Ad-nominal epistemic adverbials at the syntax–semantics interface

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Abstract

This paper provides an analysis of ad-nominal uses of epistemic adverbials at the syntax–semantics interface. The analysis is couched in Lexical Functional Grammar (LFG) and Glue Semantics (GS).

1 Introduction

It has been long noted that certain – especially epistemic – adverbials may modify nominal constituents, as in (1) (Ernst 1983: 180) and (2) (Collins 1988: 5).

(1) He reduced us to *maybe* the size of a pinhead before dropping us in the bottle.

(2) John and *maybe* Mary went to the store.

In a recent paper, Bogal-Allbritten and Weir (2017) (BAW, henceforth) analyze examples such as (2) as ambiguous between a 'sentential' reading where it is not clear whether 1 or 2 people went to the store (John alone or both John and Mary), and a 'subsentential' reading where 2 people went to the store (both John and somebody else who may be Mary). This should be contrasted with (1), which seems to only have a 'subsentential' reading: there is certainly something that "he reduced us to", even if its nature is uncertain. They argue that such 'subsentential' readings are in principle available in all nominal positions, while 'sentential' readings are restricted to coordination. Correspondingly, they analyze 'subsentential' readings as instances of reduced relative clauses, and 'sentential' readings – as instances of conjunction reduction. So the underlying structure of the relevant fragment of (1) is analogous to "He reduced us to what maybe was the size of a pinhead…" ('subsentential' reading), while the two underlying structures of (2) are roughly "John and (someone) who maybe was Mary went to the store" ('subsentential' reading) and "John went to the store and maybe Mary went to the store" ('sentential' reading).[1] As both structures involve underlying sentential structures (reduced relative clauses or elided sentences), the usual sentential adverbials are licensed, so it is not necessary to assume that such adverbials are ambiguous between adverbal and ad-nominal uses. The analysis also explains the fact observed in Vicente 2013 that the epistemic material may have the form of sentence fragments:

(3) Alice and *I think (*that)* Bob have gone to the store.

Finally, BAW support their analysis with the claim that examples like (4) only have a 'subsentential' reading, since the weaker 'sentential' reading on their analysis requires a biclausal structure which gives an illicit binding configuration.

(4) They have praised each$_i$ professor and *perhaps* his$_i$ best student.

2 Problems

There are numerous empirical and technical problems with the analysis of BAW, some of which are already noted there. **First**, a well-known problem are collective predicates, as in:

(5) a. This stew is a mix of cabbage, sausage and *possibly* ham.
b. John, Bill, and *possibly* Mary gathered to discuss the matter.

BAW note that these sentences cannot receive the natural conjunction reduction analysis, and they suggest that the underlying structures might be as in (6), thus implicitly relying on a more powerful non-standard mechanism of ellipsis.

[1]Schein 2017 assumes that only 'sentential' – conjunction reduction – readings are available in cases such as (2). We side with BAW and most of the literature – and provide attested evidence – that such examples also have 'subsentential' readings, but the analysis below does not posit the kind of structural ambiguity proposed by BAW.

(6) a. This stew is a mix of cabbage and sausage and *possibly* ham ~~is in the stew~~.
b. John and Bill and *possibly* Mary ~~did this~~ gathered to discuss the matter.

The problem is exacerbated in the case of sentences with two or more such coordinate structures, e.g.:

(7) Tom, *probably* Bill, and *perhaps* John will soon bake croissants and *maybe* scones.

Even allowing for powerful syntactic, semantic and phonological transformations from the underlying structure to the 'conjunction reduced' form, it is not clear what such an underlying structure should be in the case of (7), and how to ensure the most salient single event reading of this sentence (but see Schein 2017 for an attempt). **Second**, as BAW note, their analysis would predict a much wider range of possible sentential material in addition to *I think*, *I suspect*, etc., including their versions with complementizers and non-bridge predicates:

(8) *Tom and *I think that* Bill gave Rachel some flowers.

(9) *Tom and *I {found out / am surprised}* Bill gave Rachel some flowers.

Third, a similar problem is that the analysis also predicts that any sentential adverbs should be allowed on the conjunction reduction analysis, contrary to facts (Collins 1988: 6):

(10) *John, Bill and *quickly* Mary went to the store.

Fourth, the conjunction reduction analysis of BAW is seriously undermined by the fact that not only coordinate structures cancel the existential entailment (i.e., have 'sentential' readings). Consider the attested (cf. ʷʷ) examples:

(11) ʷʷ Outside of *possibly* Murphy there is not much high-end talent in the Hurricanes prospect pool.

