

Quantification At a Distance and Grammatical Illusions in French

Abstract

Recent research in psycholinguistics supports the hypothesis that retrieval from working memory is a key component of establishing syntactic dependencies in comprehension. This can result in so-called grammatical illusions (Phillips, Wagers, and Lau 2011); for example, one such illusion, intrusive NPI licensing, has been modeled as the result of this retrieval process allowing grammatically inaccessible licensing elements to be reactivated and create a spurious but fleeting perception of acceptability. This paper reports six studies which establish the existence of a similar new grammatical illusion involving quantification at a distance and the licensing of so-called de-NPs in European French. Our results suggest this grammatical illusion is interestingly different from NPI illusions, however: French ‘d’illusions’ depend on the type of (intrusive) licenser used. We found that only licensors that have certain syntactic properties trigger the grammatical illusion; specifically, only quantifiers that independently participate in quantification at a distance constructions were seen to create grammatical illusions. Consistent with previous work on the nature of cues in memory retrieval, we argue that this is the result of fairly specific abstract syntactic cues that guide the search for a licensing element. This paper thus brings further evidence that syntax is crucially used to structure working memory over the course of a parse.

1 Introduction

One of the central tasks in language comprehension is the process of establishing linguistic dependencies between elements in a sentence. For example, to understand the sentence *Linda, whose*

office is near room N400, often drinks herbal tea, it is necessary to integrate the subject phrase *Linda* with the verb *drinks*. Psycholinguistic research into this basic process suggests that the process of establishing this dependency in comprehension critically relies on *memory retrieval*: upon reaching the verb, the comprehender uses a set of *retrieval cues* (viz. features) that reactivate the desired dependent in working memory. Critically, this process of cue-based retrieval works via a process of feature matching against the contents of working memory. This means that syntactic constraints on dependency formation are deployed alongside semantic constraints. For this reason, these models predict the existence of *illusions of grammaticality*, which are said to occur when an ungrammatical dependency appears well-formed due to the presence of a syntactically inaccessible, but semantically appropriate, licensing element. Grammatical illusions are a case of misalignment between grammaticality and acceptability, and as such, they have been argued to provide a window into the architecture of the language system (Phillips et al. 2011). In particular, they have been investigated to provide insight into how the grammar of a particular language interacts with properties of the processing system that implements that grammar during the course of language comprehension or production.

In this paper we use offline judgment methodology to establish the existence of a new grammatical illusion, illusory *de*-Noun Phrase licensing in French. Across six experiments we show that illusory *de*-Noun Phrase licensing in French arises when a licensing quantifier linearly precedes, but does not c-command, the *de*-Noun Phrase. We hypothesize that licensing *de*-NPs in processing involves a memory retrieval operation to identify a licensor. We propose that this search may reactivate a non-local quantifier even if the quantifier is not c-commanding, but critically, we show that this only arises for quantifiers that, among other things, independently participate in quantification at a distance constructions in French. Our results from *de*-NP illusions thus suggest that these memory retrieval operations are guided by fairly abstract syntactic cues, despite their lack of sensitivity to c-command relations. Building on work on the structure of quantification at a distance and quantifiers in French, we propose that these syntactic cues are indexed on the structure of some (but not all) *de*-NP licensing quantifiers, thus tying together the asymmetry between non-c-commanding quantifiers that give rise to intrusive licensing and those that do not intrusively license *de*-NPs to other asymmetries in the syntax of these quantifiers.

We now turn to a discussion of grammatical illusions, and present the specific construction we

investigate in this paper. Because we will show that syntax is key to understanding our results, we review both descriptive and theoretical work on the relevant grammatical construction. Finally, we discuss relevant approaches to how grammatical illusions have been argued to arise. In section 2, we present our experimental results which (i) establish the existence of this novel grammatical illusion, and (ii) show that this grammatical illusion only arises in specific syntactic conditions. In section 3, we discuss our results against the background of previous models of grammatical illusions and the grammatical properties of this construction. This leads us to build on previous accounts to construct our own analysis of how the grammatical illusion we observed arises. Section 4 concludes.

1.1 What’s a grammatical illusion?

Broadly speaking, grammatical illusions arise when an ungrammatical sentence sounds acceptable, at least at first blush (Phillips et al. 2011). For instance, consider the examples in (1). On standard treatments of NPIs (Ladusaw 1979), (1a) is grammatical because the NPI *ever* is in the scope of a downward-entailing operator *no* (i.e. *no* c-commands the NPI). This is not true in (1b), hence the sentence is predicted to be ungrammatical.

However, the sentence in (1b) is judged more acceptable than the minimally-different ungrammatical sentence without *no* (1c, cf. the grammatical sentence in 1a); similarly in ERP measures (Drenhaus, Saddy, and Frisch 2004) and in eye-tracking-measures (Vasishth, Brüßow, Lewis, and Drenhaus 2008), less disruption is seen at the NPI in (1b) than (1c). The finding of increased acceptability, and concomitant eased processing, is the evidence for an illusion of grammaticality in (1b).

(1) NPI illusions (examples from Vasishth et al. 2008)

- a. No man who had a beard was ever thrifty.
- b.* A man who had no beard was ever thrifty.
- c.* A man who had a beard was ever thrifty.

This phenomenon is not limited to NPI licensing. Similar effects obtain with subject-verb agreement in a range of languages (*English*: Wagers, Lau, and Phillips 2009; Dillon, Mishler,

Sloggett, and Phillips 2013; *Spanish*: Lago, Shalom, Sigman, Lau, and Phillips 2015; *Arabic*: Tucker, Idrissi, and Almeida 2015) and reflexive licensing (Parker and Phillips 2017; Sloggett 2017; Jäger, Mertzen, Van Dyke, and Vasishth 2019). Potentially similar grammatical illusions are found in comparative constructions (Wellwood, Pancheva, Hacquard, and Phillips 2018) and the so-called missing VP illusion (Frazier 1985; Gibson and Thomas 1999).

One way of understanding the NPI illusion, descriptively, is that an item in need of licensing, e.g. *ever* in (2b), spuriously appears to be licensed because the presence of a potential licensor, e.g. *no* in (2b), although grammatically inaccessible, somehow creates the illusion of a well-formed dependency between the NPI and the quantifier. One hypothesis for the underlying source of this phenomenon attributes it to a memory retrieval process that is used to establish the dependency between the NPI and its licensor. This hypothesis is rooted in the observation that working memory retrieval processes form an integral part of incremental language processing (McElree, Foraker, and Dyer 2003; McElree 2006; Lewis, Vasishth, and Van Dyke 2006; Phillips et al. 2011; Parker and Phillips 2017). Broadly speaking, these models adopt a content-addressable memory architecture for the parser, and propose that the retrieval mechanism that activates representations when they are necessary during processing operates in a cue-based fashion. This means that in order to retrieve or reactivate some encoding from earlier in the sentence, all representations stored in memory are probed simultaneously to evaluate how well they match a set of features specified by the retrieval ‘cues’. The degree of match between the retrieval cues determines which representations are likely to be reactivated, as well as how easily this process will proceed.

Content-addressable models of cue-based retrieval have been successful at accounting for many types of grammatical illusions. For example, suppose that the NPI *ever* initiates a search in working memory for a licensing element. Plausible retrieval cues for this process are [+Downward Entailing] (i.e. a semantic constraint) and [+c-commanding] (i.e. a syntactic constraint)¹. In (1b) there is a situation of partial cue match: the inaccessible licensor *no* has the correct semantic feature, but it does not match the syntactic cue. However, this partial feature match makes it possible that the inaccessible licensor will be retrieved from time to time. When it is, the sentence will appear well formed, at least temporarily. There are multiple distinct implementations of this

1. We set aside here the question of whether configurational cues such as [+c-commanding] can be straightforwardly specified in a cue-based architecture, but we refer the reader to Cummings and Sturt 2014, Dillon 2014, Kush, Lidz, and Phillips 2015, and Kush, Lohndal, and Sprouse 2017 for further discussion.

core idea: we refer the reader to Vasisht et al. (2008) and Van Dyke (2007) for two different formalizations of this process.

Because these models attribute the NPI illusion in (1b) to a feature of the working memory systems used to establish linguistic dependencies during parsing, they lead us to expect that these effects should be fairly general across languages and across constructions. For instance, the ungrammatical sentence in (2b) is consistently rated higher than the ungrammatical sentence in (2c) (Wagers et al. 2009; Parker and Phillips 2017; Hammerly, Staub, and Dillon 2019). The explanation for this grammatical illusion under the cue-based account is the same: the parser initiates a search at the verb for a [+PL], [+NOM] agreement controller. In b we find a partial feature match to this retrieval probe with the word *cabinets*, thus making the sentence more acceptable even though the word bearing the cue is not in a grammatically-accessible position. Similar effects have been reported across a range of languages, including Spanish (Lago et al. 2015), Turkish (Lago, Gračanin-Yukse, Şafak, Demir, Kırkıcı, and Felser 2018)), Armenian (Avetisyan, Lago, and Vasisht 2019), Arabic (Tucker et al. 2015), and Russian (Slioussar 2018).

- (2) a. The keys to the cabinet are on the table.
b. *The key to the cabinets are on the table.
c. *The key to the cabinet are on the table.

Work on these illusions has explored the conditions that give rise to these effects. For example, Parker and Phillips 2016 have shown that NPI illusions can be turned on or off by modulating the linear distance / time between intrusive licenser and NPI. For instance in (3b), no illusory licensing was observed when a parenthetical, e.g. *as the editors mentioned*, intervened between the *no* and *ever*, but it was observed when the parenthetical was sentence initial (3a).

- (3) a. *As the editors mentioned, the authors [that **no** critics recommended for the assignment] have **ever** received a pay raise.
b. *The authors [that **no** critics recommended for the assignment] have, as the editor mentioned, **ever** received a pay raise.

Interestingly, Parker and Phillips found that linear distance / time did not have any effect on agreement attraction: increased acceptability was observed in both (4a) and (4b).

- (4) a. *According to the janitor, the key to the **cabinets** probably **were** destroyed by the fire.
 b. *The key to the **cabinets**, according to the janitor, probably *were* destroyed by the fire.

They proposed that the difference in illusion profile came down to a difference in memory encoding between syntactic and semantic/pragmatic representations. But they note that grammatical illusions could, in principle, reflect either an error in how we mentally encode structured linguistic representations in memory, or an error in how we later access information in those representations.

As mentioned, one important feature of the cue-based model is that it predicts that these effects should be rather pervasive across constructions and languages. This is the starting point for our investigation. We look at ungrammatical constructions like (5b) in European French. As in (1), in the examples in (5) there is an element that needs to be licensed; here it is the de-Noun Phrase *de livres* ‘de books’. As we detail below, this de-Noun Phrase needs to be licensed by a quantifier, as it is in (5a). Example (5b) provides a sentence that is superficially analogous to the NPI sentence in (5b). Like the more acceptable ungrammatical sentence in (1b), there is an element that needs to be licensed – *ever* or *de livres* – but the licenser – *no* or *beaucoup* – though present, is in a grammatically inaccessible position.

- (5) a. Des gens ont lu beaucoup de livres.
INDEF.PL people have read a_lot DE books
Some people have read many books.
 b. *Beaucoup de gens ont lu de livres.
 c. *Des gens ont lu de livres.

We ask whether speakers of French find the ungrammatical sentence in (6b) significantly more acceptable than the unacceptable/ungrammatical sentence in (6c); this would constitute a grammatical illusion for de-Noun Phrases analogous to that seen for NPI illusions, insofar as it is the presence of the structurally inaccessible quantifier *beaucoup* that is responsible for this effect. To preview our findings, we find that this is indeed the case, and further ask under what conditions this new grammatical illusion arises. We explore how current models of sentence processing might explain this finding. However, we first turn to a description of the grammatical phenomenon under

Quantifiers that license de-NPs² are listed in Table 1.

Table 1: Quantifiers licensing de-NPs

<i>assez</i> ‘enough’	<i>de plus en plus</i> ‘more and more’
<i>suffisamment</i> ‘enough’	<i>de moins en moins</i> ‘less and less’
<i>trop</i> ‘too’	<i>tellement</i> ‘so much/many’
<i>beaucoup</i> ‘a lot’	<i>le plus</i> ‘the most’
<i>énormément</i> ‘a great deal of’	<i>le moins</i> ‘the least’
<i>pas mal</i> ‘quite a few/some’	<i>plus</i> ‘more’
<i>peu</i> ‘little’	<i>davantage</i> ‘more’
<i>un peu</i> ‘a little’	<i>moins</i> ‘less’
<i>vachement</i> ‘a lot’ (fam.)	<i>autant</i> ‘as much/many as’
<i>sacrément</i> ‘a lot’	<i>plein</i> ‘a lot’
<i>drôlement</i> ‘a lot’	<i>quantité</i> ‘many’
<i>guère</i> ‘little’	<i>nombre</i> ‘many’
<i>tant</i> ‘so much/many’	

French allows some of these quantifiers to be separated (non-adjacent) from their de-NP restrictor in a construction known as Quantification At a Distance (QAD); we return to this in more detail below. For example, in (9) the quantifier *beaucoup* ‘many’ appears separated from *de lettres* ‘letters’.

(9) Des gens ont beaucoup lu de livres.

INDEF.PL people have many read DE books

Some people have read many books.

However, mere linear precedence does not suffice to license quantification at a distance in French. The syntactic position of the potential licenser in the sentence prior to a de-NP is critical: if the licensing quantifier does not c-command the de-NP (10a) and if it is already associated with another de-NP (10c), then it is reliably judged to be significantly less acceptable than (10b) and (10d) respectively when speakers are given sufficient time to make their judgment.

(10) a.*Les enfants [que je vois peu] lisent de livres.

the children that I see little read DE books

Int. The children that I see seldom read books.

