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1. Introduction

Overview
Since our theory of metonymy interpretation relies on a full grammar and a Gricean pragmatic component tied to it, a detailed overview of the set-up of the paper might be of help. We first provide an intuitive description of our data and the function of representational metonymies therein (1.1), followed by some initial methodological considerations (1.2). Then we present three arguments which show that only a pragmatic theory of representational metonymies will work (2).

In ch. 3 we develop the syntax-semantics interface for the description of metonymies following Chierchia and McConnell-Ginet (1990, 2000) where SS, LF and *lf* [1] are given for a small fragment of English. It is argued that we need a context-based intensional semantics incorporating characters in the manner advocated by Kaplan (1977) and Stalnaker (1974). Arguments demonstrating the role of contexts in the resolution of metonymies are also provided. Ch. 4 describes the model M used for semantic interpretation. In addition to traditional parameters like the interpretation function *V*, M contains a modal base as argued for by Kratzer and others (1981). Modal bases depend on contexts; they are used for the interpretation of features of "non-classical" indexicality as exhibited by context-dependent lexical items, natural modalities or expressions for which an indirect interpretation must be given. As can be expected, ch. 4 also contains a definition of the interpretation function *V* for *lf*-expressions as well as definitions of truth, validity, and entailment. Some methodological remarks concerning the relation of truth in M and indirect interpretation lead up to the semantics-pragmatics-interface used for the interpretation of metonymies (ch. 5). Chapter 5 contains the newly developed tools for metonymy resolution, the algorithm for reconstructing false *lf*-formulas, and a formulation of Gricean conversational implicature as default based on M. Ch. 6 develops our account of compositional semantics for metonymies. We show that the formulation captures representational metonymies and that it can be easily generalised to other kinds of metonymies. The discussion of more complicated examples in ch. 7 shows that developing theories of compositionality for complex metonymies presents a real challenge, despite the efficient new tools developed. We conclude with remarks concerning future research (ch. 8), several problems remain still to be solved; we hope to handle these on the basis of the theory developed.

1.1 Corpus-based Investigation and Consequences thereof

Experimental setting
We rely in our investigation of metonymies on a corpus of 21 task-oriented dialogues collected at the Research Unit "Situated Artificial Communicators", Bielefeld University, Germany. The experimental setting on which the corpus is based involves an instructor, a constructor and the director of the experiment (see Fig. 2). Instructor and constructor are separated by a screen. The experiment proceeds in the following way: The instructor has built up a toy-airplane called "Baufix"-airplane according to the product's name (see Fig. 1). The constructor has all the necessary parts to assemble an object of this kind.

[1] We use GB-terminology here. "SS" means surface structure, "LF" logical form, "*lf*" is an addition of Chierchia and McConnell-Ginet's; it denotes formulas in an intensional predicate logic. "DS" used later on means deep structure

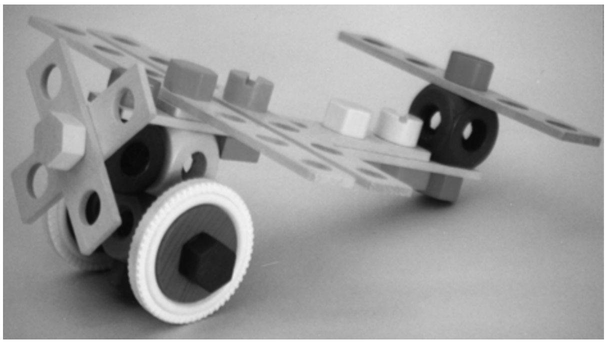

Fig. 1 „Baufix“-airplane

The task then consists in the constructor’s building up the airplane according to the directives of the instructor. This setting gave rise to ample empirical data such as transcriptions of construction dialogues, speech recordings, video films of agents’ actions and studies of their eye-movements during assembling processes.

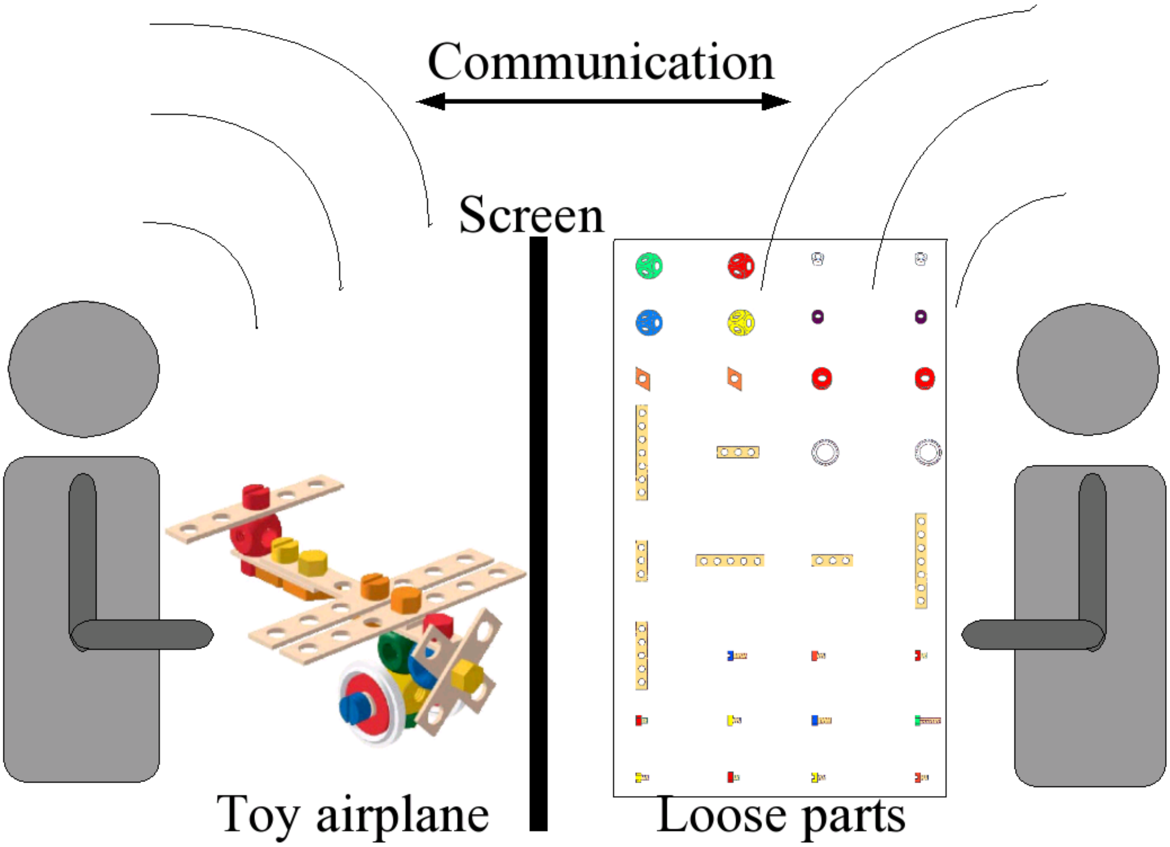

Fig. 2 SFB-Setting

Metonymy in Use

Agents. A prominent feature of the lexicon of the construction dialogues is that instructor and constructor use airplane terminology for parts and aggregates. We call wordings of this kind “representational“ or “depictional” metonymies, since they are based on a relation of representation or, more specifically, of depiction. The use of these metonymies is of considerable importance for the progression of the dialogue and the accomplishment of the task. A few observations may add substance to this claim:

The instructor makes use of depictional metonymies in order to further different aims. He wants to categorise aggregates difficult to describe in pure “Baufix“-terms as belonging to a certain kind (propeller, wings, tail, fuselage); this is done in order to anticipate the future result of a sequence of instruction-action pairs or to test whether the constructor’s last actions match the instructor’s overall intention.

An even more subtle use can be observed in the following context: In order to map topological orientations like left, right, top, bottom or front, rear onto the “Baufix“-aggregates, the intrinsic orientation of an airplane (nose, tail, left wing, right wing etc.) is exploited. As a consequence, the orientation can be relied upon in directives involving regions as in *The nut goes to the bottom of the fuselage*. Observe that in general it is the instructor, who does the “dubbing“, and the constructor, who learns how to classify things according to the instructor’s intent.

As one would expext, metonymies are used in referring and predicating expressions.

Research Strategy.

Observations wrt the Corpus. The use of metonymies in the corpus can be characterised in the following way: Agents use expressions for objects which do not exist in the construction situation, namely planes and their parts. However, applying “plane terminology“, they manage to refer to things which do exist in the construction situation, namely “Baufix“-parts and “Baufix“-aggregates. The agents’ use of words has to meet their needs at stake, of course. Since the agents either demand manipulation of objects or manipulate objects, it is, theoretically speaking, extensions of natural language expressions (reference and truth with respect to a changing domain) that matter. Determining an agent’s intended extension is a difficult thing to do: In rare cases we can get information from video films or eye-tracker data.

The effects of agents’ wordings, metonymical or not, can be traced throughout the construction dialogues. *Vis-à-vis* the task there are felicitous uses and failures, leading to swift progression or backtracking sequences respectively.

Hypothesis Concerning Depictional Metonymies. Concerning the occurrence of depictional metonymies, we subscribe to the following hypothesis: Since “Baufix“-aggregates depict real-world entities, namely airplanes and their parts, agents can use names of real-world entities (“airplane“, “tail“ etc.) to stand proxy for names or descriptions of “Baufix“-aggregates. As a consequence, two relations are of interest to us:

(α) the relation of “Baufix“-aggregates to entities in the world (planes and their parts), *i.e.* the depicting power of the assembled aggregates and

(β) the relation of expressions (plane terminology) to “Baufix“-aggregates, *i.e.* the interpretation of the plane terminology used.

Dealing with other real-world domains, for example referring to computer icons, shows that metonymy is ubiquitous and not restricted to construction dialogues. This will become clear from our discussion of numerous examples in the following (ch.s 6 and 7).

After these remarks on data, we first turn to more general problems concerning the explanation of metonymies.

1.2 Guiding Methodological Principles and Set-up of Theory

A first question we have to address is where we want to place the locus of explanation for metonymies. Trading upon the linguistic and the philosophical folklore, we could try to provide an explanation in terms of either the lexicon and word senses, morphological composition, or logical form (the syntax of a logical language) and interpretation (models). The morphological aspects, although quite revealing, will be put aside in this paper, where we will focus on matters of logical form and interpretation.
We concede that metonymies can be lexicalised; as a rule, however, this is not the case. So we will not have lexical entries for *Marx* in the sense of "book written by Marx", for *six-cylinder* in the sense of "cars with motors having six cylinders" or for *airplane* in the sense of "toy airplane". Since patterns generating metonymies are extremely productive, it seems neither possible nor advisable to lexicalise them. Observe that even if we relied on lexicalisation, we would not provide an explanation doing justice to their productivity. It follows that metonymies cannot be taken as homonyms or ambiguous expressions like *bench*, which has more than ten lexicalised senses[2].
If metonymies cannot in general be treated as ambiguous expressions, it might be revealing to look at their interpretation. See what that could give us. We start from a word like *airplane* and consider the set of models which satisfy sentences like *This is an airplane*. We might then scan through our models and detect that a subset of them also satisfies *This is a self-propelling aircraft* and another disjunctive subset *This is a toy*. Hence we see that the expression *airplane* covers complementary domains, and we may conclude that if we get one interpretation, we do not get the other. But that is about all.[3]

Our aim is to develop a framework for the description of depiction metonymies and to show that it can be generalised for other types of metonymies such as representation, part-whole, type-token etc.

From the theoretical point of view, several objectives are at issue: the structure of depicting objects, indirect interpretation, the semantics-pragmatics borderline, the structure of complex default implications and general problems of interface construction (syntax – intensional semantics, semantics – Gricean pragmatics).

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[2] The OED (The Oxford English Dictionary, 1989)lists the following major readings for *bench*:

(1) a long seat
(2) a seat or thwart in a boat
(3) the judge's seat
(4) the place where justice is administered
(5) a court of justice
(6) the judges or magistrates collectively
(7) a seat where a number of persons sit side by side in some official capacity
(8) the dignity of occupying such a seat (*scl.* wrt (7))
(9) an article of furniture similar in form to the long seat
(10) the ledge or floor upon which the retorts stand in a retort-house
(11) a collection of dogs as exhibited at a show on benches or platforms
(12) a natural terrace
(13) to furnish with benches

Observe that the readings (2) to (13) are all metonymies derived from (1). This illustrates how productive a (lexical) process the derivation of metonymies is.

[3] Observe that it is this property that we exploit in working with the Gricean Quality maxim within our default-based theory of metonymy.

The set-up of the theory proper implementing these arguments is shown in the diagram in Fig. 3.

Based on empirical observations ①, we go on to develop a GB-based grammar for a small fragment of English containing metonymical expressions. Grammar development follows Chierchia and McConnell-Ginet (1990, 2000). First we specify the fragment's syntax and its logical form LF ②. LF- expressions are translated into formulas of an intensional predicate calculus (IPC), called *lf* ③. These formulas get an interpretation wrt a model M ④. Literal interpretations of metonymies turn out to be false (or non-relevant) ⑤. *lf*-expressions false in M are reconstructed using an operator Op in order to determine possible scopes of metonymies ⑥. A reconstructed formula is fed into a Gricean conversational implicature defined as a default ⑦. Then the original *lf*-expression gets a pragmatic interpretation via the implicature ⑧. It intuitively represents the metonymical reading of the *lf*-expression originally started with: E. g. if we started with *This is an airplane* which turned out to be false, we will end up roughly with *This is an airplane-representing object* ⑨, which is true if all goes well ⑩. It is shown that this formula can be used for purposes of information processing, the determination of anaphora, establishing semantic relations etc.

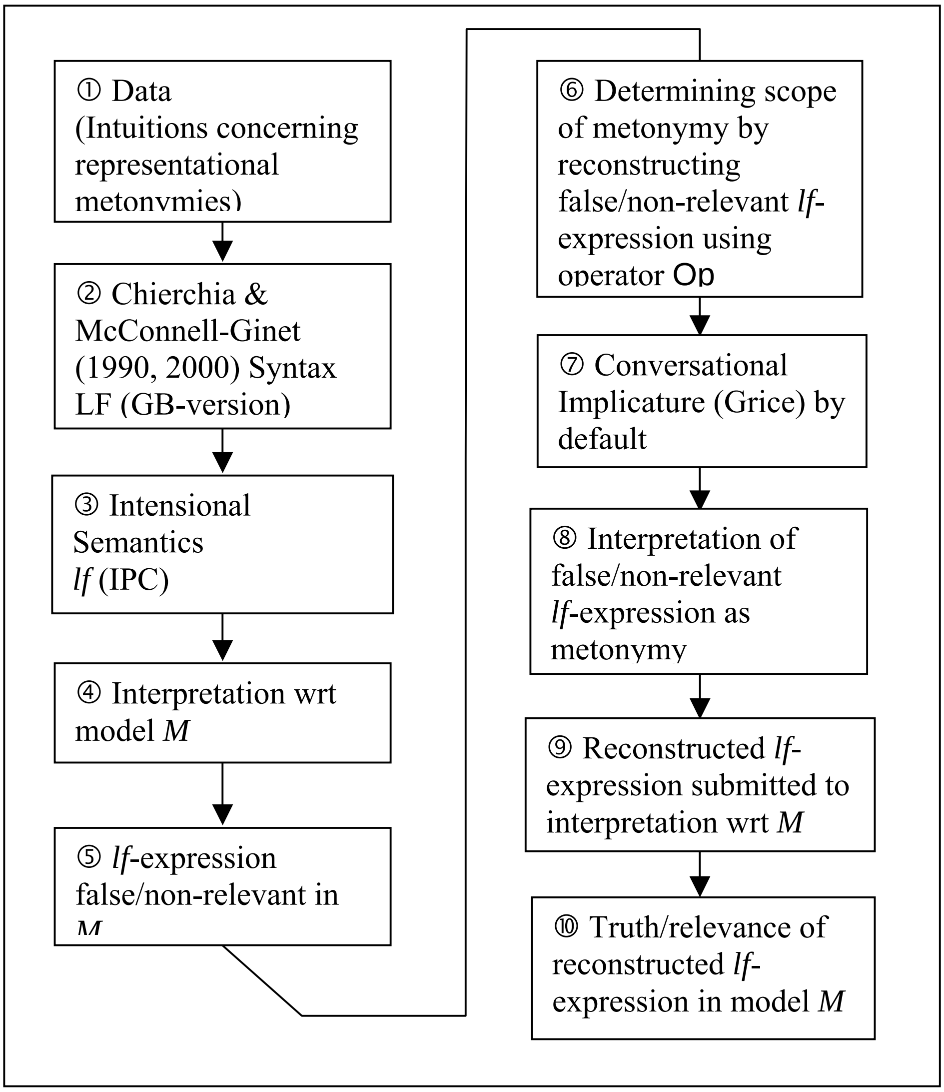

Fig. 3 Setup of Theory

2. Strategy Pursued

We now want to add substance to the following argument: Interpretation of metonymies can be based on the non-satisfiability or non-relevance of the literal interpretation of the respective NL-expressions wrt some (usually the actual) context *c*. Non-satisfiability or non-relevance then serves as a link for a semantics-pragmatics interface and provides a starting point for the pragmatic interpretation providing the meaning needed.
However this might be too rash a decision, since, at first sight, several options seem to be open to us:
Firstly, we might try to conceive of metonymies as normal word meanings, treating the word forms involved like homonyms.
Secondly, a different solution emerges if we exploit the representational resources provided by a syntax-semantics interface. The syntax-semantics interface we use here is GB-based, mainly because it opens up the possibility to use formulas at the levels of LF (roughly PC) or *lf* (roughly intensional PC) in order to give expressions metonymical interpretations *via* some model M.
Thirdly, as already indicated, a pragmatic solution seems feasible: The non-literal interpretation can be generated using a sophisticated pragmatics tool.
Finally, something will have to be said concerning underspecification accounts and metonymy resolution. Perhaps we could avoid the whole gamut if we simply stated that the interpretation of certain expressions is undecided, it could be a literal interpretation or one based on some of the relevant types of metonymy. We discuss these topics in turn.

2.1 Metonymies and the Lexicon

Consider the following roughly contextualised examples:

(1) *This is an airplane* (mother pointing at toy airplane to child).
(2) *Germany* (pointing to label "Gerhard Schröder") *votes against the US* (pointing to label "George W. Bush").
(3) *This is now 8.000 €* (pointing to a Jaeger LeCoultre wrist watch).[4]
(4) *The schnitzel complained* (waiter to cook).
(5) *I am the red Ferrari* (said by Michael Schuhmacher to the McLaren Mercedes guys).

For (5) no lexical treatment seems to be feasible, and the same holds true for (3) and (4). Similarly, we would not like to maintain that represented institutions enter into the meaning of proper names in a way such that e.g. "Germany" acquires the meaning "Schröder" and "the US" the meaning "Bush".
For "airplane" one could try to establish various senses such as

(1a) real airplane,
(1b) airplane model,
(1c) airplane picture,
(1d) noise of airplane,
and so on.

[4] The sort of metonymy involved here is called *token-for-type*. The meaning expressed in (3) is that an object of the kind indicated by deixis is now 8000 €, whereas the object pointed at might have been less at the time of purchase

However, if we did so, we would make the lexicon a source of indirect interpretation and blow it up by a large factor. Strictly speaking, it would have to be infinite, and create pseudo-ambiguities. As a consequence, we would overlook the fact that the relevant readings arise in particular contexts equipped with special coordinates. Observe also that all of the examples above are tied up with contexts and indexicals anyway. Even if we admit that some of the metonymies could be lexicalised such as “white” and “black” in a chess context, lexicalisation does not seem to be a feasible general strategy for metonymy resolution.