(12) ʷʷ Sometimes I will start the day with a bowl of blueberries and pecans with *perhaps* a little natural peanut butter stirred in.

(11) does not mean "With one exception – and this exception is possibly Murphy…", but rather "Possibly with the exception of Murphy…" Similarly, (12) is not saying "…a bowl… with something – perhaps with a little natural peanut butter", but rather "…a bowl perhaps with a little natural peanut butter". **Fifth**, we do not agree that (4) has obligatory existential entailment (i.e., that it only has a 'subsentential' reading). Whereas the reading of that made-up example is hard to judge, it is easy to find natural examples with the same binding pattern that clearly do not have existential entailment, e.g.:

(13) ʷʷ Now it was clear that every$_i$ soldier's effort, and *perhaps* his$_i$ life, would be required.

(14) ʷʷ It is up to each and every$_i$ member, and *perhaps* even their$_i$ spouses… to please step forward and grow even more.

Such examples directly contradict BAW's analysis (on the same grounds on which (4) is supposed to support it). **Finally**, BAW's analysis of 'subsentential' readings assumes that the nominals modified by adverbials are of the intensional equivalent of type e, type shifted to the intensional equivalent of type $\langle e, t\rangle$. However, such adverbials may also modify generalized quantifiers of type $\langle et, t\rangle$, as in the attested:

(15) ʷʷ Once she had spoken to *possibly* every person…

(16) ʷʷ …here is the only answer that actually works on *maybe* most flavours of Linux…

(17) ʷʷ Rhinosporidiosis is a complex phenotype with *perhaps* no parallel in medical science.

Such examples pose a serious problem also for earlier analyses of ad-nominal uses of adverbial modifiers.

3 Analysis

We provide a syntactico-semantic analysis of ad-nominal adverbial modifiers – simpler than that of BAW and free from the problems listed above – which is couched in Lexical Functional Grammar (LFG; Bresnan 1982, Bresnan et al. 2015, Dalrymple et al. 2019) and in Glue Semantics (Dalrymple 1999, Gotham 2018). The main points of the analysis are: 1) as adverbs are now known to modify not only verbal projections, but also nominal constituents (Ernst 1983, Collins 1988, Munn 1993, Huddleston et al. 2002, etc.), adjectives (e.g., Cinque 2010: 57), numerals (e.g., Zaroukian 2011: 678), etc., we assume a general syntactic rule that allows adverbs to combine with any syntactic category, subject to syntactic and semantic constraints introduced by particular adverbs; 2) epistemic adverbs are of the standard (intensional equivalent of the) semantic type $\langle t, t\rangle$– whether they are used ad-verbally or ad-nominally; 3) such $\langle t, t\rangle$ adverbs may combine with other items of the semantic type 'ending in t' thanks to the flexible approach to semantic composition offered by Glue Semantics, where a functor can 'ignore' unsatu-

rated positions in its argument; 4) there is no structural ambiguity between 'sentential' and 'subsentential' readings; instead, the composed meanings are underspecified for these two readings, with one or the other becoming prominent or obligatory for pragmatic or event structure reasons.

Below, we present these aspects of the analysis in more detail, illustrating them with two simple examples:

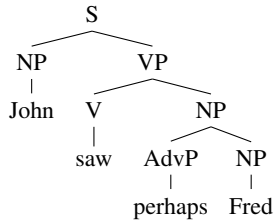
(18) John saw perhaps Fred.

(19) John and perhaps Fred met.

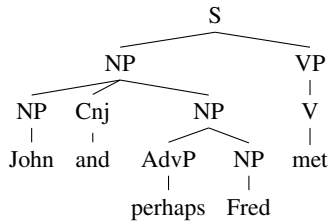
3.1 Syntax

In LFG, each utterance has two syntactic representations: c(onstituent)-structure and f(unctional)-structure. C-structures are simple syntactic trees, usually free from phonetically empty constituents (and corresponding multiple functional projections); c-structures for the two running examples might look as follows:

(20)



(21)



The corresponding syntactic rule responsible for adjoining adverbials to NPs is an instance of the following schema, where XP may be any maximal projection:[2]

(22) XP → AdvP XP
$\downarrow \in (\uparrow \text{ADJ})$ $\uparrow = \downarrow$

The part below nonterminal names contains functional annotations which specify the second kind of syntactic representations assumed in LFG, f-structures. In the case of the two running examples the corresponding f-structures are:

(23) $s\begin{bmatrix} \text{PRED} & \text{'SEE}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{SUBJ} & _j\big[\text{PRED} \ \text{'JOHN'}\big] \\ \text{OBJ} & _f\begin{bmatrix} \text{PRED} & \text{'FRED'} \\ \text{ADJ} & \big\{_p\big[\text{PRED} \ \text{'PERHAPS'}\big]\big\} \end{bmatrix} \end{bmatrix}$

(24) $m\begin{bmatrix} \text{PRED} & \text{'MEET}\langle\text{SUBJ}\rangle\text{'} \\ \text{SUBJ} & _c\left[\left\{_j\big[\text{PRED} \ \text{'JOHN'}\big], _f\begin{bmatrix} \text{PRED} & \text{'FRED'} \\ \text{ADJ} & \big\{_p\big[\text{PRED} \ \text{'PERHAPS'}\big]\big\} \end{bmatrix}\right\}\right] \end{bmatrix}$

The rule (22) takes part in building the functional substructures (marked as f in (23) and in (24)) corresponding to the NP "perhaps Fred": the equation below "XP" makes sure that the f-structure corresponding to this NP ($\uparrow$) is the same as that corresponding to the NP "Fred" ($\downarrow$), while the membership statement below "AdvP" ensures that the f-structure of "perhaps" ($\downarrow$) belongs to the ADJ(unct) set within this nominal f-structure (($\uparrow$ ADJ)).

3.2 Semantics

Epistemic adverbials are standardly analysed as bearing the semantic type $\langle\langle s,t\rangle,\langle s,t\rangle\rangle$, where s is the type of possible worlds. Here, in order to simplify the presentation, we cast it in extensional terms, i.e., we assume that such adverbials are of type $\langle t,t\rangle$ (tt, in short): $\lambda p.\Diamond p$. The main challenge for an account of adverbials – such as the one advocated here – which does not assume any underlying sentential representations in their adnominal uses is to preserve their semantic uniformity as modifiers of propositions.

3.2.1 Flexible Composition

Glue Semantics (GS) is an approach to compositional semantics in which semantic composition is not determined by the constituent structure but rather by the functional structure, via explicit instructions expressed in a subset of linear logic (Girard 1987).[3] The pair ⟨MR, LLF⟩, consisting of a meaning representation MR and a linear logic formula LLF, usually written as "MR : LLF", is called a 'meaning constructor' (MC). For example, the MC introduced by "perhaps" as used in the first running example (18) is:

(25) $\lambda p.\Diamond p \ : \ t(f) \multimap t(f)$

We assume here the first-order variant of Glue (Kokkonidis 2008), where atomic glue formulae (e.g., $t(f)$) consist of a semantic type (e.g., t) and an f-structure (e.g., f).[4] Hence, (25) couples the meaning representation $\lambda p.\Diamond p$ with the linear implication $t(f) \multimap t(f)$. Applying the Implication

[2] Technically, this can be implemented via the mechanism of metarules as defined in XLE (Crouch et al. 2011).

[3] For a gentle introduction to GS as used in LFG, see, e.g., Dalrymple 2001: ch.9 or Dalrymple et al. 2019: ch.8.

[4] In the original notation of Kokkonidis 2008, $t(f)$ would be written as t_f; here we make explicit the first-order character of this variant of GS, where semantic types are predicates and f-structures are their arguments, which may be universally quantified.

Elimination rule (26) to this MC and an MC of the form $q : t(f)$ will result in the 'consumption' of both MCs and 'production' of (β-reduced) $\Diamond q$ of type $t(f)$.

(26) $$\frac{a : A \qquad f : A \multimap B}{f(a) : B} \multimap_{\mathcal{E}}$$

Meaning constructors are introduced either lexically (all MCs in this paper) or constructionally (cf., e.g., Asudeh et al. 2013); e.g., the lexical entry of "perhaps" contains the following line:

(27) $\lambda p. \Diamond p \ : \ t((\text{ADJ} \in \uparrow)) \multimap t((\text{ADJ} \in \uparrow))$

The symbol "$\uparrow$" indicates the f-structure associated with "perhaps", i.e., p in (23), and "$(\text{ADJ} \in \uparrow)$" indicates the f-structure with the attribute ADJ whose value contains ("$\in$") the f-structure of "perhaps" ("$\uparrow$" again), i.e., f in (23). Hence, as the lexical entry for "perhaps" is used in the analysis of the running example (18), the specification in (27) gets instantiated to the meaning constructor in (25). In the rest of the paper, we only provide such instantiated MCs.

