AFFECTED EXPERIENCERS AND MIXED SEMANTICS IN LFG/GLUE

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Abstract

Bosse, Bruening and Yamada (2012) (BBY) provides a study of several constructions involving 'non-selected' arguments, and outlines an approach to the syntax and semantics of one such construction: the Affected Experiencer (AE) construction. The syntactic analysis relies on abstract functional projections and particular assumptions about configurational syntax. We show how an account may be given without these syntactic assumptions. Semantically, BBY argue that AEs may contribute both at-issue content and conventional implicatures, which raises interesting issues for the approach of e.g. Potts (2005). We explore some consequences of their semantic analysis and show that it faces a number of difficulties.

1 Introduction

In a number of recent papers Bosse and others have presented analyses of a variety of constructions involving 'non-selected' arguments (i.e. complements that do not intuitively fill lexical argument slots), including affected experiencer (AE) constructions, external possessor constructions, and benefactives, arguing for the existence of a number of subtypes (see e.g. Bosse et al., 2012; Bosse and Bruening, 2011; Bosse, 2011), and providing relatively detailed syntactic and semantic analyses. In particular, Bosse et al. (2012) presents an appealing analysis of an affected experiencer (AE) dative construction in German, exemplified in (1), below. Semantically, the approach is based on that of Potts (2005), though it purports to raise some fundamental problems for Potts. Syntactically, the approach relies on abstract/functional projections, and particular assumptions about configurational syntax.

In the first part of this paper, we explore whether the insights of Bosse et al.'s analysis can be expressed, without these syntactic assumptions, in an LFG/glue-based implementation of Potts' ideas – specifically the approach presented in Arnold and Sadler (2010), Arnold and Sadler (2011). We will see that the answer here is positive. However, it turns out that when the analysis is explored in more detail, the initial appeal of the approach evaporates. The second part of the paper demonstrates this, and shows that some of the theoretical points that Bosse et al. seek to make about Potts's approach do not bear close scrutiny.

In more detail, the paper is structured as follows. Section 2 presents Bosse et al.'s account of the AE construction in German, with some observations about other languages, including Hebrew and Japanese. We will pay particular attention to the syntax that Bosse et al. propose, which is highly configurational, and involves a rich array of functional categories, and the semantics, which Bosse et al. believe motivates some interesting modifications of Potts' ideas.

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Section 3 presents an implementation of Bosse et al.'s descriptive insights in the framework of LFG, specifically a variant of the 'Pottsian LFG' approach presented in Arnold and Sadler (2010), Arnold and Sadler (2011). This framework is briefly summarized in Section 3.1; the actual analysis is presented in 3.2. We will see that while Bosse et al.'s insights can be adequately captured in this framework, close examination shows there is reason to think that the modifications to Potts' framework that they propose are problematic.

2 AE Constructions: Bosse *et al*'s Analysis

2.1 Basic Properties

A basic example of the AE construction in German can be seen in (1). Like its English equivalent, *zerbrechen* ('break') can occur with a subject (denoting the agent), and a direct object (denoting the patient), as in (2). In (1) it occurs with an additional complement, *Chris*, which denotes an entity which is some way affected by the breaking event. This is normally glossed with the preposition *on*, presumably because it has some similarity with the usage of *on* in examples like *My laptop has just died on me*, *They have closed the local shop on us*. Though it is not obvious from (1), because a proper noun like *Chris* does not show case marking, this extra complement is in fact dative, as can be seen when a pronoun is used, as in (3).[1]

(1) Alex zerbrach Chris Bens Vase.
Alex broke Chris.DAT Ben's vase
Alex broke Ben's vase 'on Chris'. (i.e. and this affected Chris)

(2) Alex zerbrach Bens Vase.
Alex broke Ben's vase
Alex broke Ben's vase.

(3) Alex zerbrach mir Bens Vase.
Alex broke me.DAT Ben's vase
Alex broke Ben's vase 'on me'.

The AE dative complement must be both a potential experiencer (thus, e.g. sentient) and actually affected. For example, Bosse et al. point out that (4) is unacceptable if Paul was

[1]Superficially, AE constructions are often similar to, and can be confused with, instances of the external possessor construction. An example like the following is ambiguous – *mir* can be interpreted as an AE, giving the meaning 'She cleaned the suit on me' (i.e. she cleaned it, and the cleaning affected me), but it can also be interpreted as an 'external possessor' (EP), in which case the interpretation will be just 'She cleaned my suit'.

Sie säuberte mir den Anzug.
she clearned me.DAT the suit
She cleaned the suit 'on me'. AE
She cleaned my suit. EP

In this paper, examples are always intended to be instances of the AE construction.

already dead when his mother died,

(4) *Dann starb ihm auch seine Mütter. (Context: Paul died first)
Then died *him.*DAT also his mother
Then his mother died 'on him', too.

Bosse et al. suggest that in some languages (e.g. French, Hebrew), what we will call the 'AE content' (i.e. with respect to (1), the assertion that the vase breaking affected Chris) is not part of the 'at issue' content at all, contributing only to what Potts calls 'conventionally implicated' (*ci*) content (Potts, 2005). For example, it cannot be questioned or negated, and is generally rather strictly separated from the normal *at-issue* content. However, they suggest that in other languages (including Japanese, Albanian and German) AE datives contribute **both** *at-issue* content and *ci*-content. For example in (5), the assertion that the vase-breaking matters to Chris appears to be *ci* content, since it can escape the negation – (5) conveys the idea that though the breaking did not occur, it would have mattered to Chris.

(5) Alex zerbrach Chris Bens Vase nicht.
Alex broke Chris.DAT Ben's vase not
Alex didn't break Ben's vase 'on Chris'. (But it would matter to Chris.)

Similarly, consideration of (6) suggests that the AE content is not part of the question: notice in particular, that it would be wrong to answer 'Nein' ('No') to (6) if Alex did break Ben's vase, but Chris does not care. This information cannot be conveyed in response to (6) with any simple answer – it requires a fuller explanation.

(6) Zerbrach Alex Chris Bens Vase?
broke Alex Chris.DAT Ben's vase
Did Alex break Ben's vase 'on Chris'?

But in other ways the AE seems to contribute *at-issue* content, as witness the way the AE itself can be questioned as in (7) (which is not generally possible with *ci* content), can contribute to the truth conditions of a conditional as in (8), and can bind an argument in the at-issue domain, as in (9).[2]

(7) Wem hat Alex Bens Vase zerbrochen?
who.DAT has Alex Ben's vase broken
On whom did Alex break Ben's vase?

