‘Grammatical’ vs. ‘Lexical’ Meaning Constructors for Glue Semantics

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Abstract. Current theories of formal semantics allow arguments of predicates to be of non-basic types, such as $e{\rightarrow}p$ (*e* for ‘entity’, *p* for ‘proposition’, with no commitment to any particular treatment of propositions). ‘Modal adjectives’ such as *alleged* are for example standardly analysed as being of type $(e{\rightarrow}p){\rightarrow}(e{\rightarrow}p)$. But such analyses allow certain kinds of modal adjectives that don’t seem to exist, such as a hypothetical *alleger,* such that *an alleger murderer* would be somebody who has made allegations that somebody (else) is a murderer. Here I make a proposal using LFG ‘glue semantics’ that permits it to avoid allowing this kind of adjectival meaning, by dividing the basic compositional units of meaning into an open class of ‘lexical meanings’, of strongly restricted form, and a finite class fixed by UG of ‘grammatical meanings’, which don’t obey these restrictions.

Keywords: Lexical-Functional Grammar, Glue Semantics, Semantic Typology, Adjectives

It is a standard idea in current formal semantics that the type of ordinary ‘intersective’ adjectives such as *Swedish* is $e{\rightarrow}p$, i.e. a ‘property’, in both attributive and predicative uses (something which, when presented with an entity, produces a proposition, with attributive uses produced by a type-shifting operation).[1] But other kinds of adjectives, such as especially the ‘modal’ adjec-

[1] I here use $\rightarrow$ rather than than angle-brackets to construct implicational types, and use *p* to designate ‘propositions’, without taking any position on whether they are a semantically

tives, such as *alleged* and *self-proclaimed*, are generally taken to be of the type $(e{\rightarrow}p){\rightarrow}(e{\rightarrow}p)$, originally proposed for attributive adjectives by Montague, and usually written as $(e{\rightarrow}p){\rightarrow}e{\rightarrow}p$, following the convention of omitting rightmost parentheses. These apply to a property to produce a property.

However, this semantic type can be regarded as undesirable, since it allows a kind of non-occurring modal adjective that can be exemplified by the hypothetical, but impossible, adjective **alleger*, used as follows:

(1) * He is an alleger murderer
(meaning: he is someone who has alleged that somebody is a murderer)

The problem here can be stated by saying that if an NP of the form 'A N' is predicated of some entity *x*, then the content of that predication always seems to involve a proposition of the form 'N(*x*)' rather than, as happens in (1), 'N(*y*)' for *y* other than *x*.

I will here show that this kind of adjectival meaning can be blocked in LFG's 'glue semantics' by means of the following ideas:

(2) There are two kinds of meaning-constructors (buildings blocks out of which sentence-meanings can be assembled):

a. Lexical constructors, which constitute an open-ended supply, taking only arguments of basic types (in particular, no property arguments of type $X{\rightarrow}p$).

b. Grammatical constructors, which can take arguments of higher types, but which are chosen from a limited inventory, fixed by UG.

This is a rather strong, possibly over-strong, hypothesis, which will have to deal with quite a range of evident problems in order to survive. But I will argue here that it's worth working on.

basic type, as in for example Pollard (2008), or functions from sets of indexes to truth-values. I'm also ignoring the problems posed by individual concepts such as *the temperature* in *the temperature is ninety and rising*. *e* might in fact have to represent individual concepts rather than 'entities' as commonly understood. The more general point is that the 'basic types' here are types that are basic for describing semantic composition, not necessarily meaning *per se*.

1. Glue

All approaches to semantic interpretation that I am aware of respect what might be called the ‘by default, use once and once only’ principle,[2] to the effect that, *in the absence of special provisions* provided by specific lexical items and grammatical constructions (such as pronouns), each meaningful element must contribute to the assembled meaning once and only once. For example, one cannot construe a denial such as *I did not eat the last brownie* as a confession, either by failing to interpret the negative at all, or interpreting it twice.[3] A central technique for enforcing this respect is to do the semantics by scanning a tree, with one of the usual methods that visits each node once and only once. But in LFG, the structure most centrally involved in semantic interpretation, the f-structure, is not a tree, since it can contain multiattachments, and perhaps even cycles.

Glue semantics, developed in the 1990s at Xerox PARC,[4] deals with this and certain other problems by using (a small fragment of) linear logic to control semantic interpretation. Linear logic was developed by J.-Y. Girard in the 1980s, although many of its essential ideas were investigated earlier, for example by Carew Meredith in the 1950s, and, later, by Relevant Logicians such as Robert Meyer in the 1970s. The basic idea of linear logic is that each premise must be used once and only once in a linearly valid deduction. This becomes relevant to semantic assembly via the so-called Curry-Howard Isomorphism (CHI), which says, roughly, that any proof in a certain range of logical systems (all obeying the ‘intuitionistic’ resriction) determines a way of applying functions to arguments, including λ-abstraction to define new functions in terms of old ones.[5] From these ideas, we get a system wherein meaning-assembly obeys the once-

[2] Which I found first stated as such in Dougherty (1993), although Klein & Sag (1985) is very close, and various other principles with similar effects are discussed in Asudeh (2004:87-100).

[3] The techniques for controlled re-use and discard of meanings in glue are discussed extensively in Asudeh (2004). We will make use of one of them later.

[4] See Dalrymple (2001) and Asudeh (2004) for recent and thorough presentations.

[5] Girard et al. (1989) is still possibly the best place to get an idea of what the CHI really amounts to.

and-once-only constraint without relying on tree-scanning algorithms, or tricky modifications thereof to deal with things that aren't quite trees. Furthermore, the logical aspect of the system turns out to automatically handle a significant range of type-shifting phenomena, such as type lifting, function composition and the Geach rule, which often require special provisions in other kinds of systems.

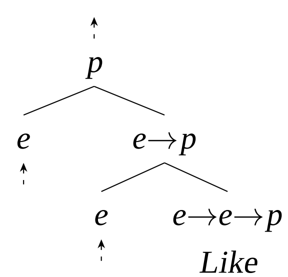
In this paper, I'll use a rather heavily modified presentation of glue semantics, discussed from a formal point of view in Andrews (2008a), and presented informally in Andrews (2009), wherein the 'glue proofs' that represent meaning-assembly are constructed from prebuilt pieces specified in the lexicon, which are then assembled to form a full specification of semantic composition, by connecting 'output' to 'input' nodes according to a version of the rules for hookup up proof-nets, as discussed below. The novel appearance of the presentation does not alter the fact that, mathematically, it's just proof-nets (of a very simple and well-understood kind).

The semantic type information for a two-place predicate such as *Like* can for example be represented like this ('give me an entity, and I'll give you something which, if you give it an entity, will produce a proposition'):

(3) *Like* : $e{\rightarrow}e{\rightarrow}p$

Andrews (2008a, 2009) shows how to restructure (3) as a 'prefab' piece of an assembled meaning, where arrows coming out of nodes represent 'outputs' (final resultant meanings) and ones coming in represent 'inputs' (arguments):[6]

(4)



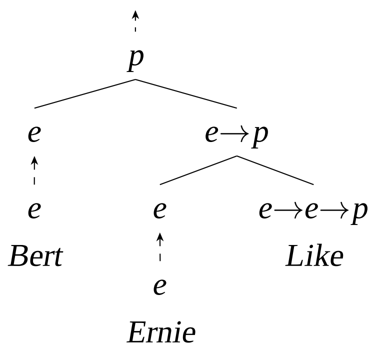
[6] The outbound arrows appear on atom-labelled nodes with 'negative polarity', the inbound ones on atom-labelled nodes with 'positive polarity' in the terminology of these papers. The tree-representation of meaning-constructors is highly redundant, for the sake of easier comprension.