2. The category of what I am calling ‘(licensing) quantifiers’ is not uncontroversial. In recent work (Kayne 2002), Kayne suggests that they may always be adverbs involved in a complex DP structure. Whatever the correct status of the lexical items listed in table 1, I continue to use the description ‘quantifiers’ to refer to them.

b. Les enfants [que je vois peu] lisent des livres.

the children that I see little read INDF.PL books

The children that I see seldom read books.

c.*Peu de gens ont lu de livres.

few DE people have read DE books

Int. Few people have read books.

d. Peu de gens ont lu des livres.

few DE people have read INDF.PL books

Few people have read books.

Based on these observations, we may formulate the generalization concerning de-NP licensing as in (11).

(11) **Grammatical de-NP licensing generalization**

For every de-NP, there must be one licensing quantifier, such that:

- that quantifier c-commands the de-NP it licenses, and
- it licenses exactly one de-NP.

The generalization in (11) thus correctly rules out (10a/b) as ungrammatical: sentence (10a) is ruled out because the licensing quantifier *peu* does not c-command the de-NP *de livres* and sentence (10b) is ruled out because there are two de-NPs, but only one licensing quantifier³.

We wonder to what extent the licensing dependency between a quantifier and the de-NP it licenses is similar to the licensing dependency between a negative element and the NPI it licenses. Consider the examples in (12). (12a) repeats the example of the spurious NPI illusion effect from Vasishth et al (2008; translated to English). (12b) presents an example of a comparable configuration with a de-NP. If we suppose that the process of licensing a de-NP that does not have an adjacent quantifier (i.e. one in a QAD configuration) involves a memory retrieval process for a licensor, then there is a clear parallel between the two cases. In (12b), the licensor *beaucoup* should match whatever features code for appropriate quantifiers, but it will not match the appropriate

3. Note that rule (11) correctly predicts that (i) is grammatical since for every de-NP, there can be one (or more) licensing quantifier.

(i) J' ai lu trop peu de livres.

I have read too few DE books

I have read too few books.

structural features. Therefore, it may be considered a partial match to the retrieval cues that a de-NP uses to find a long-distance quantifier as a licenser.

Thus, we might ask: do we see an increase in acceptability in the ungrammatical sentence in (12b) compared to a relevant control sentence, just as we see one in (12a) when the negative element *no* is present albeit in an inaccessible position for the NPI *ever*? This is our first empirical question (Question 1).

- (12) a. -GRAM+INT *A man who had no beard was ever thrifty.
-GRAM-INT *A man who had a beard was ever thrifty.
- b. -GRAM?INT *Beaucoup de gens ont lu de livres.
-GRAM-INT *Des gens ont lu de livres.

There are several other features of the French QAD construction, however, that raise very interesting questions from this point of view. Any of the quantifiers listed in table 1 can license an immediately-adjacent de-NP as in(6c and 10c), that much is uncontroversial. However, we might also ask: are all of these de-NP licensing quantifiers equally capable of creating illusions of grammaticality? This is our Question 2, and here we draw our inspiration from ?, who asked a similar question with NPI licensers. If the answer to Question 2 is negative, then, the final question we would like to answer is what are the properties that make a quantifier eligible to create illusory licensing of de-NPs? This is Question 3, our final question.

It is important to note that not all de-NP-licensing quantifiers listed in Table 1 are created equal: these quantifiers are differentiated syntactically in a number of critical ways listed in (13). These quantifiers may be divided into two classes, which we will call the *beaucoup*-class and *plein*-class, using prototypical examples of each class as its label. These differences are not apparent in the (simple) cases where quantifier and de-NP are immediately adjacent (6c), but instead refer to the behavior of these quantifiers in other contexts.

(13) Properties of *beaucoup* and *plein* type quantifiers

	beaucoup	plein
quantify at a distance	✓	x
can be used as an adverb	✓	x
can be used as an object pronoun	✓	x

The first crucial difference among de-NP-licensing quantifiers is that only some de-NP licensing quantifiers can appear separated from the de-NP they license in a QAD construction. As previously mentioned, constructions where the de-NP-licensing quantifier is not immediately adjacent to the de-NP it licenses are known as Quantification At a Distance (QAD) (Kayne 1975; Milner 1978; Obenauer 1983; 1994; Boivin 1999; Burnett 2009; 2012; Rizzi 1990; Doetjes 1995; 1997; Pasquereau 2015; 2016; 2018). Most of the quantifiers in Table 1 can Quantify At a Distance; for ease of exposition, we will refer to these as +QAD quantifiers (e.g. *beaucoup* ‘many’ in 14b). However, others cannot, and must be strictly local to the de-NP (-QAD; e.g. *plein* ‘many’ in 15b).

- (14) a. F. a écrit *beaucoup de lettres*.
 F. has written a.lot DE letters
Francis has written a lot of letters.
- b. F. a *beaucoup* écrit *de lettres*.
 F. has a.lot written DE letters
Francis has written a lot of letters.

- (15) a. Francis a écrit *plein de lettres*.
 Francis has written a.lot DE letters
Francis has written a lot of letters.
- b.*Francis a *plein* écrit *de lettres*.
 Francis has a.lot written DE letters

The second crucial difference between de-NP-licensing quantifiers is that some are (also) VP adverbs while others are not. Kayne (1975) noticed that this property correlated with the ability to participate in QAD constructions, offering the following generalization (16).

(16) **QAD adverb quantifier generalization** (Kayne 1975)

An adnominal quantifier can quantify at a distance iff it can be used as a preverbal adverb.

The quantifiers *beaucoup* ‘a lot’ and *plein* ‘a lot’ illustrate this correlation: in (17), *beaucoup* may be used as a VP adverb and as quantifier licensing its de-NP restrictor ‘at a distance’. On

the other hand, the quantifier *plein* ‘a lot’ cannot be used as a VP adverb, and it cannot quantify at a distance (18).

(17) a. J’ ai acheté beaucoup de pommes.

I have bought a_lot DE apples

I bought many apples.

b. J’ ai beaucoup acheté de pommes.

c. J’ ai beaucoup dormi.

I have a_lot slept

I’ve slept a lot.

(18) a. J’ ai acheté plein de pommes.

I have bought a_lot DE apples

I bought many apples.

b.*J’ ai plein acheté de pommes.

c.*J’ ai plein dormi.

I have a_lot slept

Intended: I’ve slept a lot.

The adverb-quantifier generalization has motivated an analysis that takes the correlation between the possibilities to be used as VP adverbs and as distant quantifiers at face value. Under such an analysis, the quantifier is base-generated in the position where it appears and a dependency is established between it and the de-NP. In other words, the local quantification construction (17a) and the QAD construction (17b) have different underlying structures: the quantifier is a determiner when it appears adjacent to the de-NP and an adverb when it appears in preverbal position. This type of analysis, known as the base-generation analysis, is defended in most work on this construction (Kayne 1975; Milner 1978; Obenauer 1983; Azoulay-Vicente 1989; Rizzi 1990; Obenauer 1994; Doetjes 1995; 1997; Boivin 1999; Heyd 2003; Mathieu 2005; Burnett 2009; 2012).

Another phenomenon that has supported the base-generation analysis is what Burnett 2009 calls the Multiplicity of Events requirement which was first reported in Obenauer 1983. According

to this requirement, a QAD construction is judged true only if the context involves multiple events. By contrast, local quantification constructions do not have such a requirement.

(19) **Multiplicity of Events requirement** (Obenauer 1983)

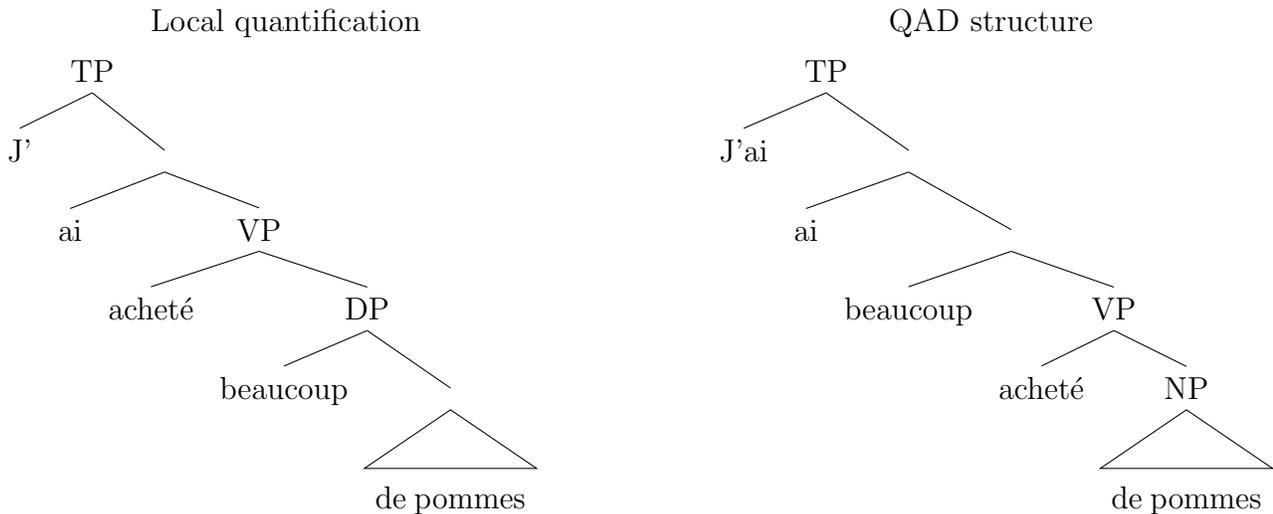
QAD sentences are true only if the context involves multiple events.

This requirement that only applies to the QAD construction has been used as an argument in favor of the base-generation analysis and against the derivational type of analysis where the QAD and local quantification constructions have the same underlying structure (see below). Note however that, as Burnett 2009 discusses, the Multiplicity of Events requirement is not present in every variety of French, and it remains unknown what determines one variety or the other. Nevertheless, since our goal is to consider the maximal number of ways in which the QAD construction might be characterized as different from the local quantification construction, we will assume that the QAD construction indeed has a Multiplicity of Events requirement.

For the sake of concreteness and brevity, we present just one implementation of the base-generation analysis (Burnett 2009). Although the particular analytical details are not crucial for us, Burnett (2009)'s analysis has the advantage of building on a lot of previous work and thus providing a good summary of the insights of the work done in the base-generation line of enquiry. Syntactically, Burnett 2009 analyzes *beaucoup* in (17a) as a quantificational determiner and in (17b) as a quantificational adverb, as in Figure 1. These assumptions are shared among all the implementations of the base-generation type of analysis.⁴

Figure 1: Base-generation analysis in Burnett 2009

4. Where the implementations differ is in their treatment of the structure of the de-NP, e.g. for Burnett 2009 de-NPs do not have more structure, they are just NPs and the *de* is the morphological reflex of the application of a semantic compositional operator (see below) while for Obenauer 1994 de-NPs contain an empty category (that is, a variable) which must be bound by the quantifier.



The analytical burden in the implementations of this analysis is in the semantic interpretation of the structures. In Burnett 2009, the local quantification construction is not discussed. We assume this is because it is treated like a structure containing a generalized quantifier phrase. The QAD structure is treated as involving a polyadic (adverbial) quantifier that binds an event variable and an object variable at the same time. Burnett assumes that adverbial *beaucoup* ‘many’ in SF (20) takes a set of $\langle \text{event}, \text{object} \rangle$ pairs and yields true just in case the cardinality of the set of first coordinates is a lot according to the context, and the cardinality of the set of second coordinates is also a lot⁵.

- (20) $\llbracket \text{beaucoup}_{Adv} \rrbracket =$ the function BCP^{SF} , defined as follows: Let $s, t \in \mathbb{N}$ such that $0 < s_e, t_x < |E|$,
 For all $R \in \mathcal{P}(E^e \times E^x)$, $\text{BCP}_{s,t}^{SF}(R) = 1$ iff $|\text{Dom}(R)| > s_e$ & $|\text{Ran}(R)| > t_x$

Burnett assumes that *de*-NPs denote bare properties following (Heyd and Mathieu 2005). In her system, the verb and the *de*-NP combine without existentially closing the direct object via a modified version of Chung and Ladusaw (2004)’s *Restrict* compositional rule, which she calls *Restrict’* (21).

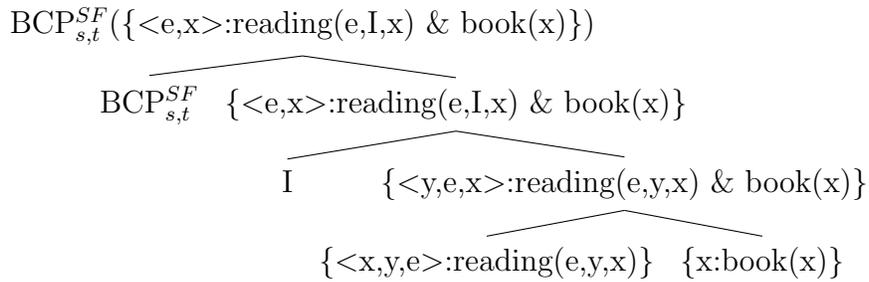
5. $|\text{Dom}(R)|$ gives the cardinality of the set of events, E^e , and s_e is the contextually-defined threshold, such that if $|E^e| > s_e$, and s_e is at least equal to 1, then it is true that there are many events of the predicate denote by R. Likewise $|\text{Ran}(R)|$ gives the cardinality of the set of individuals, E^x , and t_x is the contextually-defined threshold, which is at least equal to 1, such that if $|E^x| > t_x$, then it is true that there are many individuals involved in the relation R. Note that the ‘a lot’ component that is understood to be expressed by *beaucoup* ‘many’ is not encoded in its denotation. All the denotation of *beaucoup* says is that the contextually-defined thresholds have to be at least 1, and so there must be at least 2 events of R and 2 objects satisfying R. I assume that the ‘a lot’ requirement is supplied by context which gives their values to the thresholds.

