear what actually determines the beginning/start of a given event such as a lecture or a fight – is it the preparation, a petition, an announcement, an actual punch? We do believe, however, that when one begins *to fight* one is actually engaged in it – and so with *to lecture*.

Clearly, an event nominal such as *war*, as in (27a) does not denote necessarily that the agent is actually involved in the hostilities, nor that it is involved in any other way, as interpretations such as those in (27b) and (27c) exemplify, or as the contexts in (28) make clear.

(27) a. The general started the war
b. The general started to fight the war
c. The general caused the war to start

(28) a. By accidently pressing the red button, the general started the war
b. By accidently pressing the red button, the general started to fight the war
c. By accidently pressing the red button, the general caused the war to start

Similarly, when another entity is in the subject position, participation in the event denoted by the nominal complement is not entailed, as shown in (29)

(29) China's veto started (*to fight) the war between the Koreas

There is yet another possibility for the hypothetical difference between event and entity nominals which would support the main tenets of type-shifting and coercion. The idea is that the gap we proposed above is the site for an unexpressed verb which comes from the nominal complement itself. Thus, the lack of coercion effects found in sentences such as (30a) and (31a) could be due to a default filler being supplied by a morphological operation on the deverbal nouns that usually characterize event nominals.[7]

(30) a. John began the fight
b. John began [v to fight [the fight]]

7. The study by Traxler et al. (2002), showing a coercion effect in *entity* vs. *event* nominals, actually employed several derived nominals in the *event* condition (e.g. *fight*, *battle, contest, argument, audit, recital, robbery, show, visit*).

(31) a. Mary began a song
b. Mary began to sing
c. Mary began to sing a song

One of the perils of this analysis is that it conflates a morphological operation with a definitional account of deverbal nouns – that is, it conflates what is a purely derivational analysis of *fight* with the idea that a noun such as *fight* actually incorporates a definition such as what is shown in (30b), i.e. that *the fight* actually means *to fight the fight*, just like *to sing* actually means *to sing a song*, as in (31c), as proposed by Hale and Keyser (1993). Again, we contend that examples such as those in (30) and (31) suggest that event nominals, if they are real, might not provide a filler verb to the empty V position, for the overt sentences with decomposed nouns (e.g. (30b) and (31c)) are not synonymous with their reduced conterparts ((30a) and (31a)). Moreover, this operation cannot yield a local default interpretation, for different agent nominals can produce *n* different intended meanings such as in (32).

(32) a. The conductor began a song
b. The conductor began to play/to sing/to rehearse a song

Yet, although this argument might work for most event complements used in the literature (e.g. Traxler et al. 2002), it might not work for all (e.g. cases of non-deverbal nouns). Nevertheless, we think that this analysis holds to the extent that it can account for the lack of coercion effects found in experiments with event nominals. And even if it is the case that a default filler verb is indeed extracted from the event nominal by morphological decomposition, we contend that this would be an argument in favor of our empty V head analysis: this structural position would be the site of the verb extracted from the nominal complement.

4. Pragmatic *triggers*

We have established that *aspectual* and often other verbs said to produce coercion in their nominal complements might comprise a structurally determined place for an event verb or nominal within their VPs. We turn now to a discussion of what we take to be the role of the proposed structural position in the interpretation of aspectual predicates as well as other predicates said to produce coercion effects.

We have proposed that the structural gaps are *triggers* for pragmatic inferences that allow for enrichment of indeterminate sentences. Although we cannot legislate on the particular types of inferences that might occur, much less on the actual content of particular predicates, we can in principle propose that structural gaps are the very places where the parsing and interpretation mechanisms start off

their content-enriching processes. In fact, we take it that *any* enrichment is at first a consequence of structurally-determined gaps in the linguistic representation of a phrase or sentence.

In the particular case we are discussing – of VPs said to produce coercion effects – the proposal is that the effects found in the empirical literature are most likely due to the empty V head we discussed (see also de Almeida & Dwivedi 2008). We take this V head to be the primary trigger to initiate pragmatic enrichment. It is possible that this trigger has the same function of the so-called *unarticulated constituents* we discussed earlier. There is, however, a crucial distinction: while the pragmatic enrichment we allow for comes from positions that are structurally determined at the linguistic level (syntax or logical form), in the case of unarticulated constituents as conceived by Recanati (2004), there are no such positions – or at least they are not tied to any particular syntactically or semantically determined structural position. We see this as a crucial distinction because while the interpretation of examples such as those in (1) and (2) above are determined by either analytic decomposition or by contextual demands, in the present proposal the primary processes of enrichment ought to be *linguistically active* (Grimshaw 2005).