Given suitable prefabs for proper names:

(5) b. c.

we can plug outputs into inputs of matching type to produce this (and of course one other possibility):

(6)



A preliminary version of the rules for a conceptually coherent assembly is:

(7) a. Compatibility: an input arrow can only be connected to an output arrow of the same semantic type.

b. Monogamy: an input arrow can be connected to only one output arrow and vice-versa.

c. Completeness: every input arrow must be connected to an output arrow.

d. Only one left over: every output arrow but one must be connected to an input arrow.

e. Correctness: from every element with a specified meaning, there must be a path to the sole unconnected output, oriented upwards along the dotted lines and in the directionality of the arrow in the dashed ones (those added to effect the assembly).

These are a version of the standard rules for connecting up a well-formed proof-net in linear logic, restricted to the case of nets representing only function applications. A revision for λ-abstraction is presented later, and the full system and relation to standard formulations are described in Andrews (2008a).[7] The system has significant resemblances to what is proposed for assembling conceptual structures in Jackendoff (2002), but the logical formulation suppresses various kinds of perverse combinations that might otherwise arise.

The theory is highly noncommittal about exactly what the meanings are, as long as they can be presented in a typed lambda-calculus, so that the underlying semantic theory could be model-theoretic, proof-theoretic, or purely representational.[8]

The standard technique for producing the constructors involves the c-structure rules and the lexicon, but here (mostly to reduce the amount of material that the reader has to look at at one time) I will use a method presented in Andrews (2007a, 2008b) that works directly off the f-structure. To see how it works, consider a sentence such as:

(8) Bert likes Ernie

The f-structure for this will be (ignoring tense, number, etc.; glue obviates the need for argument-lists in PRED-features, as discussed in Andrews (2008b)):

(9)
$$f:\begin{bmatrix} \text{SUBJ} & g:\begin{bmatrix}\text{PRED} & \text{`Bert'}\end{bmatrix} \\ \text{PRED} & \text{`Like'} \\ \text{OBJ} & h:\begin{bmatrix}\text{PRED} & \text{`Ernie}\end{bmatrix}\end{bmatrix}$$

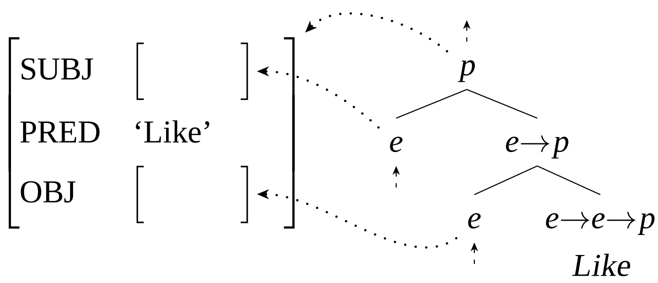
In this rather simple case, each feature-value will ‘trigger’ the introduction of a meaning-constructor via a ‘Semantic Lexicon Entry’ (SLE), which consists of

[7] The modification is to replace the standard proof-net links, other than the ones from a positive implication to its negative antecedent, with the ‘essential net’ links of Lamarche (1994), but with the directionality reversed as in de Groote (1999). The result is something that looks like an fairly ordinary linguistic structure, but has the mathematical properties of a proof-net.

[8] For example, Andrews (2006) investigates the possibilities for using Anna Wierzbicka’s Natural Semantic Metalanguage (NSM, discussed for example in Goddard (1998, 2008), Wierzbicka & Goddard 2002, and the NSM homepage at http://www.une.edu.au/bcss/linguistics/nsm/semantics-in-brief.php) to specify the meanings. One could regard NSM as a ‘purely representational’ semantic theory in that the explications it proposes deliver (some) intuitively definite entailments, regardless of whether or not there is any known formal account of what those entailments are.

two components, a description of a piece of f-structure, and a meaning-prefab, where the atomic formulas of the meaning-prefab are connected to parts of the f-description. Here is a sample SLE, where an Attribute-Value Matrix (AVM) is used for the description of f-structure:

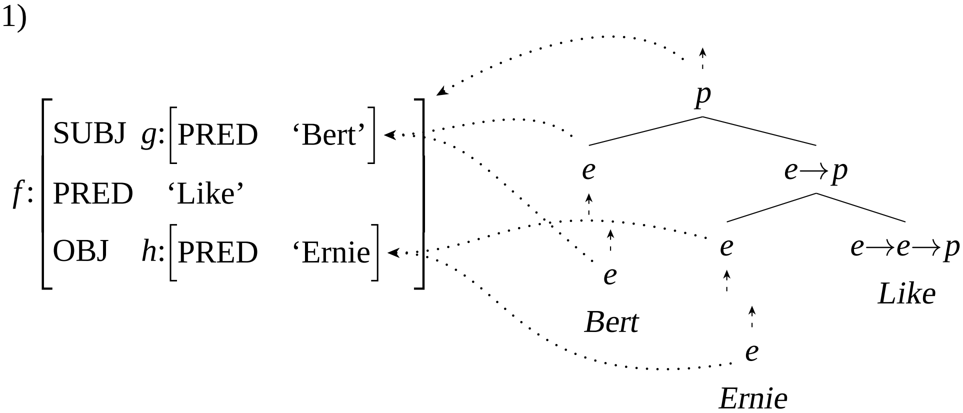
(10)



A significant feature of this account is the from-semantics-to-syntax directionality of the linking; this is implicit in the standard presentations due to the use of f-structure labels in the meaning-constructors, but somewhat obscured by the involvement of an additional 'semantic projection', argued against in Andrews (2008a).

When an SLE introduces a constructor on the basis of the presence of a feature, that feature is 'checked off', and not used for further feature introductions. Well-formedness then requires that all 'interpretable' features be checked off by SLEs (syntactic case would not be interpretable, while number would be; the notion is discussed further in Andrews (2007a, 2008b)). Adding the results of the obvious SLE's for the subject and object of (10), we get:

(11)



The next step is to assemble the constructors by plugging each small outbound arrow into an inbound one, subject to the purely semantic constraints plus two additional ones (which are not proof-net rules, but principles of LFG relating the glue proof/proof-net to the f-structure):

(7) f. Syntactic Matching: an output and input can only be matched if their f-structure correspondents are the same

g. Final Output: the unpaired output must be connected to the entire f-structure

The only way to assemble the constructors of (9) so as to satisfy all the constraints is now (6), the other semantically OK possibility being ruled out by the syntax.

It is surely the case that if all glue assemblies were as straightforward as this, then glue wouldn't be very hard to learn. But problems arise with various constructions that can be argued to involve arguments of non-basic types, such as, in particular $e \rightarrow p$, that is, 'properties': things that, when fed an entity, produce a proposition. These include attributive adjectives, and various other kinds of lexical items such as control predicates and intensional verbs. In this paper, I will only attempt to analyse the adjectives, but will mention some of these other cases at the end.