(21) **Restrict'**

For any nodes β and γ such that, β dominates a lexical item whose interpretation is P, and γ dominates a lexical item whose interpretation is Q, $\llbracket\beta\rrbracket = \{\langle \nu_1, \nu_2 \dots \nu_n \rangle : P(\nu_n, \nu_{n-1} \dots \nu_1)\}$ and $\llbracket\gamma\rrbracket = \{\nu_k : Q(\nu_k)\}$, then $\llbracket Merge(\beta, \gamma) \rrbracket = \{\langle \nu_2, \nu_3 \dots \nu_n, \nu_1 \rangle : P(\nu_n, \nu_{n-1} \dots \nu_1) \ \& \ Q(\nu_1)\}$

Figure 2 gives the derivation of the meaning of the QAD sentence as Burnett gives it. The verb and the object combine via *Restrict'*. Then the VP and the subject combine via *Functional Application* (Kratzer and Heim 1998). Finally, *beaucoup* combines with the whole sentence.

Figure 2: Burnett's compositional semantics for QAD in SF



$\llbracket J'ai \text{ beaucoup lu de livres}_{Adv} \rrbracket = 1$

iff $|\{e : \text{reading}(e, I, x) \ \& \ \text{book}(x) \mid \rangle_{s_e} \ \& \ |\{x : \text{reading}(e, I, x) \ \& \ \text{book}(x)\}| \rangle_{t_x}$ ⁶

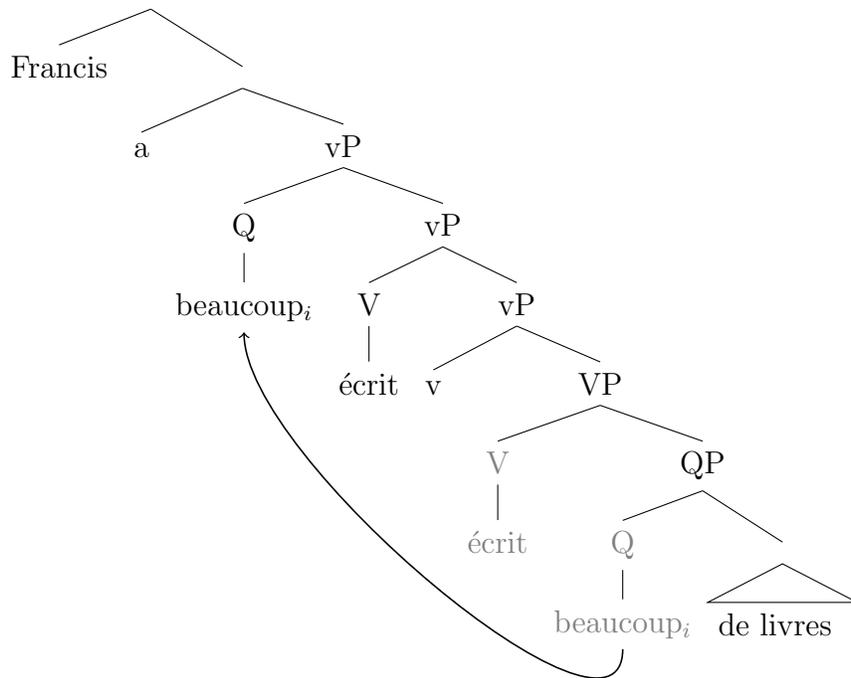
In short, *J'ai beaucoup lu de livres* is true just in case there were many events of me book-reading, and I read many books. Or, to paraphrase Burnett, the sentence is true just in case there were more events than a contextually-defined threshold, s_e , and the number of books I read was greater than a contextually-defined threshold, t_x . If those conditions are not met, the sentence is not true. The base generation analysis we have described until now proposes that the non-local quantifiers in a QAD construction are essentially different from those that appear local to the de-NP. The insight in Burnett's analysis, then, is critical for the studies we pursue below: the quantifiers in non-local QAD constructions are not the same syntactic or semantic objects as those in local configurations, despite the superficial similarity of the local and non-local quantifiers. We will draw on this insight directly in our research.

An alternative type of account is one in which the QAD structure is derived from the structure where quantifier and de-NP are adjacent. Under a derivational analysis, the quantifier is generated

6. It seems to me that this formula is not well-formed: some variables are not bound.

next to de-NP, where it can be pronounced, or it can feed a ‘movement’ rule and end up being pronounced (and possibly interpreted) in the preverbal position (Milner 1978; Boivin 1999; Kayne 2002; Labelle and Valois 2004; Authier 2016, Author 2016, Author2018). Crucially, the underlying structure of QAD is one in which the quantifier is adjacent to the de-NP. We discuss one movement account: Authier 2016 to illustrate how this type of analysis can be implemented. For Authier, *beaucoup* may optionally undergo head-movement from the position where it is merged into the structure to [Spec, *vP*]^{7,8} as in Figure 3.

Figure 3: Movement analysis (Authier 2016)



Kayne (1975) points out that if we explain QAD by a derivational rule targeting adnominal quantifiers, then we would expect all de-NP licensing adnominal quantifiers to be able to appear preverbally, but this is incorrect since *plein*, *quantité*, and *nombre* cannot quantify at a distance though they can license de-NPs. It is not clear how Authier 2016’s account handles quantifiers

7. A semantic account is not given thus it is not clear how Authier 2016’s account derives the Multiplicity of Events requirements.

8. In line with Fukui and Takano 1998; Nakamura 2000; ?, Authier 2016 assumes that head movement is movement of a head to *the specifier* of another head, possibly followed by m-merger of the two heads.

like *plein* which cannot be used in QAD constructions. Kayne 2002 however provides what we believe to be ingredients towards a solution to this issue within the movement analysis. Before detailing Kayne’s proposal however, we would like to discuss an argument made in Author 2015 and Authier 2016 which is used to motivate the movement analysis of Authier 2016 and which may provide a hint towards understanding why *plein*-type quantifiers cannot undergo movement Kayne 2002.

One of the premises of this argument is that quantifiers that can move have the same distribution as ‘pronominal’ quantifiers *tout* ‘everything’ and *rien* ‘nothing’ (we only consider *tout* here). This premise is built on two sub-generalizations. First, *beaucoup*-type quantifiers can be used ‘pronominally’ or bare (just like *tout*) to satisfy the object requirement of transitive verbs. Given that *tout/beaucoup* is the object of the verb, it must have been merged in the structure as the complement of the verb, i.e. to the right of *fait* in (22). Given the Uniformity of Theta Assignment Hypothesis, it follows that the structure in (b) where *tout/beaucoup* is pronounced to the left of *fait* must be derived from the structure in (a).

(22) a. Il a fait tout/beaucoup/*plein.

he has done every/much/much

He did everything/much.

b. Il a tout/beaucoup/*plein fait.

Second, whether bare or followed by a de-NP the distribution of *beaucoup* is the same as the distribution of *tout*: they are subject to the same locality restrictions. For instance, movement of *beaucoup/tout* is not possible across a finite-clause boundary (23) but it is possible across some non-finite clause boundaries (24). For more details, see Authier 2016 or Author 2018.

(23) a. J’ ai pensé que tu avais tout/beaucoup vendu aujourd’hui.

I have thought that you had every/much sold today

I had thought that you had sold everything/a lot of things today.

b.*J’ai tout/beaucoup pensé que tu avais vendu aujourd’hui.

(24) a. J' ai dû tout/beaucoup vendre aujourd'hui.

I had must every/much sell today

I must have sold everything/a lot of things today.

b. J'ai tout/beaucoup dû vendre aujourd'hui.

The argument goes as follows: given that *tout* moves and given that *beaucoup*-type quantifiers have the same distribution as *tout*, then *beaucoup*-type quantifiers move too. We use the second premise to posit the following generalization as holding of the set of QAD operators (25).

(25) **QAD nominal quantifiers generalization**

An adnominal quantifier can quantify at a distance iff it can be used pronominally in object position.⁹

We hasten to say that we do not literally mean that the quantifier is a pronoun in certain contexts: rather it can be used *like* a pronoun, where its restrictor is specified anaphorically. The important observation is that in this use, it appears without an (overt) de-NP. Indeed, while adding the +QAD quantifier *beaucoup* 'a lot' in CQ (26a) or QAD (26b) satisfies the selectional requirements of *faire* 'do', adding *plein* 'much' does not (27).

9. The reason this correlation is restricted to the object position is because the quantifier *nombre*, which cannot quantify at a distance and cannot be used as an adverb (constitently with Kayne's generalization) seem to be able to be used nominally in subject position (i) unlike *plein* and *quantités*.

(i) a.*J' ai nombre/plein/quantité acheté de choses.

I have many bought DE things

Int. I bought many things.

b.*Je suis nombre/plein/quantité tombé.

I am many fallen

Int. I fell many times.

c.*Marie a fait nombre/plein/quantité pour les pauvres.

Marie has done much for the poor

Int. Marie did much for the poor.

d. Nombre/*plein/*quantité sont venus me voir.

many are come me see

(Int.) Many came to see me.

In fact *nombre/plein/quantité* differ in a few other ways. We leave the question of why this is the case for further research.

(26) a. J' ai fait beaucoup pour les pauvres.

I have done a.lot for the poor

I did a lot for the poor.

b. J'ai beaucoup fait pour les pauvres.

(27) a.*J' ai fait plein pour les pauvres.

I have done a.lot for the poor

Int. I did a lot for the poor.

b.*J'ai plein fait pour les pauvres.

Kayne 2002; 2008 makes the proposal that a sentence like (28a) has the underlying structure in (28b). That is, he proposes that the phrase *beaucoup de livres* contains an adverb *beaucoup* which modifies a silent adjective which itself modifies a silent noun which denotes a quantity.^{10,11}

(28) a. J' ai lu beaucoup de livres.

I have read many DE books

I read many books.

b. J'ai lu beaucoup MANY NUMBER de livres.

Kayne does not specify what the exact structure of this sentence is, and we do not commit to a particular structure either. Doing so is beyond the scope of the present paper. Following Kayne 2002, all we commit to is that *beaucoup*-type quantifiers involve a silent adjective and a silent noun. For the sake of making the discussion and the representations we will use to illustrate

10. He notes that an alternative to making this hypothesis would be to assume that *peu* [or, we assume, *beaucoup*, *trop*, ...] is itself a noun. It is not clear though how this alternative hypothesis would handle the fact that *peu*, *beaucoup*, *trop* ... are also all adverbs. We refer the interested reader to this discussion in Kayne 2002, p. 98.

11. We do not pursue Kayne 2002's movement analysis of QAD since it predicts that *plein* can quantify at a distance which is strongly unacceptable for our informants and the participants in our experiments. Kayne 2002 reports that, according to Viviane Déprez, (i) is judged 'passably acceptable'.

(i) (?) Elle a tout plein acheté de bouquins.

she has every many bought DE books

(Int.) She has bought a great many books.

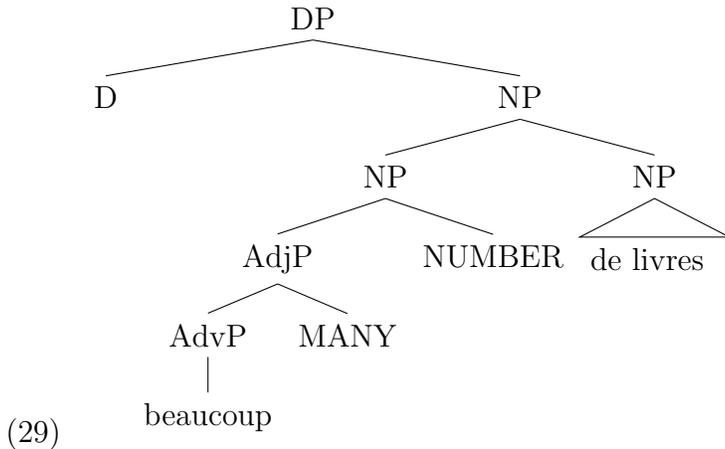
Notice that the sentence does not contain just *plein* but *tout plein*. There is a number of expressions in French that are perfectly acceptable with *tout plein* but not with *plein* or *tout* on their own (ii).

(ii) a. Merci tout plein. 'Thanks a lot.' *Merci plein. *Merci tout.

b. Il est mignon tout plein. 'He's very cute.' *Il est mignon plein. *Il est mignon tout.

In any case, as our experiments repeatedly show, sentences where *plein*-type quantifiers are separated from de-NP, are judged unacceptable.

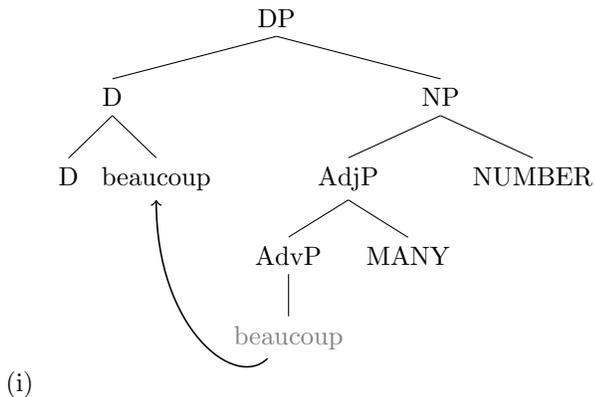
it more concrete, we use the structure in (29) for +QAD quantifiers, where de-NP is an NP constituent.¹²



We now show how this structure captures three generalizations. First, +QAD *beaucoup*-quantifiers are always adverbs, whether they appear in local quantification, QAD, or as adverbs. Second, *beaucoup*-type quantifiers have the same distribution as bare *tout* ‘all’ because we assume that in an example like (26a/b), the structure of ‘bare’ *beaucoup* is as in (30)¹³. In (26b) where bare *beaucoup* appears to the left of the verb, we assume following Authier 2016 that Adv has undergone head-movement to [Spec, VP] (or to [Spec, vP] to be more specific, though we do not represent the *v* layer).¹⁴

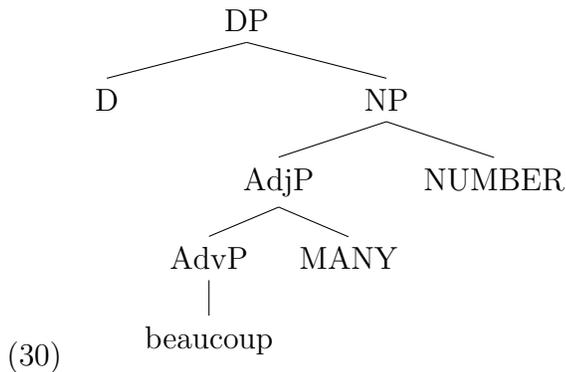
12. In fact, Pesetsky 2013, p. 100 proposes to treat de-NPs in French as genitive case NP, which happens to be realized at the constituent level in French via the preposition *de*.