2.2 Metonymy Resolution at the Level of Logical Form (LF or *lf*) and Models M

From the arguments in 2.1 one can already gather that an additional information source for the interpretation of metonymy is needed. In 2.1 we identified the information source with the extra readings of words but only to finally dismiss the approach.
Next we have a look at LF, *lf* and some associated model M in order to find out where to situate metonymy information. In other words, we investigate solutions along the lines of pure syntax and semantics here. Concerning LF and *lf* we may attempt to discuss either the parsing perspective or generation matters. We already did away with lexicalisation of metonymies; sticking to this decision, a stock-in-trade parsing tool using LF or *lf* levels would not be able to transport metonymical information. Looking at generation, we might use a paraphrase like “something x which depicts airplanes”, lexicalise it by one terminal “airplane” and accordingly restrict the interpretation of “airplane” in M. Following this lead, we would merge information tied up with a (perhaps very special) context *c* into LF and *lf*, which amounts to a contextualisation of these levels. Going this way would mean to loose generality. Surely, if we aim at a process neutral grammar, i.e. one not committed to either parsing or generation, handling metonymy at the LF or the *lf* level is no serious option.
What then about the model M and separate truth conditions for metonymical readings? This could work, if we took the liberty of introducing indices at the lexical level and get entries like $\text{airplane}_{\text{real}}$, $\text{airplane}_{\text{metonymical}_1}$, ..., $\text{airplane}_{\text{metonymical}_n}$. As truth conditions will refer to these indices, this again amounts to a hidden form of lexicalisation which we already declined on independent reasons.
Similar arguments hold for the resolution of metonymy using disjunction in the meta-language.

2.3 The Pragmatic Shift

If the arguments above are based on plausible assumptions and the conclusions have been correctly drawn, no metonymy resolution, however sophisticated, can be based on LF, *lf* and the respective model M. The following conclusion seems to be warranted: Metonymy resolution cannot be solely based on the object language and its model. So, if there is a way out, it must needs be a pragmatical one. Using Gricean conversational postulates, we may reason that if conversational maxims are flouted, a metonymical reading can obtain by default.

Taking resort to the default notion, we avoid the strength of entailment. We will show in sect. 5.4 how, tying the default interpretation to a context *c*, we can further specialise the default. In view of the examples (1) to (5) above this seems to be a desirable move.

In the following, we want to investigate which parameters go into the interpretation of metonymies.

Besides knowing the fact that the Gricean quality maxim is flouted in (1), we need knowledge as to which part of the utterance is responsible for the lack of satisfaction of the literal meaning and as to what the context indicates. We want to show that by the following examples. Examples (6) – (10) were chosen to indicate that the interaction between context and utterance does not yield a metonymical interpretation. In comparison, example (11) shows the opposite.

Suppose, e.g., speaker and addressee standing in front of a yellow (real-world) car and a green (real-world) bike. The speaker says
(6) *The car is green.*
Although the literal meaning is not satisfied in these circumstances, there is no reason for a metonymical interpretation. In fact, no metonymical interpretation comes to mind that could be satisfied: A benevolent hearer will suppose the speaker had a slip of the tongue, intending to produce *the bike* instead of *the car* or *is yellow* instead of *is green*. The addressee will probably just give up in cases where in the above situation the speaker says
(7) *The car is violet.*
or
(8) *The train is purple.*
In the case of
(9) *The train is yellow.*
he might consider a slip of the tongue replacing *car* by *train* because in fact there is a yellow object.

In case speaker and addressee are in front of a green bike and a colour picture of a yellow car and the speaker says
(10) *The bike is purple.*
no metonymical interpretation will occur/make sense/be justified.
However, if in this situation the speaker says
(11) *The car is yellow.*
there are two possible metonymical readings:
(12) *The car shown here is yellow.*
and
(13) *The car on the picture is yellow.* (In the sense of *The area of the picture representing the car is yellow*.)
As the examples make clear, three conditions are involved in triggering metonymical interpretation:
(i) A maxim is violated due to an assertion about an object A.
(ii) Some constituent X is responsible for trouble.
(iii) The context indicates that an object represents a class of objects denoted by X.

The violated maxim need not always be the quality maxim; if speaker and addressee stand in front of a grey table with a yellow helicopter model on it and the speaker says:
(14) *This is not an airplane.*
his utterance is satisfied in its literal sense but irrelevant. The metonymical reading
(15) *This is not a model of an airplane.*
is equally satisfied and may be considered relevant.
In sum: Semantics is characterized by a systematic, normally compositional derivation of truth conditions from utterances. It uses a formal language and a deductive apparatus.
In our case of metonymical utterances, it is only important that the truth conditions or relevance of the literal meaning are violated in the actual circumstances.

For triggering metonymical interpretations, it is however important that speaker and addressee are aware of the fact that the truth conditions of the utterance are not satisfied or relevance does not obtain in the actual circumstances. In other words, this fact must be part of the common ground of speaker and addressee. It is also important that the addressee supposes cooperativity in the Gricean sense on the part of the speaker. This clearly falls into the realm of pragmatics, not of semantics.

2.4 A Note on Underspecification

Following Asher and Lascarides (2003), we take quantifier scope as the paradigm example of underspecification accounts: Grammatical information does not determine quantifier scope. At first sight, we could set up a similar argument for metonymical *vs* literal readings. The idea in underspecification accounts of the sort we are considering here is to establish an additional representational level which by itself can take object language expressions as values. So, in a sense, object language expressions build the model for the "higher" representation language which provides partial descriptions of a class of resolved object language structures.
How would underspecification accounts fare *vis à vis* literal *vs* metonymical readings? The argument is that given the considerations in 2.1 and 2.3, literal readings and metonymical readings are not to be treated on a par. In other words, there is no object language level containing expressions for literal and metonymical readings. Hence, there can be no "higher" representation acquiring literal or metonymical values and metonymy problems cannot after all be modelled according to the paradigm of quantification.

3. The Syntax-Semantics Interface

We do not place any special restrictions on the grammar we want to work with. The paradigm chosen must of course have the power of the PC and it must also be equipped with models containing contexts, possible worlds and instants of time. I.e. the core of the semantics to be used will be an extended modal or intensional logic. In addition, the logic has to be set up in a way to yield a robust interface to Gricean pragmatics. In order to get that we need definitions of truth, validity and entailment, above all a definition of truth presupposing the notion of a model. This being the case, several paradigms attractive for various reasons such as constraint-based grammar with MRS are not open to us. We must rely on a fairly well-equipped modal logics.
We develop the grammar only to the extent necessary to deal with our problems, i.e. to specify the interface links needed in order to get a pragmatic interpretation for expressions containing metonymies. The same holds good of the empirical examples we choose. For didactic reasons we elaborate most of our ideas wrt to example (1); more complex examples will be taken up in ch.s 6 and 7.

(1) *This is an airplane.*

The noun *airplane* will finally get an indirect interpretation, namely "something depicting a set C of objects all of which are airplanes". We frequently find a combination of deixis, expressions to be interpreted in the most direct way imaginable, and indirect interpretation in our corpus. Deixis also determines the set-up of the semantic framework to be chosen to a large extent, as we shall soon see.

The grammar follows Chierchia and McConnell-Ginet's fragment F_3 (Chierchia and McConnell-Ginet (2000), p. 399); because of minor modifications we refer to it as F_3'.

3.1 Context-free Base

(16)	*a.*	S	→	NP Pred
	b.	S	→	S conj S
	c.	VP	→	V_{cop} NP
	d.	VP	→	V_i
	e.	VP	→	V_i PP[to]
	f.	VP	→	V_{dt} NP PP[to]
	g.	INFL	→	$\text{(NEG)} \left\{\begin{array}{l}\text{PAST}\\ \text{PRES}\\ \text{FUT}\\ \text{M}\end{array}\right\} \text{3rd SNG}$
	h.	M	→	might, can, must
	i.	Pred	→	NFL VP
	j.	NP	→	Det (Nom)
	k.	PP[to]	→	to NP
	l.	Det	→	this, that, the, an, ...
	m.	N	→	Max, Peter, ..., $x_{n[\text{PRO, FEM, ...}]}$, ...
	n.	Nom	→	airplane, car, bird, ...
	o.	V_i	→	be left, be right, ...
	p.	V_{cop}	→	be
	q.	V_{dt}	→	give, show, ...
	r.	conj	→	and, or
	s.	NP	→	N
	t.	$\hat{S}$	→	COMP S
	u.	VP	→	V_S $\hat{S}$
	v.	V_S	→	believe, know, regret,...
	w.	COMP	→	that

It should be clear that we are not concerned with questions of descriptive adequacy here. The grammar generates expressions like

This be an airplane (henceforth (1')),
Peter believe/know that this be an airplane,
The airplane be left to the car and/or the car be right to the airplane,
Max give that airplane to Peter.

The map from SS to PF[5] will produce correct sentences, i.e. translate (1') into (1). What is of interest for us is the mapping of SS-expressions onto a logical form and the ensuing translation into a formula of IPC.

[5] PF abbreviates "phonetic form".

3.2 Raising Rules and LF

For moving *in situ* quantifier phrases like *an airplane* in (1') and introducing variable-like entities we need rule (17) for quantifier raising. In addition, to get a suitable interpretation for tenses, rule (18) for INFL raising is used, yielding wide scope for PAST, PRES, and FUT in (16*g*), respectively. (16) as it stands, conflates DS and SS. The rules (17) and (18) also provide the map from SS to LF.

(17) $[_S\ X\quad \mathrm{NP}\quad Y] \quad\Rightarrow\quad [_S\ \mathrm{NP_i}\ \ [_S\ X\ \ e_i\quad Y]]$,
where NP = [Det Nom] and X and Y cover the rest of the sentence.

(18) $[_S\ \mathrm{NP}\ \ \mathrm{INFL}\ \ X] \quad\Rightarrow\quad [_S\ \mathrm{INFL}\ [_S\ \mathrm{NP}\quad X]]$.

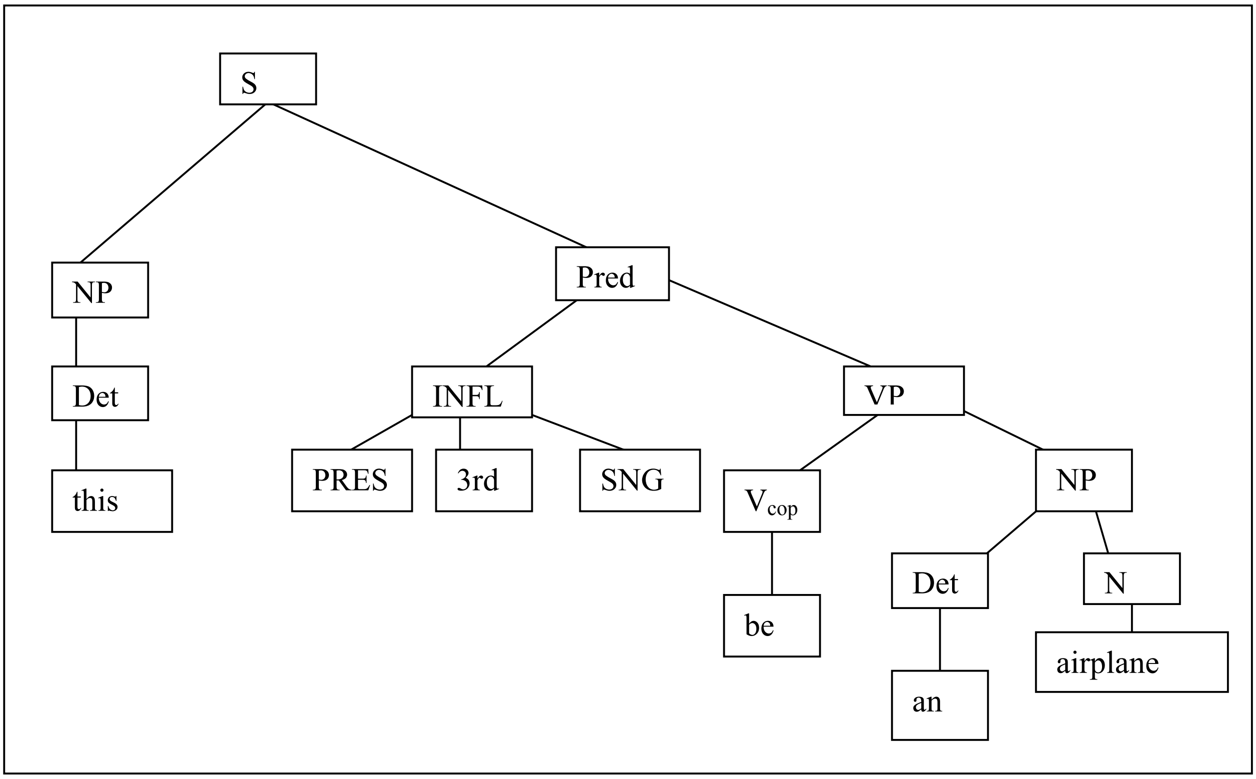

Fig. 4 S-structure

We do not want to go deeper into matters of grammar engineering than necessary here. For (1) we get the S-structure (Fig. 4) and the LF (Fig. 5) which is also represented as labelled bracketing (19).

(19) $[_S[_{NP_i}$ an airplane$][_S[_{NP}$ this$]\ [_{Pred}\ [_{VP}[_{V_{cop}}$ be $e_i]]]]]$.

We do not represent the effects of INFL-raising, because the interpretation of PRES needed does not add anything to the truth conditions of present tense sentences as can be seen from (23*h*) below.

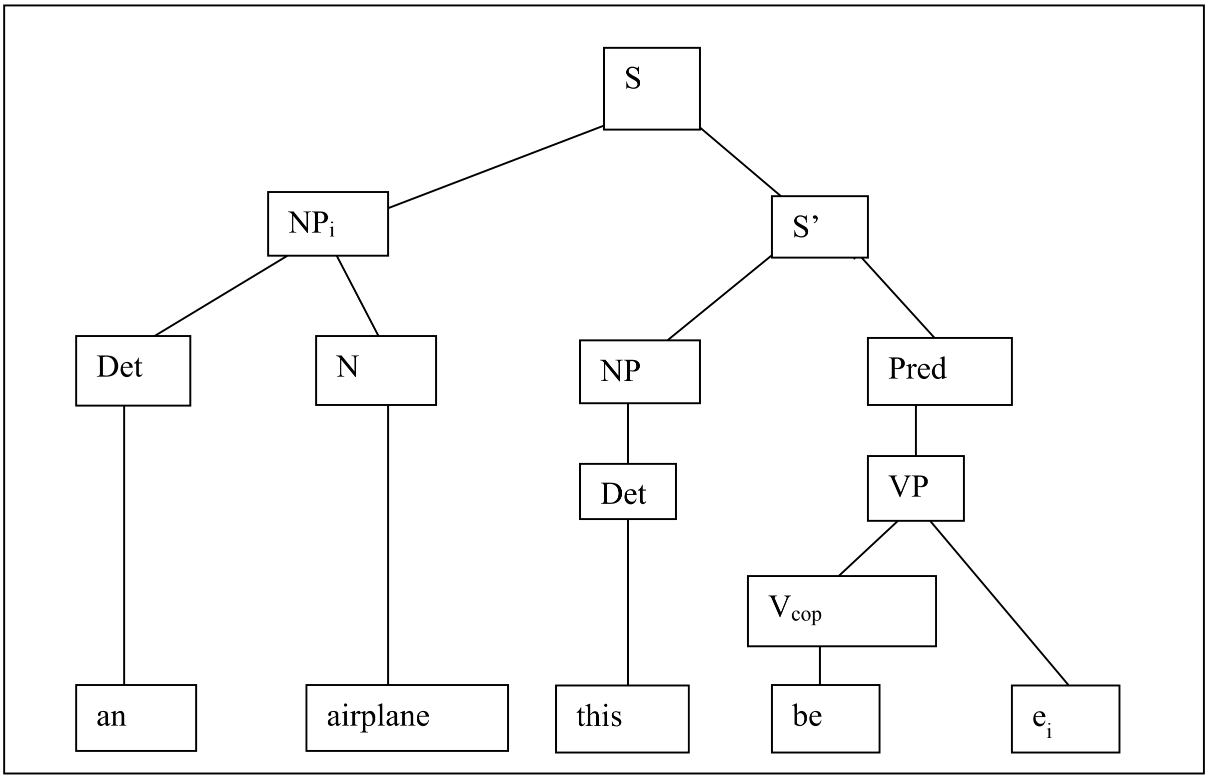

Fig. 5 LF of (1) *This is an airplane.*

3.3 Translation from LF to IPC and *lf*

Next we need a recursively defined translation form LF to IPC. First a correspondence between the categories of (16) and those of the IPC is provided. The correspondence gives the logical type of the expressions. It specifies which sort of semantic entities will be attributed to expressions of the different syntactic categories by the interpretation depending on the model (see Chierchia and McConnell-Ginet (2000), pp. 400).

(20)

F_3'	IPC
N, Det_{NP}	individual terms (variables and constants)
V_i	$Pred_1$ (one-place predicates)
Nom (common nouns)	$Pred_1$
V_{cop} (copula)	$Pred_2$ (copula *be*, two-place)
V_t (transitive verbs)	$Pred_2$ (two-place predicates)
V_{dt} (ditransitive verbs)	$Pred_3$ (three-place predicates)

Some of the lexical entries of F_3' have logical particles as their meaning. (21) provides a list of them where α' indicates the translation of α into IPC.

(21) NEG' = $\neg$
and' = $\wedge$
or' = $\vee$
FUT' = **F**
PAST' = **P**
that' = ^
t_n = x_n, where t_n is a trace or pronoun
be' = " = "
a' = $\lambda P \lambda S\ \exists x_i(P(x_i) \wedge S)$

Nonlogical lexical entries are translated by the convention given in (22):

(22) If α is of lexical category A, α' is a constant of IPC of the appropriate type as defined by table (20).

(20), (21), and (22) give us a translation of the atoms into IPC; what we have to achieve next is a translation of the constituents of LF into IPC, more precisely, into *lf*. As dictated by considerations of compositionality, every node of an LF tree gets a translation in terms of its daughters. For any category A, A' stands for the translation of the subtree A. Hence we arrive at (23) (taken over from Chierchia and McConnell-Ginet (1990), p. 326, cf. also Chierchia and McConnell-Ginet (2000), p. 402).

(23)

a. If $\Delta = [_A\ B\ ]$ or $\Delta = [_A$ to B], then $\Delta' = B'$
b. If Δ = [NP Pred], then Δ' = Pred'(NP')
c. If $\Delta = [\ S_1$ conj $S_2]$, then $\Delta' = S_1'$ conj' S_2'
d. If Δ = [V NP], then $\Delta' = \lambda x[V'(x, NP')]$
e. If Δ = [V NP PP], then $\Delta' = \lambda x[V'(x, NP', PP')]$
f. If $\Delta = [_S$ COMP S], then Δ' = COMP' S'
g. If $\Delta = [\ NP_i\ S]$, then
if $NP_i = [\text{every } \beta]_i$, then $\Delta' = \forall x_i[\beta'(x_i) \rightarrow S']$
if $NP_i = [\text{a } \beta]_i$, then $\Delta' = \exists x_i[\beta'(x_i) \wedge S']$
if $NP_i = [\text{the } \beta]_i$, then $\Delta' = \exists x_i[\beta'(x_i) \wedge [\forall y\ [\beta'(y) \rightarrow\ x_i = y] \wedge\ S']]$
h. If Δ = [INFL S] and TNS = PRES, PAST, or FUT, then
if INFL = PRES AGR, then Δ' = S'
if INFL = PAST AGR, then Δ' = PAST' S'
if INFL = FUT AGR, then Δ' = FUT' S'
if INFL = NEG TNS AGR, then Δ' = NEG' [TNS AGR S]'

The *lf*-translation of (1) is

(24) $\exists x\ (\text{airplane}'(x_i) \wedge \lambda y = (y,x_i)\ \text{this}')$

cf. (Fig. 6) below.

