Links without Locations

Information Packaging and Non-Monotone Anaphora

Herman Hendriks and Paul Dekker[1]

Utrecht University and University of Amsterdam

Abstract

In his work on information packaging—i.e., the structuring of propositional content in function of the speaker's assumptions about the hearer's information state—Vallduví (1992, 1993, 1994) identifies the informational primitives *focus*, *link* and *tail*, which are adapted from the traditional focus/ground and topic/comment approaches, and argues that the exploitation of information states of hearers by the information-packaging strategies of speakers reveals that these states have at least the internal structure of a system of Heimian file cards: links, which correspond to what are traditionally known as topics, say *where*–on what file card—the focal information goes, and tails indicate *how* it fits there. The present paper gives various reasons for not believing this and proposes to model information states as Kampian discourse representation structures, without locations. This requires and leads to a different perspective on the function of links. They signal non-monotone anaphora: their discourse referent Y is anaphoric to an antecedent discourse marker X such that $X \not\subseteq Y$. This idea will be shown to subsume 'non-identity' anaphora, contrastive stress, pronoun referent resolution, and restrictiveness of relatives and adjectives.

1 Information Packaging

The notion of information packaging is introduced in Chafe (1976):

> [The phenomena at issue] have to do primarily with how the message is sent and only secondarily with the message itself, just as the packaging of toothpaste can affect sales in partial independence of the quality of the tooth paste inside. (Chafe 1976: 28)

The basic idea is that speakers do not present information in an unstructured way, but that they provide a hearer with detailed instructions on how to manipulate and integrate this information according to their beliefs about the hearer's knowledge and attentional state:

> To ensure reasonably efficient communication, [... t]he speaker tries, to the best of his ability, to make the structure of his utterances congruent with his knowledge of the listener's mental world. (Clark and Haviland 1977: 5)

> On all levels the crucial factor appears to be the tailoring of an utterance by a sender to meet the particular assumed needs of the intended receiver. That is, information packaging in natural languge reflects the sender's hypotheses about the receiver's assumptions and beliefs and strategies. (Prince 1981: 224)

1. Sections 1 and 3 of the present paper have been written by the first author. Section 2 reflects joint work of the two authors.

For instance, sentences such as (1) and (2) are truth-conditionally equivalent in that they express the same proposition, but each of them 'packages' this proposition in a prosodically different way:[2]

(1) **The boss** *hates* BROCCOLI

(2) **The boss** HATES *broccoli*

Typically, speakers will use (1) if the hearer at the time of utterance knows nothing about or is not attending to the boss' relation to broccoli, while they will use (2) if the hearer at the time of utterance knows that there exists a relation between the boss and broccoli, is attending to this relation, but does not know what it is. Apparently, speakers are sensitive to such differences in the hearer's knowledge and attentional state, and hearers rely on this:

> speakers not using this device systematically give their listeners a harder time. (Nooteboom and Terken 1982: 317)

Truth-conditionally equivalent sentences that encode different information packaging instructions are not mutually interchangeable *salva felicitate* in a given context of utterance: e.g., of the above sentences, only the first one is a felicitous answer to the question *What does the boss hate?* It is this context-sensitivity that has traditionally placed information packaging within the realm of pragmatics.

Vallduví's account of information packaging (1992, 1993, 1994) is a combination of two influential earlier pragmatic approaches, the 'topic/comment' approach and the 'focus/ground' approach.

According to the focus/ground approach, sentences consist of a 'focus' and a 'ground'.[3] The focus is the informative part of the sentence, the part that (the speaker believes) makes some contribution to the hearer's mental state. The ground is the non-informative part of the sentence, the part that anchors the sentence to what is already established or under discussion in (the speaker's picture of) the hearer's mental state. Although sentences may lack a ground altogether, sentences without focus do not exist.

The topic/comment approach splits the set of subexpressions of a sentence into a 'topic', the—typically sentence-initial—part that expresses what the sentence is about, and a 'comment', the part that expresses what is said about the topic. Topics are points of departure for what the sentence conveys, they link it to previous discourse. Sentences may be topicless: so-called 'presentational' or 'news' sentences consist entirely of a comment.

In Reinhart (1982), it is argued that the dimension of 'old'/'new' information is irrelevant for the analysis of sentence topics. Instead, the notion of 'pragmatic aboutness' is is defined in terms of the organization of information. The set of Possible Pragmatic Assertions that can be made with a sentence S expressing proposition φ is defined as $\mathrm{PPA}_{(S)} = \{\varphi\} \cup \{\langle a, \varphi\rangle \mid a$ is the interpretation of an NP[4] in S$\}$ A pragmatic assertion $\langle a, \varphi\rangle$ is assumed to be *about* a.

Notice, by way of example (adopted from Dahl 1974), that the sentence **The boss** *hates* BROCCOLI gives rise to the parallel topic/comment and ground/focus

2. *Italics* are used for unaccented expressions; SMALL CAPS for expressions that bear a (focal) H* pitch accent; and **boldface** for expressions that bear a L+H* pitch accent. This is the terminology of Pierrehumbert (1980). H* accent and L+H* accent are called A accent and B accent, respectively, in Jackendoff (1972). We will assume that the relevant intonational unit for links is not the accent but rather the whole phrase, so that there is no such thing as a link-associated accent, but rather a link-associated tune.).
3. The ground is also known as 'presupposition' and as 'open proposition'.
4. Subject to further syntactic and semantic restrictions, cf. footnote 9 below.

partitions indicated in (3) if it answers the questions *What about the boss? What does he feel?*, whereas it induces the partitions specified by (4) in the interrogative context *What about the boss? What does he hate?*