13. The adverb *beaucoup* could undergo head-movement to D as in Russian (Pesetsky 2013), we leave this issue for further work.



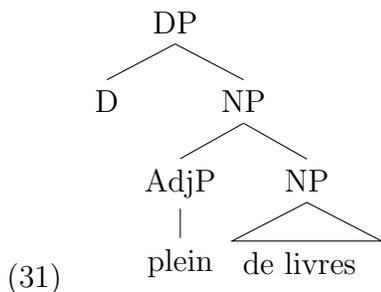
We assume the copy theory of movement (Chomsky 1992). The grayed out copy is the one that is not pronounced.

14. Alternatively, it could be that the *whole DP* has moved to [Spec, vP]. This would be consistent with the fact that the phrase *un peu* ‘a little’ can quantify at a distance (and be used pronominally in object position and be used as an adverb).



Finally, *beaucoup*-type quantifiers can quantify at a distance for the same reason that they can appear without an (overt) restrictor. In QAD, we assume that just the adverb has moved to [Spec, VP].

Kayne does not treat *plein*-type quantifiers as different from *beaucoup*-type quantifiers, which is probably because he assumes that they can quantify at a distance too. However, as our results will show, this is clearly not the case for the participants we tested. We assume that *plein*-type quantifiers are adjectives which directly modify de-NPs (31): this explains why they cannot be used as VP adverbs, why they cannot appear without a de-NP (at least in object position) and why they cannot quantify at a distance if we assume that adjectives cannot move in French.



This concludes our review of the different grammatical properties of the QAD construction in French, the analyses they have been given and those they could be given. We do not intend to argue for a specific analysis, rather we want to make use of the insights of these analyses when

-
- (i) a. J' ai un peu fait de repassage.
 I have a little done DE ironing
I have done a little bit of ironing.
- b. J' ai fait un peu pour cette cause, mais pas beaucoup.
 I have done a little for this cause but not much
- c. J' ai un peu dormi.
 I have a little slept
I slept a little.

interpreting the results of our studies.

1.3 The present study

To summarize, in the present study we are interested in asking whether de-NP licensing quantifiers can intrusively license de-NPs, drawing an analogy between this construction and the more widely studied NPI illusion effects. We investigate the acceptability of de-NPs by comparing different kinds of similar dependencies in an attempt to create configurations parallels to those involving NPIs. Across six experiments, we attempt to address three central questions, which we repeat in (32).

(32) Three questions

- a. Question 1: Can de-NP-licensing quantifiers intrusively license de-NPs?
- b. Question 2: Can all de-NP-licensing quantifiers intrusively license de-NPs?
- c. Question 3: What properties of a quantifier are critical for intrusive licensing?

In addressing these three questions in French, we aim to bring a new construction to bear on our understanding of grammatical illusions and on the debate concerning how grammatical illusions arise. We now turn to our experimental investigations in order to answer our three questions. Experiment 1 investigates question 1, and experiments 2-4 investigate questions 2 and 3 by testing intrusive structures with different types of de-NP licensing quantifiers. Experiments 5-6 explore question 3.

2 Experiments

2.1 Experiment 1

2.1.1 Methods

Participants Forty eight subjects participated in this experiment. They were recruited by word of mouth or via Facebook. A total of seven participants were excluded: four were not native speakers of French and three did not perform well on the control items. Prior to participation in the

experiment, participants filled out a questionnaire aimed at assessing their language background and their provenance. All 41 remaining participants self-reported as native speakers of French, and all 41 indicated that French was their dominant daily language. Completion of the survey took approximately 10 minutes.

Materials Eighteen sets of experimental items that consisted of the 3 experimental conditions shown in table 4 were developed. The experiment contains 3 conditions varying along two factors: grammaticality and acceptability. The 18 critical experimental items were combined with 23 filler sentences. Fillers included 9 grammatical sentences with NPI, 9 ungrammatical, unacceptable sentences with NPI, and 5 ungrammatical, unacceptable sentences containing quantifiers of the kind used in the experimental items.

Figure 4: Design

	description	label
A	grammatical, acceptable	GRAM
B	ungrammatical, intrusive	INT
C	ungrammatical, unacceptable	UNGRAM

The particle *de* in dePs has two forms: *de* (pronounced [də]) before a word starting with a consonant and *d'* (pronounced [d]) before a word starting with a vowel. To block for a potential effect of this difference, half of the items contain a quantifier followed by a deP in the reduced form, and the other half contains a quantifier followed by a deP in the full form.

(33) Item from Block 1

- a. GRAM: J' ai donné à **beaucoup d' amis** des livres sur
 I have given to many DE friends INDEF.PL books about
 la vie de mon oncle qui a passé vingt ans au Vietnam.
 the life of my uncle who has spent twenty years in Vietnam
*I have given to many friends books about the life of my
 grand-father who spent twenty years in Vietnam.*

- b. INT: J'ai donné à **beaucoup d'amis de livres** sur la vie de mon oncle qui a passé vingt ans au Vietnam.
- c. UNGRAM: J'ai donné à des amis **de livres** sur la vie de mon oncle qui a passé vingt ans au Vietnam.

(34) Item from Block 2

- a. GRAM: Michel a demandé à **beaucoup de gens** des conseils
 Michel has asked to many DE people INDEF.PL advice
 concernant le discours qu' il doit prononcer le 14 juillet.
 about the speech that he must pronounce the 14 July
*Michel has asked to many people advice concerning the
 speech that he must make on July 14th.*
- b. INT: Michel a demandé à **beaucoup de gens de conseils** concernant le discours qu'il doit prononcer le 14 juillet.
- c. UNGRAM: Michel a demandé à des gens **de conseils** concernant le discours qu'il doit prononcer le 14 juillet.

Six different quantifiers licensing *de* were used in the study (1 quantifier/3 items). They are listed in (35).

(35) Quantifiers used in the study

- beaucoup* 'much'
- trop* 'too much/many'
- énormément* 'a great many'
- suffisamment* 'sufficiently many/much'
- pas mal* 'not that few/little'
- de plus en plus* 'more and more'

All sentences used ditransitive verbs such that the goal or addressee (encoded by a PP headed by *à*) was ordered to the left of the direct object. The more standard order (object-PP) was not kept to avoid having the preposition intervene between the two dePs.

Predictions If comprehenders only pay attention to grammatical licensing of dePs, then we predict GRAM > UNGRAM, INT in terms of percentages of ‘yes’ answers. If the presence of a quantifier to the left of an unlicensed deP improves acceptability, we predict INT > UNGRAM.

Procedure The experimental items were distributed into 3 Latin Square lists, and each participant was assigned to a different list. For each participant, the order of presentation was randomized. Participants were instructed to judge whether a sentence was ‘acceptable’ by replying *oui* ‘yes’ or *non* ‘no’ to the question *Avez-vous trouvé cette phrase acceptable ?* ‘Did you find this sentence acceptable?’. They were first given 2 examples to introduce them to the RSVP + speeded-acceptability judgement task. Then they were given several examples with feedback to illustrate the difference between acceptability and grammaticality, something especially important to do with a language with such a strong-prescriptive tradition as the one European French has. Each trial consisted of a sentence presented on the screen, then the question with the two response options appeared. Sentences were cut up in chunks. Each chunk appeared for 350ms and a 100ms pause separated each chunk. Participants responded by choosing their desired response using the F and J keys or the mouse. Participants were given 2s to give their judgments. Reaction times were recorded, but not analyzed. Chunk presentation was chosen as opposed to word-by-word in an attempt to not draw attention to the critical word ‘de’¹⁵. An example of how items were chunked is given in (36).

(36) a. GRAM: J’ ai donné / à beaucoup / d’ amis / des livres /
 I have given to many DE friends INDEF.PL books
 sur la vie / de mon oncle / qui a passé / vingt ans /
 on the life of my uncle who has spent twenty years
 au Vietnam.
 at.the Vietnam

b. INT: J’ai donné / à beaucoup / d’amis / de livres / sur la vie / de mon oncle / qui a
 passé / vingt ans / au Vietnam.

c. UNGRAM: J’ai donné / à / des amis / de livres / sur la vie / de mon oncle / qui a

15. The intuition is that displaying *de* on its own would make comprehenders prosodify it differently from the way they would if it were displayed next to the NP it is part of.

passé / vingt ans / au Vietnam.

2.1.2 Results

By-condition average ratings of sentences found acceptable for all experimental conditions are presented in table 2, along with by-participant standard errors.

Table 2: Condition means and standard errors

Conditions	mean	s.e.
GRAM	0.91	0.02
INT	0.43	0.04
UNGRAM	0.27	0.04

The rating scores were analyzed using a mixed-effects logistic regression model (with optimizer *bobyqa*) with correlated random slopes and intercepts for subjects and items¹⁶. Helmert contrast-coding was used to decompose the three conditions into two comparisons: a grammaticality contrast that compares GRAM against INT+UNGRAM, and an intrusion contrast that compares INT against UNGRAM.

The model revealed a significant effect of grammaticality (GRAM>UNGRAM+INT) (Estimate = 1.20 (+/- .17), $z = 7.11$, $p < .001$) and a significant effect of intrusion (INT>UNGRAM) (Estimate = .75 (+/- .22), $z = 3.36$, $p < .001$).

2.1.3 Discussion

On the basis of the statistical model, we may sum up the results of this experiment as follows. First, we observed a very significant effect of grammaticality, which was expected (GRAM > INT, UNGRAM) given that only condition GRAM does not violate the grammatical rule (11). In addition, we observed a significant effect of intrusion in the two ungrammatical conditions (INT > UNGRAM), which confirms that if a sentence violates the grammatical rule (11), its acceptability is improved when a quantifier stands to the left of a deP even if this deP is grammatically unlicensed. The results of this experiment establish a robust illusion of grammaticality effect.

In this experiment, we only used quantifiers that can take part in the QAD construction. What is interesting is that, in QAD constructions, material can stand between the quantifier and

16. Running an ANOVA was not possible due to gaps in the data due to several participants' having given no response to some items

Table 3: Design of experiment 2

	+QAD	-QAD
GRAM	A	D
UNGRAM		C
INT	B	E

the licensed deP similarly to the way a deP stands between the quantifier and the second (grammatically-unlicensed) deP in condition INT of the experiment. This parallelism suggests the following remark. If it is the case that the temporary illusion of grammaticality is linked to the possibility of QAD (i.e. to the possibility of the quantifier’s being separated from the deP it licenses), then we would expect *plein*-type deP-licensing quantifiers to not give rise to illusory *de*-licensing. This is what we test in experiment 2.

2.2 Experiment 2

2.2.1 Methods

Participants Seventy four participated in this experiment. They were recruited via the mailing list of the CNRS RISC.¹⁷ A total of 15 participants were excluded according to our criteria. Prior to participation in the experiment, participants filled out a questionnaire aimed at assessing their language background and their provenance. All 59 remaining participants self-reported as native speakers of French, and all 59 indicated that French was their dominant daily language. Completion of the survey took approximately 15 minutes.

Materials Thirty sets of experimental items that consisted of the 5 experimental conditions shown in table 3 were developed. The experiment contains 5 conditions varying along three factors: grammaticality, acceptability, and whether the quantifier can move (+QAD) or not (-QAD). Note that there is just one ungrammatical condition because in that condition, no quantifier is present; condition C is common to both the +QAD and -QAD levels.

The 30 critical experimental items were combined with 40 filler sentences. Fillers included 15 grammatical sentences with NPI, 15 ungrammatical, unacceptable sentences with NPI, and 6

¹⁷. Note that the RISC recruitment pool does not allow for setting a precise number of subjects. The reason the sample sizes are inconsistent across experiments is because we aimed for a specific number of subjects but analyzed everyone who managed to take the experiment in the allotted portion of time.

ungrammatical, unacceptable sentences containing quantifiers of the kind used in the experimental items, and 4 sentences that the experimenter was interested in having rated.

The particle *de* in dePs has two forms: *de* (pronounced [də]) before a word starting with a consonant and *d'* (pronounced [d]) before a word starting with a vowel. To block for a potential effect of this difference, half of the items contain a quantifier followed by a deP in the reduced form, and the other half contains a quantifier followed by a deP in the full form.

(37) Item from Block 1

- a. GRAM+QAD: J' ai donné à **beaucoup** d' amis des livres sur la
I have given to many DE friends INDEF.PL books on the
vie de mon oncle qui a passé vingt ans au Vietnam.
life of my uncle who has spent twenty years in Vietnam
*I have given to many friends books about the life of my
grand-father who spent twenty years in Vietnam.*
- b. INT+QAD: J'ai donné à beaucoup d'amis de livres sur la vie de mon oncle qui a passé
vingt ans au Vietnam.
- c. UNGRAM: J'ai donné à des amis de livres sur la vie de mon oncle qui a passé vingt ans
au Vietnam.
- d. GRAM-QAD: J'ai donné à plein d'amis des livres sur la vie de mon oncle qui a passé
vingt ans au Vietnam.¹⁸
- e. INT-QAD: J'ai donné à plein d'amis de livres sur la vie de mon oncle qui a passé vingt
ans au Vietnam.

