The German Temporal Anaphor *danach* – Ambiguity in Interpretation and Annotation

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In this paper I present different types of ambiguity that occur in annotating and resolving anaphoric adverbials. My analysis concentrates on the German temporal adverbial *danach* ("after that" or "thereafter"). However, issues discussed here go beyond the analysis of this particular German word. I assume that the types of ambiguity presented in this paper occur not only with other anaphoric adverbials like *therefore* or *besides* but also with other types of anaphoric expressions (e.g. personal pronouns). At least, the "Justified Sloppiness Hypothesis" proposed by Poesio et al. (2005) leads to this conclusion. First, I present an account of the meaning and anaphoric character of the German pronominal adverb *danach*. By means of a pilot study, I then show that the resolution of *danach* involves several types of ambiguity, namely structural and referential ambiguity. Regarding referential ambiguity, we can distinguish the following sub-types: 1. competition between temporal and situation referents, 2. competition between simple and structured situation referents and 3. competition between different situation referents. Finally, I make some suggestions for handling these types of ambiguity.

1 The German Pronominal Adverb *danach*

Following Webber et al. (2003) and Miltsakaki et al. (2004), adverbial connectives like *however*, *therefore* etc. are assumed to express (as subordinate and coordinate conjunctions) binary predicate-argument relations. Nonetheless, they only get one of their two arguments structurally, namely the matrix-clause. The other argument has to be derived anaphorically from the discourse context. In German there are so-called pronominal adverbs like *danach* and *dadurch* (*thereby*) which consist of an anaphoric element (e.g. *da-*) and a relational element (e.g. *-nach* or *-durch*) (cf. Rüttenauer 1978, Fraurud 1992, Pasch et al. 2003). Due to their anaphoric element these pronominal adverbs refer to a referent previously introduced into the discourse. By means of their relational element they can also establish a temporal, causal or any other discourse relation between the referent of the antecedent (e.g. a situation or a time-entiy) and the situation-referent of the matrix-clause of the anaphor (s. example (1)). Thus, they can function as relational anaphora and adverbial connectives.

(1) [*Eine Abordnung des Münchner Polizeipräsidiums legte an der Gedenktafel einen Kranz für den 1972 getöteten Polizeibeamten Anton Fliegerbauer nieder.*]₁ **Danach** begaben sich die Mitglieder der Deutsch-Israelischen Gesellschaft und der anderen Gruppen zu Fuß ins 17 Kilometer entfernte Dachau.

[*A delegation of the police headquarters of Munich put down a wreath at the commemorative plaque of the police officier Anton Fliegenbauer killed in 1972.*]₁ **After that** the members of the German-Israelic Society and other groups walked to Dachau which was 17 kilometers away.

In order to find out which factors influence the resolution of the relational anaphor *danach*, I selected and classified a variety of occurrences of *danach* from a corpus study. In the TIGER corpus, only 45 of approximately 100 occurrences of *danach* (used anaphorically) express temporal succession. The remaining ones mean "according to" and introduce the

content of a previously mentioned 'documentation'-noun like *study*, *agreement* or *report*.[1] In this paper I focus on the temporal incidences of *danach*. In general, temporal *danach* expresses the temporal succession of two temporal entities which have been mentioned in the text and which are usually conceptually related to each other. Only situations (i.e. events, processes, states) and time-entities (given by a temporal expression like *2006* or *New Year*) have a temporal dimension and can be temporally located. The situation introduced in the anaphor-matrix-clause is temporally located with respect to some reference time in the previous discourse given by a temporal expression or by an expression referring to a situation. More precisely, *danach* locates the matrix-situation in the post-phase of the reference time (s. figure 1).[2]
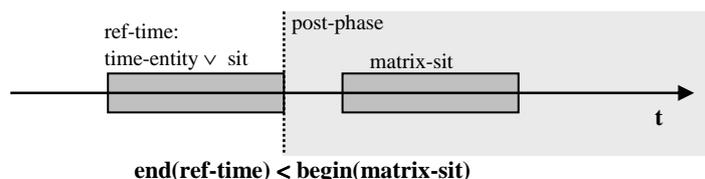

Figure 1: Temporal interpretation of *danach*

Syntactically, the antecedent of *danach* is either an S-based phrase (a sentence, a clause, a VP etc.) referring to a situation or an NP-based phrase (an NP or PP) referring to a situation, a time-entity or an object (coerced into a situation). Considering the ontological status of the referents of the antecedent and of the anaphor, we can distinguish between **situational** reference (the referent is a situation) and **temporal** reference (the referent is a time-entity).