(8) Wenn Lisa ihrem Mann den Anzug lobt, dann bekommt Jan €100 von ihm.
if Lisa her.DAT husband the suit praises, then get Jan €100 from him
If Lisa praises the suit 'on her husband', then Jan will get €100 from him.

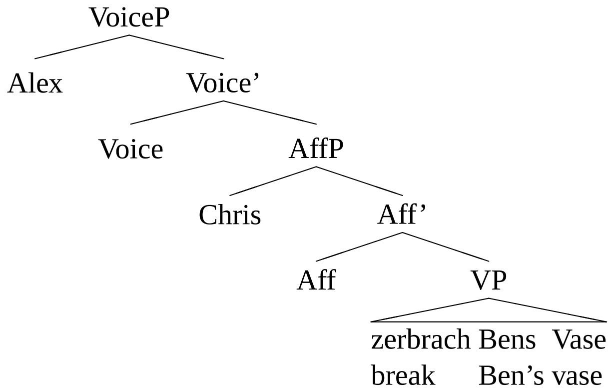
[2]Bosse et al. claim that the truth conditions of (8) are such that Jan will only get the €100 if Lisa praises the suit *and* her husband is affected by the praising. The praising alone is insufficient.

(9) Ich habe jedem Jungen$_i$ seine$_i$ Vase zerbrochen.
I have every.DAT boy his vase broken
I broke his vase 'on every boy.'

2.2 Bosse *et al*'s Analysis

Bosse et al.'s account of these data involves a number of functional projections, as in (10), notably VoiceP and AffP ('Aff' for *affected*).

(10)



The semantics of Aff' and Voice' are derived by applying the semantics of Aff and Voice to the semantics of their sisters, the semantics of AffP and VoiceP are derived by applying the semantics of Aff' and Voice' to their NP sisters. That is, schematically:

(11) a. $[\![VoiceP]\!]^{Mg} = [\ [\![Voice]\!]^{Mg}(\ [\![AffP]\!]^{Mg})\ ](\ [\![Alex]\!]^{Mg})$
b. $[\![AffP]\!]^{Mg} = [\ [\![Aff]\!]^{Mg}(\ [\![VP]\!]^{Mg})\ ](\ [\![Chris]\!]^{Mg})$

This is most easily appreciated by way of an example, making the (false) assumption that AE content is contributed to the *at-issue* dimension of meaning (we will correct this directly below). Suppose the interpretation of the lowest VP *zerbrach Bens Vase* is as in (12) (intuitively, it denotes the set of breaking events that involve Ben's vase as Theme – the set of events where Ben's vase gets broken).

(12) $[\![VP]\!]^{Mg} = \lambda e.break(e)\&Thm(Ben's\ vase)(e)$

The interpretation of AffP is derived from this as in (13) (ignoring for the moment the distinction between *ci* and *at-issue* dimensions of meaning).

(13) $[\![AffP]\!]^{Mg} = [\![Aff]\!]^{Mg}(\ [\![VP]\!]^{Mg})](\ [\![Chris]\!]^{Mg})$
$= [\lambda P_{vt}.\lambda x.\lambda e.P(e)\&\exists e'(exp(e')\&Exp(x)(e'))$
$\forall e''(P(e'') \rightarrow Source(e'')(e')](\lambda e.break(e)\&Thm(Ben's\ vase)(e))](Chris)$
$= \lambda e.break(e)\&Thm(Ben's\ vase)(e)\&\exists e'(exp(e')\&Exp(Chris)(e'))$
$\forall e''((break(e'')\&Thm(Ben's\ vase)(e'')) \rightarrow Source(e'')(e'))$

Intuitively, this adds (i) the assertion that there exists an experiencing event e' where Chris is the experiencer and (ii) the assertion that if any event at all is a breaking event involving

Ben's vase, then that event will cause (be the source of) the aforesaid experiencing event. Very roughly, it adds the information that Chris would care about Ben's vase getting broken, and that an event of Chris experiencing this emotion actually occurred.

The interpretation of VoiceP is as in (14).

(14) $\llbracket VoiceP \rrbracket^{Mg} = \llbracket [Voice \rrbracket^{Mg}(\llbracket AffP \rrbracket^{Mg})](\llbracket Alex \rrbracket^{Mg})$
$= \lambda e.break(e) \& Thm(Ben's\ vase)(e) \& Agt(Alex)(e) \& \exists e'((exp(e') \& Exp(Chris)(e'))$
$\forall e''((break(e'') \& Thm(Ben's\ vase)(e'')) \rightarrow Source(e'')(e'))$

Intuitively, this just adds the information that Alex is the agent of the breaking.

For simplicity, this explanation has assumed that all the content is contributed to the *at-issue* dimension. This is incorrect, but it is easily corrected. Bosse et al. follow Potts in separating *at-issue* and *ci* content with an uninterpreted operator; in the case of Bosse et al., this is a colon. The proper meaning derivation is then as follows (15), with the colon highlighted at line endings.

(15) $\llbracket VP \rrbracket^{Mg} = \lambda e.break(e) \& Thm(Ben's\ vase)(e)$

(16) $\llbracket AffP \rrbracket^{Mg} = \llbracket Aff \rrbracket^{Mg}(\llbracket VP \rrbracket^{Mg})](\llbracket Chris \rrbracket^{Mg})$
$= [\lambda P_{vt}.\lambda x.\lambda e.P(e) \& \exists e'(exp(e') \& Exp(x)(e'))$:
$\forall e''(P(e'') \rightarrow Source(e'')(e')](\lambda e.break(e) \& Thm(Ben's\ vase)(e))](Chris)$
$= \lambda e.break(e) \& Thm(Ben's\ vase)(e) \& \exists e'(exp(e') \& Exp(Chris)(e'))$:
$\forall e''((break(e'') \& Thm(Ben's\ vase)(e'')) \rightarrow Source(e'')(e'))$

(17) $\llbracket VoiceP \rrbracket^{Mg} = \llbracket [Voice \rrbracket^{Mg}(\llbracket AffP \rrbracket^{Mg})](\llbracket Alex \rrbracket^{Mg})$
$= \lambda e.break(e) \& Thm(Ben's\ vase)(e) \& Agt(Alex)(e) \& \exists e'((exp(e') \& Exp(Chris)(e'))$:
$\forall e''((break(e'') \& Thm(Ben's\ vase)(e'')) \rightarrow Source(e'')(e'))$

The effect of tense interpretation will be to existentially bind the 'main' event variable e (as well as adding information about time reference, which we ignore), giving a two dimensional interpretation as in (18).