(3)

topic	comment
The boss	*hates* BROCCOLI
ground	focus

(4)

topic	comment	
The boss	*hates*	BROCCOLI
ground		focus

The fact that the two informational articulations correspond to different partitions in (4) shows that neither of them is by itself capable of capturing all the informational distinctions present in the sentence. Therefore, Vallduví proposes to conflate the two traditional binomial articulations of focus/ground and topic/comment into a single trinomial and hierarchical one. The core distinction is the one between new information and anchoring, between focus and ground. In addition, the ground is further divided into the 'link', which corresponds approximately to the topic in the traditional topic/comment approach,[5] and the 'tail'.[6] In a picture:

(5) $\gg$

topic	comment		'aboutness'
link	tail	focus	
ground		focus	'old'/'new'

Given this articulation, the answer **The boss** *hates* BROCCOLI to the questions *What about the boss? What does he hate?* will receive the following analysis:

(6)

The boss	*hates*	BROCCOLI
link	tail	focus
ground		focus

.

Roughly speaking, the different parts—focus and ground, link and tail—of a sentence S have the following informational functions.

The focus encodes I_S, the *information* of S, which can be metaphorically described as ϕ_S, the proposition expressed by S, minus K_h, the information (the speaker presumes) already present in the hearer's information state.

The ground performs an *ushering* role—it specifies the way in which I_S fits in the hearer's information state: links indicate *where* I_S should go by denoting a location in the hearer's information state, and tails indicate *how* I_S fits there by signaling a certain mode of information update. Of course, talking about ushering information to some location in the hearer's information state presupposes that this information state has some sort of internal structure. In this respect, Vallduví purports to

5. To the extent that links correspond to the *topic* in the traditional topic/comment distinction, Vallduví's theory is quite similar to the analysis of sentence topics presented in Reinhart (1982), where a pragmatic assertion of φ about a is formalized as $\langle a, \varphi\rangle$, in that a functions as a kind of 'locus of update' for φ (cf. below). A difference is that Reinhart allows assertions without a topic (since also $\varphi \in \mathrm{PPA}_{(S)}$) and topics that express new information.
6. The hierarchy does not imply constituency or (even) continuity. In particular, the two parts (link and tail) of the ground may not constitute a linear unit at the surface. Moreover, sentences may have more than one link, and more than one element may constitute the tail.

> agree with Heim that there has to be some additional internal structure in the hearer's model of the common ground that plays an important role in natural language interpretation, even if this internal structure is of tangential relevance in truth value computation. It is this internal structure of information states which is, in fact, crucially exploited by the different information-packaging strategies used by speakers in pursuing communicative efficiency. (Vallduví 1994: 7)

In fact, Vallduví takes the metaphor of Heim's file change semantics (1982, 1983) literally, in that he assumes that the information in the hearer's model is organized in files, i.e., collections of file cards. Each file card represents a discourse entity: its attributes and its links with other discourse entities are recorded on the card in the form of conditions. Such a discourse entity may be known to the hearer but not salient at the time of utterance, it may be salient at the time of utterance, it may be completely new to the hearer, it may be inferable from what the hearer knows, etc. Discourse entities mediate between referring expressions (noun phrases) and entities in the real world: indefinite noun phrases prompt hearers to create a new file card, and definite noun phrases incite them to retrieve an already existing file card. Both definites and pronouns denote already existing file cards, but pronouns denote salient file cards, whereas (other) definites refer to non-salient ones.

File change comprises the above aspects of file card management, but it also involves content update, i.e., the incorporation of information conveyed by a given sentence into records on novel and familiar file cards, and this is where Vallduví lets information packaging come in.

Links are associated with so-called GOTO instructions. In file change semantics, the target location of such a declaration is a file card *fc*. A tail points at an information record—normally a (possibly underspecified) condition—on such a file card, RECORD(*fc*), and indicates that it has to be *modified* (or further specified) by the focus information I_S of the sentence. The associated instruction type is called UPDATE-REPLACE. In the absence of a tail, the focus information I_S of a sentence is simply *added* at the current location. The associated instruction type is called UPDATE-ADD.

Sentences may lack links and tails (recall that the focus is the only non-optional part of a sentence), so the following four sentence types can be distinguished:

(7) *a.* link-focus
b. focus
c. focus-tail
d. link-focus-tail

The above sentence types are associated with the below (compound) instruction types, respectively:

(8) *a.* GOTO(*fc*)(UPDATE-ADD(I_S))
b. UPDATE-ADD(I_S)
c. UPDATE-REPLACE(I_S,RECORD(*fc*))
d. GOTO(*fc*)(UPDATE-REPLACE(I_S,RECORD(*fc*)))

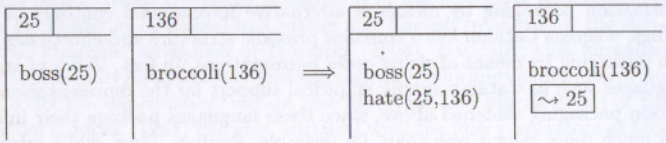
The sentence and instruction types in (7) and (8) can be illustrated with the following examples, where links, tails and foci are specified by means of [L...], [T...] and [F...] brackets, respectively, and accented expressions in foci and links are—as above—written in small caps (representing H* pitch accent) and boldface (for L+H* pitch accent), respectively:

(9) *a.* link-focus: [L**The boss**][F*hates* BROCCOLI]
GOTO(*fc*)(UPDATE-ADD(I_S))
b. focus: [F*He always eats* BEANS]
UPDATE-ADD(I_S)
c focus-tail: [F*He is* NOT][T*dead*]
UPDATE-REPLACE(I_S,RECORD(*fc*))
d. link-focus-tail: [L**The boss**][FHATES][T*broccoli*]
GOTO(*fc*)(UPDATE-REPLACE(I_S,RECORD(*fc*)))