1.1 The Pilot Study

As I assumed that the *danach*-occurrences of my corpus study might be ambiguous and therefore difficult to annotate, I did a pilot study with 6 test persons (all of them linguists). I selected 24 examples (ranging from easy to tricky) and asked the subjects not only to mark the antecedent but also to name the referent of *danach*. As I annotated the data (i.e. marked the antecedent) I largely followed the annotation convention for marking arguments of discourse connectives proposed in the Penn Discourse Treebank annotation manual (cf. Prasad et al. 2006). Thus, only S- or NP-based phrases with all their attributes were possible antecedents of *danach*. To include all attributes has two advantages. First the antecedent is not fragmented too much, so the annotation is clearer and easier. Second the annotator does not have to decide which attributes are absolutely necessary and which are not – generally a hard decision, s. example (2). Here the modification *within the forthcoming 24 hours* is not crucial for the interpretation of *danach* since it focusses on the potential occurring of the event rather than on a specific moment. Nonetheless, the modification does not spoil the interpretation. Therefore, all attributes of the antecedents are contained in the annotations.

(2)   Zu spät, wie amnesty international fürchtet, [*weil die Todesurteile binnen der kommenden 24 Stunden vollstreckt werden könnten*]₁. **Danach**, so steht zu vermuten, werden wir uns den Namen Ken Saro-Wiwa endlich gemerkt haben.

   Too late, as amnesty international fears, [*since the death sentences could be executed within the next 24 hours*]₁. It could be supposed that **thereafter** we will keep in mind the name Ken Saro-Wiwa at last.

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[1] As one of the reviewers pointed out Dutch *daarna* appears to behave like German *danach*, except that it does not have a content reading (meaning *according to*) but only a temporal one.

[2] My analysis of the temporal meaning of *danach* is influenced by work on temporal connectors by Herweg (1992), Schilder (2004) and Habel & Knees (2004).

The disadvantage of keeping all (even unnecessary) attributes is that the antecedent often only partly refers to the referent of the anaphor. This also happens regardless of its unnecessary attributes. Thus, in some cases, the referent of the anaphor has to be derived from the antecedent or better from the textual anchor. Another annotation convention is to choose as antecedent only the textually closest and shortest referential expression from which the referent of *danach* can be derived.[3] In the PDTB annotation manual this convention is called "Minimality Principle" (cf. Prasad et al. 2006:13).

The subjects of the pilot study did not know about the conventions.[4] I wanted to check whether these conventions are really necessary as they are quite strict and for reasons just illustrated not completely sound. Moreover, I wanted to know whether and how my annotations differ from those of the subjects.

In general, the subjects had less problems to name the referent than to mark the antecedent. There are two possible explanations for this observation. First, as the subjects did not know about the annotation conventions, i.e. as they had no systematic method for marking the antecedent (e.g. to choose only referring expressions like an NP, PP or S and including all their attributes) they had trouble identifying the borders of the textual material to be marked. Thus, to hand out the conventions to the subject in advance might help to amend the reliability of the annotated data. Second, the referent was often only mentioned implicitly, i.e. it had to be derived from the text. Then the subjects were uncertain which and how much of the textual material was necessary in order to specify the referent. This difficulty can be explained as follows: Text understanding requires the activation of lexical and conceptual knowledge and many inferences are drawn in order to build up a coherent conceptual representation of the text. The conceptual representation of the text is much richer than the text itself (cf. e.g. Schwarz 2001, Graesser et al. 2001). As text understanding also relies on implicit knowledge which is difficult to determine explicitly, people are at a loss when they are asked to precisely determine the antecedent. They have the impression that the textual material contains less or more information than needed.

The aim of the paper is to show that annotating occurrences of *danach* and representing their meaning is a quite difficult task since there is a lot of implicit and explicit ambiguity[5] involved. I will now present different types of ambiguity found in the data. Then, I make some suggestions how annotating the examples can be facilitated (e.g. by the annotation conventions) and why we should and how we could account for the different types of ambiguity e.g. by using underspecified representations.