(18) $\exists e(break(e) \& Thm(Ben's\ vase)(e) \& Agt(Alex)(e) \&$
$\exists e'(exp(e') \& Exp(Chris)(e'))$:
$\forall e''((break(e'') \& Thm(Ben's\ vase)(e'')) \rightarrow Source(e'')(e')))$

The *at-issue* content here asserts the existence of (i) a breaking event e where Alex is the Agent, and Ben's vase is the Theme, and (ii) an experiencing event e', where Chris is the experiencer. The *ci* content asserts that any such breaking event (i.e. any breaking event involving Ben's vase) would be the source of e'.

This semantics is plausible, so far as it goes, and seems to reflect the basic intuition about the meaning of this example (viz that Alex broke Ben's vase, and that Chris is affected by this).

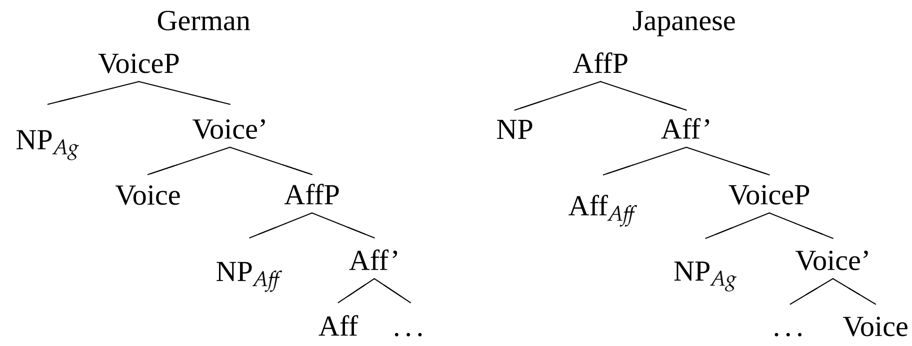
At this point, at least two points are worth developing further. The first relates directly to cross-linguistic variation. Notice that with respect to these German examples, 'any such breaking event' means any breaking of Ben's vase (by Chris, or anyone else). Bosse et al.

suggest that this reflects one parameter of cross linguistic variation. They suggest that for example in Japanese, an example like (19), which roughly corresponds to (1), conveys the more precise meaning that any breaking of Ben's vase *by Alex* would affect Chris.[3]

(19) Chris-ga Alex-ni Ben-no kabin-o kowas-are-ta. (Japanese).
Chris-Nom Alex-Dat Ben-Gen vase-Acc break-Aff-Past
Alex broke Ben's vase 'on Chris'.

That is, in Japanese, the *ci* content includes the agent. To deal with this, Bosse et al. assume that there is parametric variation in the height at which the Aff head attaches. In German VoiceP is higher than AffP, in Japanese it is the other way round. Because VoiceP is responsible for introducing the Agent into the semantics, this captures the variation with respect to whether the Agent part of the *ci* content or not.

(20)



The second point is also a matter of cross-linguistic variation, but the real interest is the formal issue raised by this construction in a language like German. Bosse et al. claim that in some languages AE content is contributed entirely in the *ci* dimension. This is formally unproblematic for the two-dimensional, Pottsian, approach. But German, where some content seems to be in the *at-issue* dimension, and some in the *ci* dimension, and where, in particular, there is variable binding across the dimensions (cf. in (18) the variable e' is associated with a quantifier in the *at-issue* dimension, and also appears after the colon in the *ci* dimension), is a serious challenge for Potts.[4]

The questions are: Can we provide an LFG implementation that deals with this data, without the projections? Can we get a neat account of the parametric variation across languages? What are we to make of the challenge this construction in German seems to pose for the Pottsian enterprise?

[3]Example (19) is similar to one given by Bosse et al., and there are some complications, which we will ignore. In particular, there is a potential complication due to voice (where the German example is in the active voice, the Japanese is morphologically passive, with the Agent (*Alex*) marked with *ni*, and the Experiencer (*Chris*) marked as nominative: Bosse et al. assume the 'passive' morphology is spell out of the Voice head.

[4]Bosse et al. note that their analysis also involves a single item introducing elements of meaning in both *ci* and *at-issue* tiers of meaning, which Potts had claimed was not possible. Since we think Potts' claim has been convincingly challenged elsewhere, (e.g. McCready, 2010; Sawada, 2011), we will not pursue this issue here.

3 An LFG Implementation

3.1 Basic Framework

In this section we introduce the formal and conceptual framework in which we will investigate these questions. On the morpho-syntactic side, our assumption are entirely conventional LFG (e.g. Dalrymple, 2001). On the semantic representation side, we will assume a Discourse Representation Theory (DRT) style semantics (using a version of DRT augmented with a λ operator).[5] The syntax-semantics interface uses the standard LFG/Glue logic approach (e.g. Dalrymple, 2001; Asudeh, 2004, 2012), as modified by Arnold and Sadler (2010, 2011) to provide a Potts style account of appositive constructions.[6]

For the sake of familiarity, we exemplify with reference to non-restrictive ('appositive') relative clauses (ARCs), as in (21a).

(21) a. Kim believes that linguists, who dislike Maths, are stupid. [ARC]
b. Kim believes that linguists who dislike Maths are stupid. [RRC]

Compared to a restrictive relative clause (RRC), as in (21b), ARCs display a number of distinctive syntactic and semantic properties. Most obviously, in (21b), the relative clause *who dislike Maths* is used to restrict the denotation of *linguists* so that the NP *linguists who dislike Maths* denotes an intersection. By contrast, (21a) is about all linguists, not some subset thereof. This provides a useful test, since in the former, but not the latter, one can infer the existence of a 'contrast' set (linguists who do not dislike Maths) and pick this out anaphorically with an expression like 'other kinds'. Compare:

(22) a. Kim believes that linguists, who dislike Maths, are stupid. #Other kinds she regards as cool. [ARC]
b. Kim believes that linguists who dislike Maths are stupid. Other kinds she regards as cool. [RRC]

A less obvious, but none-the-less well known, property of ARCs is that they generally appear to be semantically scopeless, or interpreted with wide scope.[7] This can be seen with respect to (21b)/(21a). Notice that in the case of the RRC the interpretation involves Kim having a belief that '(some) linguists don't understand first order predicate calculus (FOPC)', or something equivalent, and must therefore involve Kim having, in the widest sense, some notion of what FOPC is. This is not required in the case of the ARC, where the (false) assertion that 'linguists do not understand FOPC' is associated with the speaker, and need not form any part of Kim's beliefs. A natural account of this is that in the case of the ARC, the content of the ARC is interpreted outside the scope of the belief operator.

