CHAPTER 11

On Being Trivial: Grammar vs. Logic

Gennaro Chierchia

The importance of the function/content dichotomy manifests itself in the recurrent and arguably successful attempts at explaining aspects of grammar in terms of logic. The claim emerging more and more forcefully in this connection is that many cases of linguistic deviance owe their status not to the violation of some syntactic well-formedness condition but to the fact the relevant structures are logically determined (i.e., logically true or logically false), and hence in some sense 'trivial'. Since classical tautologies or contradictions (of the form *Is John smart? Well, he is and he isn't*) are logically determined but are not perceived as ungrammatical, one immediately faces the issue of how to tease apart (possibly, as a matter of principle) trivialities rooted in grammar and perceived as ungrammatical (which I will call G-trivialities) from classical tautologies and contradictions (L-determined sentences). In what follows, I will go over an example, rather compelling in my view, of a class of phenomena best explained in terms of G-triviality. I will then present and discuss the way of conceptualizing the special status of G-trivialities vis-à-vis standard tautologies put forth by J. Gajewski (2002). I will point out a problem with Gajewski's approach and sketch a solution that embodies a somewhat different view of the relationship between grammar and logic.

As is well known, Negative Polarity Items (NPIs) like *ever* or *any* are restricted in their distribution to (roughly) 'Downward Entailing' (DE) contexts, i.e., contexts that license 'subset inferences' such as those in (1a) as opposed to (1b):

(1) a. I didn't eat pizza → I didn't eat pizza with anchovies *Subset inference* (DE)
b. I ate pizza with anchovies → I ate pizza *Superset inference* (UE)

Thanks to the participants of the 2018 Münich Workshop and to an anonymous referee for helpful comments. I am also grateful to Guillermo Del Pinal, Danny Fox, and Jon Gajewski for extensive discussions of these matters over time.

A representative set of contrasts involving NPIs is given in (2) vs. (3):

(2) a. There isn't any pizza left
b. I doubt that there is any pizza left
c. If there is any pizza left, we won't go hungry

(3) a. * There is any pizza left
b. * I believe that there is any pizza left.
c. * If you are hungry, there is any pizza left

One and the same string of words, namely *there is any pizza left* is deviant in a non-DE environment (e.g., under *believe* or in the consequent of a conditional) and becomes perfect in a DE one (e.g., embedded under negation, or under *doubt* or in the antecedent of a conditional). Notice that dropping the item *any* in the sentences in (3) renders them grammatical, which confirms that the occurrence of *any* is the culprit for their degraded status in (3). The deviance of the sentences in (3) is quite severe, comparable to an agreement mismatch or a basic word order violation of the form *boy the walked in*. In spite of this, a thesis that has consistently gained credibility is that there is nothing wrong with the syntax of the sentences in (3). The problem is wholly semantic: These sentences are unrescuably trivial. Let me flesh out this prima facie implausible claim, starting with a seemingly unrelated example of linguistic deviance.

Consider the dialogue in (4):

(4) Speaker A: How many of the twenty papers you have to grade do you think you will have graded in two hours?
Speaker B:
a. Possibly, even ten b. Possibly not even one c. * Possibly, even one

You will agree that while (4a) and (4b) are natural answers to Speaker A's question, (4c) is distinctly deviant. Why? Use of *even* generally conveys that the proposition *even* applies to (i.e., the prejacent) is regarded as the least likely among some relevant set of alternatives:

(5) a. I understood even Chomsky's paper
b. Alternatives under consideration: Given some set A of contextually salient individuals, ALT = I understood a's paper: $a \in A$
c. Presupposition of Sentence (a):
Understanding Chomsky's paper $<_{LIKELY}$ Understanding a's paper (for any $a \in A$)

The way in which the alternatives are typically individuated is determined by the context (e.g., by some question under discussion), which in turn is often coded into the focal structure of sentences. In the context of the question in (4), the answer in (4a) will evoke a scale of the form:

(6) < (in two hours) I will have graded ten or more papers ,
I will have graded nine or more papers,
. . . ,
I will have graded one or more papers>

The arrow in (6) indicates the entailment pattern holding among the alternatives, where if X is stronger than Y, X is true in fewer worlds and hence necessarily less likely than Y (or at most as likely as Y). So, sentence (4a) states that I will grade probably ten assignments and this is the least likely and best scenario option among the alternatives that stand a chance at being true, and this yields a felicitous response. Consider next (4b). The presence of negation in (4b) reverses the scale in (6):

(7) < (two hours from now) I won't have graded a (single) paper,
I won't have graded two or more papers,
. . . ,
I won't have graded ten or more papers >

In this reversed scale, grading no paper becomes the strongest, and hence least likely member of the relevant alternative set, which again makes use of *even* appropriate. At this point, the reason why (4c) sounds weird becomes apparent. With respect to the scale in (6), naturally associated with positive sentences, the sentence *I graded one paper* is the weakest member and hence it cannot be the least likely. Claiming the contrary results in a contradiction (for a proposition cannot be less likely than its entailments). So, it looks like behind the immediacy of our reaction to (4c) there is a rapid computation that leads to the following conclusion: sentence (4c) triggers a contradictory (i.e., trivial) presupposition. This seemingly obscure corner of the grammar of *even* constitutes an illustration of what I mean by G-triviality.

This example of G-triviality is directly relevant to NPIs. Suppose that *any* means something like *even* + *one*, and associates with a scale analogous to (6). This would immediately explain why the sentences in (2) are fine. More specifically, replacing *any* in (2) with something like *even* + *one (single)* is grammatical and yields virtual synonyms of the original sentences:

(8) a. There isn't even one (single piece of) pizza left
b. I doubt there is even one (single piece of) pizza left
c. If there is even one (single piece of) pizza left, we won't go hungry.