In fact, we assume that high-level enrichment of any given sentence is a natural consequence of linguistic-system output, for the linguistic system cannot be informed about possible contextual manifestations of sentence tokens. Of course, the crux of the matter is to show that a context-free representation actually occurs prior to or concomitantly with possible contextual fitting processes. For no one denies that eventually a given sentence gets disambiguated or becomes properly fitting in a given context. One form of evidence for this view comes from a memory experiment showing that enriched reconstructions of indeterminate sentences emerge over time.

4.1 Context and enrichment: A memory experiment

There are classical experiments in the psycholinguistic literature (e.g. Sachs 1967, 1974) showing that following the loss of verbatim representations in working memory, individuals reconstruct sentences in a manner consistent with their underlying semantic "gist." Although these reconstructions deviate from the verbatim structure of sentences, they reflect what individuals eventually perceive to be the content of a sentence. Following Sach's sentence recognition paradigm, we (Riven & de Almeida in preparation) embedded indeterminate expressions such as (33a) within a relatively long discourse context (about 25 seconds of recorded speech prior to the presentation of the probe sentence) that strongly biased an interpretation consistent with (33b) but inconsistent

with (33c), and later asked participants whether they recognized the various sentence probes (i.e. (33a)–(33c)) from the passage.

(33) a. *Indeterminate*: Lisa began the book.
b. *Contextually biased interpretation*: Lisa began reading the book
c. *Contextually unbiased interpretation*: Lisa began writing the book.

Crucially, while both (33b) and (33c) represented plausible interpretations for (33a), the discourse contexts only permitted an interpretation resembling (33b) by constraining the range of plausible inferences. For example, the relevant passage stated that "Lisa had been looking forward to the new Grisham novel," before stating (33a), hinting at her intention to *read* as opposed to *write* a book.

We found that participants enriched the indeterminate sentences in a manner that was dependent on the discourse context. In particular, while participants were able to discriminate the various probes in (33) early on with greater than 95% accuracy, they began to falsely recognize (33b) following a 25 second delay, once a verbatim representation of (33a) was lost. Interestingly, participants reported a high degree of confidence (71%) that they were correct when committing such errors of recognition. In contrast, they remained fairly accurate at rejecting (33c), even following an extended delay. These results are presented in Figure 1.

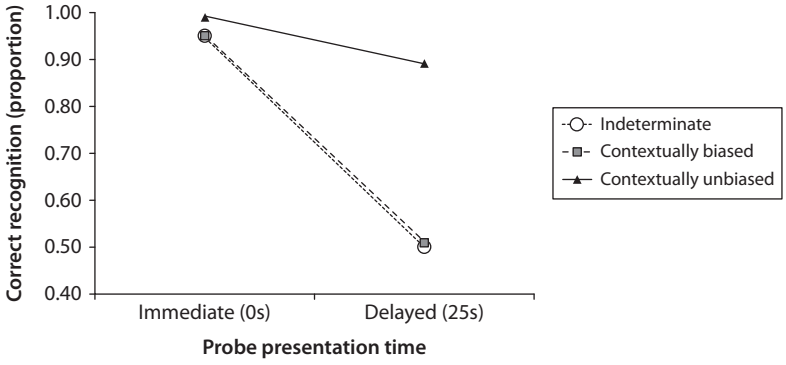

Figure 1. Proportion of correct recognition for each sentence type used in Riven and de Almeida's (in preparation) experiment

These results were obtained even though a subset of passages biased interpretations that would otherwise be considered less plausible than the alternative in (33c), illustrating that the context trumped any potential *default* mechanism of enrichment proposed to be a central feature of coercion (Pustejovsky 1995). Thus our data suggest that false-recognition was driven by discourse-dependent inferential processes emerging over time, and provide compelling evidence that pragmatic computations enrich these sentences.