(38) Item from Block 2

18. I have given to many friends books about the life of my grand-father who spent twenty years in Vietnam.

- a. GRAM+QAD: Michel a demandé à beaucoup de gens des conseils
 Michel has asked to many DE people INDEF.PL advice
 concernant le discours qu'il doit prononcer le 14 juillet.
 concerning the speech that he must pronounce the 14 July
*Michel has asked to many people advice concerning the speech
 that he must make on July 14th.*
- b. INT+QAD: Michel a demandé à beaucoup de gens de conseils concernant le discours
 qu'il doit prononcer le 14 juillet.
- c. UNGRAM: Michel a demandé à des gens de conseils concernant le discours qu'il doit
 prononcer le 14 juillet.
- d. GRAM-QAD: Michel a demandé à plein de gens des conseils concernant le discours qu'il
 doit prononcer le 14 juillet.
- e. INT-QAD: Michel a demandé à plein de gens de conseils concernant le discours qu'il
 doit prononcer le 14 juillet.

Six different quantifiers licensing *de* were used in the study (1 quantifier/3 items). They are listed in (39).

(39) Quantifiers used in the study

+QAD	-QAD
<i>beaucoup</i> 'much'	<i>plein</i> 'much'
<i>suffisamment</i> 'sufficiently many/much'	<i>nombre</i> 'much'
<i>de plus en plus</i> 'more and more'	<i>quantité</i> 'much'

As in experiment 1, all sentences used ditransitive verbs such that the goal or addressee (encoded by a PP headed by *à*) was ordered to the left of the direct object. The more standard order (object-PP) was not kept to avoid having the preposition intervene between the two dePs.

Predictions It is expected that the results from experiment 1 will be replicated. In addition, if the QAD property does not matter for illusory licensing, we predict GRAM>INT>UNGRAM. If, however, the QAD property does condition intrusion, we expect an interaction of INT and QAD:

INT+QAD>INT-QAD.

Procedure The same procedure as in experiment 1 was used.

2.2.2 Results

By-condition average ratings of sentences found acceptable for all experimental conditions are presented in table 8 on page 45 along with by-participant standard errors.

Table 4: Condition means and standard errors

Conditions	mean	s.e.
GRAM+QAD	.87	.02
GRAM-QAD	.89	.02
UNGRAM	.22	.03
INT+QAD	.35	.04
INT-QAD	.25	.03

We ran two logistic mixed effects models with the dependent variable ‘response’ taking the factor ‘condition’ as a fixed effect and fitting random intercepts by subject and item¹⁹.

Helmert contrast-coding was used to decompose the five conditions into four comparisons for the first model: 1 GRAM+QAD+GRAM-QAD vs UNGRAM+INT+QAD+INT-QAD (effect of grammaticality), 2 UNGRAM vs INT+QAD+INT-QAD (effect of intrusion), 3 GRAM+QAD+INT+QAD vs GRAM-QAD+INT-QAD (effect of QAD), 4 INT+QAD vs INT-QAD (Interaction of intrusion and QAD). This model revealed a significant effect of grammaticality (GRAM > UNGRAM, INT) ($\beta = 1.34$ (+/- .06), $z = 21.29$, $p < 2e-16$), a significant effect of intrusion (INT > UNGRAM) ($\beta = .29$ (+/- .11), $z = 2.7$, $p < .01$), and an interaction of intrusion and QAD (INT+QAD > INT-QAD) ($\beta = .72$ (+/- .31), $z = 2.37$, $p < .05$), but no main effect of QAD ($\beta = -.07$ (+/- .12), $z = -.61$, $p = .54$).

The second model used Helmert contrast-coding to compare each of the four quantified conditions to the ungrammatical baseline (UNGRAM): GRAM+QAD vs UNGRAM, INT+QAD vs UNGRAM, GRAM-QAD vs UNGRAM, INT-QAD vs UNGRAM. This model revealed a main effect of grammaticality (GRAM+QAD > UNGRAM, $\beta = 3.57$ (+/- .23), $z = 15.68$, $p < 2e-16$; GRAM-QAD > UNGRAM, $\beta = 3.72$ (+/- .23), $z = 15.79$, $p < 2e-16$), a main effect of INT+QAD

19. The model with random intercepts and slopes did not converge.

(INT+QAD > UNGRAM, $\beta = .73$ (+/- .18), $z = 3.95$, $p < .001$), but no significant effect of INT-QAD ($\beta = .16$ (+/- .19), $z = .84$, $p = .402$).

2.2.3 Discussion

The results of experiment 1 and 2 were replicated, quantifiers give rise to intrusive licensing of de-NP. However this experiment showed that it is not the case that all quantifiers do. The intuition that only certain quantifiers do give rise to intrusive licensing has been confirmed: only quantifiers that have the property of being able to quantify at a distance. In experiment 3, we confirmed this pattern holds in offline judgments using Likert scale responses.

2.3 Experiment 3

2.3.1 Methods

Sentences were presented whole and with no time limit, participants had to press the space bar to get to the next screen where a Likert scale was given and participants could click on any one number from 1 to 7 to rate the acceptability of the sentence they had just seen on the previous screen.

Participants Fifty seven people participated in this experiment. They were recruited via the mailing list of the CNRS RISC. A total of 4 participants were excluded according to similar criteria as in experiment 1 and 2. Prior to participation in the experiment, participants filled out a questionnaire aimed at assessing their language background and their provenance. All 53 remaining participants self-reported as native speakers of French, and all 53 indicated that French was their dominant daily language.

Materials The material and design are identical to those used in experiment 2.

Predictions We want to see whether the intrusion disappears offline.

Procedure Sentences were presented whole. Subjects could look at them for as long as they wanted and they could take as long as they wanted to give their judgment of it as well. A Likert

scale was used from 1 to 7.

2.3.2 Results

By-condition average ratings for all experimental conditions are presented in table 5, along with by-participant standard errors. In table 5 are the results in percentages of sentences found acceptable.

Table 5: Condition means and standard errors

Conditions	mean	s.e.
GRAM+QAD	5.73	.11
GRAM-QAD	5.87	.14
UNGRAM	2.49	.18
INT+QAD	2.87	.17
INT-QAD	2.62	.17

We ran two mixed-effects models with the dependent variable "response" taking the factor "condition" as a fixed effect and fitting random slopes/intercepts by subject and item. Helmert contrast-coding was used to decompose the five conditions into four comparisons for each model.

The first model reveals a significant effect of grammaticality (GRAM > UNGRAM, INT) ($\beta = 1.26$ (+/- .08), $t = 14.99$, $p < 2e-16$), a significant effect of intrusion (INT > UNGRAM) ($\beta = .2$ (+/- .07), $t = 2.79$, $p < .01$), and an interaction of intrusion and QAD (INT+QAD > INT-QAD) ($\beta = .41$ (+/- .18), $z = 2.27$, $p < .05$).

The second model used treatment coding to compare each of the four quantified conditions to the ungrammatical baseline (UNGRAM). This model revealed a main effect of grammaticality (GRAM > UNGRAM)

- A significant difference between conditions GRAM+QAD and UNGRAM ($\beta = 3.27$ (+/- .23), $t = 13.97$, $p < 2e-16$)
- A significant difference between conditions GRAM-QAD and UNGRAM ($\beta = 3.42$ (+/- .25), $t = 13.80$, $p < 2e-16$)

and a main effect of +QAD intrusion (INT+QAD > UNGRAM) ($\beta = .43$ (+/- .16), $t = 2.67$, $p < .05$).

2.3.3 Discussion

The offline/online asymmetry has been taken to be the hallmark of grammatical illusions based on NPI illusions. For instance Parker 2014, p. 6 defines grammatical illusions as in (40).

(40) Parker 2014’s definition of grammatical illusions (Parker 2014, p. 6)

Linguistic illusions are cases where comprehenders temporarily accept or mis-judge ungrammatical sentences in online or timed measures (e.g., speeded-acceptability judgments, self-paced reading, eye-tracking, ERPs), but later judge those same sentences as unacceptable after more reflection in untimed tasks (e.g., offline acceptability rating tasks).

The results of experiment 1 and 2 were replicated offline which is quite surprising if one considers that grammatical illusions are acceptability raises that are observable online but disappear offline, as has been observed repeatedly for intrusive NPI licensing for instance (Parker 2014, p. 270).

However, there is reason to doubt that such an asymmetry between online and offline judgments should be considered a necessary condition for a contrast in acceptability to qualify as a grammatical illusion. First other mismatches between ungrammaticality and unacceptability have been observed offline e.g. logophlexives (Sloggett 2017), comparative illusions (Wellwood et al. 2018). Second, under a unitary conception of the relation between processing and grammar as developed in Lewis and Phillips 2015, one can expect illusions to differ in how much time it takes for the signal-to-noise ratio to exceed 1 (at which point the grammatical signal should be stronger than the noise). Thus it is plausible that, for de-NP intrusive licensing, the signal-to-noise ratio takes longer to exceed 1 than for e.g. NPI illusions.

To summarise, we observed in experiment 1 that the presence of an intrusive quantifier in an ungrammatical sentence (41) improves its acceptability, however we found in experiments 2 and 3 that this does not happen with all de-NP licensing quantifiers: crucially only +QAD quantifiers give rise to an increase in acceptability.

(41) INT+QAD: J’ ai donné à **beaucoup** d’ amis de livres sur la

I have given to many DE friends DE books on the

vie de mon oncle qui a passé vingt ans au Vietnam.

life of my uncle who has spent twenty years in Vietnam

In these 3 experiments, we used verbs that take both a direct and an indirect object headed by the preposition *à* and the linear order we used extraposes the direct object to the left of the indirect object – to avoid having the preposition *à* directly adjacent to a grammatically unlicensed de-NP. This word order however is slightly marked/stilted (although we have tried to make it natural by making the direct object heavy) and we want to make sure to test for potential effects of this dispreferred order using a more natural construction such as (42), where the quantifier is in subject position and the grammatically unlicensed de-NP is in object position, and there is no extraposition.

- (42) INT+QAD: Beaucoup de gens ont lu de livres sur la
 many DE people have read DE books on the
 vie de mon oncle qui a passé vingt ans au Vietnam.
 life of my uncle who has spent twenty years in Vietnam

Note that in this new configuration, the constituent containing the quantifier and the constituent containing the grammatically unlicensed de-NP are no longer adjacent to one another. Linear distance between two items in a dependency has been shown to condition whether a grammatical illusion arises (Parker and Phillips 2016). In experiment 4, we confirmed that the illusion of grammaticality holds even when the intrusive quantifier is in subject position.

2.4 Experiment 4

2.4.1 Methods

Same as for experiments 1 and 2.

Participants Sixty two people participated in this experiment. They were recruited via the mailing list of the CNRS RISC. A total of 6 participants were excluded according to same criteria as the previous experiments. Prior to participation in the experiment, participants filled out a questionnaire aimed at assessing their language background and their provenance. All 56 remaining participants self-reported as native speakers of French, and all 56 indicated that French was their dominant daily language.

Materials Thirty sets of experimental items that consisted of the 5 experimental conditions shown in table 5 were developed. The experiment contains 5 conditions varying along three factors: grammaticality, acceptability, and whether the quantifier can move (+QAD) or not (-QAD). The design is the same as experiment 2 except that the quantifier phrases are in subject position and the unlicensed deP is in object position (37).

Figure 5: Design

	+QAD	-QAD
GRAM	A	D
UNGRAM		C
INT	B	E

The 30 critical experimental items were combined with 37 filler sentences. Fillers included 12 grammatical sentences with NPI, 6 ungrammatical, unacceptable sentences containing quantifiers of the kind used in the experimental items, and 19 sentences that the experimenter was interested in having rated.

- (43) a. GRAM+QAD: **Beaucoup de gens** ont envoyé [**des** invitations]
 many DE people have sent INDEF.PL invitations
 pour mon anniversaire.
 for my birthday
 Many people have sent out invitations for my birthday.
- b. INT+QAD: **Beaucoup de gens** ont envoyé [**d'** invitations] pour mon anniversaire.
- c. UNGRAM: **Des gens** ont envoyé [**d'** invitations] pour mon anniversaire.
- d. GRAM-QAD: **Plein de gens** ont envoyé [**des** invitations] pour mon anniversaire.
- e. INT-QAD: **Plein de gens** ont envoyé [**d'** invitations] pour mon anniversaire.

The same +QAD/-QAD quantifiers as in the experiments 2 and 3 were used.

Predictions It is expected that the results from experiments 1-3 will be replicated:

- main effect of grammaticality GRAM>INT,UNGRAM
- interaction of INT and QAD: INT+QAD>INT-QAD.

Procedure Same as in experiment 2.

2.4.2 Results

By-condition average ratings for all experimental conditions are presented in table 6, along with by-participant standard errors.

Table 6: Condition means and standard errors

Conditions	mean	s.e.
GRAM+QAD	.87	.02
GRAM-QAD	.89	.01
UNGRAM	.33	.03
INT+QAD	.42	.04
INT-QAD	.33	.04

We ran two mixed-effects models with the dependent variable ‘response’ taking the factor ‘condition’ as a fixed effect and fitting random intercepts²⁰ by subject and item. Helmert contrast-coding was used to decompose the five conditions into four comparisons for each model.

The first model revealed a significant effect of grammaticality (GRAM > UNGRAM, INT) ($\beta = 1.43$ (+/- .07), $z = 18.68$, $p < 2e-16$) and an interaction of intrusion and QAD (INT+QAD > INT-QAD) ($\beta = .79$ (+/- .34), $z = 2.34$, $p < .05$).