2   Different Types of Ambiguity

I distinguish two main types of ambiguity: structural and referential ambiguity. When the subjects specified the same referent for *danach* but marked different antecedents as in example (3), I call this structural ambiguity. For the interpretation of the example it does not make a difference whether one assumes only the NP or the whole S as antecedent.

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[3] This definition of the antecedent differs from a text-linguistic one where the antecedent is the first (not the last) expression referring to the referent of the anaphor.

[4] The instructions given in the pilot study were: 1) For the antecedent: Please mark the text span that you think *danach* relates to. and 2) For the referent: Please name the entity (in the world), i.e. an event, a time-entity or an object to which *danach* refers to. 3) Please indicate the degree of difficulty for each example as easy, medium or tricky. 4) Please comment on the example, if you want to.

[5] The distinction between implicit and explicit ambiguity is taken from Poesio et al. (2005). Implicit ambiguity means that subjects do not notice the ambiguity but as a group specify different antecedents and referents. Explicit ambiguity means that the subjects notice and specify the ambiguity.

(3) **[[*Die erste Explosion*]₁ *ereignete sich gegen 9 Uhr in einem Pulver- und Munitionsdepot.*]₂** Stundenlang kam es **danach** im Abstand von 10 bis 15 Minuten zu weiteren Detonationen.

[*At 9 o'clock* [*the first explosion*]₁ *took place in a depot for gunpowder and ammunition.*]₂ For hours **after that** further detonations took place at intervals of 10 to 15 minutes.

In contrast, in referentially ambiguous cases there are several plausible referents and antecedents for *danach*. Thus, we get distinctive readings when different textual spans referring to different referents are marked as antecedents (s. example (4)).

(4) **[*In* [*dem Schauprozess 1981*]₁ *wird er zu* [*20 Jahren Haft*]₂ *verurteilt.*]₃ Danach** lebte er als Rentner in seiner Heimatstadt.

[*In* [*the show trial 1981*]₃ *he was sentenced to* [*20 years in prison*]₁.]₂ **After that** he lived as pensioner in his hometown.

In (4) choosing antecedent₁ or antecedent₃ makes no difference with respect to the interpretation of the temporal constellation of the two situations related by *danach*. The end of the trial and the end of the proclamation of sentence are temporally identical. However, choosing antecedent₂ which is preferred due to world knowledge yields another temporal constellation between different situtations.

2.1 Annotating Structural Ambiguity

Example (3) demonstrates only one possible variant of structural ambiguity. Structural ambiguity can also be observed in anaphoric chains. In example (5) the subjects marked different antecedents while specifying the same referent, namely the bombing.

(5) **[[*Ein Mann sei herausgesprungen und habe eine Handgranate gegen das Tor und die Wachposten geschleudert, hieß es. Daraufhin sei der zweite Täter durch das Tor gerast und habe sich vor dem Botschaftseingang samt der Bombe in die Luft gesprengt.*]₁ [[*Die Tat*]₂ *geschah gegen 9.30 Uhr Ortszeit,*]₃ *als in der Botschaft normaler Alltagsbetrieb herrschte.*]₄** Teilweise standen **danach** nur noch Gerippe des Gebäudes.

[[*It is said that a man jumped out and threw a grenade against the gate and the sentinels. Thereupon, the second committer ran amuck through the gate and blew himself and the bomb up in front of entrance of the embassy.*]₁ [[*The action*]₂ *happened about 9.30am at local time,*]₃ *when in the embassy everything was at normal course of life.*]₄ **Thereafter**, in part only the framework of the building was there.

Due to the complex anaphor[6] *die Tat* referring to the propositionally structured referent (the BOMBING) mentioned in the first two sentences either antecedent₁ or the complex anaphor₂ is marked as antecedent. In the third sentence we again have the structural choice between the NP-based-antecedent₂ and the S-based-antecedent₃. One subject marked all sentences as antecedent₄. I will turn to this issue in section 2.2.2.

I assume that structural ambiguity as in such cases can be handled consistently by the annotation conventions proposed in section 1.1.[7] So according to the conventions antecedent₁ in example (3) and antecedent₂ in example (5) should be marked. In section 2.2.2, I will discuss why this only partly resolves the ambiguity in example (5).