As regards the first example, suppose that a newly appointed temp is ordering dinner for the boss and asks the executive secretary whether there is anything that should known about the boss' taste. The executive secretary gives the following answer:

(10) [L**The boss**][F*hates* BROCCOLI]

Example (10) is a link-focus construction, and as such it is associated with a GOTO(*fc*)(UPDATE-ADD(I_S)) instruction. The link subject *the boss* specifies a locus of update *fc*, viz., the card representing the boss—card #25, say. The focus verb phrase *hates broccoli* specifies the information I_S that has to be added to this card. Suppose that broccoli is represented by card #136. Then, passng over some formal details, the UPDATE-ADD(I_S) instruction associated with the focus *hates broccoli* amounts to adding the condition 'hates(25,136)' to the locus of update, i.e., the boss' card #25. Moreover, the record '$\boxed{\rightsquigarrow 25}$', a pointer to the locus of update, is added to card #136, rendering the condition 'hates(25,136)' on card #25 'accessible' from card #136: Vallduví says that this linking mechanism, which designates a unique location for content update, is 'much more efficient' than straightforward multiple recording of information on cards.



(11) [F*He always eats* BEANS]

Example (11), an all-focus construction, is simply associated with an UPDATE-ADD(I_S) instruction. Here, this instruction involves the addition of the focus information I_S that the value of the current card always eats beans. That is: if it is interpreted immediately after example (10) and if we leave its adverbially modified transitive verb phrase unanalyzed for simplicity, it amounts to adding the condition 'always eats beans(25)' to card #25.

The presence of a tail in a sentence signals a mode of update different from the straightforward UPDATE-ADD(I_S) instruction. A tail indicates that a (possibly underspecified) record on a file card has to be replaced (or specified further). The material in the tail serves the purpose of determining *which* record. Suppose, for example, that (12) is a reaction to the statement *Since John is dead, we can now split his inheritance*:

(12) *I hate to spoil the fun, but* [F*he is* NOT][T*dead*]

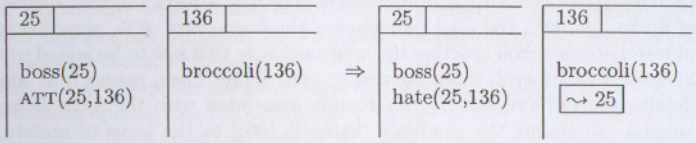
With this focus-tail example, the speaker instructs the hearer to replace the record on the current locus of update—card #17, say, for John—expressing that the value

of card #17 is dead by one saying that he is not dead. In short, the tail serves to highlight a condition on file card #17, the one saying its value is dead. This condition is then modified in the way specified by the material in the focus.

In addition to the option of replacing a record on a file card, there is the possibility of further specifying an underspecified record, something which is assumed to be going on in the link-focus-tail example (13) given below. Suppose now that the newly appointed temp asks the executive secretary whether it was a good idea to order broccoli for the boss, and that the executive secretary gives the following answer:

(13) [L **The boss**][F HATES][T *broccoli*]

The idea is that the temp has an underspecified record on his card for the boss, which says that the boss has some attitude towards broccoli. The lack of information about the nature of this attitude is reflected by the record 'ATT', and it is this record which is replaced by 'hate' after hearing the executive secretary's answer (13):



Different languages choose different structural means to spell out the same informational interpretations. Vallduví studies the manifestation of information packaging in several languages, with an emphasis on Catalan and English. Cross-language comparison shows that in expressing information packaging, languages exploit word order and prosody in various ways. Roughly speaking, English structurally realizes information packaging by means of alternative intonational contours of identical strings, whereas Catalan has a constant prosodic structure and effectuates information packaging by means of string order permutations. In fact, Vallduví argues that languages such as Catalan supply empirical support for the representation of information packaging sketched above, since these languages package their information in a much more salient way than, for example, English. Thus, while informational interpretations may be expressed exclusively by prosodic means in English, information packaging instructions in Catalan are straightforwardly reflected in syntax.

In English, the focus is associated with a H* pitch accent (written in small caps), links are marked by a L+H* pitch accent (written in boldface), and tails are structurally characterized by being deaccented. One and the same string may be assigned different intonational phrasings in order to realize different informational interpretations. In particular, the focal pitch accent may be realized on different positions in the sentence. This is illustrated by the sentences (15), (17) and (19), construed as answers to the questions (14), (16) and (18), respectively:

(14) *What did you find out about the company?*

(15) [F *The boss hates* BROCCOLI]

(16) *What did you find out about the boss?*

(17) [L**The boss**][F*hates* BROCCOLI]

(18) *What does the boss feel about broccoli?*

(19) [L**The boss**][F HATES][T*broccoli*]

In Catalan, the situation is as follows. Metaphorically speaking, one can say that Catalan focal elements remain within a so-called 'core clause', but that ground elements are 'detached' to a clause-peripheral position. In particular, links are detached to the left, and non-link ground elements undergo right-detachment. As a result of detaching both links and tails, the core clause (CC) is left containing only the focus of the sentence:

(20) LINKS [CC FOCUS] TAILS

Consider the Catalan counterparts (21), (22) and (23) of (15), (17) and (19), respectively. The all-focus sentence (21) displays the basic verb-object-subject word order. In (22) and (23), the link subject *l'amo* has been detached to the left. In (23), moreover, the tail direct object *el bròquil* has been detached to the right, leaving a clitic (*l'*) in the focal core clause. Note that intonational structure plays a part in Catalan too, albeit 'a rather lame one' (Vallduví 1993: 33): a focal H* pitch acent is invariably associated with the last item of the core clause.