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[5]For DRT, see e.g. Kamp and Reyle (1993). For versions of DRT that have a λ operator, see e.g. Muskens (1996).

[6]See Giorgolo and Asudeh (2011) for an alternative approach to these issues.

[7]It is now clear that though this is generally true, it is not invariably true, and there are many situations where ARCs and other appositives display narrow scope. See Arnold and Sadler (2011) and references there.

(23) a. Kim believes that linguists, who don't understand FOPC, are stupid.
b. Kim believes that linguists who don't understand FOPC are stupid.

This phenomenon is not restricted to propositional verbs, but can be observed with respect to a wide range of scope related phenomena. To take just two other examples: in (24a) the issue of linguists' understanding of FOPC is not part of the question (which is, essentially, 'Are linguists stupid'), but the content of the RRC is part of the question in (24b). Similarly, (25a), where there is a negative polarity item (*any*) inside the ARC, is ungrammatical. Plausibly this is because the ARC, and hence the negative polarity item, is outside the scope of negation. Compare the fully acceptable (25b), where *any* is in an RRC, and in the scope of negation.

(24) a. Are linguists, who understand FOPC, stupid? [ARC]
b. Are linguists who understand FOPC stupid? [RRC]

(25) a. *We did not write to the customers, who had any complaints.
b. We did not write to the customers who had any complaints.

Potts' account of these phenomena involves having two dimensions of meaning: a dimension of 'normal' '*at-issue*' meaning, and a second dimension of 'conventionally implicated' (*ci*) content. The content of RRCs belongs to the *at-issue* dimension, the content of ARCs belongs to the *ci* dimension. Potts' account involves a very strict separation of these dimensions of meaning. In particular, the way material in the two dimensions is assigned semantic types guarantees that nothing in the *at-issue* dimension can access anything in the *ci* dimension. Hence, *ci* content is always outside the scope of *at-issue* operators (e.g. negation, question operators, propositional verbs).

The LFG/Glue implementation of these ideas presented in Arnold and Sadler (2011) (which is a refinement of that in Arnold and Sadler (2010)) differs from Potts' in two main ways. First, it uses the projection architecture of LFG so that the separation of semantic content into two types (*at-issue*, and *ci*) is not necessary. The second difference is that Potts assumes that *at-issue* and *ci* content are always entirely separate: the only commonality is that they are interpreted in the same model. Arnold and Sadler (2011) point out that on standard LFG/Glue assumptions about anaphora (Dalrymple, 2001; Asudeh, 2004, 2012, e.g.), this should make ARCs and other appositives anaphoric islands, which they clearly are not, as witness the following, where one can see anaphora into and out of ARCs:

(26) a. Pissarro, *who Matisse$_i$ met in 1898*, encouraged him$_i$ greatly.
b. Matisse$_i$ was greatly encouraged by Pissarro, *who he$_i$ met in 1898*.

To deal with this, Arnold and Sadler (2011) propose that *at-issue* and *ci* content should be integrated 'at the top' (i.e. the final representation of a sentence should be a representation where *at-issue* and *ci* content is conjoined).[8]

The basic ideas of Arnold and Sadler (2011, 2010) can be seen in Figure 1, which repre-

[8]Conjunction is empirically the correct interpretation: *Kim, who Sam dislikes, left* means roughly the same as the conjunction *Kim left*, and *Sam dislikes Kim*.

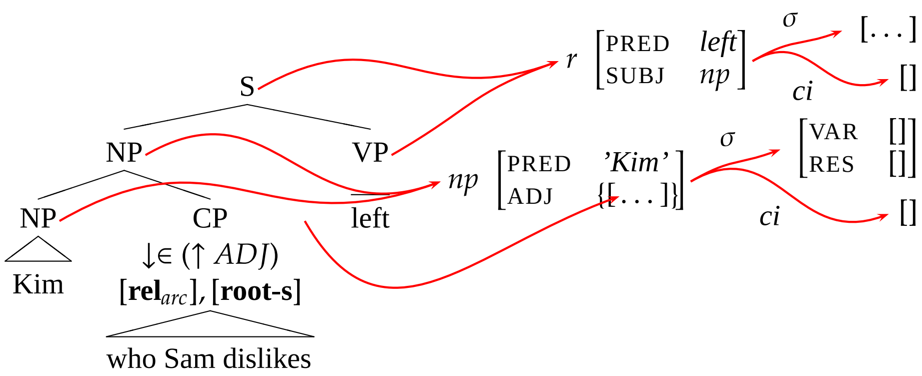

Figure 1

sents (27). The c- and f-structures are entirely conventional, and in fact identical to what one would have for a restrictive relative (though one would not normally have a restrictive relative with a proper noun, of course). In particular, the ARC is a normal adjunct, fully integrated into the c- and f-structures.

(27) Kim, who Sam dislikes, left.

The semantics is more interesting. Notice that as well as the standard σ projection, which introduces normal *at-issue* semantic resources, there is an additional *ci* projection, which introduces 'conventionally implicated' content. Thus one has resources np_σ and np_{ci}, corresponding to the two semantic projections of the f-structure np.

The resources associated with the projections of *Kim*, and *left* are standard:

(28) [**Kim**] $Kim : np_\sigma$

(29) [**leave**] $\lambda X.left(X) : np_\sigma \multimap r_\sigma$

We associate two semantic resources with the ARC: [**rel**$_{arc}$], and [**root-ci**]. The latter is given in (30). Its role is to combine the *ci* resource that the ARC introduces with the semantics of the root S, which we will designate as r_σ, conjoining the associated meanings, as $p \wedge q$.[9]

(30) [**root-ci**] $\lambda q.\lambda p.(p \wedge q) : np_{ci} \multimap [r_\sigma \multimap r_\sigma]$

We will not present [**rel**$_{arc}$] here, because it is not relevant, what is relevant is the resource that it produces when it combines with the resource associated with the host NP, [**Kim**]. This is given in (31).

(31) $Kim \times dislikes(Sam, Kim) : np_\sigma \otimes np_{ci}$

[9]The resource r_σ appears in both (29), and (30), but in the former r is the f-structure of *leave* (e.g. the value of ↑ with respect to the subject NP, which is the host of the ARC) but in (30) it is the topmost (root) f-structure (which can be picked out by an inside-out functional uncertainty expression): conjoining *ci* content to the root is what gives it wide scope. In a monoclausal structure like (27), these are the same, but this would not be the case in examples like (21a), where the ARC is in a subordinate clause.

This is a 'tensor' resource, consisting of two components, np_σ and np_{ci}, corresponding to, respectively, the *at-issue* content of *Kim, who Sam dislikes*, namely, just *Kim*, and its *ci* resource, whose meaning is the proposition $dislikes(Sam, Kim)$.

