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Associative anaphora between event-denoting expressions*

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Introduction

This paper presents a classification of associative anaphora (henceforth AA) between event-denoting expressions, from a semantic interpretation of the link holding between the anaphor and its antecedent. The focus is on Italian data. An example of AA between the antecedent *l'intervista* 'the interview' and the anaphor *le domande* 'the questions' is given below:

1) Grande attesa in Francia per **l'intervista** con cui Dominique Strauss-Kahn romperà domenica per la prima volta il silenzio sulle accuse di stupro [...]. A rivolgere **le domande** all'ex direttore dell'Fmi, rientrato in patria il 4 settembre, sarà Claire Chazal di Tf-1 [...].

'There's a long wait in France for **the interview** in which Dominique Strauss-Kahn will break the silence, on Sunday for the first time, about the rape charge [...]. It will be up to Claire Chazal of TF1 to address **questions** [lit. **the questions**] to the former director of FMI, who came back home on September 4th [...]'¹.

The phenomenon of AA (Hawkins, 1978) has been identified with different labels in the literature: *bridging anaphora* (Clark, 1975), *indirect anaphora* (Chafe, 1976), *implicit reference* (Conte, 1981) and *inferrable entities* (Prince 1981). These labels do not overlap; for example, as highlighted by Korzen (forth.), the label of « bridging » has been used for both AA proper, as in (1), and so-called

* The paper is the outcome of a joint discussion between the co-authors. For the specific concerns of the Italian Academy only, F. Pecorari bears responsibility for sections 1 and 2 and E. Ježek for sections 3 and 4.

¹ The English translations of the Italian examples are idiomatic; a literal translation of the anaphor is added in square brackets where English does not signal its associative-anaphoric status with a definite article.

coreferential « unfaithful » anaphora (*i.e.* anaphora with lexical variation between antecedent and anaphor), as in (2) below :

2) **Scontri** tra manifestanti e polizia. **I disordini** erano iniziati ieri [...].

‘**Clashes** between protesters and police. **The riots** had started yesterday [...]’.

Associative anaphora is the most widely used term in the French-speaking literature (cf. Schnedecker *et al.*, 1994, Charolles et Kleiber, 1999, Kleiber, 2001a, *inter alia*), and we will follow this tradition in the paper. The definition of AA we will adopt is based on Lundquist (2000), according to which an anaphoric relation can be said to be associative when it exhibits the following four properties:

An associative anaphor

1. introduces a new entity in the discourse
2. by means of the definite article
3. which signals that there is something « known » about the new entity
4. and that this « knownness » comes in via a relation to an entity introduced previously in the discourse. (Lundquist, 2000: 114)²

The linking relation between the two entities involved in AA may come from lexical knowledge, discourse coherence principles or background common-sense knowledge. We are mostly interested in relations licensed by the lexicon, which connect two lexical items by means of « un savoir *a priori* ou conventionnel associé aux lexèmes en question » (Kleiber, 2001 a: 89).

Event-denoting expressions have a strong potential for AA because they are inherently complex configurations, with relational

² Lundquist adopts a broad concept of “entity introduced previously in the discourse”, which covers also predicative elements, such as verbs. In our work, we will share this view: event-denoting antecedents can be realized, from a syntactic point of view, by VPs or NPs, while anaphors can only be realized by definite NPs, in which the definite article discloses the associative-anaphoric nature of the entity. This yields a basic two-output syntactic classification of AA between event-denoting expressions: on the one hand, we have AA with a verbal antecedent and an event-denoting NP as anaphor; on the other hand we have AA with an event-denoting NP both as antecedent and as anaphor.

properties; their introduction in the text entails implicit reference to various aspects, from participants in the denoted event to elements of the script in which it usually takes place. Their semantic nature has been described through the notion of *cognitive amalgam* by Apothéloz & Reichler-Béguelin (1995):

Une des caractéristiques des procès, en tant qu'objets-de-discours, est que ce sont des configurations relationnelles impliquant, de fait, plusieurs objets : le procès proprement dit, ses actants, éventuellement les phases qui en marquent le déroulement, le scénario dans lequel il s'inscrit, etc. Ce type d'objet est donc particulièrement représentatif des amalgames cognitifs auxquels nous venons de faire allusion.