The second model used treatment coding to compare each of the four quantified conditions to the ungrammatical baseline (UNGRAM). This model revealed a main effect of grammaticality (GRAM > UNGRAM)

- A significant difference between conditions GRAM+QAD and UNGRAM ($\beta = 3.57$ (+/- .25), $z = 14.06$, $p < 2e-16$)
- A significant difference between conditions GRAM-QAD and UNGRAM ($\beta = 3.92$ (+/- .27), $z = 14.28$, $p < 2e-16$)

20. The model with random slopes and intercepts did not converge.

and a main effect of +QAD intrusion (INT+QAD > UNGRAM) ($\beta = .46 (+/- .19)$, $z = 2.42$, $p < .05$).

2.4.3 Discussion

In experiment 4, we observed that dePs can be intrusively licensed by a subject quantifier but only if this quantifier is +QAD.²¹ In four experiments (1-4), we consistently observed that only +QAD quantifiers create illusory licensing. A simple memory retrieval account such as the one sketched in section 1.2 cannot derive this asymmetry given that -QAD and +QAD quantifiers occupy the same position in the string, are in the same constituent, and have the same [+deP] cue given that they both license dePs. Because deP illusions are restricted to those quantifiers that can independently move, we explore the possibility that this effect could be the result of a repair process that capitalizes on this grammatical option.

2.5 Interim discussion: de-NP illusory licensing and retrieval

2.5.1 Retrieval hypothesis

Our experiments until now suggest two empirical generalizations. One, de-NP licensing is subject to illusions of grammaticality in a way that mirrors NPI illusions, at least in offline measures. Two, we only saw reliable de-NP illusions for +QAD quantifiers, not for -QAD quantifiers. This pattern may be accommodated in the cue-based parsing framework, with certain modifications.

A memory-retrieval account for these de-NP grammatical illusions might go as follows. If the parser reaches a de-NP that has an immediately preceding licenser, no memory retrieval is necessary.

However, when the parser encounters a de-NP that does not have an immediately local quantifier

21. An anonymous reviewer to a conference abstract suggested that perhaps the interaction we observed was not due to the syntactic differences between *beaucoup* and *plein* -type quantifiers, but perhaps to a difference in what type of variable they can bind. The suggestion does not elaborate further but we suppose the reviewer had the following scenario in mind. In Obenauer 1983; Doetjes 1997; Burnett 2009 (among others), it is argued that +QAD quantifiers bind an event variable when they appear preverbally. Indeed it has been entertained that illusory sentences in experiments 1-3 could be analysed as one in which the quantifier (although appearing in object position) is in fact structurally preverbal, an underlying structure that is obscured because participles can undergo ‘short movement’ in French (Pollock 1989). Under such an analysis, whether the quantifier appears adjacent to the deP or preverbally, it always binds an event variable.

(i) J’ai mangé beaucoup ~~mangé~~ de pommes.

Here is how this challenge might be answered. First, it is not clear how the possibility to bind event variables would give rise to de-NP licensing illusions, no linking hypothesis has been proposed. But even if this were a viable idea, the fact that quantifiers in subject position can give rise to d’illusions would be completely unpredicted.

licensing it, the parser executes a memory retrieval operation for a licensing quantifier that matches the retrieval cues. When the target of the search matches the retrieval cues, it is activated. If the target is not in a structural position to grammatically license the de-NP, as in our intrusive conditions, a partial match with the features may nevertheless give rise to the illusion of licensing and grammaticality. A pressing question for this account, however, is what exactly these retrieval cues are. A different but equally well motivated hypothesis could be repair.

2.5.2 Alternative hypothesis: repair

Till now, we have largely focused on the hypothesis that these errors are driven by memory retrieval errors. However, competing hypotheses exist to explain these effects that merit consideration. One alternative explanation for our grammatical illusions is based on the idea that comprehenders receive imperfect input and may use information beyond the grammar per se (e.g. knowledge of the speech production system, knowledge of real world plausibility and probability) to arrive at an understanding of the speaker's intended message. A similar idea is the core of the so-called Noisy Channel model of sentence comprehension (CITES), although these approaches differ in the implementation of this leading idea and in what factors are presumed to be relevant for this covert repair process.

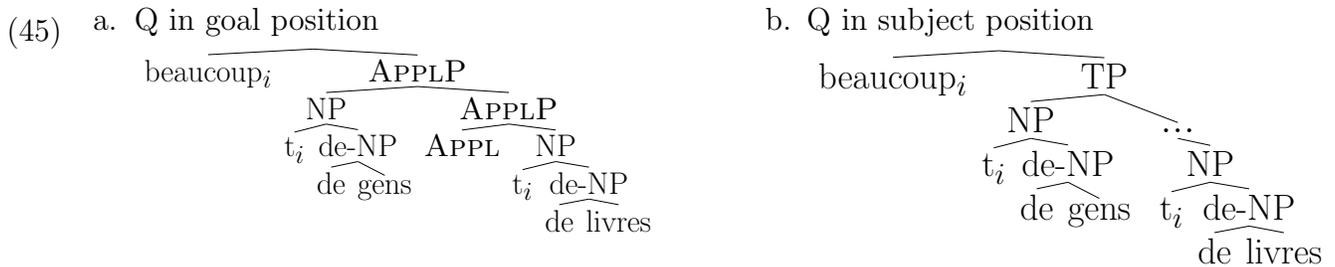
Support for this view comes from findings that suggest that comprehenders are at times willing to consider certain imperfect input (mismatch ellipsis (44), doubled quantifiers, doubled negation) as syntactic blends, and assign the input both a relatively acceptable rating (compared to undiagnosable or irreparable ungrammatical counterparts) and an interpretation supported by the repair (see Frazier 2015 for an overview). For instance Arregui, Clifton Jr, Frazier, and Moulton 2006 found that speakers rated the imperfect ellipsis cases in (44b-d) from best in the case of a structure needing no repair at all (44a) to worst (44b) as a function of the number of repairs the structure needed.

- (44) a. None of the astronomers saw the comet, /but John did. (Available verb phrase)
b. Seeing the comet was nearly impossible, /but John did. (Embedded verb phrase)
c. The comet was nearly impossible to see, /but John did. (Verb phrase with trace)

d. The comet was nearly unseeable, /but John did. (Negative adjective)

From this perspective, we could imagine an alternative account of our core findings. When processing ungrammatical sentences containing a *de*-NP and a quantifier in an inaccessible position, comprehenders would first recognize that the sentence is ill-formed, and attempt to repair the input to a form that would license two *de*-NPs. Subsequent to this repair, comprehenders would interpret the repaired structure.

To our knowledge, ungrammatical intrusive structures such as (5b/12b) are not produced by native speakers, unlike the other structures that have been argued to involve repairs. Nevertheless the correlation we observe between participating in QAD constructions and spurious licensing receives a natural interpretation under this perspective. One repair account of INT+QAD sentences might go as follows: +QAD quantifiers are covertly reanalyzed as binding both *de*-NPs and a co-indexed bound trace is inserted next to each one. We illustrate this in (45).²² This explains the correlation between +QAD quantifiers and *de*-NP illusions, because only +QAD quantifiers can establish long-distance dependencies whereas -QAD quantifiers cannot.



The repair account makes a signature, distinct prediction: *de*-NP illusions should be assigned a particular interpretation where *beaucoup* modifies both *de*-NPs. Given our specific hypothesis, this predicts that a spuriously licensed *de*-NP is interpreted as bound by the quantifier. Thus according to this repair hypothesis, each *de*-NP is indexed to the quantifier, which might lead us to expect an interpretation where each *de*-NP is alternately interpreted as being a restrictor of the quantifier it is bound by. In other words, according to this repair hypothesis, a sentence like (46)

22. We hasten to precise two things. First, this account is agnostic as to whether the dependency between the quantifier and the *de*-NP is obtained via movement of the quantifier or via binding. How the dependency is established is irrelevant for our repair account, what matters is that such a dependency is obtained. Secondly, in the cases where the quantifier is in the indirect object argument, we assume that the quantifier takes scope over both *de*-NPs but remains within APPLP.

should be given a doubly quantified interpretation.²³

(46) Beaucoup de gens ont lu de livres pendant l' été.

a.lot DE people have read DE books during the summer

Predicted interpretation: Many people read many books this summer.

We now turn to two experiments that test whether this predicted interpretation occurs for *de*-NP illusions.

2.6 Experiment 5

2.6.1 Methods

We used the same methods as for experiments 1, 2, and 4: RSVP. In addition, we asked participants to choose between two paraphrases of the sentence they had just seen: one corresponding to a sentence where the object is quantified and one corresponding to a sentence where the object is interpreted as a plural indefinite. Each sentence was presented in chunk in RSVP in the center of the screen. Compared to the previous experiment we gave more time per chunk (440ms per chunk with 150ms pause in between) because the task was different and, after receiving feedback from participants, we decided that it was necessary for them to have more time to be able to form a meaning for the sentences. After the sentence to be judged had been displayed, two paraphrases were displayed and the participant had 2s to choose the best paraphrase (see below for more detail). In addition, for each experimental item, we added an acceptability judgment question so that we could check whether the acceptability of an illusory DE structure and its interpretation are correlated.

Participants 135 people participated in this experiment. They were recruited via the mailing list of the CNRS RISC, social media and word of mouth. We excluded 6 people because they did not meet our exclusion criteria (criterion 3 does not apply here). The remaining 129 all reported they spoke French natively.

23. There are of course a number of alternative ways that a repair operation might apply to an ungrammatical structure without actually predicting a doubly-quantified interpretation. We discuss these in section 3. We now turn to the results of our investigation of the hypothesized repair operation.

Procedure and Materials In this experiment, participants were asked to give 2 judgments for each sentence that they had seen: one reformulation judgement where they had to choose between two paraphrases of the sentence they had just seen and one acceptability judgement.

After each sentence was displayed, a screen which lasted 2s was displayed (in an effort to prevent rote learning), and then a screen with the question and the reformulation choices in (48) appeared. Participants had been instructed that each displayed sentence was an utterance said by one of two characters, Jean or Marie. The name of the speaker was displayed at the beginning of each sentence.

(47) a. GRAM: MARIE: Michel a demandé à beaucoup de gens des conseils à propos du discours qu'il doit faire le 14 juillet.

b. INT: MARIE: Michel a demandé à beaucoup de gens de conseils à propos du discours qu'il doit faire le 14 juillet.

(48) D'après ce que vous avez compris de l'énoncé de Marie: 'According to your interpretation of what Marie said:'

a. A: Michel a demandé au moins un conseil à chaque personne. 'Michel asked for at least one piece of advice from everyone.'

b. B: Michel a demandé une grande quantité de conseils à chaque personne. 'Michel asked for a great deal of advice from everyone.'

Before the experiment started, participants were given two practice examples for which they had to choose the best paraphrase and tell whether it was acceptable or not. After their answer, they were given feedback. None of the two examples used in the training phase had to do with quantification or phrase licensing. Then the experiment started. The experimental phase proper consisted of 5 examples: 3 beginning examples + 2 experimental items proper (more detail below on why we chose to have only 2 items tested per participant) + 1 filler. The first three (grammatical) examples (given below) were given (in the same order) to all participants at the beginning. They were designed to act as a sort of modulus to set up expectations and 'set up the judgment scale'.

- (49) MARIE: M. Dupont a distribué à plein d'étudiants plein de tracts pour les prochaines élections présidentielles.
- a. D'après ce que vous avez compris de l'énoncé de Marie:
 - A. Chaque étudiant a reçu au moins un tract.
 - B. Chaque étudiant a reçu une grande quantité de tracts.
 - b. Trouvez-vous l'énoncé de Marie acceptable ?
 - A. Oui.
 - B. Non.
- (50) JEAN: Tous les élèves ont fait signer leur photo de classe à des professeurs.
- a. D'après ce que vous avez compris de l'énoncé de Jean:
 - A. Chaque élève a fait signer sa photo de classe à au moins un professeur.
 - B. Chaque élève a fait signer sa photo de classe à un grand nombre de professeurs.
 - b. Trouvez-vous l'énoncé de Jean acceptable ?
 - A. Oui.
 - B. Non.
- (51) JEAN: Le professeur a distribué à plein d'étudiants des affiches faisant la publicité d'un forum professionnel.
- a. D'après ce que vous avez compris de l'énoncé de Jean:
 - A. Chaque étudiant a reçu au moins une affiche.
 - B. Chaque étudiant a reçu une grande quantité d'affiches.
 - b. Trouvez-vous l'énoncé de Jean acceptable ?
 - A. Oui.
 - B. Non.

Then participants saw three more items: the 2 experimental items proper (GRAM and INT), and 1 filler item containing a completely different structure²⁴. Twenty sets of experimental items that consisted of 2 experimental conditions (GRAM, INT) were developed.

24. The extra item contained the phrase *je doute que oui* lit. 'I doubt that yes' as in (i). For a different project, we were interested in knowing whether there was a correlation between the acceptability of the sequence *je doute que oui* and the interpretation of *je doute* 'I doubt' as *je ne suis pas sûr* 'I am not sure' as opposed to *je ne pense pas* 'I don't think'.

Five different +QAD quantifiers licensing *de* were used in the study (1 quantifier/4 items). They are listed in (52) along with the corresponding phrases which were used in the B alternatives on the question screen.

(52) Quantifiers used in the study

<i>beaucoup</i> ‘much’	une grande quantité de
<i>trop</i> ‘too much/many’	un nombre excessif de
<i>énormément</i> ‘very much’	un très grand nombre de
<i>suffisamment</i> ‘sufficiently many/much’	une quantité raisonnable de
<i>pas mal</i> ‘much’	un nombre conséquent de

Whereas in previous experiments, we compared grammatical items to their ungrammatical counterparts and to their intrusive counterparts (across +QAD and -QAD levels in experiments 2-4), here we chose to only compare +QAD grammatical and +QAD intrusive items, i.e. we chose to design an experiment with just two conditions. Furthermore, we chose to have just one observation per condition. We chose to only present two conditions because our repair hypothesis makes interpretive predictions for grammatical and intrusive +QAD sentences only (not for ungrammatical sentences of the type we used in previous experiments). After receiving feedback from participants in a test-run of the experiment, we chose to present only one item per condition because we did not want participants to develop a response strategy, hence the high number of participants for this experiment.