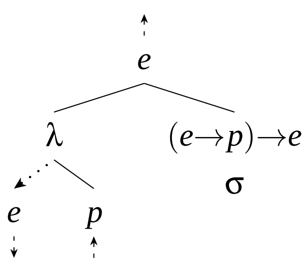
But first, we need to clarify exactly what an 'argument' is supposed to be. Any semantic type can be uniquely analysed as $X_1 \rightarrow \ldots \rightarrow X_n \rightarrow X$, where X is not a functional type (it might, however, be a tensor/pair) and rightmost parentheses are understood. The arguments are the X_i, while X is the 'final output' type. So for example the type $(e \rightarrow p) \rightarrow e \rightarrow p$ has two arguments, one of type $e \rightarrow p$, the other of type e, and a final output of type p.

2. Adjectives

In a classic Montague-grammar analysis of noun-phrases, common nouns are of type $e \rightarrow p$ (Kermit is, Frodo is not, a Muppet). Perhaps the simplest illustration of how such a type can function as an argument is provided by analyses of the definite article whereby this is something that applies to a property (type $e \rightarrow p$) and produces an entity (type e). The classic item of this type is the 'definite description' operator ι, although here we will follow Sharvy (1980), Link (1998) and Landman (2004) in using a 'σ' operator which applies to plural and mass nouns as well.

The type of this meaning is $(e \rightarrow p) \rightarrow e$ (one argument of type $e \rightarrow p$, final output of type e). To represent it in our format, we need an additional kind of substructure in the trees, whereby an argument of type $a \rightarrow b$ is represented by a node labelled λ, with a left 'pseudo daughter' labelled a, and a right daughter labelled b. The pseudo-daughter has an arrow coming out of it, and is connected to its mother by a dotted line, so that the constructor for the definite article looks like this:

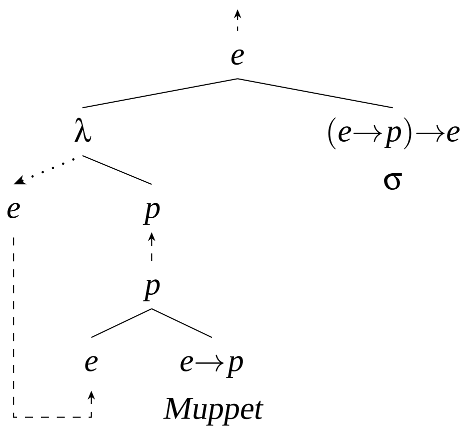
(12)



As discussed in Andrews (2008a), the λ-labelled nodes represent arguments of type $a \rightarrow b$ for some a, b, here e, p, respectively, but since the type can be easily read off from the daughters, and the function of these nodes is that of lambda-abstractions, this labelling makes for easier readability.

The arrow out of the pseudo-daughter, which is so-called because it gets different treatment from the well-formedness constraints (the proof-net Correctness Criterion) than a regular daughter, then plugs into some input of the property-argument, whose output then plugs into its right-sister node. Therefore, the assembled constructors for *the Muppet* would be:

(13)



The structure can be seen as a somewhat exploded syntax tree for a lambda-calculus expression (equivalently, a proof in Natural Deduction tree format), but one which obeys the 'linear restriction' that every λ must bind exactly one variable in the body of its lambda abstraction.[9] So read, (13) contains an unnecessary-looking application and abstraction, since σ could apply directly to *Muppet*, but this is a consequence of the way in which proof-nets are standardly formulated, with only atomic formulas connected by axiom links. Since η and β-equivalent formulas are regarded as being different representations of the same thing, this apparent awkwardness does not really matter.

So what about attributive adjectives? In the original Montague treatment, as discussed above, these were of type $(e \rightarrow p) \rightarrow e \rightarrow p$, which would apply to a meaning of type $e \rightarrow p$ to produce a new one of the same type, such as $Angry(Muppet)$. But this leads to a rather complicated relationship between attributive and predicate uses of adjectives, the latter being evidently of type $e \rightarrow p$. This relationship could be described by a lexical rule producing an attributive adjective of meaning $\lambda PX.Adj(x) \wedge P(x)$ from one of meaning *Adj*,[10] but there is a further problem, raised in the HPSG literature by Kasper (1995), and discussed in LFG+glue by Dalrymple (2001), which is that the original Montogovian type doesn't allow for an adequate treatment of adverbial modifiers in combinations such as *the apparently angry Muppet*, where there is no doubt in the judgement that Kermit is a

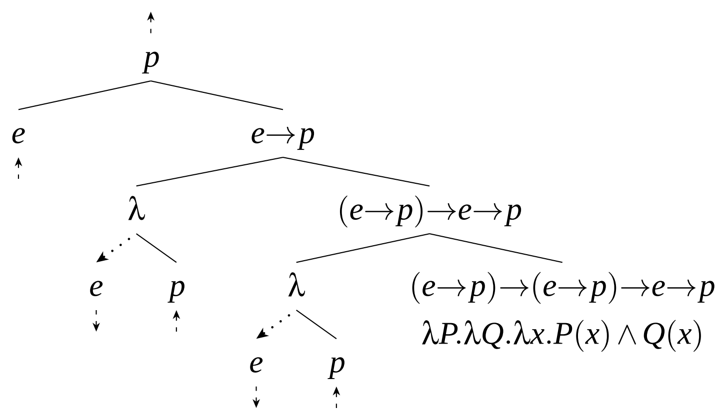
[9] de Groote & Retoré 1996 and Perrier (1999) present proof-net reading schemes for construing the assemblies as lambda terms that integrate and undergo β-reduction with the lexical meanings, in the same general manner as happens with Type-Logical Grammar (Morrill 2005).

[10] Corresponding to the ADJUNCT type-shift rule of Landman (2004).

Muppet, but whether his yelling represents genuine or feigned anger is not so clear.

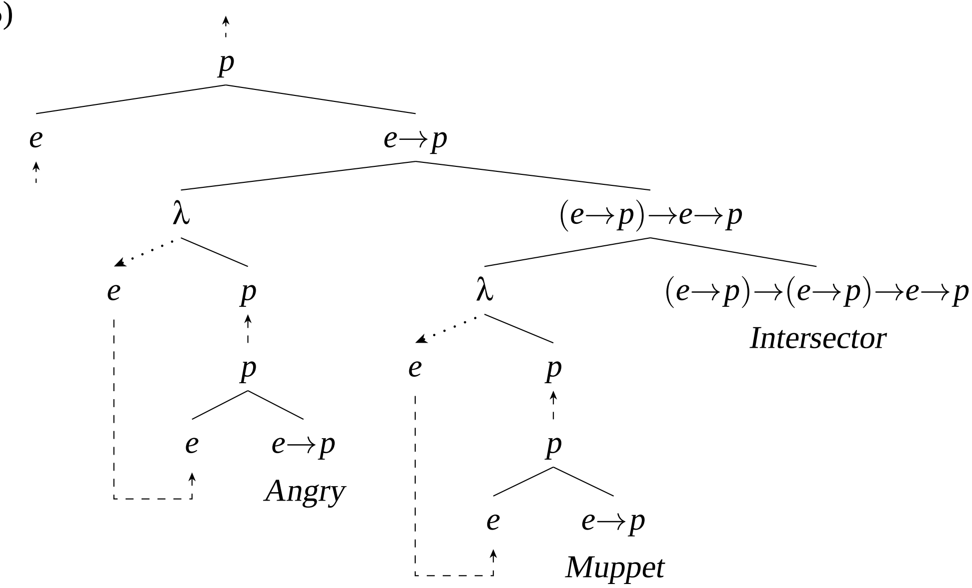
Dalrymple’s LFG glue version of Kasper’s solution is to associate the adjective with two meaning-constructors. One, which we can call the ‘lexical’ constructor, is of type $e \to p$, and expresses the basic meaning of the adjective, in a form which also works fine for predicate adjectives. The other is a grammatical constructor that we can call the ‘Intersector’, since its function is to combine the meanings of a noun and intersective adjective. It can be formulated like this:

(14)



Which is a bit intimidating, but its basic workings aren’t so different from those of the σ-constructor. It has two λ’s, one for the adjective, one for the noun, so that a sample complete assembly with both hooked in would be:

(15)



This is ready to be combined with the definiteness constructor, a quantifier (not discussed here), or another adjective (*a large angry Muppet*).

Note, however, that one could imagine a 'messy' variant of (15), in which the type *p* outputs of the two type *e*→*p* arguments were interchanged, without switching their type *e* inputs. This would in fact be an illegitimate assembly, ruled out by the following addition to clause (e) of Correctness (7), which is required once lambda-nodes are available:[11]

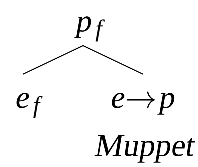
(7) e'. The path to the root from a left pseudo-daughter must pass through that pseudo-daughter's right sister (or, equivalently, mother).

(14) satisfies (15), but wouldn't if the type *p* but not the type *e* connections were interchanged (recall that the solid lines are oriented upwards, while the dashed lines go in the direction of their arrows; the dotted lines to the left of the pseudo-daughters don't count). With (e) expanded to include (e'), the (purely semantic)) Correctness rules are equivalent to the standard rules for implicational proof-nets.

[11] Lightly adapted from de Groote (1999), as discussed in Andrews (2008a).

We’ve so far proceeded without reference to the syntactic constraints on assembly, which, in the case of these adjectival constructions, don’t amount to very much. For common nouns, both the *e* input and *p* output can be linked to the f-structure of the associated f-structure, as here represented by co-labelling for easier typesetting:

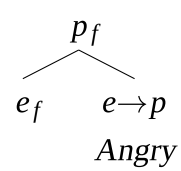
(16) $f{:}\begin{bmatrix}\text{PRED} & \text{‘Muppet}\end{bmatrix}$



A alternative worth considering, briefly discussed in Andrews (2008a), is to link the *e*-input to the CONCORD attribute that has been proposed in some recent LFG work to house nominal concord features.

For attributive (intersective) adjectives, the same form of constructor in fact seems workable:

(17) $f{:}\begin{bmatrix}\text{PRED} & \text{‘Angry’}\end{bmatrix}$



An f-structure that these would apply to would look like this:

(18)
$$f{:}\begin{bmatrix}\text{PRED} & \text{‘Muppet’} \\ \text{ADJUNCTS} & \left\{ g{:}\begin{bmatrix}\text{PRED} & \text{‘Angry’}\end{bmatrix} \right\}\end{bmatrix}$$

To fit this stuff together to get a result, the Intersector will have to connect to both the top level of the NP’s f-structure, and to the adjective’s ADJUNCT-value’s member. We can write the meaning-constructor portion of the SLE in a more compact form, without expanding it into the prefab tree format, using f-structure labels to represent the links:

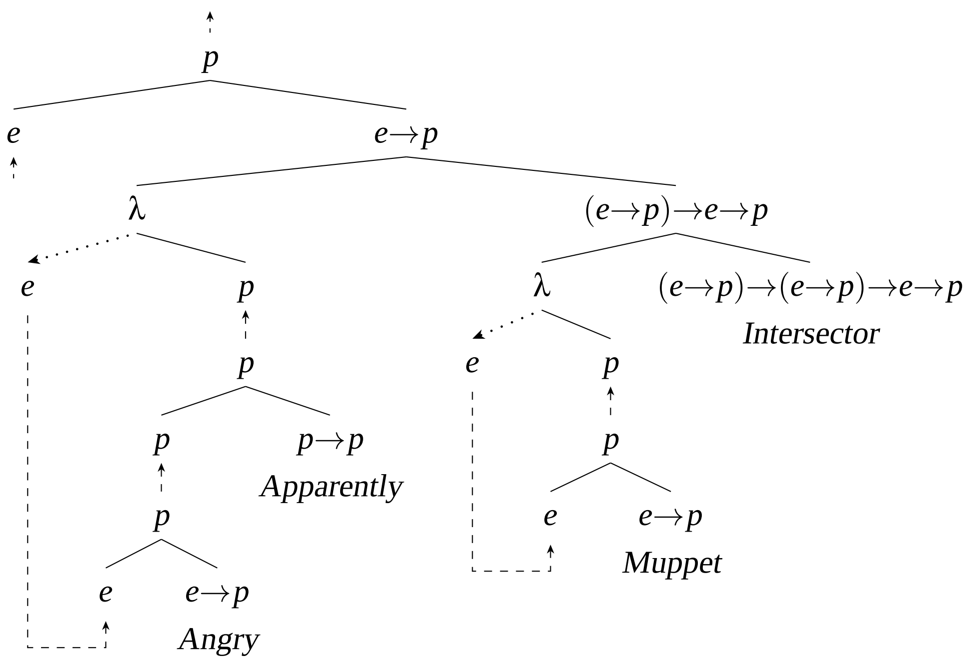
(19)
$$f{:}\begin{bmatrix}\text{ADJUNCTS} & \left\{ g{:}\begin{bmatrix} \quad \end{bmatrix} \right\}\end{bmatrix}$$
$$\lambda PQx.P(x) \wedge Q(x) \;:\; (e_f{\to}p_f){\to}(e_g{\to}p_g){\to}e_f{\to}p_f$$

All these pieces will then fit together in only one way, so as to produce (15).

Adapting Dalrymple's analysis to our account of how meaning-constructors are introduced, we can have a single adjectival PRED-feature trigger the introduction of both the Intersector and the adjective's lexical constructor. Another possibility is to have the Intersector introduced by the phrase-structure rules, or perhaps even by the ADJUNCTS configuration, using the membership relation as a resource.[12]

A benefit of employing the Intersector[13] is that we no longer have any problem in principle of splicing adverbs such as *apparently* into the structure. Such an adverb will be of type $p{\rightarrow}p$, and can fit in semantically like this:

(20)



[12] The idea would to to check off instances of the membership relation in the same manner as we have proposed to check off feature-values. Doing this with ordinary GF's would create problems with the LFG treatments of raising and control (Asudeh 2005), but it might be workable for f-structure set membership.

[13] Which can be achieved in other approaches to formal semantics by means of devices such as type-shift rules or additional principles of semantic composition such as the Predicate Modification of Kratzer & Heim (1998), as well as just using a version of the Intersector introduced into the syntactic tree.