The *any* = *even* + *one* hypothesis also explains why the sentences in (3) are ungrammatical: They are all contradictory, just like (4c) is. For example, the logical form of (3a), repeated here as (9a), would be something like (9b):

(9) a. There is any pizza left
b. $\mathtt{even}_{\mathtt{ALT}}\ [\exists_{\mathtt{x}}[\mathtt{one(x)} \wedge \mathtt{pizza(x)} \wedge \mathtt{left(x)}]]$
$\approx$ there is even ONE piece of pizza left
c. ALT = $\{[\exists_x[n(x) \wedge pizza(x) \wedge left(x)] : n \in N\}$
where the entailment in (c) goes from n to n-m, for any n and m.

It's as if (9a) was interpreted as *there is even ONE (single piece of) pizza left* in reply to a how many-question: (9a) triggers a contradictory presupposition. This account extends to all DE environments and provides an arguably elegant and simple explanation for the distribution of NPIs, that descends directly from their (hypothesized) semantics.

There is one striking fact that seems to support this hypothesis. In many languages NPIs are explicitly formed by composing focus-sensitive additive particles that mean roughly *even* with some item that expresses a low quantity like the first numeral 'one'. Here is a representative sample:

(10) Hindi: ek bhii — one even/also
Tagalog: anu-ma-ng — wh-even-CASE
Italian: neanche uno — negative agr + also one

(11) A Hindi example (from Lahiri 1998):
i. * ek bhii aadmii aayaa
one even man came — 'any man came'
ii. ek bhii aadmii nahiiN aayaa
one even man not came — 'no man came'

Historical change provides further evidence in favor of this view. *Any* comes from Old English *ænig* (lit. "one-y," "one-like"), which in turn is derived from ProtoGermanic **ainagas*. The Proto IndoEuropean source for this class of words is *oinos, the word for *one*. Now, *any*'s German cousin *einig* remained a plain vanilla indefinite without a negative polarity use. The Italian counterpart of *any/einig*, namely *alcuno/alcuni*, has a split behavior: the plural is a regular indefinite, while the singular is an NPI. It is not implausible to conjecture that when expressions of minimal amount start being used as NPIs, it is through the association with an adverbial particle like *even*, association which sometimes goes unexpressed.

All in all, it is clear that the combination *even* + *one* is a widespread source for NPI behavior, possibly even in English. Which directly lead us to the following (admittedly rhetorical) question: if the reason for why *even* + *one* is restricted to DE environments is not analogous to the reason why (4c) is deviant, then what is it?[1]

And here comes the issue of interest to our present concerns. Our account for NPI-violations relies on the fact that they turn out to be, under a plausible semantics, contradictions/trivialities. Which immediately raises the question of why aren't *all* trivialities ungrammatical. Why is it the case that (12a.ii) is odd in reply to (12a.i), while (12b.ii) is a perfectly natural answer to (12b.i)?

(12) a. i.How many papers can you grade by 5? ii. * Oh, even one
b. i. Is John smart? ii. Well, he is and he isn't

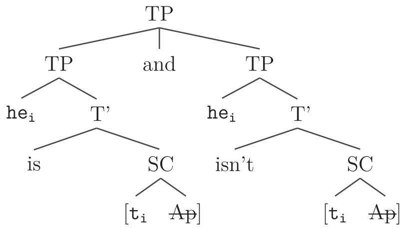
Why, moreover, the contradiction in (12a) requires analysis to unveil its contradictory nature, while the one in (12b) is readily accessible to introspection? As it turns out, these questions have principled answers, as we will see.

11.1 'Modulated' Logical Forms: A Restrictive Contextualism

What we have seen so far is that there are reasons to believe that NPIs in non-DE contexts are to be ruled out not because of some syntactic violation, but because they are contradictions (and hence useless in communicating). However, there are plenty of contradictions that sound fine and are in fact used in concrete communicative situations. So, how can the idea that NPIs in non-DE contexts are just contradictions be right? Gajewski (2002) argues that the solution is rooted in the distinction between function and content words and we are now going to review his proposal. Let us consider the key sentences in (13a) vs. (14a) and their respective syntactic structures.

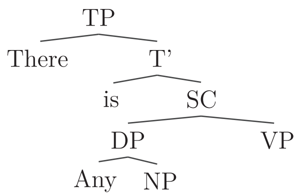
(13) a. [Is John smart?] He is ~~smart~~ and he isn't ~~smart~~
b. Key: T = Tense; T',TP = Tense Phrases; SC = Small Clause;

[1] The Landscape of Polarity Sensitive Items is much richer than the one sketched in the text. But I think that dealing with it in more detail still requires dealing in depth with the problem of how logicality affects grammar. Compare with, e.g., Chierchia (2013) and references therein for a more thorough investigation of the relevant issues.



crossed out constituents go unpronounced but are used for interpretive purposes.

(14) a. There is any pizza left
b.



The trees in (13b) and (14b) constitute the rough syntactic analysis of the two key example sentences, along relatively uncontroversial lines, easy to translate into other popular approaches to these constructions. They may be viewed as the functional skeleta of sentences (13a) and (14a) respectively. I.e., they constitute the kind of structure that grammar would generate out of the functional elements alone. The pronoun he_i is treated as a variable, whose value is assumed to be contextually set, and variables qualify as logical elements. Within the framework of Distributed Morphology (see, e.g., Halle and Marantz 1993) sentences are composed by assembling their functional structure first; content words are inserted at a later stage so as to take into account the contribution of functional structure. This design is meant to make sense of the fact that the final shape of content words is sensitive to the functional structure in which they are inserted: think for example of the common place observation that PAST + V sequence spells out in English as V-ed if the chosen verb is regular like *loved* or *walked*, but the same grammatical information spells out differently if the verb is irregular, like *went* or *hit*. Within Distributed Morphology, which adopts this 'late lexical insertion' strategy, structures roughly like (13c)–(14c) correspond to an actual phase of the derivation of the relevant sentences.