The psycholinguistic evidence in favor of coercion has relied almost exclusively on measures of processing time. Typically researchers demonstrate a cost for indeterminate sentences relative to controls (e.g. McElree et al. 2001; Traxler et al. 2002). But while such manipulations provide evidence that the enrichment process might be costly, they cannot definitively illuminate the specific mechanism of enrichment (i.e. whether it is indeed the product of coercion or pragmatic inferences) for they provide no data on the content of enrichment per se. We believe that our memory manipulation addresses this gap in the literature and highlights a possible source of coercion effects. In particular, our study demonstrates that enrichment occurs as a function of pragmatic variables (i.e. a biasing discourse context), providing further evidence for our proposal.

4.2 Neurological bases of indeterminacy

While linguistic and psycholinguistic empirical evidence for the proposal we put forth might suffice to question the lexical-semantic coercion theory, we turn now to an investigation of how indeterminate sentence processing might be implemented in the brain. In a recent study employing functional magnetic resonance imaging (fMRI), de Almeida and Riven et al. (2012) presented participants with sentences such as those in (34), comparing indeterminate structures such as (34a) with fully-determined controls as in (34b) and with sentences which represented pragmatic violations, such as (34c).[8] We investigated the neural activation elicited during the online composition of each verb (e.g. *began/marked/assassinated*) combined with their internal arguments (e.g. *the paper*). The motivation for the study was to investigate whether indeterminate VPs triggered pragmatic processes by showing a similar pattern of activation with those in (34c) and a divergent pattern of activation from those in (34b). The prediction was that (34a) and (34c) would engage right hemispheric structures typically associated with the pragmatic processing of language (see de Almeida et al. 2012 for a review), while (34b) would not (at least not to the same extent).

(34) a. *Indeterminate*: The professor began the paper
b. *Control*: The professor marked the paper
c. *Pragmatic violation*: The professor assassinated the paper

We found that the neural activation elicited by indeterminate sentences shared some features of each of the comparison conditions (see Figure 2). Similar to the control sentences, indeterminate expressions elicited activation in typical

8. Our study included three other categories of stimuli. We focus here on the three main types and summarize the basic findings only.

language areas including Broca's area and Wernicke's area in the left hemisphere (LH). Overall, however, the indeterminate VPs conformed substantively to the network of brain regions involved in the processing of pragmatic violations, engaging significantly more right hemispheric (RH) structures than the control VPs.

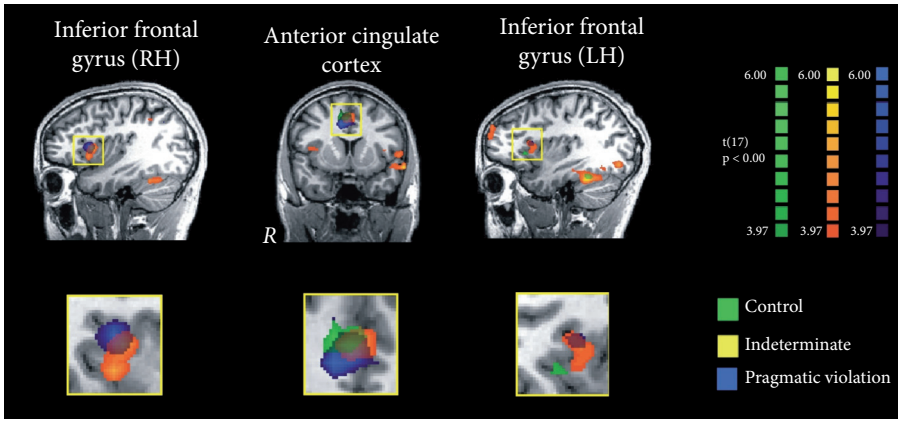

Figure 2. Scan maps from de Almeida et al. (2012). Data was obtained by generating a contrast for each sentence type, which involved the comparison of two sections of each sentence: (1) the pre-verb event (e.g. "The man") and (2) the post verb event (e.g. "began the book."). These intra-sentence contrasts were evaluated against a baseline measure of neural activation, which was obtained when participants read a set of non-experimental sentences used as filler items during the session. The maps show that indeterminate sentences elicit bilateral activation in the inferior frontal gyrus (IFG), engaging both typical language areas on the left (i.e. Broca's area) and pragmatic regions on the right. Notice that all three sentences engage Broca's area, but that indeterminate sentences and pragmatic violations tend to overlap while the control sentences largely occupy a distinct sub-region. Crucially, only the indeterminate and pragmatic violations engage the right IFG, and the activation for indeterminate sentences at the ACC (central map) surpasses the spread and level of activation for the control sentences

The pattern of activation in the LH showed unexpected divergence between the three sentence types, with the fully-determined controls activating an entirely distinct sub-structure of Broca's area than the other two sentences. This suggests that the involvement of typical language areas may have been functionally distinct for the various sentence types, with the indeterminate and pragmatically anomalous VPs presenting a special challenge for structural analysis performed by Broca's area. Crucially, the indeterminate sentence showed a much broader spread of activation in Broca's area than the two comparison sentences, which may be taken to reflect the structural gaps that we have proposed.