The type-shifting approach standard in current ‘mainstream’ formal semantics (for example the ADJUNCT rule in Landman (2004)) can also implement this kind of analysis.

But how about the connection to syntax? A standard LFG analysis would be to treat the adverb as an adjunct to the adjective:

(21)
$$\begin{bmatrix} \text{PRED} & \text{‘Muppet’} \\ \text{ADJUNCTS} & \left\{ \begin{bmatrix} \text{PRED} & \text{‘Angry’} \\ \text{ADJUNCTS} & \left\{ \begin{bmatrix} \text{PRED} & \text{‘Apparently’} \end{bmatrix} \right\} \end{bmatrix} \right\} \end{bmatrix}$$

For ‘propositional’ adverbs applying to both sentences and adjectives in NPs, an SLE like this works out:

(22)
$$f{:}\begin{bmatrix} \text{ADJUNCTS} & \left\{ \begin{bmatrix} \text{PRED} & \text{‘Apparently’} \end{bmatrix} \right\} \end{bmatrix} \qquad \mathit{Obviously} : p_f \rightarrow p_f$$

Note that the adverb is characterized as taking a properly containing structure as the location both for its argument and its returned result; some more discussion of this form of constructor can be found in Andrews (2008b).

We have now managed intersective adjectives with a combination of a lexical meaning-constructor with no complex arguments, and a grammatical one, the Intersector, with two of them. There are however a number of other adjective types to deal with, of which the most clearly problematic are the modals.

The Intersector clearly produces completely wrong results for these, and they furthermore do not appear to be of type $e \rightarrow p$, as indicated by the fact that none of them work (except perhaps as somewhat ill-formed jocularities) as predicate adjectives:

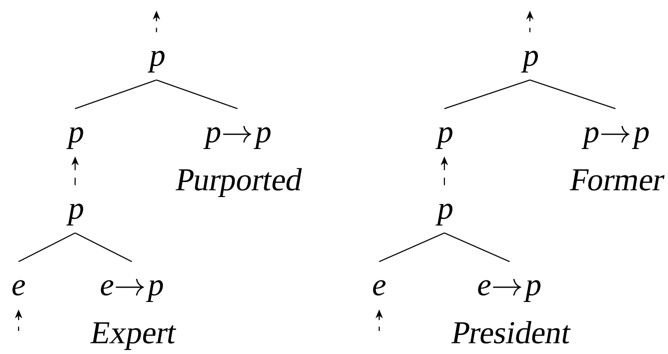
(23) a. *Bill is former

b. *Polly is purported

c. *Jack is self-proclaimed

We can give a workable account of many of them, such as *former*, *purported* and *alleged* (but not, quite, *self-proclaimed*), by supposing that their type is $p \rightarrow p$, with the same kind of connection to the f-structure as *apparently*. Sample assemblies will then be:

(24)



Former will have essentially the same meaning as the past-tense operator, while *Purported* will mean something like ‘people say that *P*’.

To get this semantics to articulate with the syntax, we need to provide an appropriate SLE, and indeed the form just proposed above for the propositional adverbs seems to work fine here as well:

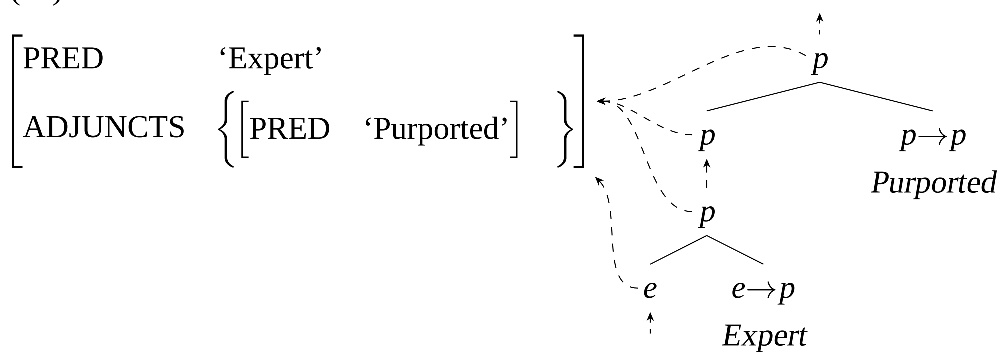
(25)

$$f{:}\left[\text{ADJUNCTS} \quad \left\{\left[\text{PRED} \quad \text{‘Purported’}\right]\right\}\right] \qquad \lambda P.\exists x(Say(P)(x)) : p_f \rightarrow p_f$$

It is perhaps worth saying a bit more how this treatment evades the need for an $(e \rightarrow p) \rightarrow e \rightarrow p$ adjective type, which is hard or impossible to avoid in most treatments of the syntax-semantics interface, due to their dependence on tree structure.

The reason is that by appropriate choice of syntactic locations to link the arguments and outputs of the meaning-assembly trees to, one can get the linear logic rules of glue to perform some of the effects of type-shifting. For example, given formulas $a \rightarrow b$ and $b \rightarrow c$, we derive $a \rightarrow c$ by transitivity of implication, which by the CHI corresponds to composition of functions. A full structure diagram with all the links would be:

(26)



The potential of this structure to participate in further assemblies is the same as that of a single common noun. A significant problem that this analysis faces is to account for the effects of order on scope, as discussed in Andrews (1983) and Andrews & Manning (1993). I won’t take this up here, but some relevant ideas are presented in Andrews (2007b).

Adverbs do not seem to easily modify these adjectives, but to the extent that they can, the formally possible meaning-assemblies seem to be appropriate. For example *an apparently former president* would be somebody whose bid for re-election appears to have gone badly (from the evidential point of view of the speaker). The type $p{\rightarrow}p$ for these adjectives doesn’t require any grammatical meaning-constructor, but there is another kind of intentional adjective that does, the type of *self-proclaimed*.

The problem is that a self-proclaimed expert is not just somebody that somebody or people say is an expert, but rather somebody who says that they themselves are an expert: in standard glue, a plausible representation for the meaning of *self-proclaimed* would be:

(27) $\lambda P.\lambda x.Proclaim(x,P(x))$

which calls for a semantic type of $(e{\rightarrow}p){\rightarrow}e{\rightarrow}p$,[14] violating our proscription against lexical meaning-constructors with arguments of non-basic type.

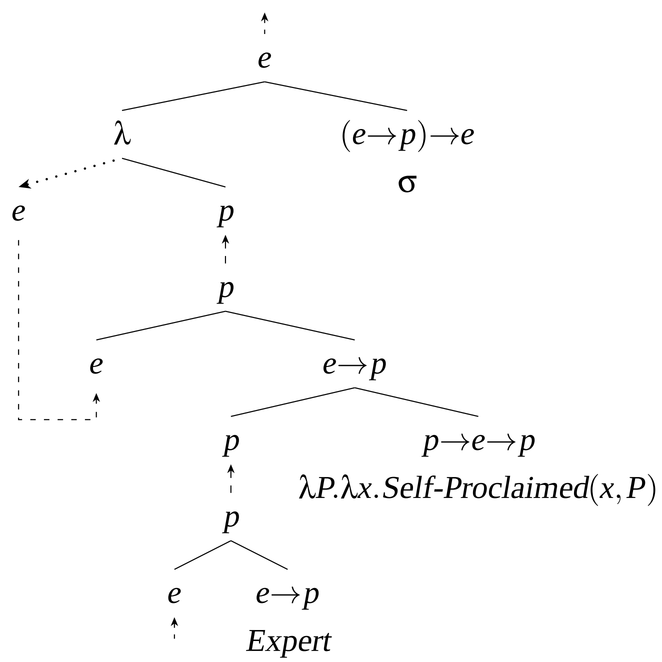
[14] Although the order of arguments is arbitrary from a logical point of view, we follow a general convention, motivated broadly by Marantz (1984), of putting the least active argument first in the type expression, meaning that it will be most deeply embedded in the corresponding formula (and standardly put last in an argument-list for an uncurried *n*-place predicate).