Predictions If people interpret INT as a doubly quantified construction, the number of B responses (i.e. reformulations corresponding to a doubly-quantified interpretation) should be significantly higher for the illusory condition (INT) than for the grammatical single-quantified condition (GRAM).

-
- (i) Jean: Louise pense que Thomas a bien pensé à envoyer son dossier à temps mais je doute que oui.
- a. D’après ce que vous avez compris de l’énoncé de Jean:
 - A. Je ne suis pas sûr que Tom ait pensé à envoyer son dossier à temps.
 - B. Je pense que Tom n’a pas pensé à envoyer son dossier à temps.
 - b. Trouvez-vous l’énoncé de Jean acceptable ?
 - A. Oui.
 - B. Non.

2.6.2 Results

By-condition average number of B choices for all experimental conditions are presented in table 7, along with by-participant standard errors.

Table 7: Condition means and standard errors in number of B responses

Conditions	mean	s.e.
GRAM	.43	.04
INT	.53	.04

We ran a mixed-effects model with the dependent variable ‘response’ taking the factor ‘condition’ as a fixed effect and fitting random intercepts/slopes by subject and item. Although the difference between the two conditions approached significance at the .05 level (in the predicted direction), it did not reach it ($z=1.62$, $p=.1$).

2.6.3 Discussion

We saw an effect in the predicted direction: the doubly-quantified interpretation was chosen more for the intrusive condition than for the grammatical condition, however this effect was not reliable, and so we could not draw clear conclusions. Still, we decided to re-run the study using the simpler construction we tested in experiment 4 (where the quantifier is in subject position and the unlicensed de-NP in object position).

2.7 Experiment 6

2.7.1 Methods

Participants 121 people participated in this experiment. They were recruited via the mailing list of the CNRS RISC, social media and word of mouth. We excluded 7 people. The remaining 114 participants self reported as native French speakers.

Procedure and Materials The procedure was identical to that in experiment 5. The materials were slightly different since we used items in which the quantifier was in subject position (as opposed to in a prepositional phrase as in experiment 5). There was also no filler item. The total number of items that each participant saw was 5.

- (53) a. GRAM: MARIE: Beaucoup de familles ont donné des livres à la bibliothèque de l'école pendant leur nettoyage de printemps.
- b. INT: MARIE: Beaucoup de familles ont donné de livres à la bibliothèque de l'école pendant leur nettoyage de printemps.
- (54) D'après ce que vous avez compris de l'énoncé de Marie: 'According to your interpretation of what Marie said:'
- a. A. Chacune des familles a donné au moins un livre à la bibliothèque. 'Each of the families has given at least one book to the library.'
- b. B. Chacune des familles a donné une grande quantité de livres à la bibliothèque. 'Each of the families has given a great deal of books to the library.'

The same five +QAD quantifiers were used and this experiment started with the same training phase as experiment 5.

This experiment started with a training phase during which participants were given two examples for which they had to choose the best paraphrase and tell whether it was acceptable or not. After their answer, they were given feedback. None of the two examples used in the training phase had to do with quantification or phrase licensing.

Predictions The prediction is the same as for experiment 5.

2.7.2 Results

By-condition average ratings for all experimental conditions are presented in table 8, along with by-participant standard errors. In table 8 are the results in percentages of B choices.

Table 8: Condition means and standard errors in number of B/doubly-quantified responses

Conditions	mean	s.e.
GRAM	.43	.05
INT	.52	.05

We ran a mixed-effects model with the dependent variable 'response' taking the factor 'condition' as a fixed effect and fitting random intercepts by subject. Although the difference between the

two conditions is in the predicted direction, it did not even approach significance at the .05 level ($z=1.38$, $p>.1$).

2.7.3 Discussion

As in experiment 5, we saw an effect in the predicted direction: the doubly-quantified interpretation was chosen more for the intrusive condition than for the grammatical condition, however this effect was not reliable, and so we cannot draw clear conclusions. We did see a *small* effect in the predicted direction in both, so we cannot rule out the doubly quantified interpretation. This is not a clear outcome either way, but we report it in the interest of fully documenting the results of our research project. With respect to the question of doubly-quantified interpretations, we simply do not have evidence for it yet, so we will not draw strong claims one way or another.²⁵ As a consequence, we continue to develop the cue-based account to model our findings, while bearing in mind that future work might yet provide evidence for a repair-based account.

3 General discussion

3.1 Our findings in light of the debate between retrieval and repair

We repeat the three central questions that guided our investigation in (55).

(55) Three questions

- a. Question 1: Can de-NP-licensing quantifiers intrusively license de-NPs?
- b. Question 2: Can all de-NP-licensing quantifiers intrusively license de-NPs?
- c. Question 3: What properties of a quantifier are critical for intrusive licensing?

We found a grammatical illusion in four experiments: the presence of a de-NP-licensing quantifier raises the acceptability of an ungrammatical sentence even if the quantifier is not accessible grammatically (answer to question 1). However we found that not all de-NP-licensing quantifiers give

25. Heather Burnett (p.c.) commented that perhaps the reason we failed to obtain a significant contrast is to be blamed on the vagueness of *beaucoup* and that perhaps further work could use quantifiers that have linguistically instanced points of comparison (i.e. *plus que* ‘more than’), which yield sharper truth conditions for the doubly quantified meaning and might therefore provide a better test.

rise to the grammatical illusion (answer to question 2). We established that only quantifiers that could be grammatically separated from their de-NP restrictor (i.e. +QAD quantifiers) can intrusively license grammatically-unlicensed de-NPs, whereas quantifiers that must appear adjacent to the de-NP they license in the grammar (-QAD quantifiers) do not give rise to intrusive licensing (answer to question 3). Moreover, the repair account we entertained makes two predictions that we failed to find support for: (i) we failed to find interpretive effects of intrusive licensing predicted in two experiments (section 2.5.2), and (ii) illusory structures ('repaired structure' on the repair account) are judged significantly less acceptable than fully grammatical sentences in all six experiments.

We attribute the contrast in acceptability between grammatical sentences and the sentences we call 'illusory' to a contrast in grammaticality (i.e. 'illusory sentences' are ungrammatical). One could argue that 'illusory sentences' are in fact grammatical and this is why they are significantly more acceptable than ungrammatical sentences. However this hypothesis would have to explain (i) why these 'grammatical' sentences are judged significantly less acceptable than other grammatical sentences, and (ii) why speakers do not produce them. Our hypothesis is that illusory sentences are ungrammatical. This explains why they are judged significantly less acceptable than other grammatical sentences and why speakers do not produce them. However we have to explain why they are significantly more acceptable than ungrammatical sentences. We contend that the explanation is to be found in how grammar is implemented by the parser, like other such phenomena (see section 1.2).

Under the cue-based retrieval type of account sketched in section 2.5.1, only non-locally licensed de-NPs trigger a search in memory for a matching cue. When the target of the search matches the retrieval cues, it is activated. If the target is not in a structural position to grammatically license the de-NP, as in our intrusive conditions, a partial match with the features may nevertheless give rise to the illusion of licensing and grammaticality. Under the repair-account in terms of structural reanalysis sketched in section 2.5.2, we correctly predict the interaction between the type of quantifiers (+QAD or -QAD) and acceptability of the INT sentences, but it faces a challenge since we failed to observe the predicted interpretive effect in experiments 5 and 6.²⁶

26. Of course there are alternative repair accounts such that our failure to observe the predicted effect do not falsify repair accounts in general. A repair account with no interpretive prediction might go as follows: the processor first indexes the first de-NP it encounters as the restrictor of the quantifier and, when it encounters the second

That a dependency cannot be entertained with *plein*-type quantifiers can be likened to other negative constraints from the point of view of the parser: a syntactic position is not entertained at all by the parser. This negative constraint, we propose, strongly argues for a complex memory-retrieval process where what guides the search is the structure of the quantifiers themselves. Search in memory has already been shown to be very structure sensitive in some ways (i.e. it respects gross syntactic categories), but it does not always respect constraints like c-command. In the present paper, we hypothesize that licensing de-NPs involves a search for a licensor, which involves retrieval if it is non-local; but the retrieval processes are keyed to identify only controllers that have the structure of the +QAD quantifiers, yielding a fairly sophisticated search process that is not (entirely) subservient to c-command.²⁷ This correctly predicts (i) the interaction between de-NP-licensing quantifier type and spurious licensing, (ii) the absence of double quantification interpretive effect, (iii) the acceptability gap between illusory and grammatical sentences.

de-NP, it revises that assignment to assign the quantifier to the second restrictor. This reassignment mechanism would be similar to the one Fodor (1978) proposes to explain the interpretive ambiguity of English examples as in (i) between the interpretation in a, b, and c.

- (i) To whom did you say that Father wrote?
 - a. You said to whom [that Father wrote]?
 - b. You said [that Father wrote to whom]?
 - c. To whom_i did you say t_i [that Father wrote t_i]?

27. Moreover, if our de-NP licensing findings are viewed in light of the findings by Parker and Phillips 2016, the fact that we do not have evidence that d’illusions can be turned on and off by changing the linear position of the spurious licensor is compatible with the retrieval search process operating over the syntactic structure. As we showed (ia) and (ib) are judged equally better than their minimally-different counterparts without quantifier.

- (i) a.*J’ai envoyé à **beaucoup de gens d’invitations** pour mon anniversaire.
 I have sent to a_lot DE people DE invitations for my birthday
- b.***Beaucoup de gens** ont envoyé d’invitations pour mon anniversaire.

This is similar to what Parker and Phillips 2016 observe for agreement-attraction error but unlike what they observe for illusory NPI licensing. Parker and Phillips 2016 anchored this difference in the kind of representation (syntactic or semantic) that the processor tries to resolve dependencies over. In their theory of the architecture of memory, semantic representations are not stable over time and therefore, if a spurious licensor is too far from the item to be licensed, then a spurious licensor cannot be retrieved at all. Syntactic representations however are stable and thus, every else being equal, a spurious licensor can be retrieved. The apparent insensitivity of d’illusions to the position of the spurious licensor is therefore consistent with the de-NP-Q dependency being resolved in the syntactic representation of the sentence. This is predicted under the blended model of cue-based retrieval presented below where d’illusions are sensitive to syntactic cues.

3.2 Parsing de-Noun Phrases in a cue-based architecture

We interpret the ‘d’illusion’ effect as a grammaticality illusion arising from the dynamics of a cue-based processing system. We turn now to a more detailed sketch of the process of parsing de-NPs from this perspective.

We couch our account in the Lewis and Vasishth’s (2005) cue-based parsing model, one prominent account of cue-based parsing that is implemented in the ACT-R cognitive architecture (Adaptive Character of Thought–Rational, Anderson 1990, Lewis and Vasishth 2005, Vasishth 2008). The Lewis and Vasishth model proposes that the parser proceeds in a left corner fashion, that is, encoding constituents into working memory as soon as any bottom-up evidence for those constituents becomes available. As the parser proceeds through a sentence, the corresponding phrase marker is split into its major constituents, which are subsequently encoded as ‘chunks’ in working memory. These chunks encode the major features of each constituent (such as its major syntactic category, its lexical head, and any relevant morphosyntactic features), along with the links between constituents in the parse tree. On this model, one of the key processing bottlenecks during incremental syntactic processing is reaccessing or retrieving these constituent encodings from working memory when they are necessary. Retrieval, in this context, refers to the process of reactivating a constituent from working memory, and moving it into an active working memory store or *focus of attention*, where it can undergo active processing. Retrieval of constituents from working memory proceeds via the use of retrieval cues, features of the to-be-retrieved constituent. A core component of this model, and others like it, is the claim that the size of the focus of attention is limited, that is, only some of the information processed up to a certain point can be maintained in an active state (McElree et al. 2003; Lewis and Vasishth 2005). Older information is stored in a passive memory store and must therefore be retrieved if needed. Parsing in this model involves continuously shunting information in and out of active memory stores in order to form dependencies during processing. In this model grammatical illusions arise as a result of the retrieval of irrelevant chunks that partially match the retrieval cues of the item in the focus of attention.

We propose that de-NP licensed by a string-adjacent quantifier (e.g. de-NP₁ in 56a and de-NP₂ in 56b) might be special because in that case, both licensor and licensee are in the focus of attention

and no search into the passive memory store is required.

(56) a. J' ai écrit beaucoup [de lettres]_{de-NP₁}.

I have written a lot DE letters

I wrote many letters.

b.*J'ai écrit à beaucoup [de gens]_{de-NP₂} de lettres.

Conversely, de-NPs that are not immediately adjacent to de-NP-licensing quantifiers (e.g. de-NP₃ in 57a and de-NP₄ in 57b) are parsed in a different chunk than the quantifier (in the ACT-R model of parsing) and thus initiate a content-addressable search for a cue in memory.

(57) a. J' ai beaucoup écrit [de lettres]_{de-NP₃}.

I have a lot written DE letters

I wrote many letters.