With the notion of functional skeleton in place, Gajewski's approach to G-triviality is based on the following central generalization. A sentence like

(14a) turns out to be contradictory regardless of the choice of content words one inserts in the corresponding structure (14b), i.e., regardless of which N and which V one eventually selects from the lexicon. A sentence like (13a), on the other hand, comes out as contradictory only if one chooses the *same* adjective from the lexicon for the two instantiations of the category AP. This is the source of the distinction between ungrammatical vs. grammatical contradictions: G-trivialities are contradictory for *any* choice of content words.

Let us put this insight in slightly different terms. Consider the interpretations of (13a)/(14a) 'minus their content words', i.e., replacing the latter with variables of the appropriate type:

(15) a. $\mathtt{P}(\mathtt{x}_\mathtt{i}) \wedge \neg\mathtt{P}'(\mathtt{x}_\mathtt{i})$
b. $\mathtt{even}_{\mathrm{ALT}}(\exists_\mathtt{x}[\mathtt{one}(\mathtt{x}) \wedge \mathtt{P}(\mathtt{x}) \wedge \mathtt{P}'(\mathtt{x})])$
where $\mathrm{ALT} = \{\exists_\mathtt{x}[\mathtt{one}(\mathtt{x}) \wedge \mathtt{P}(\mathtt{x}) \wedge \mathtt{P}'(\mathtt{x})] : \mathtt{n} \in \mathtt{N}\}$

Formula (15b) is contradictory no matter how the variables P and P' are interpreted, while (15a) is contradictory only if P and P' are mapped onto the *same* property. Gajewski's original algorithm is a 'syntactic replacement' version of this very same idea: he proposes replacing in the relevant Logical Forms (i.e., the complete syntactic trees for (13a) and (14a)) all occurrences of content words with distinct variables of the same type. If the result is contradictory, the sentence is deemed as ungrammatical.

This account, besides being algorithmic, has an arguably natural functional basis in the pragmatics of communication. What suggests itself is that the reason why sentences like (13a) are perceived as grammatical is because it is possible, and indeed natural, to reinterpret the two occurrences of the (unpronounced) adjective *smart* in slightly different ways (e.g., as 'John is clever at his job, but he is not savvy in the way he manages people', or the like). But no such strategy can be of any help with (14a): no matter how we reinterpret the N or the V, contradictoriness persists.

Gajewski's proposal provides us with a principled way of distinguishing between grammatical and ungrammatical trivialities. Appeal to this distinction is by no means limited to the case of NPIs. Other phenomena that have been argued to require an account in terms of G-triviality include the distribution of *for-* vs. in- *X time* adverbials (Dowty 1979), the definiteness effect in there-sentences (Barwise and Cooper 1981), exceptive constructions (von Fintel 1993), the distribution of quantifiers in comparative constructions (Gajewski 2008), weak island violations (Abrusán 2014), and more. This is just a pointer to some of the relevant literature and sounds like a laundry list. The important fact is that resorting to ungrammatical contradictions to explain properties of grammar is a widespread practice that is proving to be more and more fruitful in figuring out how natural language works.

The distinction between function- vs. content-words is somewhat vague and obviously in need of further clarification, but it plays a crucial role both in traditional as well as in cutting-edge linguistic theories. We will come back to the function/content distinction in later parts of this paper. For now, what is important is that we need to reconsider the widespread stance that syntax determines well-formedness and semantics determines how well-formed sentences are interpreted. On the view I see myself forced to adopt here, grammatical sentences are constituted by well-formed structures *that are non-G-trivial*, and determining the set of G-trivial sentences involves resorting to an empirically determined cast of (interpreted) function (/logical?) words, as per Gajewski's algorithm.

Del Pinal (2019) argues for an interesting modification of Gajewski's proposal. His proposed modification is meant to directly reflect the functionalistic/pragmatic interpretation of Gajewski's proposal. Del Pinal's idea can be illustrated by way of example, representing the interpretations of our two key illustrative sentences (13) and (14) as follows:

(16) a. $\mathtt{g(smart)(x_i)} \wedge \neg \mathtt{g'(smart)(x_i)}$
b. $\mathtt{even_{ALT}}(\exists_x[\mathtt{one(x)} \wedge \mathtt{g(pizza)(x)} \wedge \mathtt{g'(left)(x)}])$
where $\mathrm{ALT} = \{\exists_x[\mathtt{n(x)} \wedge \mathtt{g(pizza)(x)} \wedge \mathtt{g'(left)(x)}] : \mathtt{n} \in \mathtt{N}\}$

The assumption here is that the interpretation of content words can be modulated through the (optional) insertion of functions g, g',. . . which are contextually determined and map any semantic object into something of the same logical type. The default interpretation of these modulating functions (whenever present) is simply the identity map. However, when the default interpretation leads to a contradiction, as, say, with sentences like *John is and isn't smart*, the offending item, in this case a property, typically gets modulated on the basis of the intentions, communicative goals, etc. of the illocutionary agents, for example as in (17):

(17) John is g(~~smart~~) and isn't g'(smart)
g(smart) = clever at his job
g'(smart) = savvy in managing people

The strike through indicates that the second instance of the AP *smart* is elided under identity with the first, but present for interpretive purposes.

One might try to explain the acceptability of the prima facie contradictory sentences of this sort in different manners, e.g., through the resetting of some contextual parameter implicit in adjectives like *smart*, that require a 'comparison class' (smart with respect to what?). However, this alternative account doesn't extend in any obvious way to examples like *How is the weather? Well, it rains and it doesn't rain* ($\approx$ it rains on and off). Moreover, resetting grammatically determined variables (such as comparison classes) is generally banned in VP-ellipsis environments such as those in (17). The present proposal doesn't suffer from these drawbacks and is thus superior to alternatives relying solely on grammatically determined parameters.