If we want to avoid violating the proscription, we'll have to use something like this, where the type of the adjective would be $p{\rightarrow}e{\rightarrow}p$

(28) $\lambda P.\lambda x.Proclaim(x,P)$

But if we try to use such a constructor in a sentence, we'll have a problem, in the form of some unconnected input, either that of the adjective, or of the noun that the adjective is to apply to:

(29)

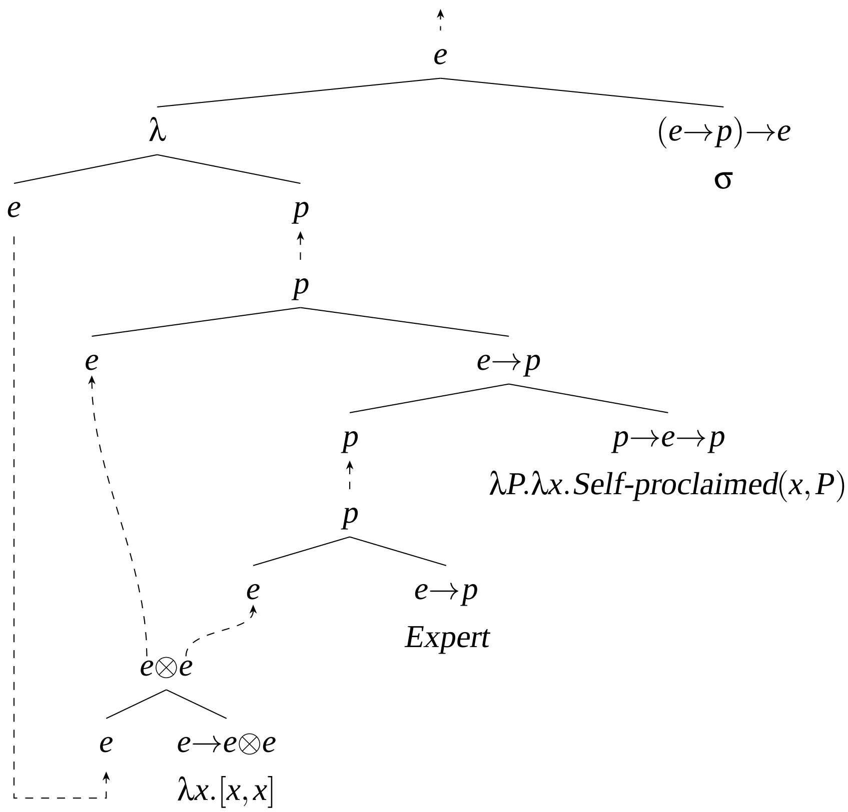


Here we've chosen to connect the determiner to the adjective and leave the noun's input hanging, but we could have done the opposite. The problem here is one of 'resource deficit', as discussed extensively in Asudeh (2004).

Our solution to this problem will be to use an additional grammatical meaning-constructor, whose semantic effects are the same as those of the constructor used to account for bound anaphora in Asudeh (2004), although its connections to f-structure are different. We'll call it the 'Nominal Reference Copier' (NRC). Its function is to make two copies of the *e*-input to a nominal, one for noun, the other for a *self-proclaimed*-type adjective.

This constructor, appearing at the lower left of (30), involves a ‘tensor output’, represented as $e{\otimes}e$, which has two components, each of which feeds into a different input of type *e*:

(30)

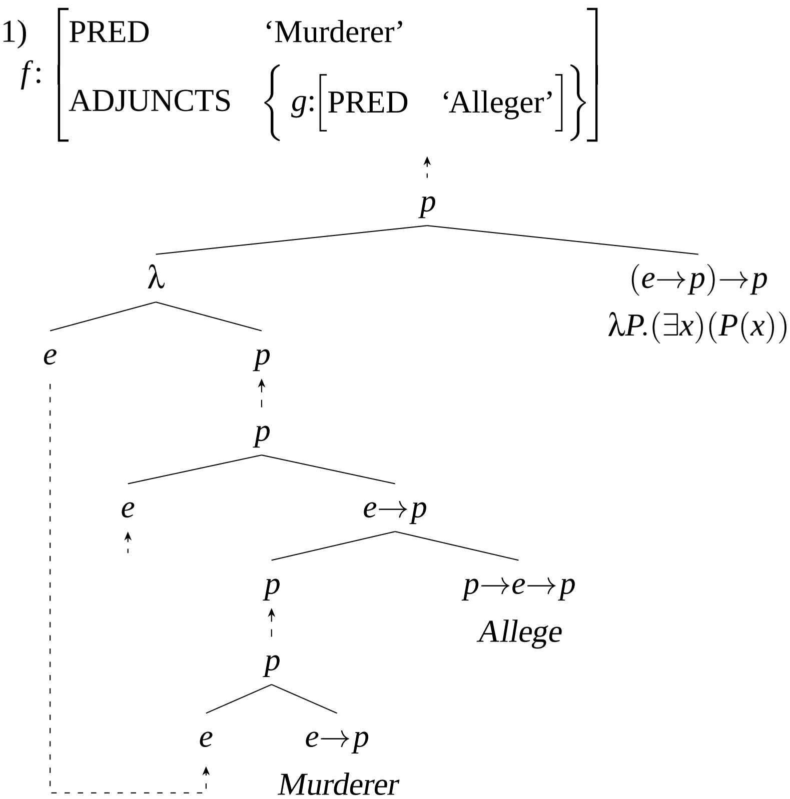


Tensor outputs are a further elaboration of the system, discussed extensively by Asudeh (2004), and, for the presentation of glue used here, by Andrews (2008a). The NRC will have to collect an input of type *e* from the containing f-structure, make two copies, and return one back to the location of the original, and pass the other to the adjunct.

Note that the semantics itself (the lambda-term in the right-daughter of the NRC) violates linearity by copying the variable. This is an important feature of the glue system: only assembly is required to be linear, while the meanings introduced by the constructors are allowed to copy (and delete) information (but only the information they’ve been given access to by the linearly constrained assembly). Asudeh (2004) provide extensive discussion of this aspect of glue.