The general strategy for dealing with tensor resources is to create a context in which the components can be simultaneously consumed. This in general involves the use of hypothetical reasoning. Here the idea is that one does not have to have all the resources one needs available before one starts a proof, or makes a particular move (which would require the resources to become available in a rather strict order). Instead, one can at any point hypothesise the resource(s) one needs: the proof will be successful so long as one can at some later time discharge those hypotheses.

At a certain point in the semantic derivation of the content of *Kim, who Sam dislikes, left*, we will have the resources in (32), which were introduced above.

(32) a. $Kim \times dislikes(Sam, Kim) : np_\sigma \otimes np_{ci}$
b. $\lambda X.left(X) : np_\sigma \multimap r_\sigma$
c. $\lambda q.\lambda p.(p \wedge q) : np_{ci} \multimap [r_\sigma \multimap r_\sigma]$

There is nothing to be done with these, as they stand. However, if we hypothesise a resource H_1 corresponding to the *at-issue* content of the subject NP, we can produce a hypothetical proof as in (33).

(33) $$\frac{[H_1 : np_\sigma]^2 \quad \lambda X.left(X) : np_\sigma \multimap r_\sigma}{left(H_1) : r_\sigma}$$

If we similarly hypothesise a resource corresponding to the *ci* content of the subject NP, we can produce a partial proof as in (34):

(34) $$\frac{[H_2 : np_{ci}]^1 \quad \lambda q.\lambda p.(p \wedge q) : np_{ci} \multimap [r_\sigma \multimap r_\sigma]}{\lambda p.(p \wedge H_2) : r_\sigma \multimap r_\sigma}$$

Abbreviating (33), which shows that hypothesizing $H_1 : np_\sigma$ allows us to derive $left(H_1) : r_\sigma$, and (34), which shows that hypothesizing $H_2 : np_{ci}$ allows us to derive $\lambda p.(p \wedge H_2) : r_\sigma \multimap r_\sigma$, we can produce the derivation in (35).

(35) $$\cfrac{\cfrac{Kim \times dislikes(Sam, Kim) : np_\sigma \otimes np_{ci} \qquad \cfrac{\begin{matrix}[H_1] \\ \vdots \\ left(H_1) : r_\sigma\end{matrix} \quad \begin{matrix}[H_2] \\ \vdots \\ \lambda p.(p \wedge H_2) : r_\sigma \multimap r_\sigma\end{matrix}}{left(H_1) \wedge H_2 : r_\sigma}[a]}{\textbf{let } Kim \times dislikes(Sam, Kim) \textbf{ be } H_1 \times H_2 \text{ in } left(H_1) \wedge H_2 : r_\sigma}[b]}{left(Kim) \wedge dislikes(Sam, Kim) : r_\sigma}[c]$$

Up to step [*a*], the hypothetical proofs from above are used. At [*a*] itself there is simple function application. At step [*b*] the result of this function application is combined with the tensor resource associated with *Kim, who Sam dislikes* into a 'let' expression. This is simplified by pair-wise substitution at step [*c*]. Notice this gives the intuitively correct

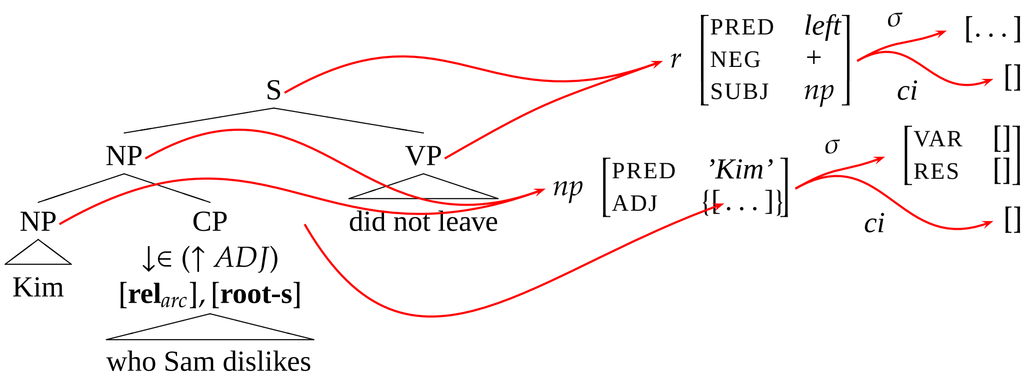

Figure 2

interpretation: issues of focus, backgrounding, etc. aside, example (27) means the same as *Sam dislikes Kim* and *Kim left*.

In this case, there is only one level of embedding, so conjoining the *ci* content with the root content (r_σ) is the same as conjoining it with the *at-issue* content of *dislikes* (s_σ). But this will not always be the case: the *at-issue* content of *dislikes* may be consumed by another operator, e.g. a propositional verb, question operator, or negation. In this case, the *ci* content will escape the scope of that operator (i.e. will get wide scope). We will demonstrate this using negation.

Consider example (36). For our purposes, the c- and f-structures involved are not very different. The main difference will be the existence of an additional resource, corresponding to sentential negation. We assume this to be of the form (37), which, intuitively, consumes a resource associated with the sentence and produces another resource associated with the sentence, but with the difference that the output resource has a negative meaning.

(36) Kim, who Sam dislikes, did not leave.

(37) [**Neg**] $\lambda p.(\neg p) : r_\sigma \multimap r_\sigma$

The proofs are also almost the same as above. (38) differs from (33) only in using the negative resource just mentioned, and in producing an appropriately different result (cf. the meaning is $(\neg left(Kim))$ instead of $left(Kim)$).

(38)
$$\dfrac{\lambda p.(\neg p) : r_\sigma \qquad \dfrac{[H_1 : np_\sigma]^2 \qquad \lambda X.left(X) : np_\sigma \multimap r_\sigma}{left(H_1) : r_\sigma}}{(\neg left(H_1)) : r_\sigma}$$

For the rest, the premises and the structure of the proofs are identical. But notice that the result of the proof is that the scope of negation is restricted to the *at-issue* content.[10]

[10] The careful reader will notice that while we show how the *ci*-content *can* get wide scope with respect to negation, we have not show that it *must*: as things stand, there is an equally valid glue derivation that applies [**root-ci**] before [**Neg**], putting the *ci*-content in the scope of negation – which we do not want. There is no

(39)

$$\dfrac{\dfrac{Kim \times dislikes(Sam,Kim) : np_\sigma \otimes np_{ci} \qquad \dfrac{\begin{array}{c}[H_1]\\ \vdots\\ (\neg left(H_1)) : r_\sigma\end{array} \quad \begin{array}{c}[H_2]\\ \vdots\\ \lambda p.(p \wedge H_2) : r_\sigma \multimap r_\sigma\end{array}}{(\neg left(H_1)) \wedge H_2 : r_\sigma}}{\textbf{let } Kim \times dislikes(Sam,Kim) \textbf{ be } H_1 \times H_2 \text{ in } (\neg left(H_1)) \wedge H_2 : r_\sigma}}{(\neg left(Kim)) \wedge dislikes(Sam,Kim) : r_\sigma}$$

3.2 AE Constructions: LFG Analysis

In this section, we will show how the facts and basic insights of Bosse et al.'s analysis can be expressed using the grammatical apparatus of LFG, as discussed in the previous section.