We call logical forms/interpretations such as those in (16) 'modulated logical forms'.[2] We may regard Del Pinal's proposal as variant of Gajewski's that embeds the latter within a contextualist stance according to which the standard interpretation of content words is context dependent. On Del Pinal's modification, G-trivial sentences are those that are true/false for any value of the modulating functions, while classical tautologies/contradictions are those that are true/false when all modulating functions are interpreted as identity maps. Obviously, G-trivial sentences are a proper subset of the classical tautologies/contradictions. This approach requires constraints on modulation. Mapping some content word W into something g(W) of the same type is not enough. The mappings appealed to must be in some sense 'natural', address the communicative intentions of the illocutionary agents in pragmatically sensible ways, e.g., by resolving appropriately the questions under discussion (*how smart is John?*). Nobody has a fully worked out theory of what makes a modulation 'natural', beyond appealing to context, questions under discussion, and the like.[3] Still, with these limits acknowledged, Del Pinal's proposal provides a useful characterization of G-triviality and is more general than Gajewsky's, since resetting of basic word meanings happens extensively.[4] Here are two cases. One can be illustrated by a famous example, due to G. Nunberg:

[2] Del Pinal uses the terms 'rescaling' and 'rescaled logical forms' in this connection. I prefer the term 'modulation'. This terminological choice foreshadows a generalization of Del Pinal's approach in two ways, which will be developed in Section 11.4 below. First Del Pinal limits rescaling to predicates (or types that 'end in' the type $< \mathtt{e}, \mathtt{t} >$), while I generalize it also to individuals. Second, I think that the present proposal fits with and accommodates also a treatment of de re belief.

[3] Del Pinal suggests that modulation may be subsective, i.e., map a property into some subproperty. I believe this constraint to be too restrictive in light of examples like (18) and others considered below.

[4] Notice that Del Pinal's proposal does not make contradictions inexpressible in English, a worry expressed by an anonymous referee. It all depends on the intended interpretation of remodulation. In the following quote, from Aristotle's *Metaphysics*, for example, a contradiction is clearly intended and communicatively effective:

(18) a. [A waiter to a fellow waiter:] The ham sandwich wants his bill
b. wants(his bill)($\iota x[\mathtt{g(hamsandwich)(x)}]$)
where g(ham sandwich) = *person that ordered the ham sandwich*

The logical form in (18b) illustrates how Nunberg's example might be handled on an approach based on modulation. A second class of cases is exemplified by sentences like (19a), due to B. Partee:

(19) a. Tommy believes that clouds are alive
b. $\forall_w[\mathtt{BEL}_{\mathtt{TOMMY,w0}}(w) \rightarrow \forall_x[\mathtt{g(cloud)(w)(x)} \rightarrow \mathtt{alive(w)(x)}]]$
Where for any individual u and world w, $BEL_{u,w}$ is the (characteristic function of the) set of worlds compatible with u's beliefs in w.

A sentence like (19a) expresses a (typically *de re*) belief about instances of the cloud-kind, namely that they have life. Given how life is understood in our linguistic community, the belief attributed to Tommy constitutes a metaphysical impossibility that fails in every possible world (much like Hesperus cannot be different from Phosphorus, given how names work, etc.). Hence the semantics for (19a), say (19b), would condemn Tommy's belief state to incoherence (under the default interpretation of g as identity). Modulation offers a way out. The g-function in (19b) may map clouds into some cloud-like living creature, for example.

Del Pinal's proposal, besides providing a conceptual embedding of Gajewski's approach within an independently plausible form of contextualism, also has, perhaps, a further technical advantage. Consider yet again our toy NPI violation, repeated here.

(20) a. * There is any pizza left
b. $\mathtt{even_A LT}(\exists_x[\mathtt{one(x)} \wedge \mathtt{g(pizza)(x)} \wedge \mathtt{g'(left)(x)}])$
c. $\mathtt{ALT} = \{\exists_x[\mathtt{n(x)} \wedge \mathtt{g(pizza)(x)} \wedge \mathtt{g'(left)(x)}] : \mathtt{n} \in \mathtt{N}\}$

It is crucial that the interpretation of the non-logical words (*pizza, left*) be kept constant in the assertion (19b) and across all of the alternatives in (19c). On a substitutional approach like Gajewski's, where logical skeleta are obtained by replacing each occurrence of the non-logical words with distinct variables, some work is required to ensure that the replacement

(a) It is impossible that the same thing can at the same time both belong and not belong to the same object and in the same respect, and all other specifications that might be made, let them be added to meet local objections (Aristotle, *Metaphysics*, 1005b 19–23)

In (a), the word *belong* has to be remodulated via the identity map and hence the sentence in boldface expresses a genuine logical contradiction, as that is the choice that makes pragmatic sense.

is uniform across the alternatives. It is not hard to imagine a definition of logical skeleta that would NOT have such a property, thereby yielding wrong predictions. On Del Pinal's approach this issue doesn't arise.

On the basis of these considerations, I conclude that Del Pinal's proposal constitutes a friendly and useful amendment to Gajewski's original approach. But before attempting some general reflections on what this take on G-triviality tells about the relation between logic and grammar, we need to address a problem that both Gajewski's and Del Pinal's approach leave open.

11.2 The Problem of Bound Variables

Consider sentences of the following form:

(21) a. John is never himself
b. Yesterday, John managed to be more eloquent than himself

The first relevant observation is that these sentences are perfectly grammatical and communicatively useful. The second noticeable point is that, taken literally, they are contradictory. Third, these examples are beyond repair on the modulation approach adopted here, for the following reasons. Reflexive pronouns, comparative morphemes (*more*), and negation (*never*) are prototypical functional items. Thus the modulated structure of (21a,b) is going to be roughly as follows:

(22) a. g(John) is never himself
b. g(John) g(managed) to be more g(eloquent) than himself

The (pseudo) formulae in (22) are contradictory for any choice of g. Hence, sentences (21a,b) should be ungrammatical according to the characterization of G-triviality we are adopting. But they are not; they clearly do not have the same status as *there are any cookies left*.[5] Our proposal, as it stands, seems therefore to rule out too much.