2.2 Annotating Referential Ambiguity

In this section I will present three types of referential ambiguity: 1. competition between temporal and situation referents, 2. competition between simple and structured situation referents and 3. competition between several different situation referents.

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[6] S. Consten & Knees (forthc.) for a detailed analysis of complex anaphora.

[7] Another study is planned in order to find out whether the inter-annotator agreement of marking the antecedent raises when the subjects get the annotation conventions beforehand.

2.2.1 Competition between temporal and situation referents

In some examples there is an ambiguity between a temporal referent (usually a time span) and a situation referent which is temporally located in that time span.

(6) Und der im Grunde hypersensible Pollock scheint von solcher Männlichkeit zutiefst beeindruckt gewesen zu sein, damals [*im Jahre 1936*]$_1$, als [*er in Siqueiros New Yorker Laboratorium zur Erprobung moderner Techniken in der Kunst mitarbeitete*]$_2$. ... So erstaunlich wie unstrittig ist nämlich die Tatsache, [*dass Pollock dort jene Experimente bereits kennengelernt haben muss*]$_3$, die er selbst erst **zehn Jahre danach** anwandte: die Arbeit mit Industrielacken und das Verträufeln und Verschütteln von Farbe direkt auf dem Malgrund oder mit der Spritzpistole, in einem Akt des „kontrollierten Zufalls".

And Pollock, virtually hyper-sensitive, seemed to be deeply impressed by such a masculinity, [[at that time in 1936]$_1$, when he worked in Siqueiro's New Yorker laboratory in order to try out modern techniques in art.]$_2$ ... Thus, the fact [that there he must have got to know these experiments]$_3$ which he used himself **ten years after that**, *is amazing and indisputable at the same time: his works with industrial gloss paint and his spilling and bloting with paint directly on the subfont or with the spray guns, in an act of „controlled chance".*

In example (6) Pollock's cooperation with Siqueiros (sit$_A$) referred to by antecedent$_2$ and his getting in touch with these experiments (sit$_B$) referred to by antecedent$_3$ are interpreted as taking place at some time interval within the year 1936 referred to by antecedent$_1$. Thus, all referents selected by the subjects are at least temporally related to each other. The temporal referent provides a time frame for the situation referents (i.e. t(sit$_A$) $\wedge$ t(sit$_B$) $\subseteq$ t(1936))[8]. Thus, *danach* anchors either at t(1936), t(sit$_A$) or t(sit$_B$) where the latter ones can be merged to t$_x$ $\subseteq$ t(1936) (i.e. some time interval in 1936). So in order to account for the ambiguity, I propose the following underspecified representation: [**end**(t(1936)) $\vee$ (t$_x$ $\subseteq$ t(1936))] < 10-years **begin**(t(using modern art techniques)) which means that the matrix-situation took place either ten years after the end of 1936 or ten years after some point in time within 1936.[9]

2.2.2 Competition between single and structured situation referents

This type of ambiguity is discussed as 'circumscription' by Webber (1987), or 'reference to structured entities' by Fraurud (1992) and Poesio et al. (2005). In example (5) (repeated here as (7)) all subjects named the bombing as referent, but one subject conceptualised it as a structured entity described by antecedent$_4$.

(7) [[*Ein Mann sei herausgesprungen und habe eine Handgranate gegen das Tor und die Wachposten geschleudert, hieß es. Daraufhin sei der zweite Täter durch das Tor gerast und habe sich vor dem Botschaftseingang samt der Bombe in die Luft gesprengt.*]$_1$ [[*Die Tat*]$_2$ *geschah gegen 9.30 Uhr Ortszeit,*]$_3$ *als in der Botschaft normaler Alltagsbetrieb herrschte.*]$_4$ Teilweise standen **danach** nur noch Gerippe des Gebäudes.

[[*It is said that a man jumped out and threw a grenade against the gate and the sentinels. Thereupon, the second committer ran amuck through the gate and blew himself and the bomb up in front of entrance of the embassy.*]$_1$ [[*The action*]$_2$ *happened about 9.30am at local time,*]$_3$ *when in the embassy everything was at normal course of life.*]$_4$ **Thereafter**, in part only the framework of the building was there.