(21) [F*Odia el bròquil* L'AMO]

(22) [L*L'amo*][F*odia el* BRÒQUIL]

(23) [L*L'amo*] [F L'ODIA][T*el bróquil*]

The above observations provide confirmation that information packaging involves syntax as well as prosody; hence any attempt to reduce information packaging to either syntax (for Turkish, cf. Hoffman 1995) or prosody (for English, cf. Steedman 1991, 1992, 1993) is inadequate from a cross-linguistic point of view.[7] Accordingly, Hendriks (*draft*) treats the range of variation in the structural realization of information packaging as displayed by Catalan and English by means of the sign-based categorial grammar formalism of Hendriks (1994). Basically, this formalism is a both intonationally/syntactically and semantically/informationally interpreted version of a double 'dependency' variant (see Moortgat and Morrill 1991) of the non-associative Lambek (1961) calculus, enriched with the unary operators of Moortgat (1994). The treatment of information packaging it accommodates differs from many of its predecessors (including other extensions of standard Lambek calculus such as Oehrle 1991, Van der Linden 1991, and Moortgat 1993), in that it does not employ focusing operators, but, instead, makes use of 'defocusing' operators that license the presence of links and tails.

Acccording to most approaches, focused constituents are semantic functors which take the non-focused part of the sentence as their argument. This analysis is based on such assumptions as made in Szabolcsi (1981, 1983) and Svoboda and Materna (1987), where focus is not only considered an information-packaging primitive but also an implicit truth-conditional exhaustiveness operator, and on semantic studies of the phenomenon of 'association with focus' as provided by Jacobs (1983), Rooth (1985), Krifka (1991), and others who have argued that the quantificational structure of so-called focus-sensitive operators is crucially determined by the traditional pragmatic focus-ground partition. However, Vallduví argues convincingly that 'the claim that focused constituents truth-conditionally entail exhaustiveness leads to extreme positions' (1992: 170), and Vallduví and Zacharski (1993) show that 'association with pragmatic focus' is not an inherent semantic property of

7. Note, moreover, that the structural realization of information packaging in Catalan involves *both* syntax *and* prosody.

'focus-sensitive' operators, which may express their semantics on partitions other than the focus-ground one—witness obvious cases of association with subsegments of the informational focus, with links, and with other parts of the ground.

This dissociation of the pragmatic focus-background distinction from issues of exhaustiveness and focus-sensitivity dispels the need of analyzing focused constituents as operators which semantically take scope over the non-focused parts of the sentence, which can be considered an advantage. As sentences may lack links and tails, such analyses do not immediately reflect the core status of the focus, which is the only non-optional part of a sentence. In some sense, then, all-focus sentences constitute the basic case, and the cases where there is a ground are derived from such basic all-focus structures.

2 Files in Focus

Vallduví has it that

> [...] a proper understanding of information packaging, i.e., of the actual strategies used by human agents in effecting information update by linguistic means, will help us gain further insight into the structural properties of the cognitive states these dynamic strategies manipulate. (Vallduví 1994: 24)

As we have seen, the basic idea of information packaging is that in discourse, speakers not only present information to their interlocutors, but also provide them with detailed 'instructions' on how to manipulate and integrate this information. With respect to the role of these instructions in the determination of those aspects of the structure of information states which are relevent to natural language interpretation, Vallduví claims the following:

> The use of these instructions reveals that speakers treat information states as highly structured objects and exploit their structure to make information update more efficient for their hearers. (Vallduví 1994: 3)

More specifically, concerning 'the internal structure of information states which is, in fact, crucially exploited by the different information-packaging strategies used by speakers in pursuing communicative efficiency' (1994: 7), it is argued that information packaging instructions contribute in two ways to the optimization of information update, since they provide means to

- designate a file card as the locus of information update and hence circumvent the redundancy of multiple update; and
- identify the information of the sentence and its relation to information already present in the hearer's model.

(Recall that the information of the sentence, I_S, is expressed by the focus, and that the ground has an ushering role with respect to I_S: links indicate where I_S goes, and tails indicate how it fits there.) So, summing up, Vallduví concludes that information states constitute systems that have at least the internal structure of a collection of file cards connected by pointers.

Though the presented arguments may appear to be intuitively quite appealing, it can be argued that, strictly speaking, they are not as compelling as they seem. Somehow, Vallduví is begging the question: 'talking about ushering I_S to a location in the hearer's model K_h [...] does not make much sense unless one assumes some

sort of rich internal structure for K_h' (Vallduví 1994: 7). The relevant question, however, is whether this assumption of 'some sort of rich internal structure' itself makes sense of anything besides the ushering function of links.

If file card systems are assumed, *then* the information-packaging instruction types apparently do contribute to efficient information exchange. And if this assumption is warranted, it may even serve as an explanation of the fact that we do appear to find these ways of packaging information in a variety of languages. Nevertheless, the more theoretical question is whether this assumption itself is warranted, and whether the organization of linguistic information exchange really presupposes such information states. After all, ushers can be very useful, but there are also halls that have unnumbered seats!

Maybe links really make no sense without files, but, for that matter, maybe we simply fail to understand what links do. The notion of 'ushering I_S to a location' may be just as metaphorical as the notion of 'file card collection'. For instance, files are, as Vallduví puts it, 'dimensionally richer' than the card-less discourse representation structures of Discourse Representation Theory (see Kamp 1981, Kamp and Reyle 1993), since each file card introduces its own 'representational space' where all its records are to be found while there is no sensible notion of location in discourse representation structures. Still, a hearer who employs discourse representation structures has an easier job from a bookkeeping perspective than a hearer whose information states are collections of file cards connected by pointers.