The source of the problem seems to lie in the fact that reflexives are interpreted as variables bound to some suitable antecedent in their local syntactic environment; and bound variables are functional/logical items, if anything is. Hence they should not be targeted by replacement or modulation. This is why the Gajewski/Del Pinal approach appears to fail in

[5] This version of the bound variables problem was pointed out to me by Richard Larson, at a talk I gave at SUNY Stonybrook in 2015. Gajewski (2002, Section 4.2) is clearly aware of it. Also Del Pinal (2019) discusses it explicitly (cf. fn. 9 below).

its job of sifting ungrammatical vs. grammatical trivialities in the cases at hand. How can we modify such an approach, so as to retain its main merits and its principled character? In the present section I address this problem.

The syntax and semantics of reflexives and comparatives is a complex matter. In what follows, I will base my proposal on reflexives, sketching as much of their grammar as needed, in an as uncontroversial manner as possible. I will then indicate how my proposal extends to comparatives.

Let us say that reflexives are governed by Principle A of Chomsky's (1981) binding theory according to which they must be bound to an antecedent in their local syntactic environment, which for our purposes can simply be the smallest sentence containing the reflexives. Principle A is a syntactic axiom with semantic consequences. Binding is achieved, let us assume for the argument's sake, by assigning scope to the antecedent (via Quantifier Raising – QR – or the equivalent), which creates an abstract that binds the reflexives as illustrated in what follows.

(23) a. John is (not) $\texttt{himself}_i$
  b. $\texttt{John}_i$ [$\texttt{t}_i$ is (not) $\texttt{himself}_i$]
   → $\texttt{John}\ \lambda \texttt{x}_i[\texttt{x}_i$ is (not) $\texttt{himself}_i]$
   where $\texttt{t}_i$ is the trace left behind by (string vacuous) raising of the subject.

Following a widespread practice, we analyze the index on *John* as an abstractor that creates the derived (reflexive) predicate in (23b).[6] Principle A ensures that the index on the subject in (23b) be the same as the anaphoric index on the reflexive. We assume that the copula winds up being interpreted here as identity.

We must briefly consider a further option at this juncture. One way of addressing our problem and making (23a) non-G-trivial might consist of treating the copula as a content item and modulate it by mapping identity into some other relation that doesn't yield a contradiction. I think this move is implausible. First, the copula is, syntactically speaking, a prototypical functional item. In many languages, copular sentences like (23a) do not exploit any overt item like the verb *to be* but are assembled by mere concatenation. This is true even of some English predicative 'small clause' constructions such as:

6 See, e.g., Heim and Kratzer (1998).

(24) a. I consider [$_{SC}$ John a good player/his own worst enemy/finally himself again]
b. I regard [$_{SC}$ John as my best friend/his old self again]

Sentences like (24) seem to yield manifestations of the same problem as (23), in ways that does not rely on an overt copular verb. Moreover, in just about any language the item used in copular sentences, when attested, typically doubles up, just as in English, as a mere expression of tense and aspect (as in *John was in the bathtub/a good friend*). This behavior is symptomatic of functional elements. In fact, the most detailed attempt at analyzing the semantic side of copular construction namely Partee (1986), analyzes copular constructions as involving a (restricted) set of 'logical' type-shifting devices. Second, semantic criteria such as identity under domain permutations put identity among the logical constants.[7] Third, treating identity as a content item would not help with the case of comparatives, where the identity relation as such is not involved. We might as well look for a solution that covers also reflexives in comparatives, as the diagnosis of the source of the problem (namely, the presence of bound variables) seems to be the same.

If tinkering with the copula is of no help, the only other way to go is to modulate the bound variable itself, e.g., as follows:

(25) a. John is (not) $\texttt{himself}_{\texttt{i}}$
b. John $\lambda x_i[x_i$ is (not) g($\texttt{himself}_{\texttt{i}}$)]
c. John is not the person he usually is/the way he usually is
d. $\lambda x_i \neg[x_i = \iota x[\texttt{x behaves (in w) most similarly to how } x_i \texttt{ usually behaves}]]$

In (25c) I exemplify typical ways of understanding sentences like (25a). The modulation of variables has to have an intensional character, which spelled out in a full-fledged compositional system would yield, for example, something like (25d).[8] Notice that the outcome of modulation of the reflexive

[7] See MacFarlane (2017) and references therein – esp. McGee (1996) and Sher (2003). Compare with also the discussion in Section 11.4 below.

[8] The semantic metalanguage I have in mind is Gallin's (1975) TY2 with overt world variables. I am assuming that predicates carry a world variables (e.g., *that is red = red(that)(w)* abbreviated as red_w(*that*)); modulation of individual variables maps individuals (of type e) into individual concepts of type $< s, e >$, e.g., in the case at hand, it picks 'the individual that behaves most similarly to how John usually behaves'. Such a concept winds up being applied in the end to the actual world. In other words, the proposition associated with (24) is something like:

(i) $\lambda w \neg[j = \iota x$ behaves (in w) most similarly to how j usually behaves] in (24d) is a contingent property, which in turn ensures that sentence (25a) won't come out as G-trivial.[9]

While this modification perhaps yields an empirically adequate solution to the problem of bound variables, it seems to give up on the functional/logical vs. content distinction that we have been relying on so far, and appears to be less principled than the original. Not only content/non-logical items need to be modulated. Variables need to be modulated as well:

(26) New definition of G-triviality.
 a. Modulation: optionally insert a modulation function g on any content word or variable ($\approx$ bound pronoun or trace).
 b. A sentence is G-trivial iff it comes out as true/false on any modulation.
 c. A sentence is L-trivial iff it comes out as true/false for the default value of modulations (as identity).