The quantifiers $\forall$ and $\exists$ in (23)g must be interpreted with respect to domains of discourse that depend on context and circumstances. This will be discussed in more detail in sect. 4.1.

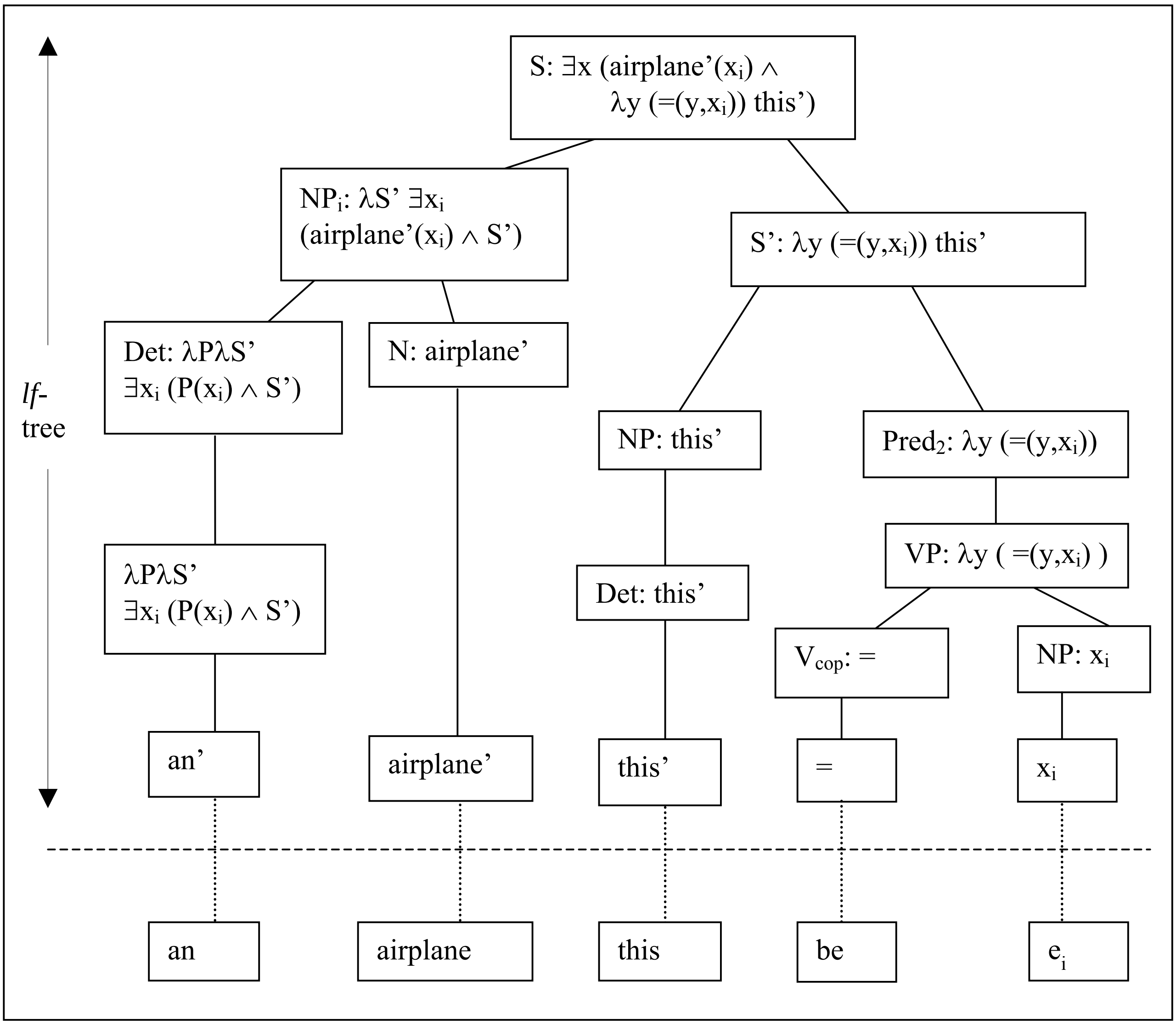

Fig. 6 Translation of LF of **Fig. 5** into *lf*

Even if the *lf*-translation is fairly straightforward, we briefly comment upon it in bottom-up fashion starting with the S containing the trace e_i. (21) renders *be* as identity "=", handed on to V_{cop} by (23*a*). The trace e_i yields a variable x_i by (21). (23*d*) gives us the VP's value λy (= (y, x_i)). Due to (23*a*), the λ-expression becomes also the value of $Pred_2$. The value of the NP, *this'*, is computed via (20), (22) and (23*a*). Then (23*b*) maps S onto λy (= (y, x_i)) *this'* with the x_i still to be bound. So, what we have so far is a sentence with a free variable, x_i . The fronted NP (= NP_i) resulting from quantifier raising (see raising rule 17) is built up in standard type-logical fashion. The structure of NP_i is [*an* β], β = *airplane'*, hence we arrive at the formula $\exists x_i$[*airplane'* (x_i) $\wedge$ S'] according to (23g). Deviating from 23g, we prefer to get this formula by a more detailed analysis translating the indefinite article *an'* into $\lambda P \lambda S' \ \exists x_i$

($P(x_i) \wedge S'$) as given in (21), last line and applying it to the argument *airplane'*. Indexing of the variable x is guaranteed by the trace in the raising rule. Then normal λ-conversion yields the formula $\exists x_i$ [*airplane'*(x_i) $\wedge$ =(*this'*, x_i)] as demanded.

3.4 Context Theory, Characters and the Modal Base

We pointed out above that utterance (1) shows characteristics of direct and indirect interpretation. In (1) direct interpretation is tied to *this*, indirect interpretation to the metonymically used *airplane.* Words like *I, here, there,* and *this* are referred to as indexicals in the linguistic and the philosophical literature. Before we start to discuss questions of indirect interpretation in greater detail, we have to be clear about the contribution of contexts to the interpretation of indexicals. One of the reasons is, as we will show below, that indexicals can play an important role in the context of metonymy interpretation but metonymies are also firmly tied to contexts independently.
In order to get appropriate values for indexicals like *this* two strategies are open to us: We can either set up an index with multiple coordinates as originally proposed by Lewis (1972) or establish an additional level of interpretation in the manner advocated by Stalnaker (1974) and Kaplan (1977). The latter route is to be preferred on methodological grounds: There is no need to change the theory in order to cope with new aspects of contexts. This strategy is also taken in Chierchia and McConnell-Ginet (2000), p. 340, our paradigm model for the syntax-semantics integration. The additional level referred to contributes so-called characters over and above Fregean intensions and extensions to the description of content.
There are several reasons for introducing characters depending on contexts *c* as we now set out to explain. The semantic values of indexicals depend on special coordinates of the context *c*, thus the interpretation of *I* on the speaker coordinate, of *you* on the coordinate for the addressee, *this* on the coordinate for the object made salient and so on. In contrast, the interpretation of descriptive expressions such as phrases containing verbs, nouns or adjectives is contingent upon coordinates like possible worlds *w* and instants *i*. Pairs <*w, i*> of possible worlds and instants are referred to as *circumstances* in the following. We have a division of labour between contexts and circumstances. Contexts provide the structure for the interpretation of indexicals. Circumstances let us decide about the truth or falsity of expressions *in toto*. In addition, sets of relevant circumstances are designated as “modal base”. For different applications such as specifying standards of normality, circumstances can be ranked using independently provided “ordering sources”.
Another observation supporting the distinction between contexts and circumstances is that circumstances can be generalised over, which is not true of contextual coordinates (cf. Chierchia and McConnell-Ginet (2000), p. 338). In contrast, contextual coordinates are systematically shifted in verbal interaction as is made manifest by the change of speaker, addressee or salient object in construction dialogues. The interpretation of indexicals of various kinds is in a way tied together by the context chosen. Seen from a foundational point of view, the interpretation of indexicals remaining constant provides a principle of individuation for contexts.
As a consequence of the context *vs* circumstances distinction, semantic interpretation is a two-stage process: Characters, i.e. interpretations *V*, are defined on contexts *c* yielding intensions. Intensions in turn fix extensions for given circumstances <*w, i*>, i.e. pairs of possible worlds and instances. Contexts *c* thus act like “special domains” or knowledge sources containing speaker, addressee, indicated objects and salient locations. Whether some parameter goes into the context *c* or is merely reflected through changing circumstances depends on the perspective maintained with respect to indexicality. Modal bases and ordering sources are also

best conceived of as aspects of contexts, since it seems to be contextually specified what has to be regarded as necessary, obligatory or simply normal. The information in modal bases can in principle be also put to other uses, so for example it may serve as a basis for modelling of common ground.

We now have to investigate whether the context *vs* circumstance distinction is also relevant for getting at the meaning of metonymical expressions.

3.5 Contexts and the Resolution of Metonymies

The role contexts play in metonymy resolution has so far not been considered seriously in the literature on indirect interpretation. The following examples will provide us with material for getting a grip on this problem.

(25) *Now we are here.* (Pointing at location on map)
(26) *Observer's location* (E.g. as indicated on public city map)
(27) *This is my wife.* (Pointing to region on photograph)
(28) *We'll work on the tail now*. (Said by instructor to constructor in toy plane setting).

All the examples above contain metonymies. *Here* and *observer's location* refer to real-world locations. *This* indicates the representation of an entity pointed at. *My wife* and *the tail*, being definite descriptions also stand in for representations. The first thing we notice from (25) to (28) is that metonymies interact naturally with familiar aspects of the context such as speaker, addressee, location or deixis. For (25) to (28) to make sense, the depicting object has to figure prominently in the actual context. Taking successful reference for granted, the respective utterances can still be false due to a failure of predication. E.g. in (25), (27), (28) the speaker may simply be wrong, in (26) one could be exposed to a pseudo map.
The relevance of this observation comes to the fore if we prefix (25) to (28) with epistemic or other modal operators. E.g. using

(29) *I know that we are here.*

the speaker might indicate that in all epistemic alternatives conceivable to him, the real-world location of the group, given by *we*, is as indicated by the area on the map. Different epistemic circumstances will neither change the map nor the position singled out, both being aspects of the context. The use of natural modalities like *must* clearly shows that we are dealing with the modal base tied to the context:

(30) *Now we must be here.*

In all circumstances relevant to context *c*, such is the speaker's assertion, the group is at the place indicated.
(28) in a way differs from the rest. Here we can argue that it is part of the agent's common ground associated with context *c* that they are busy with a toy airplane (airplane depiction) and not with a real airplane. In other words: "We work on something depicting plane tails" should be a default assumption of both agents after (28) was successfully uttered. Since it belongs to the common ground, it is mutually believed by the agents.

4. The Model M

The discussion of the metonymy examples has shown that the properties of contexts play an important role for their resolution. We will work with a very simple notion of context, whose function is quite special, nevertheless. Contexts are external, objective, located entities; they come in where matters of reference are at stake. They are given by speakers, hearers and the objects available to them. As a rule, quantified expressions also depend on the objects actually existing in contexts, e.g. our existentially quantified expressions will behave this way. Furthermore, speakers may single out objects in contexts by physically indicating them. Contextual reference is fixed but other things vary, for example the extensions of predicates. This sort of variance is time-bound. We conceptualize it using instants and possible worlds. Possible worlds can be grouped in order to express different variants of possibility and necessity. Finally, we must find a way to provide expressions with intuitively acceptable interpretations.
To illustrate how the things explained work out on the formal semantic level, we have to set up an appropriate model M.
In the following we extend the respective definitions given in Chierchia and McConnell-Ginet (2000), pp. 341 - 349, to make them suit our purposes.

A model is a 9-tupel
M = $<W, I, <, C, U$, sp, adr, loc, ind-ob, avail, mdb, $V>$
where:
W is a set of worlds,
I is a set of instants ordered by <, the before-relation,
$W \times I$ is the set of circumstances,
C is a set of contexts,
U is the set of objects (the domain of quantification; U is assumed to be the same for all worlds),
sp: $C \rightarrow U$ is the function that associates the speaker to every context,
adr: $C \rightarrow U$ is the function that associates the addressee to every context,
loc: $C \rightarrow U$ is a function that associates the location to every context,
ind-ob: $C\times(W\times I) \rightarrow U$ is a function that associates an indicated object to a context and a circumstance
avail: $C\times(W\times I) \rightarrow \mathcal{P}(U)$ is a function which associates to every context the set of objects tied to it, varying with circumstances.
mdb: $C \rightarrow \mathcal{P}(W\times I)$ is a function that associates a modal base to every context, ordered by an ordering source ordsrc(c)
V is a function that assigns an appropriate character to the constants of F_3'. That is, for any constant α, $V(\alpha)$ is a function from C to a function from $W\times I$ to an extension of the appropriate kind. So $V(\alpha)(c)$ is the intension that α has in the context c, and $V(\alpha)(c)(<w,i>)$ is the extension that α has relative to c in $<w,i>$.
The truth value of a proposition in a circumstance $<w,i>$ relative to a context c is defined as usual but for expressions of the form $\forall$x P or $\exists$x P where the following holds:

$[\![\exists xP]\!] = 1$ iff there is an individual u $\in$ avail(c)($<w,i>$) such that g[u/x](P) holds

and

$[\![\forall xP]\!] = 1$ iff $[\![\neg\exists x\neg P]\!]$.

4.1 Explanation of the Model M

Contexts are not described as such but just used as a basis to determine contextual coordinates, i.e. as arguments to functions corresponding to the latter. Among these coordinates there are those giving an interpretation to indexicals as, e.g., sp for the pronoun *I*, adr for the pronoun *you*, loc for the adverb *here*, ind-ob for the NP *this*. In contrast to the strategies subscribed to by Chierchia and McConnell-Ginet (2000, pp. 341f), we take contexts to be so fine-grained as to change during utterances. For a sentence like *This is an airplane and this is a motor-bike*, the first and the second occurence of *this* have different contexts.
We further need the contextual coordinate avail that yields the set of objects tied to the actual context. This set determines which objects e.g. quantifiers range over as in the sentences *All is green,* and which set is maximally considered when checking the Russell condition for the definite article *the* as in the sentence *The object you see is green.* For any context c, the set avail(c) can be described as the subset A of U consisting of all existing objects in c.[6]
The contextual coordinate avail is necessary because of the concern with metonymy: For literal interpretation, there is just one domain of discourse; it corresponds to avail(c). In metonymical interpretation, however, objects outside of avail(c) may come into play. E.g., in (1), the domain of discourse for metonymical interpretation must include the real-world airplanes depicted by the toy airplane, although they certainly are not in avail(c). To enlarge avail(c) in order to include real-world airplanes is not adequate as then the falsity of (1) in the actual circumstances is less evident. The lack of relevance of e.g. (14) could not be determined.
The contextual coordinate ind-ob in a context c yields the objects $u \in U$ indicated by sp(c) to adr(c) in c. It is required that ind-ob(c)($\langle w,i\rangle$) $\in$ avail(c) ($\langle w,i\rangle$) for all $\langle w,i\rangle \in W\times I$.
A modal base is a set of propositions and thus a set of sets of circumstances in the analysis of propositions as sets of circumstances (Chierchia and McGonnell-Ginet, 2000, p. 262). The modal base overlaps with the common epistemic ground, esp. the set of propositions mutually believed by speaker and addressee. It contains information about common perceptions, e.g. as to the presence of objects.

4.2 Context and Character

As explained above, we use a semantics operating in two stages in order to describe the function of contexts in a systematic and methodologically sound way. The interpretation of indexicals, especially of *this* in our prominent example, depends upon context[7]. The context fixes the semantic values of a whole set of parameters which – if tied to a context – act much like constants. Following the terminological tradition established by Kaplan (1977), the function V depending upon context is called *character*, if given a context c, we arrive at an intension $V(c)$ and if paired with a circumstance $\langle w, i\rangle$, we get an extension $V(c)(\langle w, i\rangle)$.
The interpretation function V is related to the contextual coordinates as follows (cf. Chierchia and McConnell-Ginet (2000), p. 342 (19)):
For any context c and all circumstances $\langle w,i\rangle$:
For the personal pronoun *I* (that is a constant of F_3') :

$V(I)(c)(\langle w,i\rangle) = \mathrm{sp}(c)$,

similarly

$V(you)(c)(\langle w,i\rangle) = \mathrm{adr}(c)$,

$V(here)(c)(\langle w,i\rangle) = \mathrm{loc}(c)$.

$V(this)(c)(\langle w,i\rangle) = \{\text{ind-ob}(c)(\langle w,i\rangle)\}$.

---

[6] A further description and motivation of avail is given in 5.5.2
[7] see p. 20 and e.g. the example given in 5.5.1

4.3 mdb(c) and Metonymy Interpretation

Why do we make use of mdb(c) in metonymy interpretation?
To answer this question, remember why contexts c are needed. Roughly, they help to determine objects we need to interpret indexical expressions, above all pronouns and adverbs of a certain kind as e.g., *here*, *now*. This idea can be generalised for modal expressions: We may argue that with respect to contexts we fix the range of circumstances where a natural language modal needs to be interpreted. E.g., in order to get the semantics for $[\![\text{must } S]\!]$, one will set up that $[\![S]\!]$ has to be true in all circumstances linked to c which is less than the logical space of all circumstanes. The use of mdb(c) would be obvious if we treated sentences containing indexicals and modals as well as metonymical expressions as in

I must be the airplane

said by someone who has to imitate an airplane.
However, that is not the point at issue. The preconditions triggering a metonymical interpretation are tied to contexts, where airplane models exist. Our technical notion of context is designed to capture this property of relevant empirical settings or situations. What we aim at is to keep this aspect of a context c stable across all the circumstances considered. We thus get a set of circumstances which all satisfy certain preconditions for a metonymical interpretation. Strictly speaking, it is only this idea of context-dependence and some sort of "weak validity constraint" that we want to exploit. However, as a side-effect, metonymies get characteristics of both in lexical and modal expressions.

4.4 Interpretation Function

We give the interpretation function $[\![\ ]\!]^{M,w,i,c,g}$ which assigns an extension to each expression as in Chierchia and McConnell-Ginet (2000), pp. 342 - 343, with the exception of 31 *f*, where we take up a suggestion of their own concerning modal bases.