Our assumptions about c- and f-structure are entirely conventional. Figure 3 shows the sort of c- and f-structure we assume for example (1), repeated here as (40). As previously noted, the meaning representation language will be a version of DRT augmented with an abstraction operator.

(40) Alex zerbrach Chris Bens Vase.
Alex broke Chris.DAT Ben's vase
Alex broke Ben's vase 'on Chris'. (i.e. and this affected Chris)

The basic approach we assume is lexical. We posit a derived verb $zerbrechen_{AE}$ 'break', whose entry is just like that of the normal *zerbrechen* except that (i) it allows an extra OBJ_{dat} complement; and (ii) it introduces the semantic resources in (41) and (42).

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shortage of technical fixes for this problem, but making a motivated choice among them is not easy, and would be a distraction here. Perhaps the simplest is to assume a rule like the following, taking S_{root} to be the start symbol of the grammar:

$$S_{root} \rightarrow \begin{array}{c} S \\ (\uparrow ROOT) = \downarrow \\ \lambda p.p : \downarrow_\sigma \multimap \uparrow_\sigma \end{array}$$

The effect of this is to distinguish the root f-structure (and hence the corresponding glue resources) that is involved in combining *at-issue* and *ci* content (i.e. instances of [**root-ci**]) from the one that is negated. Let us call these respectively r_σ and r'_σ. The glue type associated with the rule above is thus $r'_\sigma \multimap r_\sigma$. The glue type of [**Neg**] will be $r'_\sigma \multimap r'_\sigma$, so it cannot apply after this resource has been used. Similarly instances of [**root-ci**] will only be able to operate on the output of this resource, conjoining *ci*-content outside the scope of negation. Adding this would slightly complicate the proofs, but would be otherwise unproblematic.

Alternative solutions to this problem might involve the use of semantic features (like the book-keeping features VAR, RESTR used in treatments of quantification), or the logical type system – e.g. suppose the final goal of a semantic derivation is an object of type T (for 'text'), rather than t. Semantic negation would be of type $\langle t,t\rangle$, and [**root-ci**] would have the logical type $\langle ci,T,T\rangle$.

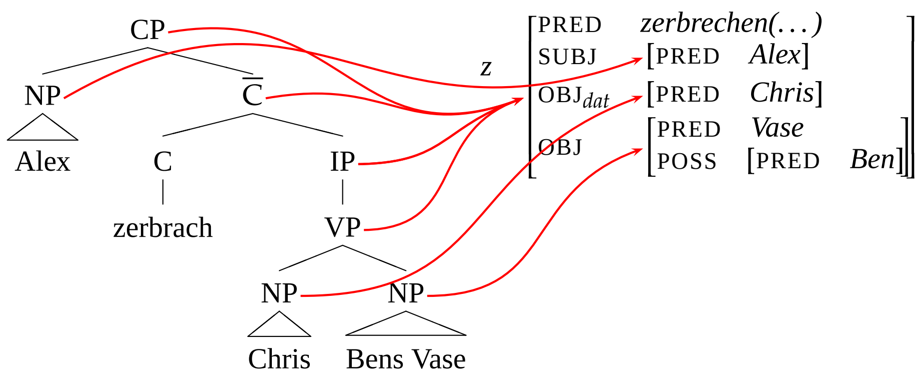


Figure 3

(41) [**zerbrechen**$_{AE}$]

$$\lambda C \lambda B \lambda A. \left(\begin{array}{|l|} \hline E, A, B, C, E' \\ \hline breaking(E) \\ Theme(E,B) \\ Agent(E,A) \\ experience(E') \\ Experiencer(E',C) \\ \hline \end{array} \times \begin{array}{|c|} \hline \\ \hline \begin{array}{|l|} \hline E'' \\ \hline breaking(E'') \\ Theme(E'',B) \\ \hline \end{array} \Rightarrow \begin{array}{|l|} \hline \\ \hline source(E',E'') \\ \hline \end{array} \\ \hline \end{array} \right) :$$

$(\uparrow OBJ_{dat})_\sigma \multimap [(\uparrow OBJ)_\sigma \multimap [(\uparrow SUBJ)_\sigma \multimap [\uparrow_\sigma \otimes \uparrow_{ci}]]]$

(42) [**ci-root**] $\lambda q.\lambda p.(p \sqcup q) : \uparrow_{ci} \multimap [r_\sigma \multimap r_\sigma]$

The [**ci-root**] resource in (42) is just as in the previous discussion. As before, it is is responsible for merging the *at-issue* and *ci* content associated with the root f-structure (r). The only difference is that instead of $\wedge$ (conjunction), the meaning representation involves $\sqcup$ (discourse merge, which has the same semantic effect as conjunction).

The meaning constructor [**zerbrechen**$_{AE}$] in (41) will consume, in order:

- the 'affected experiencer object' (OBJ$_{dat}$) resource (corresponding to *Chris*);
- the direct object resource (corresponding to *Bens Vase*)
- and the subject resource (corresponding to *Alex*) ;

It will produce a pair resource with glue type $\uparrow_\sigma \otimes \uparrow_{ci}$, as in (43), consisting of:

- the ordinary (*at-issue*) content of the verb and its arguments ; and
- a resource associated with the *ci* projection of the verb's f-structure.

If we denote the outermost f-structure in Figure 3 as z, these will be respectively z_{ci} and z_σ, and we will have (43).