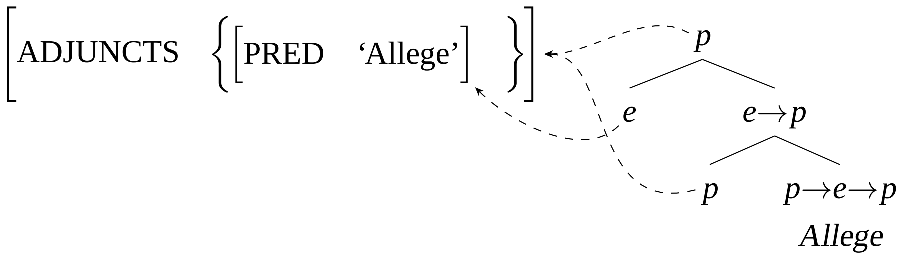
And we are now finally in a position to produce our explanation of the nonexistence of **alleger* as discussed above. If we don’t allow arguments of type $e{\rightarrow}p$, then we'll need a new grammatical meaning-constructor. To understand what it has to do and what kinds of provisions would rule it out, we look first at the f-structure and meaning-assembly that would be required:

(31)



In addition to the noun and the adjective, we have an 'existential binder', a putative grammatical meaning-constructor that existentially satisfies the (instance) argument of the noun (interpreted as Agent of the verb on which the noun is based), while the (Agent) argument is left unfilled, so as to ultimately somehow be satisfied by some grammatical constructor such as a determiner that can take a type $e{\rightarrow}p$ argument.

As one of the reviewers pointed out, existential binding of an argument is a fairly plausible sort of thing for a constructor to do (although not necessarily in this particular structural context), so the problem is very likely not with the existential binder itself, but elsewhere. And an issue becomes apparent if we examine the required constructor for *Alleger* in light of the proposals of Andrews (2008b). According to the proposals made there (whose purpose is to explain why PRED-features appear to exist, even though they are not technically necessary once glue is added to LFG), the type *e* argument would have to be linked to the ADJUNCT-member in which the PRED-feature occurs, like this:

(32)


For this argument to be filled, something has to make type *e* content available to the adjunct f-structure, but there is no reason to suppose that there is any meaning-constructor that does this, so we can assume that there isn’t. Determiners will for example provide type *e* content to the upper f-structure, not to the lower one, and without some additional constructor, a well-formed assembly will not be possible.

This is admittedly a somewhat unprincipled solution to the problem: we’re simply claiming that there are a limited number of grammatical meaning-constructors, and constraints on the lexical ones, which don’t allow the problem presented by (32) to be fixed, while the NRC exists to allow the similar problem that arises without *alleged*. However, I take the position here that the first step is to get some kind of proposal that rules out apparently impossible behavior; a better degree of theoretical integration can wait until more relevant information is available. The idea of a limited number of grammatical meaning-constructors becomes more implausible if there appear to be too many of them; but then the nature of the ones that appear to exist versus the *priori* possible ones that don’t might shed some light on what the more general principles really are. Meanwhile, there is something to be said for pursuing the easiest idea that produces some sort sort of concrete result.

3. Possible Problems

This account of the nonexistence of **alleger* depends on the idea that meaning-constructors capable of taking arguments of type $e{\to}p$ are a finite list specified by UG. There are a great many possible problems with this idea; I'll go through only a few of them here.

3.1. How much is Universal?

One issue is exactly how much is supposed to be universal. A strong form of universality would say that the entire constructor is, syntactic and semantic parts together. This would entail that the intersective constructor proposed by Nordlinger & Sadler (2008) to combine the meanings of descriptive and generic nominals in NPs in certain Australian languages would have to be a different one from the one used here, due to the different f-structures. A weaker form would say that only the semantic operations are universal, with at least some degree of latitude as to the range of syntactic structures the constructor can apply to in different languages. I will leave this issue open here.

3.2. Intensional Verbs

Another is 'intensional verbs', such as *seek*, *find*, etc. These were originally analysed by Montague (1970, 1974) as taking object arguments of what would in our system be type $(e{\rightarrow}p){\rightarrow}p$, which has also been the traditional analysis in LFG+glue, as discussed by Andrews (2008a). This rather obviously violates our proposed condition, as does the 'property analysis' proposed by Zimmermann (1993). Both of these are discussed in various recent works by Moltmann (2008a, 2008b, 2009), who proposes in recent work a different 'Nominalization' analysis which so far I can't reduce to glue meaning-constructors. McNally (in press) provides further coverage of relevant issues.

3.3. Subjectless VP Constructions

Another potential problem is VP constructions where a verb appears with no subject, including 'control predicates' such as *try* and *promise*, and various other constructions such as *criticizing rich people is fun*. These were often treated as constituting arguments of type $e{\rightarrow}p$ in early Montague Grammar, and such an analysis is proposed for control predicates in LFG+glue by (Asudeh 2005). However an alternative 'propositional analysis' can also be constructed, as discussed in Beryozkin & Francez (2004) and Dalrymple (2001). Many relevant issues are considered in Chierchia (1984), who argues that subjectless gerunds such as in *criticizing rich people is fun* must be formed with a 'nominalization; operator whose type would be $(e{\rightarrow}p){\rightarrow}e$. This would be an excellent candidate for a grammatical meaning-constructor in the system proposed here.

Predicate modifiers such as 'I consider John *intelligent*' would also constitute a problem in some syntactic frameworks, but not LFG due to the fact that functional control with a non-thematic argument allows the adjectival argument to be analysed as a proposition with no issues.

3.4. Weak Quantifiers

Another possible problem is weak quantifiers such as *many*, *forty two*, *heaps of*, etc., which are arguably of type $(e{\rightarrow}p){\rightarrow}e{\rightarrow}p$, but are too numerous to plausibly each be associated with a universal meaning-constructor. This problem can be solved by following Landman (2004) and much other work, in analysing the weak quantifier words as predicates of non-atomic lattice-elements (collections with more than one element, and quantities of stuff). These will be of type $e{\rightarrow}p$ (where e will not be a possible referent of a count singular noun, but only of a mass or plural one). Existential force can then be supplied as required by an appropriate grammatical meaning-constructor (to sort out exactly which one, we need to work out numerous issues involving DRT, choice-functional analyses of indefinites, etc.).

Strong quantifiers also constitute a potential problem, but there appear to be many fewer meanings associated with them, so that they could be plausibly treated as being based on a limited range of universal constructors.

3.5. Further Adjective Types

The last problem we'll consider, and the only one we give more than cursory attention to, is the existence of many further subclasses of adjectives, beyond the 'modal' and 'intersective' ones. The reason is that these constitute trouble right next door to the material of our argument, so that the issues they raise can impinge rather directly on our analysis. One problem in this area is that the terminology of adjective subclasses over the decades as been applied quite variably, in part due to differing analysis of what the adjective types actually are.[15]

The term ‘intersective’, for example, has been consistently applied to adjectives such as *Swedish*, for which the following inference rules clearly work, here formulated in the style of tree-format Natural Deduction, with rules of ‘modifier elimination’ and ‘modifier introduction’:

(33) Elimination:

$$\frac{\text{X is an Adj N}}{\text{X is Adj}}\ \text{Mod-elim}_A \qquad \frac{\text{X is an Adj N}}{\text{X is an N}}\ \text{Mod-elim}_N$$

(34) Introduction:

$$\frac{\text{X is Adj} \qquad \text{X is an N}}{\text{X is an Adj N}}\ \text{Mod-intr}$$

A simple deduction illustrating the behaviour of a completely noncontroversially intersective adjective is:

(35)
$$\frac{\dfrac{\text{Jens is a Swedish surgeon}}{\text{Jens is a surgeon}}\ \text{Mod-elim}_N \qquad \text{Jens is a violinist}}{\text{Jens is an Swedish violinist}}\ \text{Mod-intr}$$

Adjectives for which the elimination rules fail include the modals, plus another inconsistently distinguished group sometimes called ‘privatives’, which are adjectives such as *fake*, which seem to obey a sort of negative version of the elimination rule: *this is a fake gun* implies *this is not a gun*. These have recently been discussed in various papers by Partee, such as Partee (in press).