MCs introduced by the proper names "John" and "Fred" are very simple (note that j and f refer to feature structures in (23)):

(28) $john \ : \ e(j)$

(29) $fred \ : \ e(f)$

On the other hand, the verb *saw* introduces three more complex MCs:[5]

(30) $\lambda A \ \lambda T \ \lambda e. see(e) \wedge A(e) \wedge T(e) \ : \ [v(s) \multimap t(j)] \multimap [v(s) \multimap t(f)] \multimap v(s) \multimap t(s)$

(31) $\lambda x \lambda e. ag(e) = x \ : \ e(j) \multimap v(s) \multimap t(j)$

(32) $\lambda x \lambda e. th(e) = x \ : \ e(f) \multimap v(s) \multimap t(f)$

Using just the Implication Elimination rule (26), MCs (28)–(32) give rise to the following proof:

(33) $\lambda e. ag(e) = john \ : \ v(s) \multimap t(j)$ (from (28) and (31))

(34) $\lambda e. th(e) = fred \ : \ v(s) \multimap t(f)$ (from (29) and (32))

(35) $\lambda T \ \lambda e. see(e) \wedge ag(e) = john \wedge T(e) \ : \ [v(s) \multimap t(f)] \multimap v(s) \multimap t(s)$ (from (33) and (30))

(36) $\lambda e. see(e) \wedge ag(e) = john \wedge th(e) = fred : v(s) \multimap t(s)$ (from (34) and (35))

This last MC is subject to existential closure, via the following MC (introduced by the tensed verb or constructionally):

(37) $\lambda P. \exists e. P(e) \ : \ [v(s) \multimap t(s)] \multimap t(s)$

From this we obtain the following neo-Davidsonian representation:

(38) $\exists e. see(e) \wedge ag(e) = john \wedge th(e) = fred : t(s)$ (from (36) and (37))

Since the MC (25) introduced by "perhaps" is not used ('consumed') in this proof, (38) does not give us a representation of the first running example (18). Note that "perhaps", as used in (18), has the linear type $t(f) \multimap t(f)$, while the formula (38) is of type $t(s)$, so Implication Elimination cannot be used here. This is as expected, as the result of combining these two formulae would be $\Diamond \exists e. see(e) \wedge ag(e) = john \wedge th(e) = fred$ (allowing for the possibility of there being no seeing event), which is not the right representation of (18) (which does state the existence of a seeing event). Another standard rule of GS is needed to incorporate the contribution of "perhaps", namely, Implication Introduction:

(39) $$\frac{\begin{array}{c}[x : A]^1 \\ \vdots \\ f : B\end{array}}{\lambda x. f : A \multimap B} \multimap_{\mathcal{I},1}$$

Using this rule, the MC (25) combines with (34) as follows:

(40) $[e \ : \ v(s)]^1$ ($\mathcal{I}$,*1*)

(41) $th(e) = fred \ : \ t(f)$ (from (40) and (34))

(42) $\Diamond th(e) = fred : t(f)$ (from (41) and (25))

(43) $\lambda e. \Diamond th(e) = fred \ : \ v(s) \multimap t(f)$ ($\mathcal{I}$,*1* from (42))

From here, the proof follows as before, giving the desired representation according to which the only uncertainty is whether Fred is the theme of the seeing event:

(44) $\exists e. see(e) \wedge ag(e) = john \wedge \Diamond th(e) = fred \ : \ t(s)$

In the case of the second running example, (19), whose f-structure is given in (24), the MCs introduced by the two proper names and by "perhaps" are the same (i.e., (28)–(29) and (25), respectively), while the verb introduces the following MCs:

(45) $\lambda A \ \lambda e. meet(e) \wedge A(e) \ : \ [v(m) \multimap t(c)] \multimap v(m) \multimap t(m)$

(46) $\lambda x \lambda e. ag(e) = x \ : \ e(c) \multimap v(m) \multimap t(c)$

Note that here it is the coordination, with the f-structure c, that corresponds to the agent of the meeting event, hence the difference between the MCs for "met" in (45)–(46) and the correspond-

[5] As in some of the literature on events, e.g., Landman 2000, 2004, we distinguish the semantic type of individuals (here: e) from the type of events (here: v), but the analysis would also go through if these types were unified to a single type, e.

ing MCs for "saw" in (30)–(31). Additionally, the conjunction introduces the following MC:

(47) $\lambda\mathcal{Q}_1\lambda\mathcal{Q}_2\lambda P.\,\exists x.$
$\mathcal{Q}_1(\lambda y.y \sqsubseteq x) \wedge \mathcal{Q}_2(\lambda y.y \sqsubseteq x) \wedge P(x)$:
$[[e(j) \multimap t(j)] \multimap t(j)] \multimap$
$[[e(f) \multimap t(f)] \multimap t(f)] \multimap$
$[e(c) \multimap t(c)] \multimap t(c)$

That is, it constructs a generalized quantifier when supplied with two generalized quantifiers. Using Implication Introduction twice (with $[P : e(j) \multimap t(j)]^1$ and $[P : e(f) \multimap t(f)]^2$), type e repesentations of proper names may be raised to become generalized quantifiers:

(48) $\lambda P.\,P(john)$: $[e(j) \multimap t(j)] \multimap t(j)$

(49) $\lambda P.\,P(fred)$: $[e(f) \multimap t(f)] \multimap t(f)$

Using Implication Introduction again, the MC for "Fred" in (49) may be modified by the MC for "perhaps" in (25) resulting in:

(50) $\lambda P.\,\Diamond P(fred)$: $[e(f) \multimap t(f)] \multimap t(f)$

This leads to the following MC corresponding to the coordinate structure "John and perhaps Fred":

(51) $\lambda P.\,\exists x.\,john \sqsubseteq x \wedge \Diamond(fred \sqsubseteq x) \wedge P(x)$:
$[e(c) \multimap t(c)] \multimap t(c)$

After combining with the remaining MCs ((45)–(46) and the EC in (37)), this leads to the following semantic representation of "John and perhaps Fred met":

(52) $\exists e.\,meet(e) \wedge \exists x.\,john \sqsubseteq x \wedge$
$\Diamond(fred \sqsubseteq x) \wedge ag(e) = x$: $t(m)$

3.2.2 Sentential and subsentential readings

The two representations in (44) and (52) are underspecified wrt. the 'sentential' vs 'subsentential' readings. In the case of "John saw perhaps Fred", (44) says that perhaps the theme of the seeing event is Fred; it is in principle compatible with the lack of any theme. However, the event structure of "see" implies that there must be a theme – hence the obligatory 'subsentential reading' (with existential entailment). In the case of dependents which are not implied by the event structure, either reading is possible (recall (11)–(12)).

Similarly, the representation of "John and perhaps Fred met" in (52) is in principle underspecified as to whether only John met, or whether the agent set also contains another person (perhaps Fred). However, the predicate "meet" requires its agent to express a plurality, so the 'sentential' reading, lacking existential entailment, is unavailable here. But note that a fully analogous representation would be obtained for "John and perhaps Fred arrived", in which case the 'sentential' reading (on which perhaps John exhausts the agent set) is available again.

These considerations demonstrate that, contrary to the claim of BAW, the availability of 'sentential' and 'subsentential' readings does not depend on the syntactic structure in which the epistemic adverbial occurs, so an analysis – like the one presented here – which does not require two different syntactic representations is to be preferred.

4 Advantages

The analysis proposed here is considerably simpler than that of BAW: it assumes the simplest possible syntactic structure and it only makes use of standard Glue Semantics mechanisms. In other words, nothing special needs to be said about ad-nominal uses of adverbials in the LFG + GS setting. Yet, the analysis avoids all aforementioned problems with the account of BAW. **First**, as the current analysis does not resort to conjunction reduction, collective predicates do not pose a problem. **Second**, as no additional underlying sentential structure is assumed, it is not the case that any sentential material may be inserted, so nothing needs to be said about (8)–(9). (On the other hand, apparent sentence fragments as in (3) may be analyzed as non-clausal approximators, cf. Kaltenböck 2008, 2010.) **Third**, the analysis accounts for ad-nominal uses of sentential (type tt or $\langle st, st\rangle$) adverbials, but does not say anything about other kinds of adverbials; in particular, it does not extend to event-modifying adverbials, which expect some event structure (unavailable in the case of ordinary NPs), so the unacceptability of (10) is not problematic. **Fourth**, as already discussed above, the analysis does not assume that 'sentential' readings are available only in coordinate structures, so examples such as (11)–(12) are accounted for. **Fifth**, as the analysis does not assume any additional sentential structure in coordinate structures, it does not preclude variable binding in (attested) (13)–(14). **Finally**, the analysis readily extends to those ad-nominal uses of epistemic adverbials where the nominal in question is a quantified expression (recall (15)–(17)). This was directly demonstrated in the case of running example (19), where conjunction combines with names raised to generalized quantifiers, and it readily extends to other ad-nominal uses of epistemic adverbials.

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