(31) *a.* If α is a constant, then $[\![\alpha]\!]^{M,w,i,c,g} = V(\alpha)(c)(<w,i>)$.
b. If α is a trace or pronoun, then $[\![\alpha]\!]^{M,w,i,c,g} = g(\alpha)$.
c. If $\Delta = [\text{NP Pred}]$, then $[\![\Delta]\!]^{M,w,i,c,g} = 1$ iff $[\![\text{NP}]\!]^{M,w,i,c,g} \in [\![\text{Pred}]\!]^{M,w,i,c,g}$.
d. If $\Delta = [S_1 \text{ conj } S_2]$, then $[\![\Delta]\!]^{M,w,i,c,g} = \text{V(conj)}(c)(<w,i>)(<[\![S_1]\!]^{M,w,i,c,g}, [\![S_2]\!]^{M,w,i,c,g}>)$, where S_1 and S_2 are expressions
e. If $\Delta = [\text{that S}]$, then $[\![\Delta]\!]^{M,w,i,c,g} = \{<w',i'>: [\![S]\!]^{M,w',i',c,g} = 1\}$.
f. If $\Delta = [\text{must S}]$, then $[\![\Delta]\!]^{M,w,i,c,g} = 1$ iff for all $<w',i'>$ in mdb(c), $[\![S]\!]^{M,w',i',c,g} = 1$.

Note that mdb(c) $\subseteq W \times I$, i.e. the modality *must* is weaker than logical or epistemic necessity.

4.5 Definitions of Truth, Validity, and Entailment

Concerning semantic notions we stick to Chierchia and McConnell-Ginet's (2000), pp. 343 - 344, definitions for LF adapting them to *lf* and to the additional context-coordinate avail(c):

(32) *a.* A sentence S is *true* in a model $M = <W, I, <, C, U$, sp, adr, loc, ind-ob, avail, mdb, $V>$ and a circumstance $<w, i>$ relative to one of its *lf*s α and to a context c iff for every assignment g, $[\![\alpha]\!]^{M,w,i,c,g} = 1$. It is *false* iff for every g, $[\![\alpha]\!]^{M,w,i,c,g} = 0$.

b. A sentence *S* is *valid* relative to one of its *lf*s α iff for every model $M = \langle W, I, <, C, U,$ sp, adr, loc, ind-ob, avail, mdb, $V\rangle$, $c \in C$, $w \in W$, and $i \in I$, *S* is true in *M*, *w*, *i* relative to α and *c*.

c. A sentence *S* relative to *lf* α *entails* a sentence *S'* relative to *lf* β iff for every model *M* $= \langle W, I, <, C, U,$ sp, adr, loc, ind-ob, avail, mdb, $V\rangle$, $c \in C$, $w \in W$, and $i \in I$, if *S* is true in *M*, *w*, *i* relative to α and *c*, then S' is true in *M*, *w*, *i* relative to β and *c*.

4.6 Definition of Truth and Indirect Interpretation of Example (1)

We need the definition of truth wrt a model *M* given in (32) *a.* in order to process our example expression (1') *This be an airplane.* The argument is crucial for our theory and is set out as follows: If we choose a preferred model *M* which squares with our empirical data (see experimental setting), then (1') will be false in *M*, *w*, *i* relative to the *lf*-expression shown in (24) and *c*. The obvious reason is that there is no airplane in *c*. This may of course be different for other models *M'* which have real airplanes in them. Yet we know from the data that agents in our construction dialogues get along perfectly well with their use of *airplane*. From the semantics point of view all we can do wrt *M* is done. There is no further semantic option. Hence, we have to use different means to arrive at an indirect interpretation of (24). As we know from our arguments in ch. 2 these means are of a pragmatic nature.

5. The Semantics-Pragmatics-Interface and the Resolution of Metonymy

Recapitulation of Pragmatic Arguments

Metonymical expressions interpreted literally lead to *lf*-expressions that come out as false in a model M. They are handed on to a Gricean pragmatics component. It contains defaults for conversational implicatures based on *M* which provide the satisfaction of *lf*-expressions containing metonymies. After failing in *M*, *lf*-expressions must be restructured in order to locate the metonymy properly[8]. The part of the *lf*-expression interpreted metonymically is designated by an operator Op defined inductively on *lf*.

5.1 The Op*-Operator*

We now set out to describe, how, starting from a given utterance *Y*, e.g.

(1) *This is an airplane*.

we determine its metonymical reading.

The utterance *Y* is parsed and given an LF-structure Y_{LF} (see (19) in ch. 3). This structure is translated to *lf* (see Fig. 6 in ch. 3). The translation result will be called ψ, the truth conditions of which correspond to the literal meaning of *Y*. We consider ψ together with its tree structure generated by the structure-driven translation from Y_{LF}. If the truth conditions of the literal meaning are not satisfied, other formulas $\tilde{\psi}$ are normally derived from ψ (see Fig. 3 in ch. 1). The metonymical readings of ψ are given by a recursively defined operator Op applied to ψ. We first consider the metonymical use of noun phrases NP here and illustrate the simplest case where the noun in the NP gets a metonymical interpretation.

[8] The connection between the expression failed in *M* and its restructuring will be given via the default definition developed in 5.4.

Let β' be the *lf*-predicate the noun β has been translated to. Then Op[$_N$ β'] is defined as [$_N$ Op(β')]. For β = airplane[9], we get

(33) Op[$_N$ airplane'] = [$_N$ Op(airplane')] =

$$[_N\ \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y{\in}C \rightarrow \text{airplane'}(y)))]$$

In the example (4) in ch. 2

(4) The schnitzel complained (waiter to cook)

we get

$$[_N\ \mathsf{Op}(\text{schnitzel'})] = [_N\ \lambda x\ \exists y\ (\text{ordered'}(x,y) \wedge \text{schnitzel'}(y))\ ]$$

and thus refer to somebody who ordered a schnitzel.

In general, Op is defined recursively by induction on the structure of ψ, considered as tree labelled with grammatical categories and expressions of IPC. The application of Op to such a tree yields another such tree. The labelling with grammatical categories remains the same; only the expressions of IPC are possibly changed during this application, and in these expressions, the quantifiers, variables and logical constants as well as the λ-operator are preserved. The effect on IPC expressions depends only on the local tree configuration.

Thus, the application of Op to a tree can be considered as given by the application of an operator Op_1 to IPC expressions. Strictly speaking, in (33) we would have to write

$$\mathsf{Op}[_N\ \text{airplane'}] = [_N\ \mathsf{Op}_1(\text{airplane'})]\ .$$

In the following, we will however not distinguish between the operator Op, defined on trees, and the operator Op_1, defined on IPC expression. Both will be written Op. We will use *P* and *Q* as meta-variables for expressions, φ as a meta-variable for predicates and *v* as a meta-variable for variables. Strictly speaking, we should write

=’

for the equality predicate in IPC; we will however just write

=

as usual.

The rules describing the recursive definition of Op are given below.

Op-1. For a tree *T*, Op(*T*) is defined as the tree that results by applying Op to the daughters of the root of T. Thus for a labelled bracketing such as [$_A$ [$_B$ X] [$_C$ Y] [$_D$ Z]], the value

$$\mathsf{Op}([_A\ [_B\ X]\ [_C\ Y]\ [_D\ Z]\ ])$$

is defined as

$$[_A\ \mathsf{Op}([_B\ X])\ \mathsf{Op}([_C\ Y])\ \mathsf{Op}([_D\ Z])\ ]$$

Op-2. For every predicate φ (of IPC) and every lexical category *A*, Op[$_A$ φ] is defined as

$$[_A\ \mathsf{Op}(\varphi)].$$

(Lexical categories correspond to leaves of the tree structure; more precisely, we would have to write [$_A$ $\mathsf{Op}_1(\varphi)$]).

Op-3. For every one-place predicate φ (of IPC), Op(φ) is either

$$\varphi$$

or

an expression $\varphi^{\sim}$ containing φ that is applicable to an argument, such as a one-place λ-expression[10].

Op-4. $\mathsf{Op}(P \wedge Q) = \mathsf{Op}(P) \wedge \mathsf{Op}(Q)$ for expressions *P* and *Q*

Op-5. $\mathsf{Op}(P \vee Q) = \mathsf{Op}(P) \vee \mathsf{Op}(Q)$ for expressions *P* and *Q*

---

[9] Descriptive constants in *lf* are designated by a prime, for example airplane', descriptive constants introduced by Op are not primed.

[10] $\varphi^{\sim}$ might be, e.g., $\lambda u\ \exists C\ (\text{depicts'}(u,C) \wedge \forall x\ (x{\in}C \rightarrow \varphi(x)))$ or $\lambda u\ \exists y\ (\text{noise-of'}(u,y) \wedge \varphi(y))$

Op-6. $\mathsf{Op}(\forall v\, P) = \forall v\, \mathsf{Op}(P)$ for expressions P and variables v
Op-7. $\mathsf{Op}(\exists v\, P) = \exists v\, \mathsf{Op}(P)$ for expressions P and variables v
Op-8. $\mathsf{Op}(\lambda v\, P) = \lambda v\, \mathsf{Op}(P)$ for expressions P and variables v
Op-9. $\mathsf{Op}(\varphi(arg_1, arg_2, ..., arg_n)) = (\mathsf{Op}(\varphi))\ (\mathsf{Op}(arg_1), \mathsf{Op}(arg_2), ..., \mathsf{Op}(arg_n))$
for n-place predicates φ and terms $arg_1, arg_2, ..., arg_n$
Op-10. $\mathsf{Op}(const) = const$ for constants $const$
Op-11. $\mathsf{Op}(v) = v$ for variables v
Op-12. $\mathsf{Op}(\text{‘=’}) = \text{‘=’}$

Rule Op-3 permits the insertion of an identical expression or of a new expression that determines the metonymical interpretation, in case some conversational implicature justifies it. This implicature could require e.g. *noise of airplane* instead of *airplane-model*.

5.2 Application to an Example

Let us now consider the following example: as tree *T*, we take the tree given in Fig. 6 of ch. 3 illustrating the *lf* translation of the LF-structure (19) in ch. 3 corresponding to sentence (1). The node airplane' in Fig. 6 is replaced by its value under Op, as rules Op-2 and Op-3 allow to do. The replacement is shown in the tree of Fig. 7 given below by a shaded airplane'-node linked by an Op-arrow to the replacing node.[11] The calculus is shown below on two landscape format pages.
The corresponding tree representation, following Fig. 6 in ch. 3, is given below as Fig. 7.
One thus gets a copy of the original *lf* tree, where a terminal node labelled by a form α is relabelled by another form[12] $\alpha^{\sim} \neq \alpha$.

Here it is useful to look back on the route we have taken so far. Starting from an S-structure (see Fig. 4), we got an LF-structure by quantifier raising, see Fig. 5. This in turn was translated into *lf* using the rules on p. 14-15. Op is defined on the tree decorated with the *lf*-formulas. Now, Op changes the decoration but it does not change the syntactic label of nodes: as we have stated at various places, Op does not violate LF-tree structure, see Fig. 7. This implies that all that happens is that new *lf*-expressions come in. They are substituted for the original *lf*-expressions but do not change the terminals in the LF-structure. As a consequence, the original word form remains but gets a new interpretation by default. Hence in our example, the new IPC-information provided by Op is tied to the LF-terminal *airplane*.

In 2.1, we argued that metonymies cannot be given a lexical treatment. In this chapter we have seen that metonymy resolution needs more information than *lf* can provide. We have to get admissible “readings” and introduce them into the derivation procedure using Op.

[11] Since we think the complete requirements to be placed on C in the following formulas (i.e. $\exists C$ (depicts$(u,C) \wedge C\neq\varnothing \wedge \forall x\ (x \in C \rightarrow$ airplane’$(x))$)) do not contribute to much further insight, we rest content with giving the main ones, i.e. $\exists C$ (depicts$(u,C) \wedge \forall x\ (x \in C \rightarrow$ airplane’$(x))$)

[12] in our example, α is airplane’, and $\alpha^{\sim}$ is $\lambda u\ \exists C$ (depicts(u,C) $\wedge \forall x\ (x\in C \rightarrow$ airplane’(x)))

Example:

$$\mathrm{Op}([_S [_{NP}\ \lambda S\ \exists x_i\ (\text{airplane'}(x_i) \wedge S)]\ [_{S'} =(\text{this'}, x_i)]\ ]\ )$$

$= [_S\ \mathrm{Op}([_{NP}\ \lambda S\ \exists x_i\ (\text{airplane'}(x_i) \wedge S)])\ \mathrm{Op}([_{S'} =(\text{this'}, x_i)])\ ]$ by rule Op-1

$= [_S\ \mathrm{Op}([_{NP}\ [_{Det}\ \lambda P\ \lambda S\ \exists x_i\ (P(x_i) \wedge S)]\ [_N\ \text{airplane'}]])\ \mathrm{Op}([_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y =(y,x_i)]\ ])\ ]$ by rule Op-1

$= [_S\ [_{NP}\ \mathrm{Op}([_{Det}\ \lambda P\ \lambda S\ \exists x_i\ (P(x_i) \wedge S)])\ \mathrm{Op}([_N\ \text{airplane'}])]\ [_{S'}\ \mathrm{Op}([_{NP}\ \text{this'}])\ \mathrm{Op}([_{Pred}\ \lambda y =(y,x_i)])]]$ by rule Op-1

$= [_S\ [_{NP}\ [_{Det}\ \mathrm{Op}(\lambda P\ \lambda S\ \exists x_i\ (P(x_i) \wedge S))]\ [_N\ \mathrm{Op}(\text{airplane'})]]\ [_{S'}\ [_{NP}\ \mathrm{Op}(\text{this'})]\ [_{Pred}\ \mathrm{Op}(\lambda y =(y,x_i))]]]$ by rule Op-2

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \mathrm{Op}(\lambda S\ \exists x_i\ (P(x_i) \wedge S))]\ [_N\ \mathrm{Op}(\text{airplane'})]]\ [_{S'}\ [_{NP}\ \mathrm{Op}(\text{this'})]\ [_{Pred}\ \lambda y\ \mathrm{Op}(\ =(y,x_i)\ )]]]$ by rule Op-8

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \mathrm{Op}(\lambda S\ \exists x_i\ (P(x_i) \wedge S))]\ [_N\ \mathrm{Op}(\text{airplane'})]]\ [_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y\ \mathrm{Op}(\ =(y,x_i)\ )]]]$ by rule Op-10

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \mathrm{Op}(\lambda S\ \exists x_i\ (P(x_i) \wedge S))]\ [_N\ \lambda u\ \exists C\ (\text{depicts}(u,C) \wedge \forall x\ (x \in C \rightarrow \text{airplane'}(x)))]]$
$[_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y\ \mathrm{Op}(\ =(y,x_i)\ )]]]$ by rule Op-3

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \lambda S\ \mathrm{Op}(\exists x_i\ (P(x_i) \wedge S))]\ [_N\ \lambda u\ \exists C\ (\text{depicts}(u,C) \wedge \forall x\ (x \in C \rightarrow \text{airplane'}(x)))]]$
$[_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y\ (\mathrm{Op}(=))(\mathrm{Op}(y),\mathrm{Op}(x_i))\ ]]]$ by rules Op-8 and Op-8

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \lambda S\ \exists x_i\ \mathrm{Op}((P(x_i) \wedge S))]\ [_N\ \lambda u\ \exists C\ (\text{depicts}(u,C) \wedge \forall x\ (x \in C \rightarrow \text{airplane'}(x)))]]$
$[_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y =(y,x_i)\ ]]]$ by rules Op-7, Op-11 and Op-12

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \lambda S\ \exists x_i\ (\mathrm{Op}(P(x_i)) \wedge \mathrm{Op}(S))]\ [_N\ \lambda u\ \exists C\ (\text{depicts}(u,C) \wedge \forall x\ (x \in C \rightarrow \text{airplane'}(x)))]]$
$[_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y =(y,x_i)\ ]]]$ by rule Op-4

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \lambda S\ \exists x_i\ (\mathrm{Op}(P)(\mathrm{Op}(x_i)) \wedge \mathrm{Op}(S))]\ [_N\ \lambda u\ \exists C\ (\text{depicts}(u,C) \wedge \forall x\ (x \in C \rightarrow \text{airplane'}(x)))]]$
$[_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y =(y,x_i)\ ]]]$ by rule Op-9

$= [_S\ [_{NP}\ [_{Det}\ \lambda P\ \lambda S\ \exists x_i\ (P(x_i) \wedge S)]\ [_N\ \lambda u\ \exists C\ (\text{depicts}(u,C) \wedge \forall x\ (x \in C \rightarrow \text{airplane'}(x)))]]$
$[_{S'}\ [_{NP}\ \text{this'}]\ [_{Pred}\ \lambda y =(y,x_i)\ ]]]$ by rule Op-11

=	$[_S\,[_{NP}\,\lambda S\ \exists x_i\,((\lambda u\ \exists C\ (depicts(u,C) \wedge \forall x\ (x{\in}C \rightarrow airplane'(x))))(x_i) \wedge S)]$	
	$[_{S'}\,[_{NP}\,this']\ [_{Pred}\,\lambda y\ {=}(y,x_i)\ ]]]$	by β-reduction for λP ... (λu ...)
=	$[_S\,[_{NP}\,\lambda S\ \exists x_i\,((\exists C\ (depicts(x_i,C) \wedge \forall x\ (x{\in}C \rightarrow airplane'(x)))) \wedge S)]\ [_{S'}\,(\lambda y\ {=}(y,x_i))\ (this')\ ]]$	by β-reduction for λu ... (x_i) and translation rule (23) b from LF to *lf*
=	$[_S\,[_{NP}\,\lambda S\ \exists x_i\,((\exists C\ (depicts(x_i,C) \wedge \forall x\ (x{\in}C \rightarrow airplane'(x)))) \wedge S)]\ [_{S'}\,{=}(this',x_i)\ ]]$	by β-reduction for λy ... (this')
=	$[_S\,\exists x_i\,((\exists C\ (depicts(x_i,C) \wedge \forall x\ (x{\in}C \rightarrow airplane'(x)))) \wedge {=}(this',x_i))\ ]$	by β-reduction for λS ... (=(this',x_i))
=	$[_S\,\exists x_i\,((\exists C\ (depicts(x_i,C) \wedge \forall x\ (x{\in}C \rightarrow airplane'(x)))) \wedge this' = x_i)\ ]$	by using infix-notation for '='

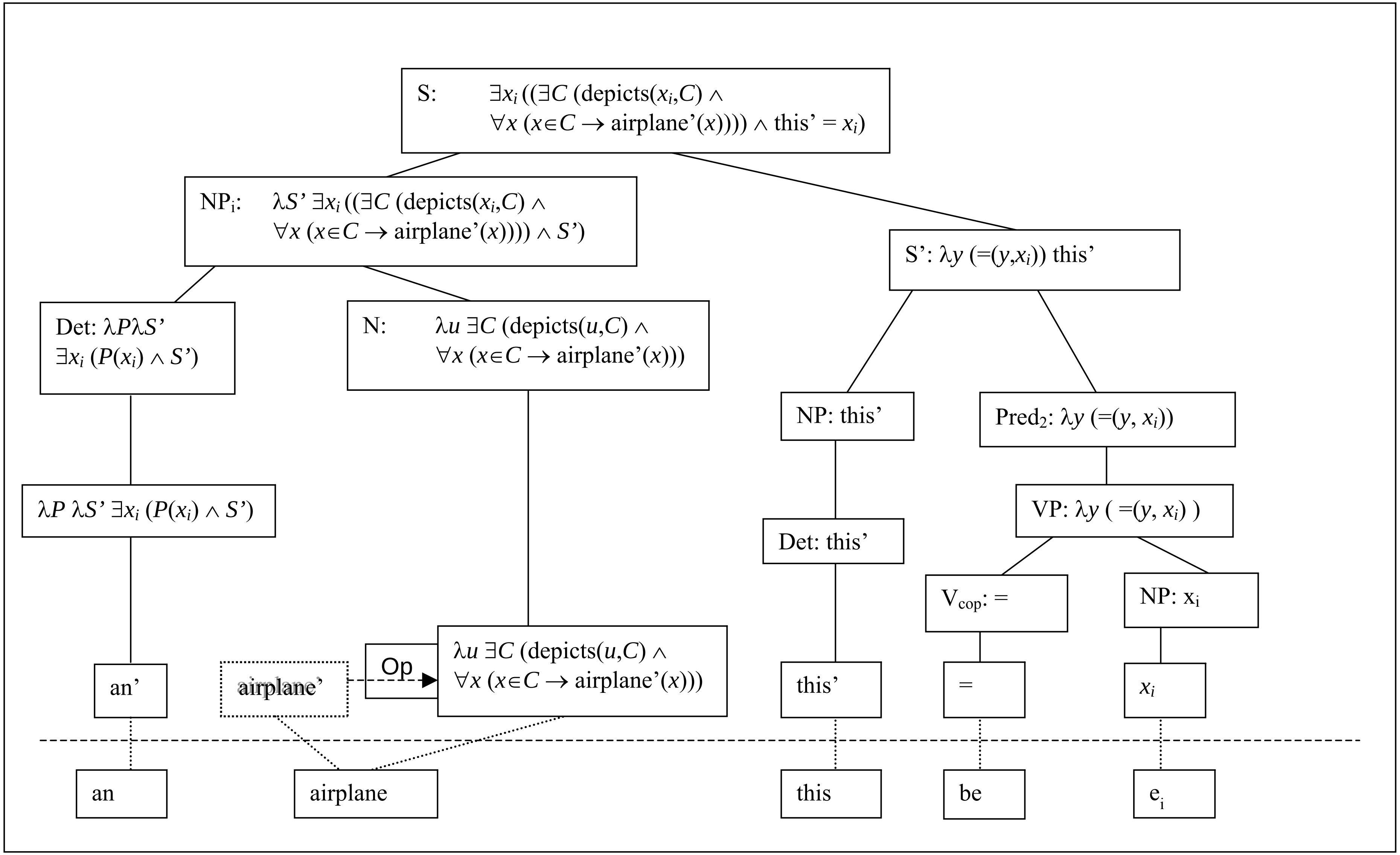

Fig. 7 Tree representation of Opified tree of Fig. 6

5.3 Metonymies are Defaults

Defaults convey defeasible meaning, i.e. they can be overridden, if additional information is provided. In addition, defaults are detachable and can be cancelled. The latter is in direct opposition to meaning generated by entailments.
In order to defend the view that expressions have to be interpreted as metonymies *via* defaults, we have to do two things, show that the relation involved is not entailment and make clear that the value provided for the expression is defeasible.
Both properties together justify the assumption that a default is at stake. We have shown in 2.3 that metonymy relations are not semantic relations at all, *a fortiori* they cannot be entailments.
In order to see defeasibility, let's consider the example Watches.