Under this new definition, sentences like those in (21) come out, correctly, as *non*-G-trivial. I think that, in spite of appearances, this proposal in fact retains the original inspiration and principled character of Gajewski's and Del Pinal's. Variables constitute stand-ins for content expressions. If you think in model-theoretic terms and consider a canonical intensional model <U,W, F>, with U a set of individuals, W a set of worlds, and F an interpretation function, the items that can be modulated are the values of F and of the assignments to variables. Logical constants, on the other hand, have values that remain constant across models and cannot be modulated. Obviously, I am not giving here a characterization of the logical/non-logical divide. I am simply adopting a standard semantic practice and pointing out how my definition of modulated logical forms falls with respect to it. Here is the guiding principle of our proposal:

(27) The referential points of a logical form (/LF tree), namely the non-logical constants and variables, may be modulated.

While making this fully explicit may require some work, I trust that the chief idea is clear enough for our present purposes.

9 Del Pinal (2019) proposes to address the problem with reflexives by modulating the property obtained by abstracting over the reflexive pronoun roughly along the following lines:

(i) John $g(\lambda x[x = x])$

This tantamounts to treating identity as a content item, which I have argued against, compounded with the complication that the property in (i) is a singleton property, that in every world maps each individual into the property of being identical to itself. It is unclear how modulation of such property can yield the right results.

The solution just sketched does extend to comparative constructions. The rough logical form of a sentence like (21b), repeated in simplified form in (28a), is as in (28b):

(28) a. John was more eloquent than himself
b. $\mathtt{John}_{\mathtt{i}}\ \lambda \mathtt{t}_{\mathtt{i}}[\mathtt{t}_{\mathtt{i}}$ was MORE(eloquent) than $\mathtt{himself}_{\mathtt{i}}$]
$= \lambda \mathtt{x}_{\mathtt{i}}[\mathtt{MORE(eloquent)}(\mathtt{x}_{\mathtt{i}})(\mathtt{x}_{\mathtt{i}})](\mathtt{j})$
where for any u, MORE(eloquent)(u) is the property of being more eloquent than u defined as follows: u' has the property of being more eloquent than u iff there is some degree d such that u' is at least d-eloquent and u is not.

The analysis sketched in (28) relies on a degree semantics for comparatives, such the one explored in Kennedy (2007) and much related work. According to it, adjectives correspond to relations between individuals and degrees: John is d-tall iff John's height is at least d. The comparative morpheme, thus, says something about the respective maximal degrees to which two individuals have a certain gradable property. The logical form in (28b) can be modulated just like other sentences involving reflexives:

(29) a. $\mathtt{John}_{\mathtt{i}}$ [$\mathtt{t}_{\mathtt{i}}$ was MORE(eloquent) than g($\mathtt{himself}_{\mathtt{i}}$)]
$= \lambda \mathtt{x}_{\mathtt{i}}$ [MORE(eloquent) (g($\mathtt{x}_{\mathtt{i}}$))($\mathtt{x}_{\mathtt{i}}$)] (j)
b. John is (today) more eloquent than the degree to which he usually is
c. John is more eloquent than the individual whose eloquence is most similar to John's usual one.

The sentences in (29b–c) are possible informal renderings of the effect of modulating the reflexive pronoun in (29a).[10]

The treatment of variables I am proposing bears a non-accidental connection, I think, to the issue of de re (and de se) belief. I have already hinted at this in connection with example (19) above, *Tommy believes that*

[10] *Than*-complements are sometimes clausal. For example, (i) is best analyzed as (ii)

(i) John is taller than Bill is
(ii) John is taller than Bill is tall

If all *than*-complements were clausal, modulation of variables would not be necessary, for one might achieve the intended results by modulating the two occurrences of the adjective *tall* in (ii). However, it is not clear whether this is right for sentences involving reflexives, for the source is ungrammatical:

(iii) * John is taller than himself is ~~tall~~

Moreover, there are languages that have been argued to lack clausal comparatives such as Fijan (cf. Pearson 2010, and for a general overview of variation in comparison constructions, Beck 2011).

clouds are alive. Let me outline the connection more fully here through a simple example. Consider:

(30) John believes that his brother is not his brother.

a. John believes that his actual brother is in fact an impostor trying to steal John's inheritance.

b. John is at the dentist. While sitting on his dentist's operating chair, he spots a man acting as an aid to the main doctor. He forms the belief that that person is the new assistant to his dentist, without recognizing that he is in fact John's own brother. While knowing that his brother is a dentist too, John doesn't think that the person assisting his dentist is his brother.

On its non-contradictory interpretation, sentence (30) may be used to report a de re belief of John's towards his actual brother, compatible with (and appropriate to) a variety of scenarios, such as for example those in (30a–b). The issue of de re belief is of course intricate. One important tradition[11] addresses the problem by appealing to concepts through which the relevant *res* is accessed by the attitude holder. A belief is de re about an individual *u* whenever *u* reliably induces a concept about *u* in the belief holder *a*, which identifies *u* for *a* in *a*'s belief state. Such concepts for example (30) might be, say, *the man that wants to share John's inheritance* for context (30a) and *the man John is seeing* for (30b). Charlow and Sharvit (2014) have proposed an implementation of this kind of approach to de re in which logical forms for de re beliefs employ 'concept generators' that are inserted in the syntactic spot of the res and drive pragmatically the propositional content of the belief. In the case of (30a), for example, we might go for a logical form like (31a), with the g-function spelled out as in (31b–c):

(31) a. $\forall_w[\mathtt{BEL}_{j,w0}(w) \rightarrow \neg\mathtt{brother}_w(\mathtt{g}(\iota\mathtt{x}.\mathtt{brother}_{w0}(j)(x))(w)]$
where j = John and $brother_{wo}(j)(x)$ = x is brother of j in w_o.

b. Let u be John's brother in the actual world. Then: $g(u) = \lambda \mathtt{w}.\iota\mathtt{x}$[x wants to share j's inheritance in w]

c. $\forall_w[\mathtt{BEL}_{John,w0}(w) \rightarrow \neg\mathtt{brother}(\iota\mathtt{x}$[x is the person who wants to share j' inheritance)(w)]
= John believes of the person who wants to share John's inheritance (namely his actual brother) that he is not his brother.