This can be illustrated as follows. Imagine an utterance made by Irene, a speaker who organizes her utterances on the basis of the assumption that her audience stores information using collections of file cards connected by pointers, to Hans, a hearer who employs discourse representation structures. Clearly, it would be inappropiate to say that Irene uses links to usher I_S to a location in the hearer's model K_S, since there is no sensible notion of location in Hans's discourse representation structures. Still, this does not at all preclude Hans from updating his discourse representation with the proposition that Irene attempts to get through. And worse, he has even got considerably less to do than a hearer who uses collections of file cards connected by pointers. Compare the following link-focus example:

(24) $[_L\mathbf{Frank}_5][_F$flew from Amsterdam$_9$ to Oslo$_8$ via STUTTGART$_2]$

Neglecting various details, if a file clerk is to update her file in order to represent the information expressed by example (24) in the way sketched above, she has to carry out the following sequence of instructions:[8]

(25) GOTO(5)(UPDATE-ADD(flew(5,9,8,2)))
GOTO(9)(UPDATE-ADD(⌜⇝ 5⌝))
GOTO(8)(UPDATE-ADD(⌜⇝ 5⌝))
GOTO(2)(UPDATE-ADD(⌜⇝ 5⌝))
GOTO(5)

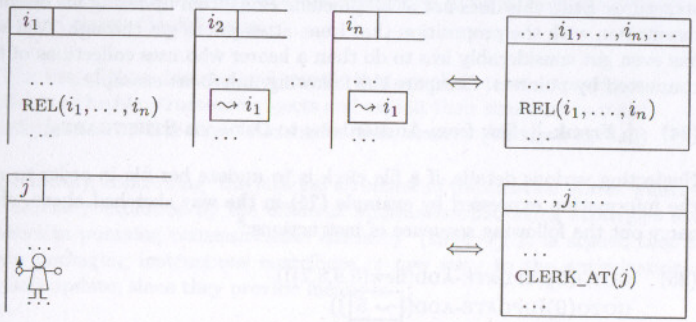
8. Assuming that establishing links to the locus of update is done via packaging instructions—of course, these links have to be established *some*how. Note, by the way, that the file clerk's task would not be made easier by structure sharing (something suggested by Enric Vallduví (personal communication)), because also the structure sharing will itself have to be established somehow—in the following way, for example:
GOTO(5)(UPDATE-ADD(⌜1⌝flew(5,9,8,2)))
GOTO(9)(UPDATE-ADD(⌜1⌝))
GOTO(8)(UPDATE-ADD(⌜1⌝))
GOTO(2)(UPDATE-ADD(⌜1⌝))
GOTO(5)

Hans, on the other hand, only has to carry out the following instruction:

(26) UPDATE-ADD(flew(5,9,8,2))

This example may serve as an indication that none of the data discussed above precludes the use of, say, Kampian discourse representation structures instead of Heimian files. Clearly, there may be evidence for assuming there to be files at work, and one of the last things we would like to claim is that people organize their information in simpler systems than collections of file cards (or discourse representation structures, for that matter). On the contrary. The only point is that the use of files does not appear to be imperative so far.

Notice that Vallduví's conclusion is, in some sense, unfalsifiable. Discourse representation structures can model precisely the same information as file card systems, except for one small difference. The only thing that discourse representation structures lack is a marked discourse referent corresponding to the file notion of 'current locus of update', i.e., the location where file clerk happens to find herself. If we assume that discourse representation structures have a way of marking such a discourse referent j—by a condition 'CLERK_AT(j)', say—, then the two systems differ only in the way in which they display their information: in one big box, or on several cards connected by pointers. But, moreover, one can show that given Vallduví's specific use of pointers to file cards, there is actually a bijective correspondence between his files and the class of discourse representation structures with atomic conditions and one marked discourse referent for the current locus of update. For note that conditions 'REL($i_1, \ldots, i_n$)' are invariably added on card i_1, inducing pointers '$\boxed{\rightsquigarrow i_1}$' on the cards $i_2, \ldots, i_n$. Hence the following correspondence can be established:



The idea that links specify a locus of update in information states that are collections of file cards connected by pointers is problematic for various reasons. First, it is unclear what locus of update must be associated with quantified, negative and disjunctive links, or—more in general—where and how quantified, negative and disjunctive information has to be put. Second, the existence of sentences with more than one link is enigmatic. Third, the replacement operation triggered by the presence of tails is complicated by the use of file cards. And fourth, the approach leads to the counterintuitive conclusion that pronouns form part of the focus. These issues will be addressed in the remainder of this section.

(*a*) Vallduví observes that files are 'dimensionally richer' than the discourse representation structures (DRSs) of Discourse Representation Theory. Now, this is true to the extent that each file card introduces its own 'representational space' where all records concerning that file card are to be found. In order to be actually richer, nonetheless, files must be adapted to model more than merely atomic

conditions—i.e., individuals having properties and standing in relations at various spatio-temporal locations. Among other things, they should be able to model quantified, negative and disjunctive information. Discourse Representation Theory allows the construction of complex conditions from sub-DRSs, and these conditions—by an appropriate semantic interpretation procedure—model precisely such information. Heim, who explicitly speaks of files and file cards as metaphors (1982: 276 and 302ff.), spells out quantified, negative and disjunctive information in purely semantic terms, i.e., in terms of the domains and satisfaction sets of files. However, it is not clear how such information must be expressed in the non-metaphorical file card set-up of Vallduví (1994).

For one thing, what loci of update are specified by the links of sentences such as (27), (28) and (29)?[9] On what file card(s)—if any—should the information expressed by these sentences be put?