Privatives appear superficially to class with the modals, but there is a generally known problem in that they appear to have many grammatical properties in common with intersectives rather than modals:

[15] Coppock (2008) provides a recent classification.

(36) a. This gun is fake

b. *This gun is purported

On similarly syntactic grounds (in which their differential behavior with respect to NP-splitting in Slavic languages figures prominently), Partee (in press) argues strongly that the privatives are actually intersectives that, by virtue of conversational principles, have the effect of widening the denotations of their associated nominals to include things that only resemble, or, to a limited extent, play the role of the nominal, without actually being an instance of the nominal in the strict sense.

Intriguingly, such a division between modal and privative adjectives seems supported by the behavior of adjectives in Bahasa Indonesia. This language appears to lack genuine modal adjectives. For example, the concept of *former* as in *former dictator* is expressed by what appears to be an ordinary postnominal possessive construction using a head noun that means ‘trace’ or ‘left-over’:[16]

(37) a. *Ia bekas diktator*
He trace dictator
‘He is a former dictator’

b. *Ini bekas koran*
this trace newspaper
‘this is something that used to be a newspaper’

Bekas can occur as an attributive adjective, but with a different meaning:

(38) *Ini koran bekas*
this newspaper non-current
‘This is non-current newspaper (that people threw away, no longer needed)’

[16] The following data is from Quinn (2001) and Wayan Arka (p.c.).

Various other English modal adjectives are rendered by circumlocutions:

(39) a. *orang yang men-yata-kan diri ber-wenang*
person REL AV-say-APPL self to be-authority
'self-proclaimed authority'

b. *pem-bunuh yang telah meng-aku*
AGT.NML-kill REL PERF AV-confess
'confessed murderer; killer who has confessed'

c. *orang yang di-duga mem-bunuh*
person REL PASS-allege AV.kill
'alleged killer; person who has been alleged to have killed'

Balinese appears to be similar (Wayan Arka, p.c.), and Australian Indigenous languages also appear to lack modal adjectives, except for possible issues with meanings related to *former*, which seem to arise with Russian and Polish as well.[17]

But Indonesian has a privative adjective *palsu*, which shows normal adjectival behavior, appearing with or without the relativizer *yang*:

(40) *Cinta-nya cinta (yang) palsu*
love-3sg love RE: false
'His/her love is false love (Quinn 2001 entry for *palsu*)'

This adjective looks as if it was borrowed from English, and it would be interesting to see if privative adjectives are actually native in the languages of the region, but even if they aren't, it may well be significant that a privative adjective appears to have been borrowed and assimilated into standard adjectival syntax, while this has not happened with the modals.

[17] Possibly because the same kind of widening that lets a fake gun be a gun might also allow a 'former camp' (*lyatenye apmere*, 'past-time camp' in Arrernte) be a camp. There seems to be a general but violable principle to the effect that 'once an X, always an X', e.g. former US Presidents can still be addressed as 'Mr. President'.

On the other hand, adjectives for which the elimination rules work, but the introduction rules fail, have often been called ‘subsectives’; a standard example is *skillful*, which exhibits the following behavior, where the attempt to apply the introduction rule produces an invalid result:

(41) a. Jens is a skillful surgeon

b. ∴ Jens is a surgeon

c. ∴ Jens is skillful

d. Jens is a violinist

e. #Jens is a skillful violist

Model-theoretically, the extension of *skillful surgeon* does not appear to be the intersection of the extensions of *skillful* and *surgeon*, in spite of the fact that rule (33) appears to work.

But the ‘subsectives’ appear to fall into many subclasses with quite a lot of different behavior. A useful classification is provided by Coppock (2008), drawing extensively on earlier work by Bolinger (1967), Siegel (1980) and Beesley (1982). Beesley provided arguments, summarized by Coppock, that ‘degree adjectives’ such as *tall* and ‘evaluative’ adjectives such as *good* in examples such as (42) are actually intersective, in spite of superficially appearing to fail to work with the Introduction rule, producing the pattern in (41).

(42) a. Mark is a tall man

b. Mike is a skillful surgeon

Siegel worked out that the difference between them is that they take parameters that are often supplied by the context, a scale for the degree adjectives and a criterion of evaluation for the evaluatives. These parameters are expressed differently:

(43) a. Merry is tall for/*as a hobbit

b. Jens is skillful as/*for a surgeon

c. Fred is a skillful mathematician for a linguist

If we specify the appropriate parameter explicitly, both kinds of adjectives behave intersectively:[18]

(44) a. Jens is a surgeon (who is) skillful as a violinist

b. ∴ Jens is a surgeon

c. ∴ Jens is skillful as a violinist

d. Jens is a violinist

e. ∴ Jens is a skillful violist

So I suggest that the nature of the problem we face with subsectives depends on what these parameters really are, when expressed overtly. If they are arguments of type $e \rightarrow p$, then the hypothesis of (2) is wrong, and must be either abandoned outright or limited.

Limitation would of course be undesirable, but not catastrophic, if we can limit type $e \rightarrow p$ arguments to a restricted range of functions. But if that latter is possible, it might also be possible to treat them as adjuncts of some kind, for example *as* might be associated with a grammatical constructor of type $(e \rightarrow p) \rightarrow (e \rightarrow p) \rightarrow e \rightarrow p$, whose function is to use the first argument to delimit the range of activity for which the second is held to be competent. Note for example, that we can use an adverb such as *generally* to say that somebody shows skillfulness across a wide range of activities:

(45) John is generally skillful, but not so good with computer hardware

[18] Note that the deduction would fail in the manner of (41) if the *as*-phrase in (a) were omitted (and, of course, it's redundant).

There is also the possibility that the arguments, if they are arguments, are of some type other than $e \rightarrow p$, such as ‘kinds’, ‘activities’, etc. (requiring various conversion operations, which could be performed by grammatical constructors).

These types, along with the privatives, can be construed as essentially intersective, and therefore treated with our current constructors, although there might be additional arguments that would be problematic for our proposals about grammatical vs lexical meaning-constructors. Coppock lists a number of other types of adjectives that don’t seem to have a good prospect of being treated intersectively; it remains to be seen how the present proposal will fare with them. Larson (1998), McNally & Boleda (2004) and McNally (2006) present further relevant discussion.

4. Conclusion

The idea of a fixed set of universal grammatical meaning-constructors is consistent with an interesting range of data, but we can’t be sure that it will prevail over all challenges. Nevertheless, I think it’s worth taking seriously, in part because it would allow semantic typology to be cast in a relatively simple form, in terms of what grammatical meaning-constructors are used by various lexical items, and what lexical meaning constructors are also allowed, the latter being chosen from a simpler inventory than would otherwise be plausible.

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