(43)
$$\begin{array}{|l|}\hline \textit{E, Alex, BV, Chris, E'} \\ \hline \textit{breaking(E)} \\ \textit{Theme(E,BV)} \\ \textit{Agent(E,Alex)} \\ \textit{experience(E')} \\ \textit{Experiencer(E',Chris)} \\ \hline \end{array} \times \begin{array}{|c|}\hline \\ \hline \begin{array}{|l|}\hline \textit{E''} \\ \hline \textit{breaking(E'')} \\ \textit{Theme(E'',BV)} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \\ \hline \textit{source(E',E'')} \\ \hline \end{array} \\ \hline \end{array} \; : z_\sigma \otimes z_{ci}$$

In words, the *at-issue* content asserts the existence of a breaking event E, two individuals ($Alex$, and BV – Ben's vase), who are respectively the Agent and Patient of E, as well as an additional individual (*Chris*), and event E', of which *Chris* is the Experiencer. That is, roughly, Alex broke Ben's vase, and Chris experienced something. The *ci* content is that every breaking event E'' would be a cause of E'. (For any event E'', if E'' is a breaking event involving Ben's Vase, then it is a source (cause) of E' – the experiencing event. This is essentially identical to the representation Bosse et al. gave in (18) above, expressed in different notation).

To present the glue proof, we will abbreviate (43) as (44) (i.e. $\mathcal{A}$ is the meaning language representation of the *at-issue* content of (43)):

(44) $\mathcal{A} \times \mathcal{B} : z_\sigma \otimes \; z_{ci}$

We can now produce a hypothetical derivation as in (45).

(45)
$$\dfrac{\dfrac{\mathcal{A} \times \mathcal{B} : z_\sigma \otimes z_{ci} \qquad \dfrac{[H_2 : r_\sigma]^2 \qquad \dfrac{[H_1 : z_{ci}]^1 \quad \lambda q.\lambda p.(p \sqcup q) : z_{ci} \multimap [r_\sigma \multimap r_\sigma]}{\lambda p.(p \sqcup H_1) : r_\sigma \multimap r_\sigma}[a]}{(H_2 \sqcup H_1) : r_\sigma}[b]}{\textbf{let } \mathcal{A} \times \mathcal{B} \textbf{ be } H_2 \times H_1 \text{ in } (H_2 \sqcup H_1) : r_\sigma}[c]}{\mathcal{A} \sqcup \mathcal{B} : r_\sigma}[d]$$

At [a], we hypothesize a resource corresponding to the *ci*-content of *zerbrechen*, which can be consumed by [**root-ci**]. We then hypothesize a resource corresponding to the *at-issue* content of the root f-structure (r_σ)[11], which can be consumed to produce a resource ($H_2 \sqcup H_1$) associated with the root f-structure r (r_σ). This provides an environment into which the pair resource associated with our example, (43), abbreviated in (44), can be substituted (at [c]). This produces a **let** expression which can be simplified, as at [d].

For our purposes, the discourse merger operation notated as $\sqcup$ can be taken to be simple merger of universes (discourse variables) and conditions of DRSs, which in this case produces (46), which has the truth conditions we want.

[11] Though notice that in this case, where *zerbrechen* is the main verb and there are complications involving negation etc., z_σ and r_σ are identical.

(46)
$$\begin{array}{|l|}\hline \textit{E, Alex, BV, Chris, E'} \\ \hline \textit{breaking(E)} \\ \textit{Theme(E,BV)} \\ \textit{Agent(E,Alex)} \\ \textit{experience(E')} \\ \textit{Experiencer(E',Chris)} \\ \begin{array}{|l|}\hline \textit{E''} \\ \hline \textit{breaking(E'')} \\ \textit{Theme(E'',BV)} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \\ \hline \textit{source(E',E'')} \\ \hline \end{array} \\ \hline \end{array} : r_\sigma$$

It is easy to see that this approach will allow *ci*-content to escape negation. Suppose we abbreviate (47), which we assume is the resource associated with sentential negation, as $\lambda p.(\neg p)$: $z_\sigma \multimap z_\sigma$.

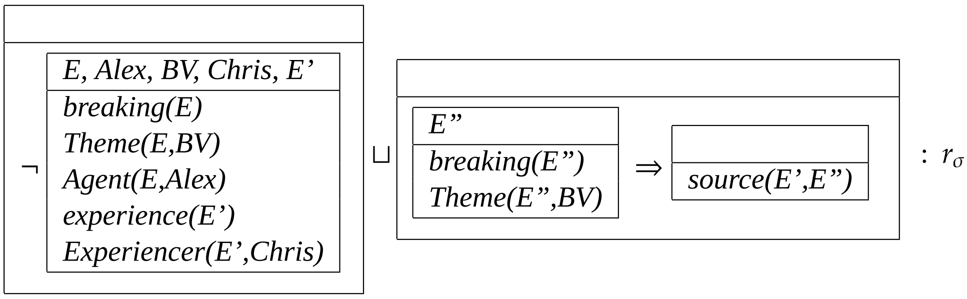
(47)
$$\lambda p.\begin{array}{|c|}\hline \\ \hline \neg\, p \\ \hline \end{array} : z_\sigma \multimap z_\sigma$$

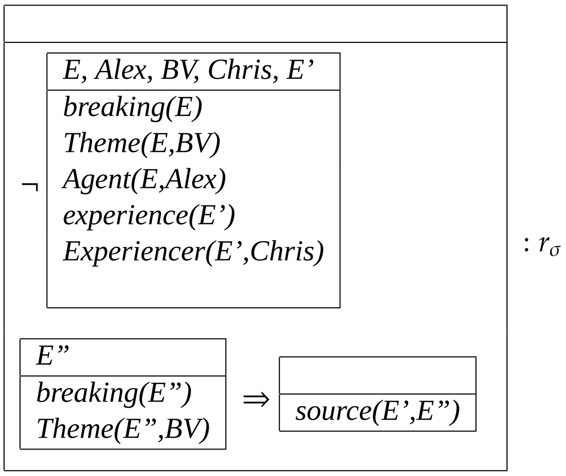
The proof that derives the interpretation of (48) can procede as in (49). The only important difference between this and (45) is at $[a']$. Here sentence negation has been applied to the resource we hypothesized for the *at-issue* content of the sentence. For the rest, the derivation is identical, except that this resource, and ultimately the non-hypothetical resource that discharges it, are thereafter in the scope of negation. Notice, however, that the *ci*-content is not the scope of negation, which is the result that we want.

(48) Alex zerbrach Chris Bens Vase nicht.
Alex broke Chris.DAT Ben's vase not
Alex didn't break Ben's vase 'on Chris'. (But it would matter to Chris.)