(27) [$_{\text{L}}$**Every man**][$_{\text{F}}$WALKS]

(28) [$_{\text{L}}$**No man**][$_{\text{F}}$WALKS]

(29) [$_{\text{L}}$**John or Mary**][$_{\text{F}}$WALKS]

For another, how should this information be put? One might think of using sub-files, but then, where must these be put? Are they attached to a main file, or must they be attached to a main file's file card? Which one? Interestingly, Heim raises similar questions in her 1983 paper:

> Take a simple sentence [...]: *It is raining*. In the context of the file metaphor, one doesn't quite know how to deal with this sentence. As an informative sentence, it ought to call for an updating of the file somehow: but what exactly is the file clerk supposed to do? The information that it is raining does not belong on any particular file card, it seems, since each file card is a description of an individual, but *It is raining* is not about any individual. Should the file clerk perhaps write on some arbitrary card: 'is such that it is raining'? Or should he write that on all cards? And what if the file so far doesn't contain any cards yet? [...] Quantified and negated propositions are similarly puzzling if we are so ambitious as to want to say what exactly the file clerk does in response to them. Under the modest aspect of domain and satisfaction set change, however, they pose no problem. (Heim 1983: 183–184)

It should be noted here that such a 'modest' position cannot be retained in the set-up of Vallduví (1994), because there the entities to be updated must be *files*, *not* their domains and satisfaction sets.

(*b*) Vallduví (1992: 104) notes that there is no structural restriction on the number of links in Catalan. 'Sentences may have more than one link, as in the Catalan example (30).

9. Though 'links tend to be definite NPs' (1992: 77), Vallduví notes the 'restricted existence of indefinite links' (1992: 46). 'Sentences with *quantifier links* are' claimed to be 'less natural than others, causing raised eyebrows among some Catalan speakers. Sentences like *A tots els estudiants$_i$ els$_i$ donen un* CARNET *t$_i$* "To all students they give an ID" or *A tothom$_i$ no el$_i$ tracten t$_i$* IGUAL "Everybody they don't treat the same" are extremely natural, some other sentences sound odder. Most sentences, however, are felicitous once the right context is construed, although in some cases it may require some sophistication' (Vallduví 1992: 153). Analogously, Reinhart notes that if they 'can be interpreted (pragmatically) as denoting sets, universally quantified NPs, as well as specific and generic indefinite NPs, can serve as topics' (1982: 65–66).

(30) [L*El bròquil*] [L*a l'amo*] [F*l'hi van* REGALAR]
the broccoli to the boss *obj-iobj 3p-past* give
Approx.: 'The broccoli the boss (they) gave it to him (for free)'.

In these cases the speaker directs the hearer to go to two addresses and enter the information under both.' (Vallduví 1992: 60). So, assuming that 'they' have card #3 and that the boss and broccoli still possess their respective cards #25 and #136, this means that the sentence is *not* associated with the instruction (31),[10] but with an instruction along the lines of (32).

(31) *GOTO(136)(GOTO(25)(UPDATE-ADD(give(3,136,25)))

(32) GOTO(136)(UPDATE-ADD(give(3,136,25))
GOTO(25)(UPDATE-ADD(give(3,136,25))

But this raises questions. What is the current locus of update after (32) has been carried out? Is the file clerk suddenly simultaneously present on two file cards? If she isn't (suppose she lands on card #25), does this then mean that (32) is equivalant to (33), the instruction associated with the one-link sentence (34)?

(33) GOTO(25)(UPDATE-ADD(give(3,136,25))
GOTO(136)(UPDATE-ADD(⇝ 25))
GOTO(25)

(34) [L*A l'amo*] [F*hi van regalar el* BRÒQUIL]]

But if (32) and (33) are equivalent, then why does Catalan allow multiple links at all? And how could (32) and (33) be non-equivalent—what sense could multiple loci of update make that pointers cannot?

(*c*) Above we gave an informal sketch of Vallduví's analysis of tail-containing sentences in terms of UPDATE-REPLACE instructions. It can be expected that various complications will arise when it comes to giving an explicit formalization of the replacement instructions associated with tails. Any attempt at giving an appropriate and fully general definition of these instructions will have to confront a number of questions. Thus, how exactly do you know which record has to be replaced or specified further? Is there guaranteed to be such a record? Is there a unique one, and what happens if there are more? Is it always one record that has to be replaced, or do we sometimes need to replace a group of records? What kind of match must there be between the material in a tail, and the material in the target record? Of course, these are tough nuts that have to be cracked when it comes to coming to theories of belief revision.

Here we will just present an example which illustrates that the replacement operation triggered by the presence of tails is specifically complicated by the idea that information is organized in file card systems. Suppose that Louis van Gaal utters (35), whereupon Johan Cruijff reacts with saying (36):

(35) [L**Ajax**][F WON]

(36) [F*No,* BARCELONA][T *won*]

Assume the file cards #1 and #2 for Ajax and Barcelona, respectively. Now, clearly, Johan Cruiff here instructs Louis van Gaal to replace his record according to which

10. Note, by the way, that the 'GOTO(3)' constitutes a superfluous detour in instruction (31).

Ajax won by one according to which Barcelona did. Presumably, this should not (only) be done on the card for Ajax. Instead of the straightforwardly simple (37), we seem to need the complex instruction given in (38).