Watches:
(34) *(a) The price of hand manufactured wrist watches has increased enormously of late.*
(b) This watch is now 8000 €. [pointing to his wrist watch]
(c) I bought it in Geneva in 1993.
(d) Then it was roughly 9.000 SFR.

Now let's investigate defeasibility:
In the Watches example, (b) can only get a reasonable interpretation if we consider *this watch* as a specimen of an instance-for-species metonymy, meaning roughly, *an instance of a class of objects similar to this watch.* In this context, we assume that the reading is supported by the fact that the watch pointed at is not 8000 € now. At first sight this looks fine concerning (a), (b). Unfortunately, this resolution of the metonymy will not yield an antecedent for the *it* in (c) and (d). The object going proxy for the discourse referent of *an instance of a class of objects similar to this watch* cannot serve as a referent for *it*, which is in part due to *now*. On the other hand, if *this watch* is interpreted literally and the referent for *an instance* etc. gets overridden by the object pointed at, the literal reading thus supplanting the metonymical one, we will arrive at the desired interpretation. It makes (b) false (due to the predicate *is now 8000 €*) but yields a coherent sequence (a)-(d).

5.4 Definition of the Default Relation for Metonymies

If we want to get at more detailed information than the exploitation of the notion of entailment can provide, we can try to use Grice's notion of *conversational implicature*. Implicatures are based on an all-pervading *principle of cooperation* existing among speakers of a language or a dialect to achieve the goals they pursue in conversation. It is spelled out as follows: "Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged". The prime purpose of talk is taken to convey information in an efficient and successful way. In order to ensure that, rational speakers observe the following four maxims which interact with the "covering" principle of cooperation:

a. *Relation*: Provide contributions relevant for current purposes.
b. *Quantity*: Be only as informative as is needed for the current conversational purpose. Do not make your contribution more informative than required.
c. *Quality*: Say only things which are true and for which you have appropriate evidence.
d. *Manner*: Be perspicuous; avoid unnecessary rhetorical parlance.

Grice suggests that the principle and the maxims together make up a conversational strategy for cooperative communication. Speakers who compute information in an efficient way rely on the assumption that, co-operativity presumed, conversants flout or exploit maxims in order to indicate which package of information they can rely on. Conversational implicatures can be fairly conventionalised (indirect speech acts, certain types of metonymies), they may be part of what the speaker directly conveys (in this case indirect interpretation gets direct) or be uncovered via chains of subtle reasoning. In most cases we will rely on the maxims of Quantity and Relation.
We now turn to the definition of the default relation for metonymies.

In the following we consider a language IPC generated by some grammar G in the sense of chapter 3, cf. e.g. (Chierchia, 2000), p. 267.

In order to describe when the meaning $[\![\mathsf{Op}(\alpha)]\!]$, $\alpha \in$ IPC, of an expression $\mathsf{Op}(\alpha)$ is conversationally implicated by a (partial) utterance *putt* under a syntactic description, LF, and one of its logical forms (*lf*) α, we make use of the kind of models introduced in ch. 4 (p. 18).

For this class of models, the definition of the default relation is as follows:
(We assume that cooperativity is given with respect to all utterances considered and one or more of the conversational maxims are obeyed.)

5.4.1 *Case of Violation of Quality Maxim*

Default Definition

Let *putt* be a subpart of an utterance *utt* and α one of its *lf* structures in which the variable *x* occurs free.
In case the quality maxim is violated, i.e.

(1) *utt* is false

and

(2) $\lambda x.\neg\alpha$ is true in the actual circumstance $<w_{act}, i_{act}>$, i.e. for every g s.th. $g(x) \in \mathrm{avail}(c)$, $[\![\lambda x.\neg\alpha]\!]\,(g(x)) = 1$ in M

and

(3) $\mathsf{Op}(\lambda x.\alpha)$ is true in at least one circumstance $<w, i> \in \mathrm{mdb}(c)$[13]

then, by default

(4) the meaning of *putt* under *lf* α is $[\![\mathsf{Op}(\lambda x.\alpha)]\!]$ in M.

Comment

Condition (3) expresses that wrt the modal base, $\mathsf{Op}(\lambda x.\alpha)$ is conceivable. This allows a metonymical interpretation of the sentence

This is a yellow airplane.

uttered in front of a red airplane-model. The metonymical interpretation is false (as far as colour is concerned), but there are circumstances in the modal base where it is true, namely, if one were in front of a red airplane-model. Normally, circumstances where one is in front of a real airplane are not in the modal base in a toy-airplane context.

[13] i.e. $[\![\mathsf{Op}(\lambda x.\alpha[x])]\!]$ is satisfiable in mdb(c)

5.4.2 Case of Violation of relevance maxim

Motivation

In order to motivate the definition capturing the case where the relevance maxim is violated, the following consideration might be of help: Imagine a situation where a motorbike-model is among the available objects in the situation. Then, *This is no airplane* is true on the literal interpretation but the informational value will be negligible. Hence, the relevance maxim is clearly violated. What do we want to get as the meaning of the expression in such a case? The most intuitive solution seems to be that its metonymical interpretation should yield *This is no airplane-model* which, in turn, is clearly relevant. Now for the definition:

Default Definition

Let α be an *lf*-structure of an utterance *utt*. We suppose α is a closed formula. Let $\alpha[x]$ be a formula where a referring term (variable or constant) is substituted by a fresh variable x. In case the relevance maxim is violated, i.e.

(1) $\lambda x.\alpha[x]$ is valid, i.e. for every circumstance $<w,i> \in \text{mdb}(c)$ and every g s.th. $g(x) \in \text{avail}(c)$, $[\![\lambda x.\alpha[x]]\!]\,(g(x)) = 1$ in M

and

(2) There is a pair $<w',i'> \in \text{mdb}(c)$ and a g s.th. $[\![\neg\mathsf{Op}(\alpha)]\!](g(x))$ is satisfied in M

and

(3) There is a pair $<w,i> \in \text{mdb}(c)$ and a g s.th. $[\![\mathsf{Op}(\alpha)]\!](g(x))$ is satisfied in M

then, by default

(4) the meaning of *utt* under *lf* α is $[\![\mathsf{Op}(\alpha)]\!]$ in M.

If the conditions of *Default Definition* hold for the (partial) utterance *utt*, we say that *utt* under *lf* α gets a metonymical interpretation $[\![\mathsf{Op}(\alpha)]\!]$.

5.5 Examples

5.5.1 Case of Quality Maxim

The first example describes the following situation depicted by our model M_1: We have a context c in which an airplane-model is pointed at by the speaker who utters

(1) *This is an airplane.*

There are no real airplanes in c, therefore, they are not in avail(c). However – this corresponds to our intuitions concerning the use of metonymies – airplanes can be introduced into the context via a metonymy. In order to guarantee that, we must have real airplanes in our domain U.

The model M_1 looks e.g. as follows:

$W = \{w_1, w_2\}$, $\text{I} = \{i_1\}$, $< \, = \emptyset$, $C = \{c\}$, $\text{ordsrc}(c) = \emptyset$,

$W \times I = \{<w_1, i_1>, \; <w_2, i_1>\}$

$U = \{\text{airplane-model}_1, \text{airplane}_1, \text{airplane}_2, \emptyset, \{\text{airplane}_1, \text{airplane}_2\}, \text{C6-217}\}$

sp(c) = Josef

adr(c) = Hannes

loc(c) = C6-217 (a room)

ind-ob(c)($<w,i>$) = airplane-model$_1$ for all $<w,i> \in W \times I$

avail(c) ($<w,i>$) = {airplane-model$_1$, C6-217} for all $<w,i> \in W \times I$

mdb(c) = {$<\mathrm{w}_1, \mathrm{i}_1>$}
Note that U is common to all circumstances in mdb(c) and that it contains ind-ob(c)($<w,i>$) as well as avail(c)($<w,i>$). The set U of individuals contains sets (e.g. $\emptyset$, {airplane$_1$, airplane$_2$}) of "ordinary" individuals such as airplane$_1$, as the metonymical interpretation needs "abstract" individuals for classes depicted, see, e.g., $g(C)$ below.
V(airplane')(c)($<w,i>$) = {airplane$_1$, airplane$_2$} for all $<w,i> \in W \times I$
V(depict)(c)$<w,i>$ = {<airplane-model$_1$, {airplane$_1$, airplane$_2$}>}
$g(x_1)$ = airplane$_1$
$g(x)$ = airplane$_2$
$g(C) = \emptyset$,
The logical form (lf) α of (1) reads (see (24))

$$\exists x_i\,(\text{airplane'}(x_i) \wedge \lambda y\,(x_i{=}y)\ \text{this'}) = \exists x_i\,(\text{airplane'}(x_i) \wedge x_i{=}\text{this'})$$

We first show that α is false in our model – in our case, the results do not depend on c, w, i and we omit the argument $<w,i>$ where values do not depend on it – :

$$\llbracket \exists x_i\,(\text{airplane'}(x_i) \wedge x_i{=}\text{this'}) \rrbracket^{M,g,c,w,i} = 0,$$

since

$$\llbracket \exists x_i\,(\text{airplane'}(x_i) \wedge x_i{=}\text{this'}) \rrbracket^{M,g,c,w,i}$$

is 0 iff there is no $u \in$ avail(c)[14] such that

$$\llbracket\ (\text{airplane'}(x_i) \wedge x_i{=}\text{this'}) \rrbracket^{M,g[u/x_i],c,w,i} = 1$$

This holds iff there is no $u \in$ avail(c) such that

$$u \in \llbracket\ (\text{airplane'} \rrbracket^{M,g,c,w,i} \text{ and } u = \llbracket \text{this'} \rrbracket^{M,g,c,w,i} = \text{ind-ob}(c) = \text{airplane-model}_1.$$

This is true as

$$\text{airplane-model}_1 \notin \llbracket \text{airplane'} \rrbracket^{M,g,c,w,i} = \{\text{airplane}_1, \text{airplane}_2\}.$$

Now we show the satisfiability of[15]

$$\llbracket \mathsf{Op}(\alpha) \rrbracket^{M,g,c,w,i} = \llbracket \exists x_i\,(\exists C \text{ depicts}(x_i,C) \wedge \forall x(x{\in}C \rightarrow \text{airplane'}(x)) \wedge \text{this'}{=}x_i) \rrbracket^{M,g,c,w,i}$$

This means

$\llbracket \exists x_i\,(\exists C\,(\text{depicts}(x_i,C) \wedge \forall x\,(x{\in}C \rightarrow \text{airplane'}(x)) \wedge \text{this'} = x_i)) \rrbracket^{M,g,c,w,i} = 1$ for at least one circumstance $<w,i> \in$ mdb(c), where x_i ranges over avail(c) (see footnote 14).
Now this holds iff
there is a $u \in$ avail(c) such that

$$\llbracket \exists C\,(\text{depicts}(x_i,C) \wedge \forall x\,(x{\in}C \rightarrow \text{airplane'}(x)) \wedge \text{this'} = x_i) \rrbracket^{M,g[u/x_i],c,w,i}, \text{ i.e.}$$

$$\llbracket \exists C\,(\text{depicts}(u,C) \wedge \forall x\,(x{\in}C \rightarrow \text{airplane'}(x)) \wedge \text{this'} = u) \rrbracket^{M,g,c,w,i}, \text{ i.e.}$$

iff there is a $u \in$ avail(c) and a set $C \in U$ such that

$$\llbracket \text{depicts}(u,C) \wedge \forall x\,(x{\in}C \rightarrow \text{airplane'}(x)) \wedge \text{this'} = u) \rrbracket^{M,g,c,w,i}, \text{ i.e.}$$

iff there is a $u \in$ avail(c) and a $C \in U$ such that

$$\llbracket \text{depicts}(u,C) \rrbracket \text{ and } \llbracket \forall x\,(x{\in}C \rightarrow \text{airplane'}(x)) \rrbracket^{M,g,c,w,i} \text{ and } \llbracket \text{this'} = u \rrbracket^{M,g,c,w,i}.$$

Since (for every $<w,i> \in W \times I$)

V(depict)(c)($<w,i>$) = {<airplane-model$_1$, {airplane$_1$, airplane$_2$}>}

this is the case iff

$$\llbracket \forall x\,(x{\in}\{\text{airplane}_1, \text{airplane}_2\} \rightarrow \text{airplane'}(x)) \rrbracket^{M,g,c,w,i} \text{ and}$$
$$\llbracket \text{this'} = \text{airplane-model}_1 \rrbracket^{M,g,c,w,i} \text{ i.e.}$$

iff

for all $u{\in}U$, if $u \in$ {airplane$_1$, airplane$_2$} then $u{\in}$V(airplane')(c)($<w,i>$) and airplane-model$_1$= $\llbracket \text{this'} \rrbracket^{M,g,c,w,i}$

Since

[14] Note that the existential quantifier is restricted to avail(c) here, cf. the definition of model M on p. 20
[15] For the derivation of the value of $\llbracket \mathsf{Op}(\alpha) \rrbracket^{M,g,c,w,i}$, cf. chapter 5.2

$V(\text{airplane'})(c)(<w,i>) = \{\text{airplane}_1, \text{airplane}_2\}$ and

$\{V(\text{this'})(c)(<w,i>)\} = \text{ind-ob}(c)\ (<w,i>) = \{\text{airplane-model}_1\}$

this holds.

Since therefore Op(α) is satisfiable in the modal base, the default meaning of utterance *utt* = *This is an airplane* is

$[\![\mathrm{Op}(\alpha)]\!]^{M,g,c,w,i} = [\![\exists x_i\,(\exists C \text{ depicts}(x_i,C) \wedge \forall x\,(x{\in}C \rightarrow \text{airplane'}(x)) \wedge \text{this'} = x_i)]\!]^{M,g,c,w,i}$ in M.

The following models M_1' and M_1'' show that not all situations admit of the default interpretation of (1). Let M_1' be like M_1, except that avail(c) ($<w,i>$) = {airplane$_1$, airplane-model$_1$}. Then M_1' does not satisfy condition 2 of the definition, since there is a real airplane in c.

Let us suppose that M_1'' is like M_1' but has a bike model as the only depicting object in it. In this case, $[\![\mathrm{Op}(\alpha)]\!]^{M_1'',g,c,w,i}$ is not satisfiable, violating condition 3 of the definition given on p. 28.

5.5.2 Case of Relevance Maxim

With the relevance maxim example, we want to capture the following intuition: Suppose there is some utterance *utt* such as

(14) *This is not an airplane*

where one of its *lf* structures α

$\neg\exists x_i\,(\text{airplane'}(x_i) \wedge \lambda y\,(x_i{=}y)\ \text{this'}) = \neg\exists x_i\,(\text{airplane'}(x_i) \wedge x_i{=}\text{this'})$

is trivially true[16] and hence not informative. If we now discover that Op(α) is true in the actual circumstances and false in some different circumstances, we are sure that Op(α) is informative and infer Op(α) as default value.

What does it mean for a sentence to be trivially true? A sentence is certainly trivially true for dialogue partners if it is part of the common ground cg(c), where c is the utterance context. Another interpretation of trivial truth might be "true throughout the modal base mdb(c)". Both interpretations are linked to each other by the relation of cg(c) to mdb(c). In the simplest cases, mdb(c) does not contain any circumstances that do not satisfy the propositions in cg(c). In more complicated cases however, e.g., where counterfactuals are considered, mdb(c) must contain further circumstances. In these cases, cg(c) plays the role of an ordering source and in some sense permits to distinguish reality and fiction. To make things more concrete, consider example (14) uttered in a context c where there is a motorbike model present but neither a real-world airplane nor a real-world motorbike. Knowledge about what is present in a context is part of the common ground; we expressed the relevant information in our models by the context parameter avail(c). This parameter depends on circumstances just as the speaker parameter sp(c) does in cases of utterances like

If I were not the speaker, Hannes would give the lecture.

Thus avail depends on the context as well as on the circumstances and determines a subset of the universe U. In other words, it is a function of two arguments mapping pairs $<c, <w,i>>$ of a context and a circumstance to subsets of U. As usual, this function is interpreted as an iterated function mapping contexts to functions from circumstances to subsets of U.

One might argue that dependence on context is not justified; avail could be considered as depending on circumstances alone. However, such an attitude would neglect the fact that avail is linked to other well-established context parameters in just the way characteristic for such parameters: irrespective of circumstances, e.g., ind-ob(c)(<w,i>) $\subseteq$ avail(c)(<w,i>), just as loc(sp(c)) = loc(c) holds irrespective of circumstances.