I consider this example to be similar to examples discussed in Poesio et al. (2005). They assume that people do not perceive this type of ambiguity as infelicitous, if the following conditions hold ("Justified Sloppiness Hypothesis"):

1) "Both explicitly mentioned potential antecedents *x* and *y* are elements of an underlying mereological structure with summum $\sigma = x \oplus y$ which has been explicitly constructed

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[8] t stands for the ‚life' or ‚run'-time of the situations and the time-entity.

[9] There are incidences where *danach* definitely locates the matrix-situation within and not after the time frame given by the temporal referent, s. the following example: [*During the Weimar Republic the interventionism was modern.*]$_1$ *What happened* **thereafter** *in the Weimar Republic, has a great deal to do with the fact that this concept did not work as a problemsolver.*

(and made salient) in the dialogue". This is only partly true for this example, as antecedent$_1$ describes several sub-events of the summum bombing and not only a single element.

2) "[I]t is possible to construct a p-underspecified interpretation" which means that the anaphor can refer to each of the elements or to the summum. Again, this condition holds only partly (for the same reason as before). The anaphor can refer to the summum (*die Tat$_2$*), to antecedent$_1$ (describing <u>several</u> sub-events) or it refers to all of them (antecedent$_4$).

3) "All possible interpretations [...] are equivalent for the purpose of the plan." This condition also needs a slight modification in order to hold: All possible interpretations in this example are equivalent with respect to the conceptualisation of the structured referent, as all subjects named the bombing as referent. Thus, examples like (7) can be explained by an expanded version of the "Justified Sloppiness Hypothesis".

(8) [*In den 80er Jahren trieben Gerüchte, dass die FDA Virazole als Mittel gegen Aids zulassen werden, die Aktienkurse von ICN und ihren beiden Tochtergesellschaften scharf in die Höhe.*]$_1$ [*Panic nahm die Gelegenheit wahr, um eigene Aktien im Wert von 13 Millionen Dollar abzugeben.*]$_2$ [*Dies brachte ihm zahlreiche Aktionärsklagen ein, die zum Teil heute noch anhängig sind.*]$_3$]$_4$ **Kurz danach** setzte die FDA das Unternehmen unter Druck, das im Zusammenhang mit der ursprünglich begrenzten Genehmigung verbreitete Werbematerial für Virazole zurückzurufen.

[*In the eighties rumours that FDA would admit Virazole as drug against Aids boosted the stock price of ICN and its two affiliates.*]$_1$ [*Panic availed himself the opportunity of selling his shares amounting to 13 million dollars.*]$_2$ [*This brought him in numerous accusations of shareholders, of which some are still pending.*]$_3$]$_4$ **Shortly thereafter** the FDA enforced his company to call back the advertisement for Virazole which had originally been approbated for limited use.

In example (8) a structured entity can be constructed, namely the chain of cause and effect resulting in the FDA'S ENFORCEMENT in the anaphor-matrix-clause. But only some of the subjects named this referent, while others preferred as referent the raising of the share price referred to by antecedent$_1$ or Panic's selling of his shares referred to antecedent$_2$. So this example differs from the previous one in two aspects: first, there is no complex anaphor explicitly introducing the structured referent and second, the single situations in antecedent$_1$, antecedent$_2$ and antecedent$_3$ are causally connected to each other. This justifies their grouping but as the results of the pilot study show the situations do not have to be clustered. As far as I am aware there is no accomplished solution for handling this kind of ambiguity (cf. Fraurud 1992, Poesio et al. 2005). Following the PDTB annotation manual (Prasad et al. 2006) cases like this are handled in accordance with the "Minimality Principle". It states that only textual material that is "*minimally required* and *sufficient* for the interpretation of the relation" is marked as argument of a discourse connective whereas "other span of text that is perceived to be relevent (but not necessary) in some way to the interpretation of arguments is annotated as *supplement information*" (s. Prasad et al. (2006:13); highlighted text as in original).[10] Thus, according to the PDTB manual only one – probably antecedent$_2$ – would be marked as antecedent. The other ones would get the status of a supplement. But this is only a convention and not a proper solution for the ambiguity of this example.