(37) *UPDATE-REPLACE(won(2),won(1))

(38) UPDATE-REPLACE(,won(1))
GOTO(2)(UPDATE-ADD(won(2)))

(*d*) A typical example of the way in which Vallduví analyzes pronouns can be obtained by combining the above example sentences (10) and (11) into one text:

(39) [L**The boss**][F*hates* BROCCOLI]
[F*He always eats* BEANS]

The first sentence is a link-focus construction, and therefore associated with an instruction to go to the file card of the boss, thereby turning it into the current locus of update, and to enrich that file card with the information that the boss hates broccoli (and the broccoli file card with a pointer to the file card of the boss). The second sentence is an all-focus construction, associated with the simple instruction to add the focus information that the value of the current locus of update always eats beans to the current locus of update. Hence if it is interpreted immediately after the first sentence, it amounts to adding the information that the boss always eats beans to the card of the boss.

Note that the pronoun *he* obviously does not induce replacement or shift the locus of update. Hence it cannot be a link or a tail, and this inevitably leads to the conclusion that it forms part of the focus. This is a counterintuitive result, however, since it is also clear that the interpretation of the pronoun is provided by the value of the current locus of update—which does not constitute new information, but can be assumed to be already present in the hearer's information state.

3 Non-Monotone Anaphora

Let us wind up the discussion so far. We have argued that the data discussed above do not enforce the conclusion that information states have at least the structure of a collection of file cards connected by pointers. For that matter, the phenomena can also be accounted for in terms of discourse representation structures, and it is very well possible that circumventing file cards might lead to the avoidance of the complications that were outlined in the previous section.

In view of these considerations, a card-less alternative will be defended in the present section, according to which information states are modelled by means of discourse representation structures, which are ontologically less committed than the 'dimensionally richer' file card system, in that discourse representation structures do not come with locations.

But if, as we have argued, the use of files does not appear to be imperative, then we face a question: what purpose *do* links serve if they do not serve to specify a locus of update by ushering to locations? What does 'ushering to a location' mean if representations do not come with locations? Thus a different perspective on the function of links is required. We would like to suggest a tentative answer which we take to carry less presuppositions than the file metaphor.

The perspective we would like to offer has its heuristic starting point in Kamp and Reyle (1993), who note that processing a plural pronoun does not always involve equating the discourse referent it introduces with one introduced earlier through the processing of some other plural NP. They consider the following example:

(40) *John took Mary to Acapulco. They had a lousy time.*

Here, the plural pronoun *they* does not have a single NP for its antecedent. Rather, the 'antecedent' has to be 'constructed' out of various parts of the preceding text. Such examples, which are very common, seem to suggest that plural pronouns can pick up any antecedent that can be obtained from antecedent information by logical deduction. However, the deductive principles that are permitted in this context turn out to be subject to restrictions.

(41) *Eight of the ten balls are in the bag. They are under the sofa.*

The pronoun *they* in (41) cannot be understood as referring to the two balls that are missing from the bag. Apparently, subtracting one set from another is not a permissible operation for the formation of pronominal antecedents.

The permissible process of antecedent formation displayed by (40) is called Summation: a new discourse referent is introduced which represents the 'union' of individuals (John and Mary) and/or sets represented by discourse referents that are already part of the discourse representation structure. Other permissible processes are Abstraction, exemplified by (42), which allows the introduction of discourse referents for quantified NPs (compare also footnote 9 above), and Kind Introduction, which introduces discourse referents for a certain 'genus' explicitly mentioned in the text by a (simple or complex) noun.If *they* in (43) refers to the (few) men who joined the (conservative) party, we are dealing with Abstraction. The more natural reading, where *they* refers to men in general (and the party is presumably non-conservative), is a case of Kind Introduction.

(42) *I found every book Bill needs. They are on his desk.*

(43) *Few men joined the party. They are very conservative.*

In their discussion of the inferential processes available for the construction of antecedents for (plural) pronouns, Kamp and Reyle suggest the following generalization:

> What sets the admissible inference processes of Summation, Abstraction and Kind Introduction apart from an inadmissible inference pattern such as set subtraction is that the former are [...] strictly *positive* (Kamp and Reyle 1993: 344),

or

> 'cumulative' in the following sense: the newly created discourse referent represents an entity of which the discourse referents used in the application of the rule represent (atomic or non-atomic) parts. (Kamp and Reyle 1993: 394)

Notice that, when this generalization is taken in conjunction with a principle that anaphora invariably involves the addition of an equational condition 'X = Y' for an anaphoric expression with discourse referent Y and a—possibly inferentially created—antecedent discourse referent X (and such an equational approach is standard practice in Dicourse Representation Theory), the necessary result will be that anaphora is always (upward) monotone: if an expression with discourse referent Y is anaphorically dependent on an expression with discourse referent X, then $X \subseteq Y$.

The latter result, however, does not seem to be borne out by the facts. For example, Van Deemter (1992, 1994a) presents cases of 'non-identity anaphora' along the lines of (44), as well as minimal pairs such as (45) and (46):

(44) *Our neigbours are extremely nice* PEOPLE.
He *is a* TEACHER, **she** *is a* HOUSEWIFE.

(45) *John fed the* ANIMALS. *The cats were* HUNGRY.

(46) *John fed the* ANIMALS. *The* **cats** *were* HUNGRY.

It can be observed that the pronouns **he** an **she** are anaphorically dependent on *our neighbours* in (44), but that the discourse referents of the pronouns represent entities which are proper subsets of the entity represented by the discourse referent of the antecedent: obvious cases of non-monotone anaphora.

Moreover, whereas the reading of (45) where *the cats* is anaphoric to *the* ANIMALS strongly and monotonously suggests that all animals fed by John were cats, the reading of (46) where *the* **cats** is anaphoric to *the* ANIMALS does not. It even seems to imply that John fed at least one non-cat.[11] Again, we are dealing with non-monotone anaphora.