16 What is meant by trivially true is explained in the following.

Moreover, the parameter avail(c) is related to contextual ellipses: An utterance

(at least) One chair is broken.

would read in a straightforward logical analysis

$\exists x\ (\text{chair}(x) \wedge \text{broken}(x))$

but is hardly ever interpreted with respect to the universe U of all objects on earth, but nearly always as the completed utterance

(at least) One chair here *is broken.*

An appropriate model M_2 looks e.g. as follows:

$W = \{w_1, w_2\}$, $I = \{i_1\}$, $< = \emptyset$, $C = \{c\}$,

$W \times I = \{<w_1, i_1>, <w_2, i_1>\}$

$U = \{\text{airplane-model}_1, \text{motorbike-model}_1, \text{airplane}_1, \text{airplane}_2, \emptyset, \{\text{airplane}_1, \text{airplane}_2\}, \text{motorbike}_1, \text{motorbike}_2, \{\text{motorbike}_1, \text{motorbike}_2\}, \text{C6-217}\}$

mdb(c) = $\{<w_1, i_1>, <w_2, i_1>\}$ with ordsrc(c) = $<w_1, i_1>$

sp(c) = Josef

adr(c) = Hannes

loc(c) = C6-217

avail(c) ($<w_1, i_1>$) = {motorbike-model$_1$, C6-217} [17]

avail(c) ($<w_2, i_1>$) = {airplane-model$_1$}

ind-ob(c) ($<w,i>$)= motorbike-model$_1$ for all $<w,i> \in W \times I$

V(airplane')(c)($<w,i>$) = {airplane$_1$, airplane$_2$} for all $<w,i> \in W \times I$

V(motorbike')(c)($<w,i>$) = {motorbike$_1$, motorbike$_2$} for all $<w,i> \in W \times I$

V(depict)(c)($<w,i>$) = {<motor-bike-model$_1$, {motor-bike$_1$, motor-bike$_2$}>, <airplane-model$_1$, {airplane$_1$, airplane$_2$}>} for all $<w,i> \in W \times I$

V(this')(c)($<w,i>$) = ind-ob(c)($<w,i>$) = {motorbike-model$_1$} for all $<w,i> \in W \times I$

g(x_1) = airplane$_1$

g(x) = airplane$_2$

g(C) = $\emptyset$,

The logical form (lf) α of (14) reads

$\neg\exists x_i\ (\text{airplane}'(x_i) \wedge \lambda y\ (x_i{=}y)\ \text{this}') = \neg\exists x_i\ (\text{airplane}'(x_i) \wedge x_i{=}\text{this}')$

Op(α) reads

$\neg\exists x_i\ (\lambda u\ (\text{depict}(u,C) \wedge \forall x\ (x{\in}C \rightarrow \text{airplane}'(x)))(x_i) \wedge x_i{=}\text{this}') =$

$\neg\exists x_i\ (\text{depict}(x_i,C) \wedge \forall x\ (x{\in}C \rightarrow \text{airplane}'(x)) \wedge x_i{=}\text{this}')$

Intuitively, Op(α) means there is *no* airplane-model. This holds[18] throughout the part of the modal base mdb(c) that is compatible with cg(c), namely $\{<w_1,i_1>\}$. There, Op(α) is true. In some other part of mdb(c) that is not compatible with cg(c), yet "near" it, namely $\{<w_2,i_1>\}$, Op(α) is false, as there *is* an airplane-model.

Technically speaking, let us first show that α is true throughout the modal base in our model:

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[17] The question now is how avail(c, <w,i>) is interpreted with respect to the universe of discourse.

For our purposes, which have an empirical motivation, it seems to be necessary to distinguish between possible objects on the one hand and the set of existing objects on the other hand.

This changes the notation and the reading of quantifiers. In general quantifiers range over possible objects. $\forall$- and $\exists$-quantifiers with an existential import are defined via normal quantifiers and a predicate E indicating existence. To illustrate, we provide below definitions for these quantifiers:

a) $\forall.x\ A[x] := \forall x(E(x) \rightarrow A[x])$
b) $\exists.x\ A[x] := \neg\ \forall.x\ \neg\ A[x]$

As a consequence, the following postulate expresses our semantic intuitions

avail(c, <w,i>) $\subset [\![E]\!]$

[18] In our case it holds independently of g as our specific α does not contain any free variables.

For all $<w,i> \in W \times I$

$[\![\neg\exists x_i\,(\text{airplane'}(x_i) \wedge x_i\text{=this'})]\!]^{M,w,i,c,g} = 1$,

as

$[\![\neg\exists x_i\,(\text{airplane'}(x_i) \wedge x_i\text{=this'})]\!]^{M,w,i,c,g}$

is 0 iff there is no $u \in \text{avail}(c)(<w,i>)$ such that

$[\![\,(\text{airplane'}(x_i) \wedge x_i\text{=this'})]\!]^{M,g[u/xi],w1i} = 1$.

This holds iff there is no $u \in \text{avail}(c)\ (<w,i>)$ such that

$u \in [\![\text{airplane'}]\!]^{M,w,i,c,g}$ and $u=[\![\text{this'}]\!]^{M,w,i,c,g}$.

For $<w_1,i_1>$, we have

avail(c) ($<w_1,i_1>$) = {motorbike-model$_1$, C6-217}.

For $<w_2,i_1>$, we have

avail(c) ($<w_2,i_1>$) = {airplane-model$_1$, C6-217}.

As neither

motorbike-model$_1$ $\in [\![\text{airplane'}]\!]^{M,w,i,c,g}$ = {airplane$_1$, airplane$_2$}

nor

airplane-model$_1$ $\in [\![\text{airplane'}]\!]^{M,w,i,c,g}$ = {airplane$_1$, airplane$_2$},

α is true in all circumstances.

Let us now look at

$\text{Op}(\alpha) = \neg\exists x_i\,(\text{depict}(x_i,C) \wedge \forall x\,(x\in C \rightarrow \text{airplane'}(x)) \wedge x_i\text{=this'})$,

first with respect to $<w_1,i_1>$. This is true iff there is no $u \in \text{avail}(c)\ (<w_1,i_1>)$ such that

$u \in [\![\text{depict}(u,C) \wedge \forall x\,(x\in C \rightarrow \text{airplane'}(x))]\!]^{M,w1,i1,c,g}$ and

$u=[\![\text{this'}]\!]^{M,w1,i1,c,g}$ = motorbike-model$_1$.

This condition is satisfied as

$[\![\text{depict}(u,C) \wedge \forall x\,(x\in C \rightarrow \text{airplane'}(x))]\!]^{M,w1,i1,c,g}$ = {airplane-model$_1$}

motorbike-model$_1$ $\notin$ {airplane-model$_1$}.

Thus Op(α) is true in a part of the modal base.

With respect to $<w_2,i_1>$, however, the condition is

There is no $u \in \text{avail}(c)\ (<w_2,i_1>)$ such that

$u \in [\![\text{depict}(u,C) \wedge \forall x\,(x\in C \rightarrow \text{airplane'}(x))]\!]^{M,w2,i1,c,g}$ and

$u=[\![\text{this'}]\!]^{M,w2,i1,c,g}$ = airplane-model$_1$.

This condition is not satisfied as

airplane-model$_1$ $\in$ {airplane-model$_1$}.

Thus Op(α) is false in a part of the modal base.

The metonymical meaning Op(α) is taken as the meaning of α because it satisfies the maxim of relevance, in contrast to the literal meaning α.

6. Semantic Compositionality and Metonymy

Introduction

NL-meanings above word level are said to work in a compositional way. Roughly, this implies that the meaning of a constituent is built up from the meanings of its daughters. This is one reason why compositionality is regarded as a benchmark problem for theories of meaning. These are evaluated with respect to the compositionality claim (Chierchia (2000), (Pinkal, 2002)). In our approach, compositionality principles can be read off from the set-up of *lf*, especially the lexicon and the translation of the syntax rules. As a result of the global construction principles for compositionality, the local categories and the arity of *lf*-

expressions are all-important. Since metonymy resolution introduces additional information, considerable attention has to be paid to the problem of maintaining the original assignment of categories. For example, if a one-place predicate is substituted by some circumscription capturing the metonymical reading, the circumscribing material must itself be one-place, even if it has a rich internal structure itself.

6.1 On the Verge of Contradiction I

These are the normal problems tied up with compositionality if substitutional processes are at issue. There are at least three other problems which are linked up with the functioning of metonymies. The first one is that metonymical interpretation can be associated with complex constituents, the sub-constituents of which are not infected by metonymy. This can be seen from example (35):

(35) *The red airplane is blue*.

There are readings of (1) which are not contradictory. It can be conceived of as meaning

(35') *The thing depicting red airplanes is blue*.

or

(35'') *The airplane depicted by the red airplane model is blue.*

which seems to be perfect. In (35) meaning transfer acts upon the constituent *red airplane*.

As a consequence, the operator Op must also be defined for constituents of arbitrary complexity rather than for atomic expressions alone.

A second problem is that constituents linearly separated may act upon each other. A relevant example in this respect is

(36) *The supersonic clay-made airplane stands on the table.*

Here *supersonic* modifies *airplane* and the depiction is clay-made.

(36) also illustrates the third problem which might arise, namely that information from different places in the original utterance have to go to different locations in the expression newly set up.

Concerning (36) we have to make sure that the depicting object is clay-made and that the depicted airplanes are supersonic. The three problems have to be treated preserving categorial integrity.

Logically speaking, it is conceivable that expressions of all categories can enter metonymical interpretations, even if one has to admit that examples outside nouns, adjectives and verbs are hard to come by.[19]

Metonymies in these domains will come with their own category problems.

As repeatedly stressed, we aim at an explanation of metonymical readings of expressions using the Gricean notion of conversational implicature. Implicatures are usually discussed with respect to whole utterances and without reference to interpreted formal grammars in our sense. However, on the basis of our example

(1) *This is an airplane.*

we can provide a more detailed picture: Intuitively, the metonymy resides with the sub-expression "airplane", the rest "This is an" and hence the individual words composing it maintain their literal meaning. From the representation of the *lf*-expression in Fig. 6 we can clearly determine the exact locus of the metonymical interpretation. It is the " N: airplane' " expression. It follows that we can locate arbitrary different metonymies in utterances using grammars of this sort, in other words, we know why an utterance is metonymical and in which respect this is the case. As a methodological consequence thereof, we must tie the idea

[19] They do exist, however: In German, seeing the waiter coming with my friend's dishes, I may say to him: *Da kommst du* meaning literally *There you are coming*, and metonymically *Your dishes are arriving*.

of conversational implicature to sub-expressions of *lf*-expressions representing propositions. From this we get two things: First, the contribution of the metonymy to the meaning of the whole expression remains compositional. Secondly, metonymy of whole utterances emerges from particular subparts. This takes into account that differently situated metonymical expressions get different "circumscriptions" and yield hence different contributions to the global meaning. The "extra" meaning provided by the metonymical expression can then be used for computing deductions and entailments.
The Op-operator reflects the locality of metonymy. The tree-representation Fig. 7 of the Opified expression shows that

N: $\mathsf{Op}(\lambda x.\text{airplane'}(x))$

yields the formula

N: $\lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \text{airplane'}(y)))$.

The argument and the result of Op are of the same type, namely one-place predicates (i.e., boolean functions of a single variable); hence, structurally speaking, nothing dramatic has happened. The Opification thus fits into the structure of the annotated tree used for the bottom-up derivation of the *lf*-value of the utterance.

In the above example (1) the expression interpreted metonymically is the predicate *airplane'* derived from the noun *airplane* by the systematic translation from LF-structures to *lf*-structures described in ch. 3 (p. 13). This reflects the metonymical interpretation of a noun and the associated metonymical interpretation of the utterance embedding it.

6.2 Metonymies for Composite Structures

However, metonymy is not always located in just a noun; often composite structures are interpreted metonymically as a whole. Subsequently, we will examine this aspect of compositionality in the case of adjective-noun-combinations. Consider, e.g., the utterance

(37) *This is a red airplane.*

said in front of an airplane model. Two readings are possible here:

(37') *This is a red object that depicts airplanes.*

(37'') *This is an object that depicts red airplanes.*

In both readings, the literal interpretation of a subutterance is connected to its metonymical interpretation by the relation *depicts*. In the first reading, the scope of the metonymical interpretation is the noun *airplane* whereas in the second, it is the $\bar{\text{N}}$-phrase *red airplane*.
Let us concentrate on the second reading: The literal meaning

$\lambda x\ \text{red'}(x) \wedge \text{airplane'}(x)$

of the subutterance

NP: *red airplane*

is connected by the relation *depicts* to its metonymical meaning

$\lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y{\in}C{\rightarrow}(\text{red'}(y) \wedge \text{airplane'}(y))))$.

We now want to show how this connection can be described by using a generalised definition of Op.

Op as introduced until now is defined recursively on IPC formulas (cf. p. 24). Most formula components χ such as e.g. '$\wedge$' or '$\exists$' are left unchanged by Op, i.e. $\mathsf{Op}(\chi) = \chi$. Only for one-place predicates φ, Op may change something[20]: it may transform φ into

$\lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y{\in}C \rightarrow \varphi(y)))$

[20] This is a restriction to the most common cases of metonymy maintained here for reasons of concise exposure of the principles used; the approach may also be used for other formula components.

in case of a depiction metonymy or into

$\lambda x\ \exists u\ (\text{has-as-part}(u, x) \wedge \varphi(u))$

in case of a part-for-whole metonymy. Op may thus be described by

(38) $\text{Op} = \lambda\varphi\ \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \varphi(y)))$

for depiction metonymies and, generally, by

(39) $\text{Op} = \lambda\varphi\ \lambda x\ \exists u\ (R(x,u) \wedge \varphi(u))$

for metonymies based on a relation *R*. For part-for-whole metonymies, we have *R* = has-as-part, and (39) amounts to

(40) $\text{Op} = \lambda\varphi\ \lambda x\ \exists u\ (\text{has-as-part}(x,u) \wedge \varphi(u))$

Op is applicable to atomic one-place predicates and transforms them into other (maybe composite) predicates. In the simplest case the former are translations of nouns to *lf*.

In order to deal with translations of $\overline{\text{N}}$-expressions to *lf*, we observe that the translation of e.g. [$_{\overline{\text{N}}}$ *red airplane*] is [$_{\overline{\text{N}}}$ *red airplane*]' = *red*' $\wedge$ *airplane*' (Chierchia (2000), p. 460 (78))[21] and thus is a suitable argument to the versions of Op given in (38) and (39) above.

The narrow-scope metonymical reading (37') of (37) is obtained by recursively descending all down to [$_{\text{N}}$ airplane]' before applying Op, yielding

$\text{Op}(\text{airplane}') =$

$\lambda\varphi\ \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \varphi(y)))\ \text{airplane}' =$

$\lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \text{airplane}'(y)))$

and thus finally

$\text{red}' \wedge \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \text{airplane}'(y))) =$

$\lambda u\ (\text{red}'(u) \wedge \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \text{airplane}'(y)))(u)) =$

$\lambda u\ (\text{red}'(u) \wedge \exists C\ (\text{depicts}(u,C) \wedge \forall y\ (y \in C \rightarrow \text{airplane}'(y))))$

as result of the Opification of [$_{\overline{\text{N}}}$ *red airplane*]'.

The wide-scope metonymical reading (37'') of (37) is obtained by recursively descending just down to the undecomposed version of [$_{\overline{\text{N}}}$ *red airplane*]' and then applying Op. This yields

$\text{Op}(\text{red}' \wedge \text{airplane}') =$

$\lambda\varphi\ \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \varphi(y)))\ (\text{red}' \wedge \text{airplane}') =$

$\lambda\varphi\ \lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \varphi(y)))\ (\lambda u\ (\text{red}'(u) \wedge \text{airplane}'(u))) =$

$\lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow (\lambda u\ (\text{red}'(u) \wedge \text{airplane}'(u)))(y)) =$

$\lambda x\ \exists C\ (\text{depicts}(x,C) \wedge \forall y\ (y \in C \rightarrow \text{red}'(y) \wedge \text{airplane}'(y)))$

The narrow-scope metonymical reading of (37) can also be obtained by applying Op to the two subnodes [$_{\text{Adj}}$ *red*]' and [$_{\overline{\text{N}}}$ *airplane*]' of [$_{\overline{\text{N}}}$ *red airplane*]' and then letting Op operate trivially on [$_{\text{Adj}}$ *red*]' = red' but non-trivially on [$_{\overline{\text{N}}}$ *airplane*]' = airplane'.

Of course, world knowledge may rule out one of the readings on the pragmatic level. For example

(41) This is a supersonic airplane.

will probably always be understood as having wide metonymical scope, whereas

(42) This is a clay-made airplane.

---

[21] For two one-place predicates φ and ψ, the composite predicate $\varphi \wedge \psi$ is defined by $\lambda u\ [\varphi(u) \wedge \psi(u)]$. Strictly speaking, the operator $\wedge$ as used in the expression $\varphi \wedge \psi$ is different from the logical connective $\wedge$ and should be notated differently, e.g. as $\dot{\wedge}$. By abuse of notation, $\wedge$ is used, however.

will probably always be understood as having narrow metonymical scope, at least if the corresponding reading is true in the model considered.

To see the generality of the approach, consider three examples of a product-for-user metonymy:
(43) *The fat schnitzel complains.*
where narrow and wide scope,
(44) *The arrogant schnitzel complains.*
where only narrow scope, and
(45) *The half-done schnitzel complains.*
where only wide scope makes sense.
The corresponding instantiation of (39) has R = ordered and φ = schnitzel'.

6.3 Long-distance Metonymies

It is obvious how to extend the approach to $\overline{\mathrm{N}}$-structures with more than one adjective. There are cases where the scope of metonymical interpretation is not connected as in

(46) The supersonic clay-made airplane stands on the table.

where sensibly *supersonic* and *airplane* should be in the scope of metonymical interpretation whereas *clay-made* should not. Such cases may be handled by exploiting the logical power of *lf* that permits to change the given order of *supersonic* and *clay-made* in the *lf*-representation of (46) to the logically equivalent inverse order that corresponds to the *lf*-representation of

(46') *The clay-made supersonic airplane stands on the table.*

From the discussion above, it becomes evident that the Op-operator must take into account the structure of *the tree annotated with syntactical categories* which underlies the *lf*-translation of an utterance. By its definition given in ch. 5.1, Op can act on a one-place predicate trivially (i.e., as identity) or non-trivially (e.g., as defined in (38)).

In the most common cases of metonymy, the metonymic relation holds between a one-place predicate corresponding to a noun or to an $\overline{\mathrm{N}}$-phrase and another one-place predicate. In these cases, Op is applied non-trivially only to predicates that appear in a node with an annotation of type N or $\overline{\mathrm{N}}$; moreover, in the latter case, it must be applied either to the entire content[22] of the $\overline{\mathrm{N}}$-annotated node or else to a subordinated $\overline{\mathrm{N}}$-annotated node.

More precisely: The production rules for $\overline{\mathrm{N}}$ read:
$\overline{\mathrm{N}} \rightarrow$ Adj $\overline{\mathrm{N}}$
$\overline{\mathrm{N}} \rightarrow$ N
This allows for the LF-subtree
[$_{\overline{\mathrm{N}}}$ [$_{\mathrm{Adj}}$: red] [$_{\overline{\mathrm{N}}}$ [$_{\mathrm{N}}$ airplane]]]
of an utterance and from there leads to the *lf*-subtree
[$\overline{\mathrm{N}}$: red' $\wedge$ airplane' [Adj: red'] [$\overline{\mathrm{N}}$: [N: airplane']]]
shown in Fig. 8.
Transition to
[$\overline{\mathrm{N}}$: Op(red' $\wedge$ airplane') [Adj: red'] [$\overline{\mathrm{N}}$: [N: airplane']]]

---

[22] We call *content* of a node in an *lf*-translation tree the IPC-formula associated with the node.

with non-trivial Op is legal whereas transition to

$[_{\overline{N}}$: Op(red’) $\wedge$ airplane’ [Adj: red’] $[_{\overline{N}}$ [N: airplane’]]]

with such Op is not.