As in the case of variables, the definite description *his brother* (evaluated in the actual world) is modulated via a concept that mediates between John,

[11] See in particular Quine (1956), Kaplan (1968), Cresswell and von Stechow (1982).

the attitude holder, and the res his belief is about. The use of modulation for individual expressions proposed here can thus be viewed as an extension of Charlow and Sharvit's proposal for the semantics of de re belief in general.

In sum, the present proposal is that logical forms (which drive the compositional interpretation of sentences) can and sometimes must be modulated by the insertion of 'replacement functions' in their referential points. Referential points of an LF are the content words ('non-logical') and variables (whose values range on the denotations of content words). Modulation is necessary for a variety of reasons, most prominently to make sense of our belief-states and to resolve contradictions in a communicatively effective way, explaining why sometimes contradictions can be useful communication tools. There are, however, sentences that cannot be rescued in this way. Their LFs turn out to be contradictory for any modulation. These sentences are useless and can be regarded as on par with syntactically ill-formed sentences. The outcome is an arguably general and principled proposal in which a characterization of G-triviality stems from the independent need of reinterpreting certain sentences in context.

11.3 Grammar vs. Logic

Our approach to modulation is rooted in the distinction between function and content words, where function words subsume logical words. In the present section, I go over some issues in the characterization of this dichotomy.

As is well known, functional items do not have a clear cut, absolute characterization, but there a number of syntactic and semantic criteria that are reliably relevant to the distinction *functional vs. content*. Starting at the syntactic end of things, here is a (partial) list of functional categories and morphemes:

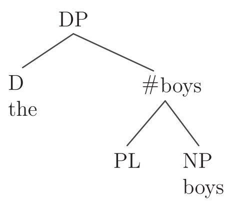
(32) Typical Functional categories and subcategories
  a. Determiners, Quantifiers, Classifiers, Complementizers, Coordinations, Negation, Comparative/Superlative markers, Tense and Aspect markers ($\approx$ 'Auxiliaries'), Modals, Focus and Topic markers, Discourse Particles, . . .
  b. Gender, Number, Case, (in)definiteness markers, Verb/Noun-class markers, pronouns, wh-elements, . . .

Those in (31a) are typical functional categories and subcategories; those in (31b) involve 'features' specific to certain items (like pronouns) or active in agreement patterns. To see what the items in (31) have in common, consider the main basic orders in the languages of the world:

(33) a. S O V b. S V O c. V S O
[where S = subject, O = Object, V = verb)

Typical functional elements such as those in (32) tend occur at the edges of the main clausal constituents in (33), relative to the basic word order a language chooses, where they may be realized as bound morphemes or as autonomous words ('free' morphemes). For example, the expression of PAST-ness occurs at the periphery of the VP and can be realized as a bound morpheme *lov-ed* (through, say, incorporation of the V into the PAST morpheme) or as an independent morpheme as in *has walked* (with semantic differences between the two options). To illustrate further, coordinators (*and, or*) typically connect clauses and hence they tend to occur at the edge of clausal structures rather than in the middle of them. Similarly, Discourse Particles (e.g., German *doch*, Greek $\mu\varepsilon\nu$) have to do with signaling discourse junctures related to topicality, backgrounding, etc. and are often placed at or near major constituent boundaries.[12] The way functional categories are conceptualized within current generative approaches is as a series of heads at the edge of NPs or VPs, forming the so-called 'functional spines' or 'extended projections' of the latter. I provide an example in (34):

(34)



The structure in (34) represents the definite plural DP *the boys*, where #P ('number phrase') is the layer driving information about number. DP and #P are (part of) the functional spine or extended projection of NP.

Functional layers are drawn from a hypothesized universal inventory and are subject to (limited) parametric variations. Variation has to do with which members of the universal inventory are exploited by a given

[12] This rough characterization needs to take into account the fact that constituents can be moved from their base position.

language, matters of word order, and whether a language admits phonologically unrealized items of specific sorts. The special character of functional items determines a further series of associated properties, schematically:

(35) a. Frequency: Highest frequency in any language is associated with functionality. The most frequent fifty lemmas in English include no more than three or four content words (with *say* in the lead, at the nineteenth position).[13]
b. Historical change: content words change constantly without affecting language identity (whence the characterization ‘open class’); changes in the functional layers involve grammatical change, which may affect the identity of a language (whence the label ‘closed class’).
c. Selective impairments: function words are often selectively impaired in a variety of language pathologies, like agrammatism or ‘non-fluent’ aphasia. (See, e.g., Caramazza and Hillis (1989), Friedman and Grodzinsky (1997) among many others.)

The properties in (35) are fairly self-explanatory, and perhaps unsurprising given the nature of function words. Notice that they are ‘one-way’ generalizations, i.e., conditionals, not biconditionals: if x is high frequency x has a high probability of being a function word. But there are of course relatively low frequency function words (e.g., *shall, ought*).

The syntactic characterization of functional items just reviewed relies primarily on the ‘slots’ they occupy within the clause. This main trait unavoidably comes with a cluster of semantic properties. Building on von Fintel (1995), I will briefly discuss here four such properties, namely:

(36) a. Having high types.
b. Being ‘inference based’
c. Being subject to crosslinguistically widespread, sometimes universal constraints.
d. Being permutation-invariant.