Note that the texts (45) and (46) differ only in the assignment of L+H* accent to the noun phrase *the cats*, which is the distinguishing mark of links in English. Hence our alternative hypothesis concerning links:

(47) *Non-Monotone Anaphora Hypothesis* (*NAH*):
Linkhood (marked by L+H* accent in English) serves to signal non-monotone anaphora. If an expression is a link, then its discourse referent Y is anaphoric to an antecedent discourse referent X such that $X \not\subseteq Y$.

As we will show, this hypothesis affects a range of phenomena. It subsumes not only the so-called 'non-identity' anaphora just exemplified and analyzed in Van Deemter (1992, 1994a), but also the cases of contrastive stress discussed in Rooth (1992) and Vallduví (1992, 1994). It contributes to an explanation of the effect of pitch accenting on pronoun referent resolution noted in Cahn (1995), Kameyama (1994), Vallduví (1994), among many others, and it sheds light on the distinction between restrictive and non-restrictive relative clauses and adjectives (see Kamp and Reyle 1993).

(*a*) The relationship between non-identity anaphora and linkhood can be demonstrated even more saliently with relational nouns:

(48) *Ten guys were playing basketball in the* RAIN.
The fathers were having FUN.

(49) *Ten guys were playing basketball in the* RAIN.
The fathers *were having* FUN.

Thus, while (48) has an 'identity' reading where *the fathers* is anaphoric to *ten guys* which suggests that all ten guys playing basketball in the rain were fathers who were having fun, and (49) has a 'subsectional' reading where **the fathers** is anaphoric to *ten guys* which suggests that the fathers who were having fun constitute a proper subset of the ten basketball-playing guys, the latter text also has a—non-monotone—'relational' reading where the fathers *of* the ten guys playing basketball in the rain were having fun.

11. 'Strongly suggests' and 'seems to imply' instead of 'entails', since though the effects are quite strong, they are of a pragmatic, rather than a logico-semantic, nature. See also (*c*), on pronoun referent resolution, below.

Observe, by the way, that Kamp and Reyle's example (40) of Summation, a case of monotone non-identity anaphora in which the pronoun *they* typically apears unaccented, shows that is not so much the 'non-identity' as the 'non-monotonicity' of the anaphora which is responsible for the L+H* accent (that is: the linkhood) of the anaphor.

(*b*) According to Rooth, contrast is the cornerstone of the interpretation of focus phenomena: 'Intonational focus has a semantic import related to the intuitive notion of contrast within a set of alternative elements' (1992: 113), and Vallduví gives the following example of 'contrastive' links (1993:14):

(50) *Where can I find the cutlery?*
The forks *are in the* CUPBOARD, *but*
the knives *I left in the* DRAWER.

However, note that contrast is not really necessary.[12] Mere non-monotonicity is sufficient for L+H* accent:

(51) *Where can I find the cutlery?*
The forks *are in the* CUPBOARD.

(*c*) Many authors have paid attention to the effect of pitch accenting on pronoun referent resolution. The examples below stem from Lakoff (1971).

(52) *Paul called Jim a Republican. Then he insulted him.*

(53) *Paul called Jim a Republican. Then* **he** *insulted* **him**.

For grammatical reasons (parallellism), the preferred antecedents for the unstressed pronouns *he* and *him* in (52) are *Paul* and *Jim*, respectively. The preferences are reverse for the stressed pronouns **he** and **him** in (53).[13]

In the theory of Kameyama (1994), this phenomenon is accounted for in the following way:

- A grammar subsystem represents the space of possibilities and a pragmatics subsystem represents the space of preferences;
- Stressed and unstressed pronouns have the same denotational range—the same range of *possible* values;
- *Complementary Preference Hypothesis* (*CPH*): A stressed pronoun takes the complementary preference of the unstressed counterpart.

However, the *NAH* formulated in (47) actually *predicts* the *CPH* effects: adding L+H* accent to pronouns means the addition of a pragmatic signal that the anaphora involved is non-monotone. In the case of singular antecedents with entity-representing discourse referents, this means that the anaphor does not *not* corefer with its antecedent. As a consequence, pronominal stress turns the grammatically determined preference for a certain antecedent into a pragmatic preference for non-reference with that antecedent.

12. Nor is contrariety (as proposed in Van Deemter 1994b), witness:

Where can I find the cutlery?
The forks *are in the* CUPBOARD, *and* **the knives** TOO.

13. The fact that (53) insinuates that calling someone a Republican is an insult is essentially due to the de-accenting of *insulted* in the second sentence of (53).

(*d*) The sentences (54) and (55) (taken from Kamp and Reyle 1993: 255) illustrate the familiar rule of English orthography that non-restrictive clauses are set apart from the surrounding text by commas, but that restrictive clauses are not.

(54) *The son who attended a boarding school was insufferable.*

(55) *The son, who attended a boarding school, was insufferable.*

Note that (54), in which the relative clause is used restrictively, suggests that there is more than one son, but only one who is boarding. In (55), where the relative clause is used non-restrictively, the suggestion is rather that there is only one son, of whom it is said not only that he was insufferable but also, parentheticlly as it were, that he attended a boarding school. If the prosody of these sentences is taken into account, it will be clear that this pragmatic difference is in keeping with the *NAH* as formulated in (47). Similar observations can be made with respect to the (non-)restrictiveness of the adjectives and nouns in (58) (Kamp and Reyle 1993: 372).

(56) **The son who attended a boarding school** *was* INSUFFERABLE.

(57) **The son**, *who attended a* BOARDING SCHOOL, *was* INSUFFERABLE.

(58) *John fed the* ANIMALS.
The young cats were HUNGRY.
The **young cats** *were* HUNGRY.
The **young** *cats were* HUNGRY.
The young **cats** *were* HUNGRY.

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