Every terminal derivation of $\overline{\text{N}}$ will contain an N-constituent in final position. The restriction of applying non-trivial Ops only to the entire content of $\overline{\text{N}}$-nodes or else to a subordinate $\overline{\text{N}}$-node thus guarantees that whenever Op is applied in a non-trivial manner, an N-constituent will be in its scope.

In our example restricting the application of Op to a subordinated $\overline{\text{N}}$-node yields the transition to

$[_{\overline{N}}$: red’ $\wedge$ Op(airplane’) [Adj: red’] $[_{\overline{N}}$ [N: Op(airplane’)]]]

In other words: one-place *lf*-predicates or conjunctions of them will only be modified by Op if they stem from a noun or if they stem from an adjective(s)-noun-group. This reflects that we only deal with metonymies here that are based on the metonymical interpretation of a noun. It blocks readings such as *This is an airplane that depicts red things* for the utterance (37) *This is a red airplane*, whereas it does yield readings (37’) and (37’’).

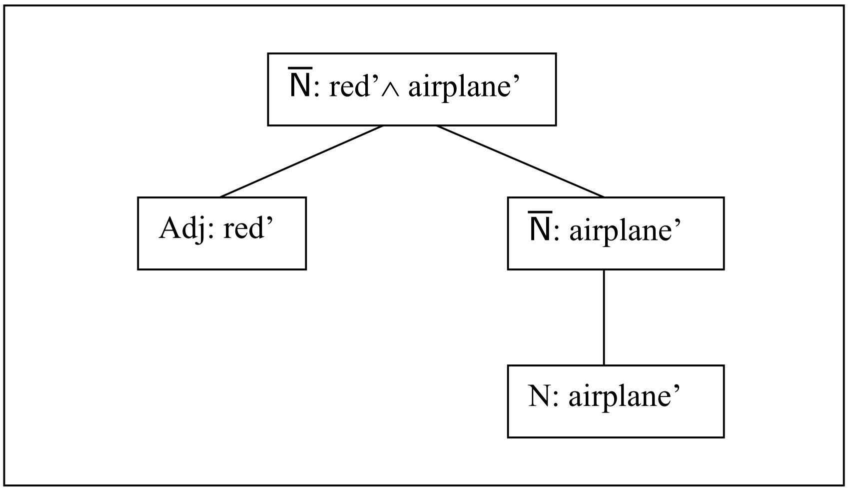

Fig. 8 *lf*-tree [$\overline{\text{N}}$: red’ $\wedge$ airplane’ [Adj: red’] [$\overline{\text{N}}$: [N: airplane’]]]

Metonymical interpretations of lexical categories other than N and $\overline{\text{N}}$ are possible, though and are handled by our approach at least as far as the transition from literal to metonymical reading of the constituents does not change the syntactic expression type. By way of example, we show here the case of adjectives.

In the utterance *the red mayor* the adjective *red* is to be interpreted metonymically as *belonging to a party whose associated colour is red*. The corresponding operator Op could have the following definition:

λx $\lambda\varphi$ [$\exists$u $\exists$v party(u) $\wedge$ has_associated_colour(u,v) $\wedge$ φ(v) $\wedge$ belongs_to(x,u)]

Applied to red’ this would yield

λx [$\exists$u $\exists$v party(u) $\wedge$ has_associated_colour(u,v) $\wedge$ red’(v) $\wedge$ belongs_to(x,u)]

and, assuming Op acts trivially on mayor’, Op($[_{\overline{N}}$ *red mayor*]’) would be

$[_{\overline{N}}$ Op($[_{Adj}$ *red*]’) Op($[_{\overline{N}}$ *mayor*]’)] =

Op(red’) $\wedge$ Op(mayor’) =

λx [$\exists$u $\exists$v party(u) $\wedge$ has_associated_colour(u,v) $\wedge$ red’(v) $\wedge$ belongs_to(x,u)]
$\wedge$ Op(mayor’) =

$\lambda x\ [\exists u\ \exists v\ party(u) \wedge has\_associated\_colour(u,v) \wedge red'(v) \wedge belongs\_to(x,u)]$
$\wedge\ mayor' =$
$\lambda w\ [\lambda x\ [\exists u\ \exists v\ party(u) \wedge has\_associated\_colour(u,v) \wedge red'(v) \wedge$
$belongs\_to(x,u)]\ (w) \wedge mayor'(w)] =$
$\lambda w\ [\exists u\ \exists v\ party(u) \wedge has\_associated\_colour(u,v) \wedge red'(v) \wedge belongs\_to(w,u)$
$\wedge\ mayor'(w)]$

Other readings for the red mayor are possible and could be easily accommodated:
(47) *The mayor with the red face*
(48) *The mayor with socialist inclinations*
(49) *The mayor coming from a socialist community*

7. Challenging Examples

7.1 On the Verge of Contradiction II

In principle, we can provide resolutions for the most complicated metonymies conceivable with the apparatus set up. As a rule, however, this will necessitate further extensions of different sorts. An illustration of some of these will be provided by discussing the example

(50) *The red tube station was built in 1910.*

Imagine (50) uttered in front of a London tube map meaning that the tube station coloured red on the map was built in 1910.

Since we want to exclude the treatment of definite descriptions here, we use an existentially bound version of (50),
(50') *A red tube station was built in 1910.*
We do, however, assume that (50') refers to exactly one object, and all our semantic arguments will depend on that intuition.[23]

In order to see what is going on in the more complicated example (50'), we compare it to
(51) *A red airplane is standing on the table.*
As is characteristic of metonymy, there is an object involved in (50') implicated by default along the lines explained in chapters 5 and 6. In simple cases such as (51), the predication expressed by adjectives (e.g., *red*) in the N'-construction (e.g. *red airplane*) and the predication expressed in the verb-phrase (e.g., *standing on the table*) are both related to the entity implicated, i.e. the airplane model. However, more complicated data, such as (50'), show that the predications can be attributed to different entities: *red* will finally apply to the default object tube-station representation whereas *was built in 1910* is said of the tube-station itself. The solution for the simple case consists in using information of the N'-construction within the definition of the depiction relation, establish the subject term by implicature and apply the main predication to it. In the more complicated case, part of the information of the N'-construction applies to the object implicated whereas the information in the main predicate is attributed to the object expressed by the literal subject term.

[23] Opting for (50') is only due to technical reasons: It would be tedious to develop a metonymical reading of (50) for either a term representation of the definite description or a Russellian treatment of it, and, above all, the reader would not gain relevant insights from a treatment of definite descriptions here.

Hence, one intuition behind (50) is that the tube station represented by the red object was built in 1910. Otherwise, given the situation, (50) would be always false. Clearly, a reconstruction along these lines must lead to several shifts of information. So far, our account of metonymy rests on two things

(a) the *lf*-form of existentially quantified subject terms and
(b) the circumscription of linguistic material.

(a) implies

(52) $\lambda P\lambda Q\exists x(P(x) \wedge Q(x))$,

where P stands for the information bound to the subject and Q for the one of the predicate.
(b) so far amounted to[24]

(53) $\lambda\phi\lambda x\exists C(depict(x,C) \wedge \forall u(u \in C \rightarrow \phi(u)))$.

Considering our semantic intuition, we get two *lf*-representations for (50')

(54) $\exists x\exists z(depicts(z,x) \wedge red'(z) \wedge tube\text{-}station'(x) \wedge was\text{-}built\text{-}in\text{-}1910'(x))$.

and

(55) $\exists x\exists z\exists C(depicts(z,C) \wedge red'(z) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow tube\text{-}station'(u))) \wedge was\text{-}built\text{-}in\text{-}1910'(x))$.

What (54) says is 'There is a red object z depicting a tube-station built in 1910'. The paraphrase of (55) is 'There is a red object z depicting a unit set C of tube-stations, where C contains an entity built in 1910'. If we want to have either of these, two problems emerge on the representational level:

First, we have to separate the information contained in the $\overline{\mathrm{N}}$ *red tube-station* in the following way: *red'* has to stay with the depicting object and *tube-station'* has to go into the consequent of the material implication. As a consequence, depiction rests with the red object alone and does not "go" with the tube station.
Secondly, the variable tied up with the literal subject does not carry over to the predicate *was-built-in-1910*', since having been built in 1910 is attributed to the tube station depicted.
This is shown in the tree given in Fig. 11 using variable x_i, in opposition to the tree given in Fig. 10 which represents the literal interpretation.

The S-structure[25] of (50') is given in Fig. 9.

In the following, we treat (54) first and then go on to (55).
We get an *lf*-formula equivalent to (54) by replacing *red* by *represented by a red object*. This transition can be made by applying a variant of Op to $\lambda P\lambda x(red'(x) \wedge P(x))$, yielding

(57) $\lambda P\lambda x(\exists z\, red'(z) \wedge represents(z,x) \wedge P(x))$

in case the red object represents only one domain object (individual) or

(58) $\lambda P\lambda x\exists z\, (red(z) \wedge represents(z,C) \wedge |C| = 1 \wedge x \in C \wedge \forall u(u \in C \rightarrow P(u))$

in case the red object represents a class of objects. The result of applying one of these operators to an expression α will be denoted α^b.

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[24] Metonymy resolution involving introduction or a change of quantifiers definitely needs a more complicated schema than the one represented in (53).
[25] We do not represent LF here.

(56)

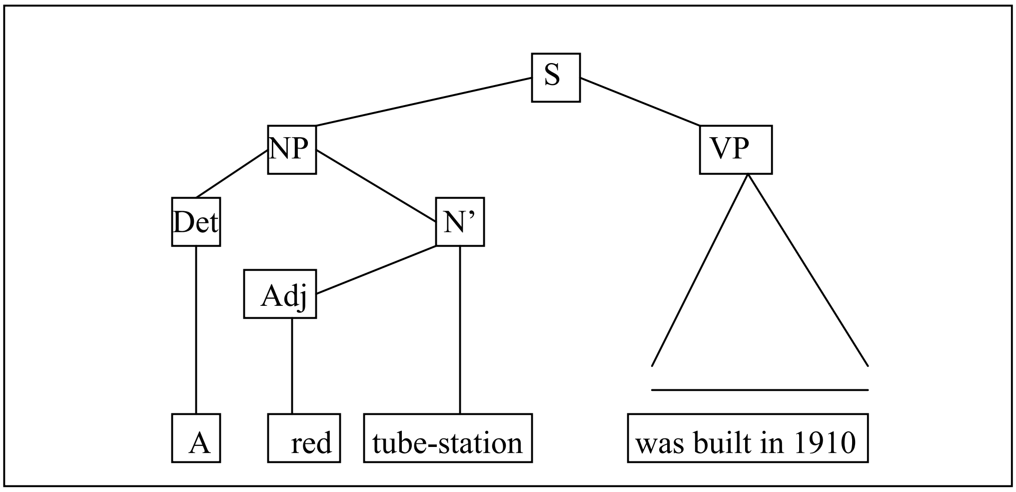

Fig. 9 S-structure of (50')

Let us show the derivation for (50'). By the standard procedure of translation from LF to *lf*, (56) yields tree (xxxiv) for the literal meaning.
In case only one domain object is represented, $(\lambda P\lambda x(\text{red}'(x) \wedge P(x)))^b$ is (57). The evaluation of (xxxiv) with $\lambda P\lambda x(\text{red}'(x) \wedge P(x))$ replaced by $(\lambda P\lambda x(\text{red}'(x) \wedge P(x)))^b$ yields

$\lambda c\, \exists z\, (\text{red}'(z) \wedge \text{represents}(z,c) \wedge \text{tubestation}'(c))$ for the subtree corresponding to $(\text{red}^b\, (\text{tubestation}'))$.

For the subtree corresponding to $(a\, (\text{red}^b\, (\text{tubestation}')))$ it yields

$$\lambda P\lambda Q(\exists x(P(x) \wedge Q(x)))\, (\lambda c\, \exists z\, (\text{red}'(z) \wedge \text{represents}(z,c) \wedge \text{tubestation}'(c))\,) =$$
$$\lambda Q\, (\exists x((\lambda c\, \exists z\, (\text{red}'(z) \wedge \text{represents}(z,c) \wedge \text{tubestation}'(c)))\, (x) \wedge Q(x))) =$$
$$\lambda Q\, (\exists x \exists z\, (\text{red}'(z) \wedge \text{represents}(z,x) \wedge \text{tubestation}'(x)) \wedge Q(x)))$$

and finally

$$\exists x \exists z\, (\text{red}'(z) \wedge \text{represents}(z,x) \wedge \text{tubestation}'(x) \wedge \text{was-built-in-1910}'(x)))$$

In case the red object depicts a class of objects, $(\lambda P\lambda x(\text{red}'(x) \wedge P(x)))^b$ is (58) and we arrive at

$$\lambda P\lambda x(\exists z\, (\text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow P(u))$$
$$(\lambda z\, \text{tubestation}(z)) =$$
$$\lambda x \exists z\, (\text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow \text{tubestation}(u))$$

for the subtree corresponding to $(\text{red}^b\, \text{tubestation})$.
We arrive at

$$\lambda P\lambda Q(\exists x(P(x) \wedge Q(x)))$$
$$(\lambda x(\exists z\, \text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow \text{tubestation}(u)) =$$
$$\lambda Q\, (\exists x \exists z\, (\text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow \text{tubestation}(u)) \wedge Q(x)))$$

for the subtree corresponding to $(a\, \text{red}^b\, \text{tubestation})$,
and we finally arrive at

$$\lambda Q\, (\exists x \exists z\, (\text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow \text{tubestation}(u)) \wedge Q(x)))\;\; (\lambda z\, \text{was-built-in-1910}'(z)) =$$
$$\exists x \exists z\, (\text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow \text{tubestation}(u)) \wedge \text{was-built-in-1910}'(x)).$$

Ordered more clearly, this is

$$\exists x(\text{was-built-in-1910'}(x) \wedge \exists z\,(\text{red}(z) \wedge \text{represents}(z,C) \wedge x \in C \wedge |C| = 1 \wedge \forall u(u \in C \rightarrow \text{tubestation}(u))$$

Thinking over the intuitions presented and the formal results obtained, we can describe the road pursued as follows: Sticking to our overall philosophy of providing a pragmatic solution for the interpretation of metonymies, we left the original S-structure shown in Fig. 9 intact, i.e., speaking in terms of S-structure, *red* remains an attributive adjective to *tube-station*. The *lf*-representation of this S-structure is set up in Fig. 10. Here *red'* modifies *tube-station'*, being finally responsible for the falsity of S. In our pragmatics however, we generate a new subject term out of the indefinite article, the Op^b-translation of the adjective *red'* and the noun *tube-station'* as shown in Fig. 11. Roughly, this step provides us with the information "a red thing representing tube-stations", resp. "a red thing representing a tube-station".

7.2 Metonymy and Anaphora Resolution

For the interpretation of expressions containing metonymical sub-expressions we have adopted the following strategy: We set up LFs within an extended GB-framework for them, translate these into intensional *lf*s and try to pair them with a truth-value relative to some model M. On finding that their literal interpretation turns out to be false, they are processed in a module of Gricean pragmatics on the assumption that the quality maxim is violated.

The possible locus of the metonymy is spotted by a reconstruction algorithm working with an operator Op. Op leaves some bits of the original structure intact and may change others. Hence it can in principle provide a circumscription for a subexpression. The relevant subexpression is the one responsible for the falsity of the embedding expression. Op may of course do nothing. However, if a circumscription exists it is fed into a Gricean default and can then provide the subexpression as well as the embedding expression with a pragmatic meaning. As we have already shown, the pragmatically derived meaning of the subexpression is compositional due to Op and may therefore be spliced into the original tree.
This may well work for single utterances but how does it fare for a larger linguistic context, if, say, the expression at stake is embedded in a discourse? In order to get an idea about that we consider cases of anaphora resolution.

Anaphora resolution I

I (a) *This is a motor cycle.*
(b) *This is an airplane.*
(c) *It is a nice model/picture*.

Classical Discourse Representation Theory (DRT), the outstanding paradigm of Dynamic Semantics (Kamp and Reyle (1993)), is an apt instrument to deal with structures like the one exhibited in I (a)-(c). DRT comes with a construction algorithm mapping utterances onto structures called DRSs. The construction algorithm is successively applied to parts of sentences and sentences until the whole discourse input has been worked on and the final DRS is established. DRSs contain two kinds of information: The discourse referents (DRs) introduced and conditions, specifying which properties these have. Discourse referents are tied up with NPs such as *this* or *a motor cycle*. A didactic means to represent DRSs is via boxes. These are divided into a top row containing the discourse referents introduced and the