(49)
$$\dfrac{\dfrac{\mathcal{A}\times\mathcal{B} : z_\sigma \otimes z_{ci} \qquad \dfrac{\dfrac{\lambda p.(\neg p) : z_\sigma \multimap z_\sigma \quad [H_2 : z_\sigma]^2}{(\neg H_2) : z_\sigma}[a'] \qquad \dfrac{[H_1 : z_{ci}]^1 \quad \lambda q.\lambda p.(p \sqcup q) : z_{ci} \multimap [r_\sigma \multimap r_\sigma]}{\lambda p.(p \sqcup H_1) : r_\sigma \multimap r_\sigma}[a]}{((\neg H_2) \sqcup H_1) : r_\sigma}[b]}{\mathbf{let}\ \mathcal{A}\times\mathcal{B}\ \mathbf{be}\ H_2 \times H_1\ \text{in}\ ((\neg H_2) \sqcup H_1) : r_\sigma}[c]}{(\neg\mathcal{A}) \sqcup \mathcal{B} : r_\sigma}[d]$$

To make this more concrete, notice that the structure $(\neg\mathcal{A}) \sqcup \mathcal{B}$ is an abbreviation for the structure in (50), which, when discourse merge has applied, gives rise to (51), where the *ci*-content is clearly outside the scope of negation.

(50) 

(51) 

In fact, there is rather more to say about (51), because it is less satisfactory than it at first seems. However, before we pursue this, we should address the issue of cross-linguistic variation with respect to the interpretation of the agent in relation to *ci* and *at-issue* content.

Recall that according to Bosse et al., there is a difference between Japanese and German, in that in the former (but not the latter), the agent is part of the *ci* content. Bosse et al. propose to capture this by variation of the relative heights of VoiceP and AffP. The question naturally arises as to whether our approach can accommodate this variation.

The answer to this question is positive, and the method almost trivial. All that is required is a very small change to the output of the lexical rule that we posit for Japanese verbs, as compared to their German counterparts. The lexical entry for the Affected Experiencer version of *kowas-are-ru* (‘break’) should be as in (52). Ignoring syntactic details, the sole difference between this and German *zerbrechen* is highlighted. Demonstrating that this has the desired effect is left as a (trivial) exercise for the reader. The difference between Japanese and German can be simply captured by a small variation in the respective lexical rules.

(52) [**kowas-are-ru**$_{AE}$]

$$\lambda C \lambda B \lambda A. \left(\begin{array}{|l|} \hline E, A, B, C, E' \\ \hline breaking(E) \\ Theme(E,B) \\ Agent(E,A) \\ experience(E') \\ Experiencer(E',C) \\ \hline \end{array} \times \begin{array}{|c|} \hline \\ \hline \begin{array}{|l|} \hline E'' \\ \hline breaking(E'') \\ Agent(E'',A) \\ Theme(E'',B) \\ \hline \end{array} \Rightarrow \begin{array}{|l|} \hline \\ \hline source(E',E'') \\ \hline \end{array} \\ \hline \end{array} \right) :$$

$$(\uparrow SUBJ)_\sigma \multimap [(\uparrow OBJ)_\sigma \multimap [(\uparrow OBJ_{ni})_\sigma \multimap [\uparrow_\sigma \otimes \uparrow_{ci}]]]$$

The question we started out with was whether an LFG/glue implementation could be provided that deals with the data that Bosse et al. present: specifically, whether an account can be found that eschews abstract functional projections like VoiceP and AffP. We see that such an account is indeed possible: the flexibility provided by LFG-glue semantics is sufficient, and allows us to operate with a simpler, and far less abstract, syntax.

4 Discussion

We appear to have replicated Bosse et al.'s analysis in the current framework, which would seem to be an entirely positive result. Unfortunately, things are not so simple. In fact, because the replication is close, it shows up some troubling problems with Bosse et al.'s approach.

Consider again the DRS of the example involving negation in (51), which correctly shows the AE content outside the scope of negation. The problem is that this is not a well-formed DRS: it is *improper*. This is because the AE content contains a variable E' (in the consequent) which is, intuitively, unbound. Notice in particular that it is not in the scope of the instance of E' which is introduced in the *at-issue* content, because this is in a more deeply embedded sub-DRS (because it is in the scope of negation).

It is important to stress that this is not some artefact of the DRT representation we have adopted, or some arbitrary piece of formalization that can be evaded by some minor reformulations.

As regards the first point, exactly the same problem would arise with the predicate logic based account that Bosse et al. present. Suppose we modify Bosse et al.'s representation (18) from above so that the *at-issue* content is in the scope of negation, and the *ci* content is outside the scope of negation. We will have the following (the brackets delimiting the scope of negation are highlighted):

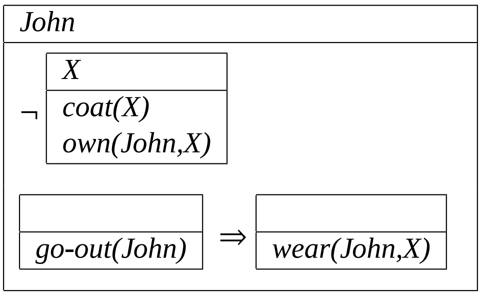
(53) $$\neg\ (\ \exists e(break(e) \& Thm(Ben's\ vase)(e) \& Agt(Alex)(e) \& \exists e'(exp(e') \& Exp(Chris)(e'))\ )\ : \\ \forall e''((break(e'') \& Thm(Ben's\ vase)(e'')) \rightarrow Source(e'')(e')))$$

There is nothing syntactically wrong with this, as a piece of predicate logic. The problem is its interpretation. Notice that here the variable e' in the *ci*-content is free – in particular, it is not bound by the existential quantifier that binds the instance of e' in the *at-issue* content. (We have followed Bosse et al.'s use of variable names, but where they write *Source*$(e'')(e')$ we write *source*(E', E'')). Since it is unbound, one can freely replace it with any other variable (x, say) without changing the meaning. Formalizations of the semantics of predicate logic differ in how they deal with the interpretation of unbound variables, but it is clear that (53) will not mean what Bosse et al. want it to mean.

As regards DRT, there is a very good reason why we would want representations like (51) to be ill-formed or in some way illicit, because this is at the heart of the DRT account of what is wrong with examples like (54), which is represented by a DRS like (55).

(54) #John doesn't have a coat. If he goes out, he wears it.

(55)



Notice that in (55), as in (18) there is a variable (X in (55)) that appears in a DRS condition in the consequent of a conditional without an instance in a 'higher' DRS to bind it. The fact that such structures are ruled out reflects an important piece of theory for DRT.

There is, in short, a serious problem for the Bosse et al. analysis here. Notice also that the problem arises precisely because of the way Bosse et al. assume that variable binding can occur across the *at-issue*/*ci* boundary, which was the challenge that the construction seemed to pose for Potts' approach. The question of how to deal with the facts that lead Bosse et al. to propose that this should occur remains open.

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