These findings may suggest that initially the LH computes a context-free, structurally shallow representation of the sentence, and in turn recruits RH resources for pragmatic enrichment. Interestingly, the process of indeterminacy resolution appears to go beyond recruiting pragmatic resources (typically, RH structures). We also found significant involvement of the anterior cingulate cortex (ACC) during the processing of sentences such as (34a), which exceeded both the spread and intensity of activation observed for the other sentences. The ACC is known to be involved in conflict monitoring and decision-making (Botvinick 2007). We suspect that the activations yielded by (33a) go beyond their pragmatically-anomalous controls (as in the case of (33c)) because they remain indeterminate, no matter how much our abductive apparatus tries to narrow the domain of interpretation.

These results are consistent with MEG studies (e.g. Pylkkanen & McElree 2007) reporting that indeterminate sentences elicit a pattern of neuronal activation that involves LH, RH, and medial regions of the brain. However, differences in methodology (MEG versus fMRI) have yielded differences in results, particularly with regards to the medial regions involved in processing these sentences. The MEG data presented by Pylkkanen and McElree (2007) was linked to a response in the ventro-medial prefrontal cortex (vmPFC), exclusively for indeterminate sentences, leading them to conclude that that particular region was involved in the coercion operation. Our fMRI experiment failed to replicate this finding, but rather revealed activation in the ACC for both indeterminate and pragmatically anomalous sentences. Given that MEG has relatively weaker spatial resolution than fMRI, it is possible that Pylkkanen and McElree's localization analysis in fact picked up activation from the ACC rather than the vmPFC, both of which represent medial regions of the brain albeit occupying distinct transversal coordinates (i.e. the ACC is superior to the vmPFC). Moreover, anatomical studies employing fMRI showed significant connectivity between the vmPFC and the ACC (Margulies et al. 2007), suggesting that MEG effects of vmPFC could actually originate at the ACC, consistent with our fMRI results. Crucially, the activation we observed in the ACC was common to both indeterminate and pragmatically anomalous sentences, suggesting that this region is not likely involved in coercion per se (a process that would be unique to indeterminate sentences), but rather participates in the pragmatic enrichment of sentences (a process that is common to both sentences).

Our fMRI data represent the neurobiological instantiation of indeterminate sentence processing, and suggest that initially the language system is challenged by the proposed structural gaps of indeterminate sentences, deploying pragmatic resources during the comprehension process, beyond that needed to interpret fully-determinate sentences and even pragmatic violations.

5. Minimal representations and enrichment

In the quest for understanding how indeterminate sentences such as (2a) above are interpreted, much has been said in support of either a lexical-decomposition theory of coercion or a theory of semantic type-shifting. In addition, many empirical studies have been offered mainly in support of a lexical-decompositional approach, although much of what has been presented in the experimental literature is far from showing the nature of what we called *coercion effects*.

We have shown that linguistic structure determines a position that might serve as a trigger for primarily pragmatic processes of enrichment. We have also presented evidence that comprehension of indeterminate sentences might be driven by inferences that occur over time and that such enrichment involves neurological structures usually involved in pragmatic processes. In addition, we have observed that the neural network of indeterminate sentence processing extends beyond typical pragmatic regions, recruiting areas known to be engaged in high-level decision-making. Such data suggest that, beyond pragmatic enrichment, the indeterminate sentences require abductive processes for the computation of their implicatures.

We take the basic Gricean picture to stand, and we concur with the main tenets of semantic minimalism: Pragmatic enrichment presupposes literal (thus, minimal) representation. We take this to be true of all cases in (1), of all cases that have been studied as coercion (i.e. indeterminate sentences), and beyond – including classical pragmatic phenomena such as metaphor, irony, indirect speech acts, and jokes. What is intended is represented minimally based on what is said and its structurally determined covert positions.

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