Starting with (36a), nouns and verbs typically express first order properties and relations that subdivide domains of discourse into classes and relate individuals, events, etc. to one another. In type-theoretic terms, this is conceptualized by positing a basic type of individuals e, and relations over individuals of type <e, t>, or <e, <e,t», etc. Functional expressions

[13] Compare with www.wordfrequency.info.

find their natural conceptualization at higher types. For example, determiners can be viewed as associated with higher order relations of type «e, t>, «e,t>,t» between sets or classes. Similarly, one can think of propositions as carving an abstract space of possibilities (say, a set of worlds) into subregions and propositional connectives can be represented as higher order functions on sets of worlds. The property in (36b) is easy to grasp but hard to define. The basic idea is that while the meaning of every kind of expression is ultimately rooted in its entailments, presuppositions, and implicatures, content words are also causally linked to fairly tangible and localized regularities in our environment (the meaning of 'cats' is causally linked to cats, that of 'run' to running events, etc.). In contrast with this, the meanings of *every*, *or*, *only*, or *even* are way more abstract and only characterizable in terms of the inference patterns they give rise to. Such patterns are moreover subject to possibly universal structural constraints. For example, *only* and *even* are always 'alternative sensitive': they require identifying a class of alternatives with respect to which their prejacent is evaluated; determiners are conservative,[14] etc.

Turning next to permutation invariance, i.e., the idea the logical word remain constant across one-one mappings of the domain onto itself,[15] there is little doubt that it is a powerful criterion that identifies a natural semantic class. Items with this property systematically fall within the functional segment of the lexicon, to an extent that simply can't be accidental. Expressions with an arguably logical meaning that behave like content words are exceedingly few. They include verbs like *deny*, or *exist*, nouns like *majority*, adjectives like *mere* or *former*. But note that these words are all morphologically derived (e.g., major + ity) and they typically undergo a drift that gives them some non-logical content (e.g., *exists* is not just 'being the value of a bound variable', but drifts into something like 'having physical existence'). So the claim that permutation-invariant functions are expressed within the functional layer of syntax is, I think, born out.

Are function words limited to expressing permutation-invariant items? I'd say no. The clearest case is perhaps that of gender features (and more generally class agreement markers).[16] Grammatical gender systems can be quite complex; they typically code some anthropologically salient trait and extend it, often arbitrarily, in order to partition or classify the domain

[14] A determiner D is conservative iff for any A and B, $D(A)(B) = D(A)(A \cap B)$. See Barwise and Cooper (1981).

[15] See, e.g., McGee (1996), Sher (2003), and, for an overview, MacFarlane (2017).

[16] Current terminology uses the term 'φ-features' for elements of this sort.

of individuals. Since at least Cooper (1983),[17] the semantic side of feature information is treated presuppositionally:

(37) a. i. $||\text{fem}|| = \lambda \mathtt{x}_\mathtt{e}$: female($\mathtt{x}_\mathtt{e}$). $\mathtt{x}_\mathtt{e}$ $||\text{male}|| = \lambda \mathtt{x}_\mathtt{e}$: male($\mathtt{x}_\mathtt{e}$). $\mathtt{x}_\mathtt{e}$
ii. $||\text{ragazz-a}|| = \lambda \mathtt{x}_\mathtt{e}$: fem($\mathtt{x}_\mathtt{e}$). young adult($\mathtt{x}_\mathtt{e}$)
iii. $||\text{ragazz-o}|| = \lambda \mathtt{x}_\mathtt{e}$: male($\mathtt{x}_\mathtt{e}$). young adult($\mathtt{x}_\mathtt{e}$)
b. $\forall_\mathtt{x}$ [female(x) $\rightarrow \neg\mathtt{male(x)}$]

The functions in (37ai) are restricted identity maps, defined only for female or male individuals, respectively; in (37a.ii) you see how such functions can be used to restrict the denotation of the words for *girl* vs. *boy* in a language with grammatical gender. The predicate in (37a.ii), for example, is defined only for female individuals; whenever defined, it is true of young adults and false of non-young adults. Use of features of this sort induces disjointness constraints such as (37b), which are among the most common across languages. This seems to require an extension of what counts as 'logical' to constraints that define 'subcategories' of various content words. Sagi (2014) provides an interesting general way of extending the notion of logicality by using constraints of this sort to relativize permutations to subcategories of content words.

So permutation invariance seems to have a core and a periphery. In very rough terms, the core is constituted by the items characterized by some strict definition of permutation invariance (say, bijections among domains of equal cardinality). The periphery takes into account more specific structural constraints on natural semantic categories like modals, tense, mass vs. count, etc. all the way to fairly idiosyncratic feature-based constraints. Jointly, core and periphery determine what might be viewed as a universal natural logic, specific to *Homo sapiens*.

Summing up, the syntax of function words systematically differs from that of content words. These syntactic differences correlate with semantic ones. Permutation-invariant items in the strict sense are systematically treated as functional by syntax and are obvious candidates for Universal Grammar membership. The remnant of the functional vocabulary seems to be constituted by a broader class of mostly inference based operations, relations, etc. subject to cross-linguistically stable structural constraints.

Our starting point has been that certain forms of linguistic deviance appear to be best made sense of in terms of logical truth or falsehood rather

[17] For a more recent version of the presuppositional treatment of grammatical features, compare with, e.g., Sudo (2012) and references therein.

than in terms of well-formedness. Assume some background logical framework, say the typed lambda calculus, and enrich it to a theory NatLog by some set of axioms/structural constraints on modals, event structures, countable vs. uncountable entities, etc. Imagine next using NatLog to specify the semantics of a natural language, say English, in the usual sense of a systematic, compositional mapping from the structures constructed by the grammar of English into formulae or statements of NatLog. Some English sentences will be logically false/true relative to their Logical Forms interpreted in NatLog. And a subset of the NatLog-logically false/true sentences will be perceived by speakers of English as 'not in the language', on a par with syntactically deviant structures. We have called such sentences 'G(rammatically)-trivial'. Our problem was to determine: (i) which sentences within the L(ogically)-determined ones are G-trivial, and (ii) why. We have proposed a modification of Gajewski's and Del Pinal's proposal that addresses these issues.

Be that as it may, the search for the components of the functional/logical lexicon and the ways in which they may vary, while still daunting, is definitely no longer mere speculation, but a well-defined and exciting research program, which delivers constantly new results. And the discovery that forms of 'ungrammaticality' are in fact due to logical inference (rather than to syntactic ill-formedness) is actually game-changing, and shows in very tangible and fruitful ways how interconnected grammar and logic are.