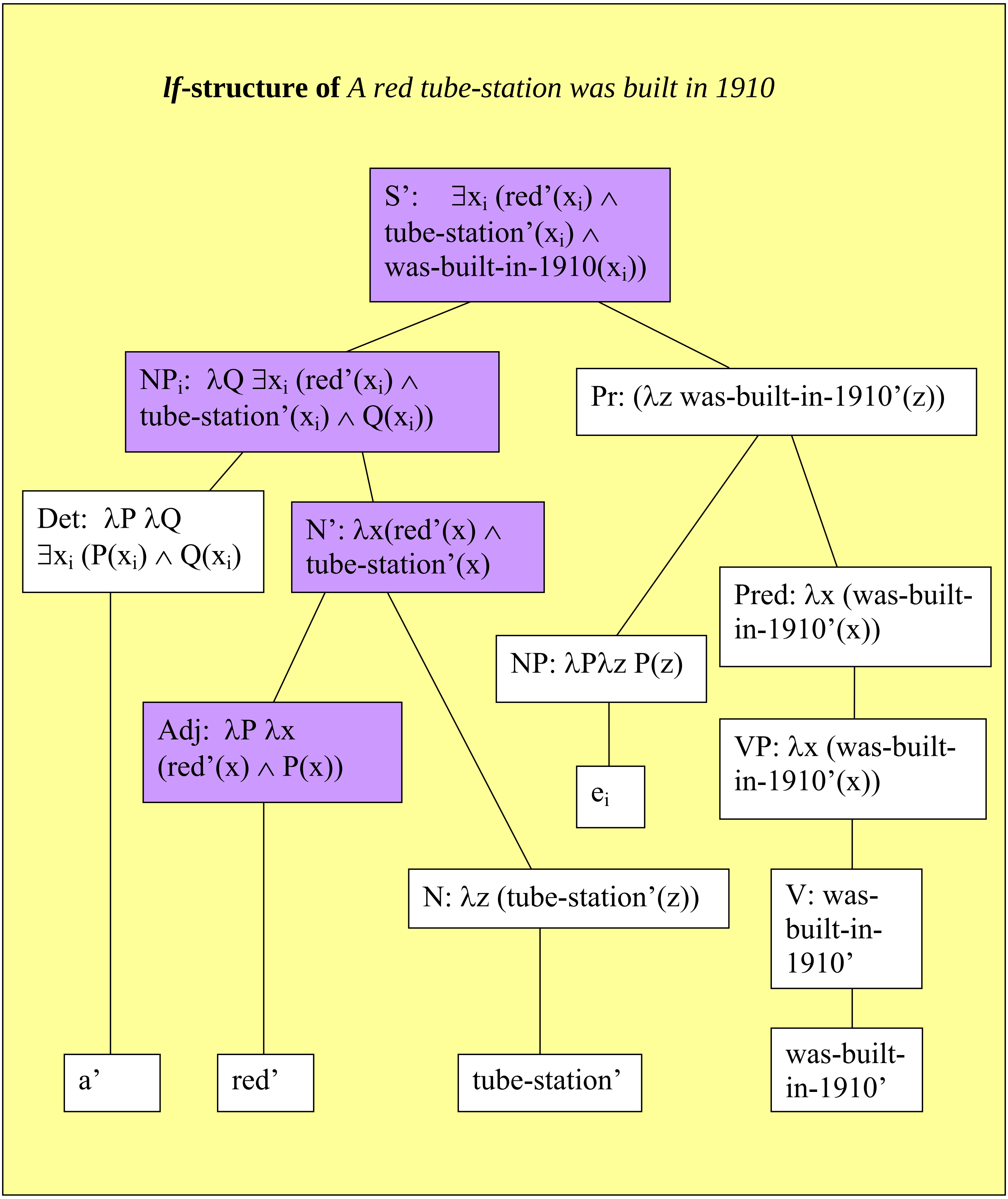

Fig. 10 *lf*-structure of *A red tube-station was built in 1910*

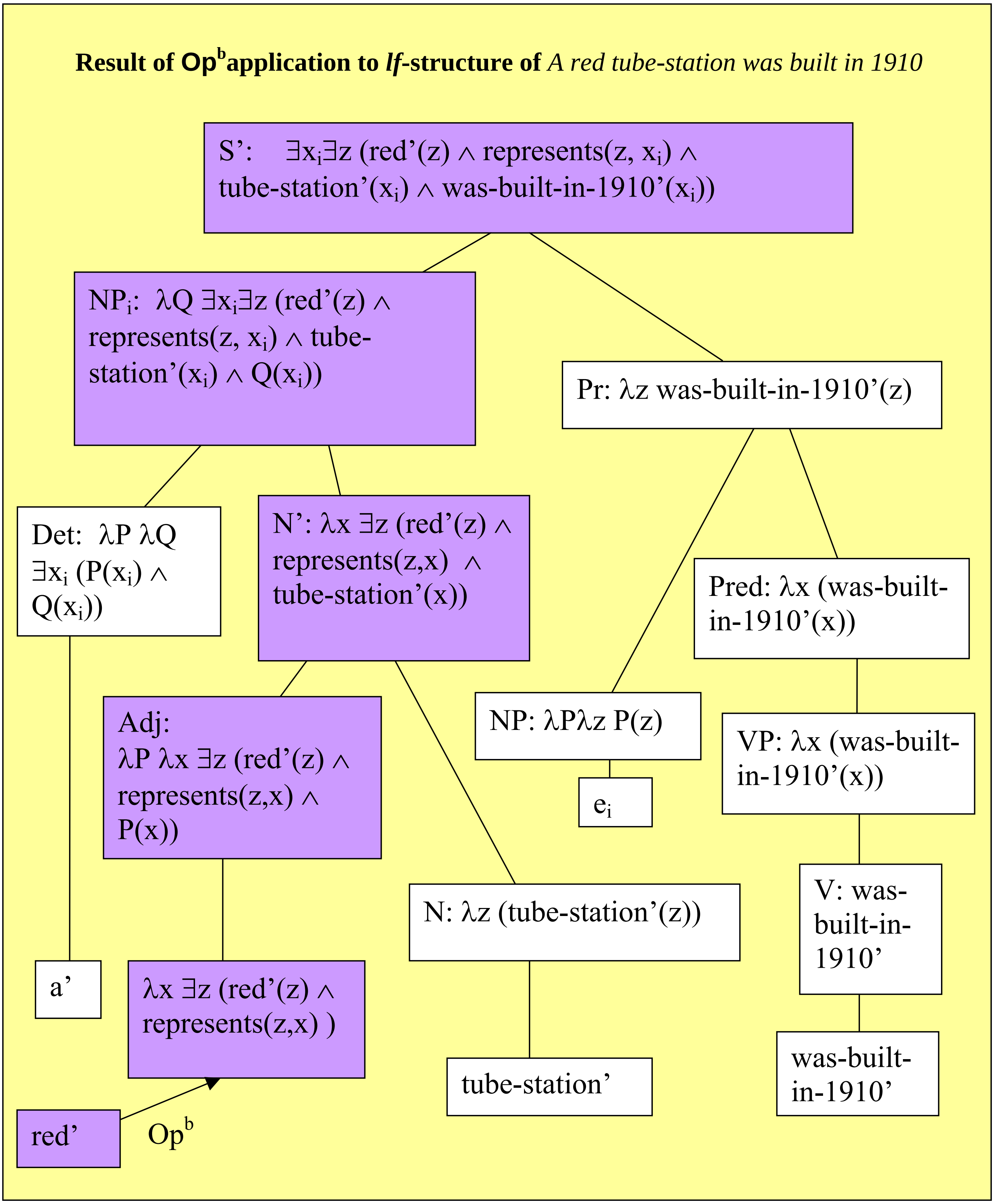

Fig. 11 Result of Op^b application to *lf*-structure of *A red tube-station was built in 1910*

rest of the DRS containing the conditions ascribed to these. Complete DRSs are evaluated wrt a model. For I (a), (b), (c) a standard procedure yields the DRS below. We do not treat deixis and the copula explicitly here in order to avoid complications which are of no avail to our concerns.

(DRS I)

x, y, z, u, v
this_1(x), motorcycle(y), is(x,y), this_2(z), airplane(u), is(z,u), nice-model/picture(v), u = v.

The resolution of the anaphor *it* wrt *an airplane* is brought about in DRT via an accessibility relation determining which DR introduced earlier a later established one can be hooked onto via "=".

Now, if we consider models making (DRS I) true, we encounter problems already familiar from the discussions in this paper: Given that *u* is in the extension of *airplane* interpreted literally, then it could not be in *nice-model/picture* and we would not get a true DRS, since $u = v$ would fail. This exactly mirrors condition (2) in our definition of the default implicature in the case of violation of quality maxim on p. 28. Clearly, what we would need is $\exists x \exists C(\text{depict}(x,C) \wedge \forall y(y \in C \rightarrow \text{airplane}(y)))$ as the meaning of *airplane*. In other words, anaphora resolution depends on resolution of metonymy here: In order to resolve the anaphorical relation between (b) and (c) we have to resolve the metonymy tied to *airplane* first.

The situation might get even more complex as example II shows, where a metonymy must be resolved in different ways[26]:

Anaphora resolution II

II

(a) *A newspaper called.*	($\text{newspaper}_{\text{rep}}$ = representative of $\text{newspaper}_{\text{inst}}$)
(b) *It is in the town center.*	(institution = $\text{newspaper}_{\text{inst}}$)
(c) *It was founded 30 years ago.*	($\text{newspaper}_{\text{inst}}$)
(d) *I left it on the kitchen table.*	($\text{newspaper}_{\text{product/copy}}$)

To the right we roughly indicated the resolution of the metonymy one needs. II (a) must be resolved to a representative of the $\text{newspaper}_{\text{inst}}$. In order to attach (b) to (a), information has to be accommodated, namely, *it* refers to $\text{newspaper}_{\text{inst}}$. The *it* of II (c) takes up $\text{newspaper}_{\text{inst}}$ again. II (d)'s *it* would only be felicitous, if it could be related to $\text{newspaper}_{\text{product/copy}}$. Strictly speaking, we have some sort of Russian doll type metonymy here: What the institution produces is a $\text{newspaper}_{\text{product}}$, which exists perhaps as some sort of Platonic essence. An embodiment of this product is a copy which might have been left on the kitchen table. Since we do not have a discourse referent for $\text{newspaper}_{\text{product/copy}}$, the anaphor *it* cannot be resolved and II as a whole remains incoherent. In order to explain the incoherence of II we must resort to pragmatic information of the following kind:

$\text{newspaper}_{\text{product/copy}}(x) \wedge \text{of}(x,y) \wedge \text{newspaper}_{\text{inst}}(y) \wedge \text{situated-in}(y,z) \wedge \text{town center}(z)$.

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[26] The example is a variant of one of Johannes Dölling's pet examples.

No semantic theory can handle I or II. However, our argument is not that we have a way of doing that. It is clear that our theory so far can only describe single utterances. We argue for a pragmatic resolution of metonymy. Obviously, it would be desirable to integrate this approach into DRT or a paradigm of comparable strength.
The problems arising for such an endeavour will be briefly commented upon in the next chapter.

7.3 Updating Semantic Information with Pragmatic Default Information

There is, as far as we know, no DRT-account of metonymy resolution. It would presumably need a lot of developmental work to achieve that. A more modest aim is to describe the role of metonymy resolution wrt abstract information states[27]. Let us assume a structure for information states quite similar to DRSs, except that we

- attribute semantic values to sentences individually
- add only true sentence meanings to an information state which may be based on metonymy resolution

Concerning example Anaphora Resolution Iabove, we set up an information state in the following way: We start with an empty information state first. Secondly, we investigate I (a) with respect to some model M. If it turns out true, we update our information state with the formula that I (a) was translated into:

Info-state I

x, y
$this_1(x)$, motorcycle(y), is(x,y)

Next we try I (b), find out that it is false in M, and look for a different model M* making I(a) and I(b) true. Else we apply the Op-algorithm and generate a reading which can be invested with a meaning true in M by a Gricean default.
It could well be that the metonymical meaning for I (b) is also false in M, then we would have to look for a more promising model M' making I (a) and I (b) true under the new reading. Let us, however, assume that M satisfies the pragmatically derived meaning. Then we can add the circumscription arrived at by Op to our information state. In order not to get into intricate problems concerning quantifier representation we abbreviate the *airplane* circumscription in the following way:

$$\text{airplane-depiction}(x) := \exists C(\text{depict}(x,C) \wedge \forall y(y \in C \rightarrow \text{airplane}(y))).$$

[27] We remain agnostic here about the ontological nature of these states.

Info-state II

x, y, z, u
$this_1(x)$, motorcycle(y), is(x,y), $this_2(z)$, airplane-depiction(u), is(z,u)

Observe that *airplane-depiction(u)* will only be satisfiable by default. Hopefully, this default will remain persistent. It would not, if we had a sentence I (d) *Oh, sorry, it's a real one*.
It is easy to see that Info-state III contains the full information of example I.

Info-state III

x, y, z, u, v, w
$this_1(x)$, motorcycle(y), is(x,y), $this_2(z)$, airplane-depiction(u), is(z,u), nice-model/picture(w), is(v,w), u=v

We can now handle the content of the info-state in the usual way, e.g. derive the information roughly equivalent to

$$\exists x\ (\text{airplane-depiction}(x) \wedge \text{nice model/picture}(x))$$

using the tools of elementary logic.
Observe that the literal interpretation of I (b) was not added to the info-state II as it had been filtered out by model M.

8. Discussion and Future Research

8.1 Recapitulation

The solution we suggested for the interpretation of metonymies is as follows: Various reasons discussed in detail in ch. 2 tell against a lexicalisation of metonymies. If one assumes that these are sound and one wants to hold on to well-established logical methodology, there is only one remaining option to interpret metonymies, the use of Gricean maxims. To proceed along these lines two foundations have to be laid:

First, the ground has to be prepared for a rigid application of the Gricean maxims, which we achieve using a formal syntax along GB paradigms getting a semantic interpretation in terms of a model theory for intensional logics. Due to this theory we can derive truth conditions for sentences containing metonymies and determine their falsity or their non-relevance; falsity or non-relevance being the two main paths leading to an indirect interpretation of metonymies.
Since due to our corpus data we deal with metonymies-in-context or metonymies-in-a-situation we must equip our models M with contexts. In addition, the notion of a context allows us to introduce further properties needed. Among these are, on the one hand, objects existing or made salient in situations and on the other hand, situation-dependent modal notions and standards of normality. Hence, the "metaphysical distinctions" we use always rest on contexts or situations. So much for grammar, semantics and models applied.

Secondly, for the rules that provide us with the content of indirect interpretation, a rigorous format has to be established. We get it *via* the notion of default. The definition of default makes heavily use of context-dependent notions, objects existing, things known in context etc. As

a consequence, model-based metonymy interpretation is context-dependent and rests on the concept of defeasibility. Intuitively, the default specifies information needed in order to get a pragmatic interpretation for the respective metonymy, for example, for the shift in meaning from the literal ‘airplane’ to the resolved ‘airplane depicting entity’.
The extra information needed for metonymy resolution is introduced by an operator Op, defined on the *lf*-structure of the literal expression and extending it: in simplified notation, Op(‘airplane’) is roughly ‘airplane depicting entity’. In general, this information includes a relation R holding between objects given and new ones introduced. Different instantiations of R yield different types of metonymy. The default states that if a set of conditions holds for the interpretation of an expression *wrt* a model M then its meaning in M is determined by some Op defined on it.

This has been a sketch of the basic machinery handling non-trivial but simple cases of metonymy where the information shifted resides in the noun. It is extended to deal with cases where e.g. adjectival information is exploited for metonymical interpretation. In addition we show that metonymy resolution interacts with all semantic mechanisms known from the semantics and pragmatics literature on literal interpretation, for example, with semantic relations like entailment or with anaphora resolution. This tells us something about the productivity and the universality of metonymy.
The explanations we suggest for metonymy are based on grammatical, proof-theoretical and model-theoretical techniques and do not contain uncontrollable intuitive gaps.

8.2 Scope of Our Theory

Since ultimately we reside on a rigorously specified grammar based on GB and intensional logic, our approach is determined by the grammar’s coverage and the definitions for Op. That is why we can clearly indicate which grammatical constructions we can handle, given appropriate grammars. Roughly, we proceed from simple constructions to more complex ones along a complexity hierarchy measured in terms of grammatical structure and Op. Motivated by our corpus-data, we first set out for an explanation of representation metonymies or depiction metonymies like ‘This is a nice car.’, said of a toy. This utterance could be true or false under a metonymical interpretation. Our paradigm construction consists of a referring subject term and a metonymy in the verb phrase as in ‘This is an airplane’ where the noun in the quantifier phrase is non-modified. We can also handle non-modified subject terms in the manner suggested. As a next step in the complexity hierarchy, pre-nominal adjectives are added and we show how to treat examples like ‘The red airplane is blue’, which seem contradictory at first sight. Moreover, we go some way towards demonstrating that the route taken easily generalises to structures with different lexical fillings; there no substantial changes must be made, only additional lexical elements and relations R in the Op definitions have to be added. If we encounter several modifying adjectives in an expression it may well be that metonymical and non-metonymical adjectives come interleaved. In these cases our explanation rests on the commutativity of conjunction in the sentence’s *lf*, packing together homogeneous information.
The most complex type of structure within the scope of our paradigm is provided by sentences like ‘The red tube–station was built in 1910’, where the metonymy can either reside in the adjective ‘red’ or in the adjective-noun combination ‘red tube station’. As a consequence either ‘red’ or ‘red tube station’ has to go into the scope of Op.
Although we do not show this in detail, it is clear how the solution of complex depictional metonymies could be generalised to different types of metonymies the understanding of which

requires elaborate reasoning. As an example, take the situation that we encounter someone pointing to a photograph of a red mayor saying 'The popular red mayor piled up a huge debt'. There, the whole information expressed can be paraphrased as 'The popular mayor with socialist inclinations shown on the photograph pointed at piled up a huge debt'. Here we have an interleaving of metonymical and non-metonymical expressions within a depictional metonymy.

8.3 Discussion

One or many Ops*?*

Since we provide rigid reconstructions, one can clearly see where problems creep up and falsification enters. So, where do interesting problems arise *wrt* our solutions? The first problem we want to discuss is whether one will need one or several Op operators. Remember the case of 'crossing' information laid out in the discussion of 'The red tube station was built in 1910'. There we had to introduce a variant of the Op-operator, Op^b. Op^b allows us to separate adjective information from noun information in adjective + noun constructions and to introduce new information, roughly, information for a "missing" noun. What this indicates is that one will ultimately need a family of Op operators depending on the type of grammatical construction and the position of the metonymical element in it. This is not really surprising because ultimately every semantic or pragmatic solution rests on *lf* which in turn is based on surface syntax. So, the rule of thumb emerging is: Larger fragments will need more elaborate machinery, especially at points, where semantical information is in a sense manipulated as in the "mayor example" above. The solution to problems like this one will be strictly fragment dependent and goes with the extension of surface syntax. How particular constructions react with respect to metonymy, for example if we look at them using fine-grained categorical grammar and generalised quantifiers, is a problem which remains to be investigated. However, our hypothesis is that there is no easy global solution for metonymy generalising across arbitrarily complex language data as classical rhetoric and philology suggest.

Information store for additional information.

A really basic problem affecting the set up of the theory is the following one: If we look at the information introduced by Op as given in ch. 5.1 we may wonder where this information comes from. Clearly, classical theories of grammar do not provide semantic information over and above the lexicon. One can gain this from our handling of LF and *lf* grafted upon surface syntax in ch. 3. Moreover, as we have argued in ch. 1, we do not subscribe to a lexicalisation of metonymies. At the time being, Op is really an extension of the whole grammar, reflecting the fact that metonymy resolution has its syntactic, LF and *lf* sides. Nevertheless, one would like to handle the information introduced by Op in a more systematic fashion, for example, setting up a module of *lf* which provides the default information we need for metonymy resolution. This would be a move towards lexicalisation but it would not mean to lexicalise, owing to the default option. Taking this route would, however, mean to set up information in advance, so to speak. This might work for some object or institution based metonymies like cases of *pars-pro-toto*. However, metonymies are produced in discourse on the fly and we cannot predict what will be needed for all contexts. E.g. consider the following example:

The football reporter says (9th of April, 2005, 5 pm, Leverkusen against Dortmund):
The shot is an easy prey for keeper Butt. The thirty-year-old takes up the ball.

We can't even hope to determine this information fully in advance. Hence, a more flexible mechanism is called for. An idea we developed in this respect is to use similar mechanisms as constraint based grammar does for inflectional and derivational morphology (see Sag, Wasow, Bender (2003), pp. 227 – 271). Moreover, the default approach advocated here for meaning generation goes well with the use of constraints. What we can hope for is to find a bound for the domain and the range of the relation R.

Default theory.
Although we use the notion of default in order to get at indirect interpretation, we do not subscribe to a particular default theory. Instead, we defend the use of defaults on empirical grounds. However, it would be interesting to set up models using different default theories (see Thomason (1998?)) and look for ensuing effects. It is obvious that grammar, i.e. finally *lf* will act as a filter for default paradigms.

Global embedding of metonymy.
The football example above shows that metonymy interacts with anaphora resolution and bridging inferences, especially the definiteness information is important in this respect since it contextually attributes a unique property. Definiteness can hence work as a link to a relation R needed for metonymy interpretation. What we can learn from that (*vide* also our discussion in ch. 7.2) is that the natural locus for metonymy theories is constraint-based syntax interfacing with dynamic semantics operating on underspecification theory. Although we did not go into this field in our current paper - more fundamental matters had to be explored - it is clear what would have to be done, namely, substitute *lf* by some version of compositional DRT which can handle underspecification.

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