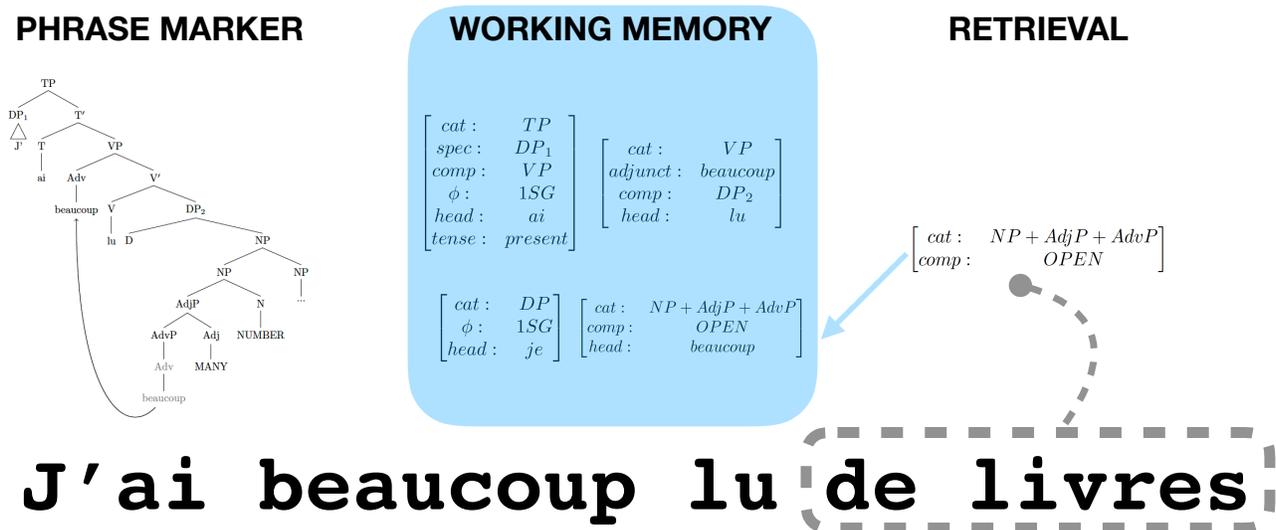
b.*J'ai écrit à beaucoup de gens [de lettres]_{de-NP₄}.

Thus, in the account we propose, only non-locally-licensed de-NPs trigger cue-based retrieval. The cue must therefore be such that +QAD quantifiers have it and -QAD quantifiers do not. The general idea is that, in ungrammatical sentences, +QAD quantifiers can match the cues on the non-locally licensed de-NP thus giving rise to a boost in acceptability, whereas sentences -QAD quantifiers do not give rise to an acceptability boost since they do not have a matching cue.

On this approach, because *beaucoup*-type quantifiers have a complex layered underlying structure, *beaucoup* is stored in memory with cues that index this underlying structure, namely [NP+AdjP+AdvP]. Recall that +QAD quantifiers like *beaucoup* have three different uses – VP adverbs, pronouns, determiners – and that we followed Kayne 2002 in assuming that this is because they have an underlying structure where, depending on how they are being used, items like *beaucoup* are adverbs that can modify a silent adjective MANY modifying a silent noun NUMBER (see section 1.2). By contrast, *plein*-type quantifiers are adjectives which cannot stand on their own but need to modify an NP. Thus if the cue de-NPs need to match in memory is [NP+AdjP+AdvP], only *beaucoup*-type quantifiers will be retrieved since only they have an underlying structure providing this cue.

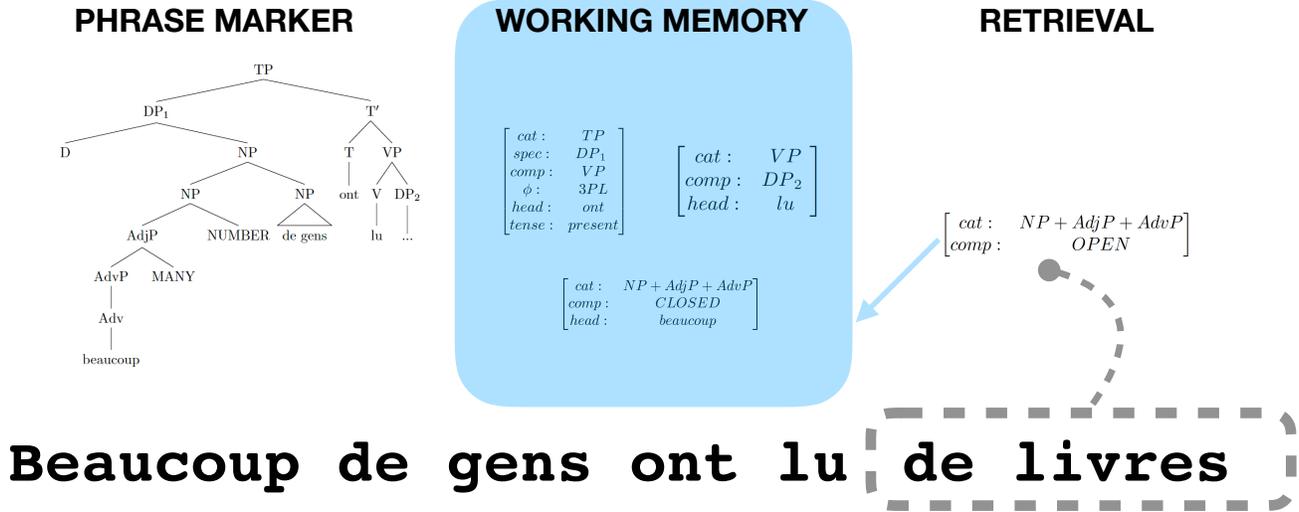
For example, consider the processing of the simple QAD sentence in Figure 6. When *beaucoup* is in the focus of attention, it is activated along with the rest of its (covert) structure, containing MANY and NUMBER. As the focus of attention moves rightwards, the verb *lu* comes into the focus of attention and *beaucoup* with its associated structure is passed to the passive memory store. When the phrase *de livres* is in the focus of attention, it starts a search in memory for a licenser with matching features. We have proposed that the cue is [NP+AdjP+AdvP, c-command], however this should not obscure what the core of our proposal is regardless of the proposed implementational detail: there is a structural difference between -QAD and +QAD quantifiers, de-NPs have a cue that indexes the syntax of +QAD quantifiers, whatever the details of that structure might be. Assuming that +QAD quantifiers have the structure proposed by Kayne 2002, the top node of the complex NP containing MANY, NUMBER, and a silent copy of the adverb *beaucoup* contains exactly these cues.

Figure 6: Retrieval in a QAD sentence



In the illusory cases like Figure 7, once the non-locally licensed de-NP *de livres* is in the focus of attention, it triggers a search in memory for a (licensing) item with the cues [NP+AdjP+AdvP, c-command]. When the search reaches *beaucoup* ‘many’, it is activated. Even though it does not c-command the de-NP that started the search, this activation gives rise to a boost in acceptability. In the case of the minimally different structure with *plein* ‘many’, no activation occurs since *plein* does not have a matching cue.

Figure 7: Retrieval in an illusory sentence



We conclude that d’illusions show, unlike NPI illusions or agreement-attraction errors, that the parser accesses the syntactic representation of the structure in linguistic memory in a structured way. The crucial cue is syntactic because it refers directly to syntactic categories as opposed to contentful features such as e.g. [plural] or [singular] (Wagers et al. 2009), [+negative] (Vasishth et al. 2008).²⁸ Spurious de-NP licensing in French provides evidence that purely structural cues are used in retrieval (van Dyke and McElree 2011; Parker, Shvartsman, and Van Dyke 2017). It suggests the the cues index the underlying sturcture, not just the surface features.

3.3 On the interpretation of illusory structures

In Experiments 5 and 6, we turned to an investigation of the interpretation of illusory structures. The interpretation of illusions of grammaticality is an area that is relatively understudied, but in light of the alternative, repair-based hypothesis we considered, we find it important to explore the link between acceptability and meaningfulness. We failed to find any evidence for the predicted ‘double quantification’ interpretation of the repair-based account. However, this prediction crucially relies on another hypothesis: that if a speaker finds a sentence acceptable, then they can assign a meaning to it but it is in fact not at all clear that the relation between acceptability

28. Building on an idea mentioned in Alcocer and Phillips 2012, p. 33, an alternative way to think about how the special syntax of *beaucoup*-type quantifiers ‘corrals’ retrieval is to posit that elements that can enter into long-distance dependencies are somehow maintained in memory in a privileged state. We do not explore this possibility here.

and meaningfulness is this straight-forward. Maybe illusions of grammaticality differ in whether acceptability reflects the assignment of a specific meaning to the illusory construction.

If it is indeed the case that the acceptability of a sentence is not always dependent on its being assigned a specific meaning, it could be that structural reanalysis we have proposed is purely syntactic without compositional semantic interpretation.

3.4 Questions to be addressed in future studies on d’illusions

The effect of distance (syntactic- and linear-based) While French grammar allows +QAD quantifiers to appear very far from their restrictor in terms of linear distance, they cannot be separated by the de-NP in need of licensing by a finite-clause boundary (58a-c vs 58d-e).

(58) a. Des familles ont dit qu’elles ont dû donner **beaucoup de livres** à la
INDEF.PL families have said that they have must give a.lot DE books to the
bibliothèque.

library

Some families said that they had to give many books to the library.

- b. Des familles ont dit qu’elles ont dû **beaucoup** donner **de livres** à la bibliothèque.
- c. Des familles ont dit qu’elles ont **beaucoup** dû donner **de livres** à la bibliothèque.
- d. *Des familles ont **beaucoup** dit qu’elles ont dû donner **de livres** à la bibliothèque.
- e. ***Beaucoup** de familles ont dit qu’elles ont dû donner **de livres** à la bibliothèque.

Our cue-based retrieval account does not say anything about the distance between the quantifier and the unlicensed de-NP, therefore it predicts that distance should not have an effect on acceptability (especially under models of memory which assume that a sentence’s syntactic representation remains stable over time Parker and Phillips 2016). In other words, the quantifier-type*acceptability interaction we observed in experiments 2-4 should be observed no matter the linear or syntactic distance between quantifier and de-NP.

(59) Linear distance: longer subject

- a. +GRAM+LONG: **Beaucoup de familles** dont les enfants ont terminé l' école ont donné des livres à la bibliothèque pendant leur nettoyage de printemps.
- a.lot DE families whose the children have finished the school have given INDEF.PL books to the library during their cleaning of spring
- Many families whose children have finished school have given books to the library during their Spring cleaning.*
- b. -GRAM+LONG: ***Beaucoup de familles** dont les enfants ont terminé l'école ont donné **de livres** à la bibliothèque pendant leur nettoyage de printemps.
- c. +GRAM-LONG: **Beaucoup de familles** ont donné des livres à la bibliothèque pendant leur nettoyage de printemps.
- d. -GRAM-LONG: ***Beaucoup de familles** ont donné **de livres** à la bibliothèque pendant leur nettoyage de printemps.

Adverb *beaucoup* does not give rise to the illusion Our account relies on the cue [+adv, +adj, +noun] which indexes the underlying structure of +QAD de-NP licensing quantifiers. We saw in section 1.2 that +QAD quantifiers like *beaucoup* have the property that can also be used as pronouns or as VP adverbs, in which case they have different underlying structures. This makes a very straight-forward prediction: *beaucoup* used adverbially should not give rise to illusory licensing because it has the cue [+adv] whereas non-locally licensed de-NP searches for a [+adv, +adj, +noun] cue.

It is hard to construct relevant examples that are monoclausal (like all the items we tested in our six experiments). But if illusory de-NP licensing is possible across clause boundaries, our account predicts that (60a) should be judged significantly less acceptable than (60b).

(60) a.*Marie [que j' aime beaucoup_[+adv]] lit de livres.

Marie that I like a.lot read DE books

Intended: Marie, who I like a lot, reads books.

b.*Marie [que beaucoup_[+adv,+adj,+noun] aiment] lit de livres.

Marie that a.lot like read DE books

Intended: Marie, who many like, reads books.

The number of unlicensed de-NPs We may also wonder how many de-NPs for one quantifier can be illusorily licensed. In our experiments we only tested sentences with 2 de-NPs (only one of which was not grammatically licensed) but it is possible to imagine sentences with 3/4 de-NPs where 2/3 de-NPs are not grammatically licensed. Given that in the model we propose each non-locally licensed de-NP starts its own search for a cue, and given that our model does not restrict the number of times a cue can be matched and activated, the model as it is predicts that the number of unlicensed de-NPs can be virtually unlimited.

(61) 3 de-NPs

a. **Beaucoup de gens** ont laissé des enfants utiliser des armes à feu.

a.lot DE people have let INDEF.PL children use INDEF.PL firearms

Many people have let children use firearms.

b.***Beaucoup de gens** ont laissé **d'enfants** utiliser **d'armes à feu**.

c.*Des gens ont laissé **d'enfants** utiliser d'armes à feu.

(62) 4 de-NPs

a. **Beaucoup d' hommes politiques** ont laissé des gens laisser des enfants

a.lot DE men political have let INDEF.PL people let INDEF.PL children

utiliser des armes à feu.

use INDEF.PL firearms

Many politicians have let people let children use firearms.

b.***Beaucoup d' hommes politiques** ont laissé **de gens** laisser **d'enfants** utiliser **d' armes à feu**.

c.*Des hommes politiques ont laissé **de gens** laisser **d' enfants** utiliser **d' armes à feu**.

4 Conclusion

We have presented the results of 6 studies which strongly support the existence of an until-now unknown grammatical illusion in European French. The distribution of d’illusions in French demonstrates that illusory licensing phenomena are not triggered merely by the presence of lexical de-NP licensors in linearly preceding material. It is not the case that ‘anything goes’ in generating illusory licensing phenomena. Instead, in the case of d’illusions, additional structural conditions must hold in order to observe spurious de-phrase licensing; the quantifiers must be, in principle, able to participate in QAD dependencies. On our analysis, this arises because the parser recruits specific syntactic cues that selectively reactivate phrases of a specific syntactic type during the course of licensing QAD dependencies. While the retrieval processes that identify the licensor in QAD constructions do not rigidly respect the c-command constraint, they are tightly keyed to elements of the proper structural type. In the case of QAD, this means phrases that are underlyingly composed of an adverb, an adjective, and a noun. This is consistent with the view espoused in van Dyke and McElree 2011 that syntactic cues (specifically, syntactic category cues in the present case) provide an important gating function at the point of memory retrieval. The semantic contents of constituent encodings in memory are only made available at the point of retrieval if they bear the appropriate category features.

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