Webber (1987, 1991) and Fraurud (1992) suggest that discourse structure guides the interpretation of anaphoric expressions emphasising the role of the right frontier constraint. I think we have to accept that some anaphoric references are just ambiguous and that Poesio et al.'s (2005) p-underspecification provides a good means for representing this type of ambiguity.

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[10] The antecedent of the complex anaphor *dies* ("this") in the third sentence would also be marked as supplement.

2.2.3 Competition between several situation referents

The third type of ambiguity concerns cases involving several plausible situation referents. In example (9) half of the subjects named Jacksons demanding as referent for *danach* whereas the other half specified the Nuremberg trials as referent where the trials are only inferred.[11]

(9) Es sollte nach Robert Jacksons Willen kein Einzelfall bleiben; [*er forderte schon damals die Einrichtung eines Internationale Strafgerichtshof*]₁. ... Gewiß, die Straßburger Konvention für Menschenrechte, die Völkermord-Konvention der Vereinten Nationen entstanden unter dem Eindruck von [*Nürnberg*]₂, Angriffskrieg gilt nicht länger als Recht souveräner Staaten. ... Ein Internationaler Strafgerichtshof aber nimmt erst heute, **50 Jahre danach**, allmählich Gestalt an: in Den Haag, wo es um die Kriegsverbrechen im ehemaligen Jugoslawien geht.

   According to Robert Jackson's volition, this should not remain an individual case; [*he has already demanded at that time that an International Criminal Division should be established.*]₁ ... Surely, the Convention of Human Rights from Strasbourg, the Convention of Genocide of the UN emerged from the impression of [*Nuremberg*]₂; war of aggression is not longer a right of sovereign states. ... But an International Criminal Division starts to gradually take shape today, **50 years after that**: in Den Haag where the war crimes of the former Yugoslavia are dealt with.

Both referents are plausible. The former Jacksons demanding as the International criminal division mentioned in antecedent₁ is described again in the anaphor-matrix-clause, so both the antecedent-clause and the anaphor-clause are thematically connected by *danach*. Nonetheless, the latter referent derived from antecedent₂ is also plausible not only as it is textually closer to the anaphor, it also gets causally related to the establishing of the International criminal division (and maybe even to Jacksons Demanding). Moreover, the Nuremberg trials are triggered by textual anchors like *Völkermord* ("genocide"). Nonetheless, Jacksons demanding does not have to be inferred. Thus, choosing antecedent₁ reflects staying closer to the explicit textual material while choosing antecedent₂ suggests a more conceptually guided decision. Still, both referents are somehow conceptually related. Thus, this example may also be only another case of ambiguity by structured enities. But we cannot formulate a preference for one referent, so I conclude that we have to allow for some instances of 'proper' ambiguity.

3   Summary and Conclusions

In the paper I first presented an account of the meaning and anaphoric character of the German pronominal adverb *danach*. By means of a pilot study, I have shown that the resolution of *danach* involves several types of ambiguity, namely structural and referential ambiguity which have to be dealt with in the annotation of *danach*-occurrences. In the case of referential ambiguity we can distinguish the following sub-types: 1. competition between temporal and situation referents, 2. competition between simple and structured situation referents and 3. competition between several different situation referents. In conlusion, I argue that referential ambiguity has to be accounted for by underspecified representations, while structural ambiguity (e.g. anaphoric chains, competing NP- and S-antecedents) can be dealt with by the annotation conventions proposed. We should keep in mind that annotation conventions are a good means to standardise annotations but they are sometimes only partial solution for problems you have to deal with annotating and interpreting anaphoric references.

Finally, we have to consider that the subjects often chose one candidate from a set of plausible referents not noticing an ambiguity (implicit ambiguity). Thus, as *danach* seems to allow for some ambiguity, recipients are not expected to be able to precisely determine its antecedent and/or its referent. So we better account for some types of ambiguity, e.g. by

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[11] The use of *Nuremberg* to refer to the TRIALS is an example of the kind of metonymy where a location name stands for something that happened there (s. Markert / Nissim's (2003: 9) on metonyny and reference resolution).

underspecified representations, since humans seem to tolerate them as Poesio et al.'s (2005) "Justified Sloppiness Hypothesis" suggests.

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