As referenced earlier, we are mostly concerned with only a subset of the relations described in Apothéloz & Reichler-Béguelin (1995), *i.e.* those relations which connect an event, with the function of antecedent, to another event, with the function of associative anaphor. Relations between an event and one of its participants, such as *operare* 'operate' – *chirurgo* 'surgeon' (Korzen, 2003), are not included in our discussion.

The rest of the paper is structured as follows: in section 2 we give a survey of relevant literature focusing on AA and events; in section 3 we introduce the theoretical background of our analysis and the representational system; in section 4 we describe our results. We conclude by describing ongoing work and future research in section 5.

Associative anaphora and events: a short review

AA between event-denoting expressions has received far less attention in the extant literature than AA between object-denoting elements, or between an event and one of its participants. Two notable exceptions are Clark (1975) and Gardent *et al.* (2003).

Clark (1975: 169) builds a taxonomy of possible «bridges», *i.e.* “inferences [...] the speaker intends the listener to draw as an integral part of the message”. One of the proposed categories is *indirect reference by association*, which is in turn split up into three sub-categories: *necessary*, *probable* and *inducible parts*. The following are examples:

3) I hit a home run. **The swing** had been a good one.

4) I went shopping yesterday. **The walk** did me good.

5) I went shopping yesterday. **The climb** did me good.

According to Clark, a swing is a necessary part of hitting a home run, a walk is a probable part of going shopping and a climb is definitely not a prototypical part of going shopping, but an inducible one, adjusted by the reader's reconstruction of textual coherence.

Gardent *et al.* (2003) propose a typology for associative anaphoric relations. Relations holding between events are subsumed under the categories of *definitional*s (whose relation is licensed by the lexical features of either the antecedent or the anaphor) and *co-participants* (whose relation is licensed by a general frame, shared between antecedent and anaphor). The authors comment on some pairs of event-denoting nouns in an associative relationship (e.g. *operation-convalescence*, *question-answer*, *investigation-witness reports*) and underline that the semantic relations which hold between the two elements go beyond the set of possible bridging relations usually identified in the literature: a convalescence *follows* an operation, an answer is a *reaction to* a question, an investigation is *based on* witness reports.

As regards the Italian literature, AA is a somewhat neglected topic: in the current state of the art, there is no monograph devoted to the subject³. The anaphoric nature of the phenomenon has also been questioned. Prandi (2006: 185), in a short note, rejects the use of the label 'associative anaphora' altogether, arguing that anaphora should concern only given referents, with an explicitly realised antecedent in the text (in other words, anaphora should coincide with direct anaphora). As far as AA is concerned, the so-called anaphor is actually a new referent, introduced with the definite article because of the conceptual relations it holds with other textual elements, thus non-anaphoric in Prandi's terms.

Three interesting Italian works on AA, namely Korzen (2003, 2009) and Caselli (2009), exploit resources based on GL the

³ Some notes can be found, in addition to the works quoted below, in early contributions by Conte (1981, 1996) and Korzen (1996), as well as in the more recent Ferrari (2010). Associative relations between event-denoting elements, however, are not mentioned in these works.

Generative Lexicon (the framework we adopt in our analysis). Korzen (2003) uses GL (notably Qualia Structure) as a means of capturing the relational force of object-denoting nouns as possible antecedents of AA; Korzen (2009) exploits Qualia Structure to resolve the reference of non-coreferential anaphoric pronouns (e.g. *a restaurant - they = the waiters*); finally, Caselli's (2009) work aims at computational resolution of AA by means of a GL-based lexical resource, namely the computational lexicon called SIMPLE (Lenci *et al.* 2000). Neither of the authors, however, focuses on AA between event-denoting expressions.

A major reference in the French literature on AA is Kleiber's (2001a) monograph. The author proposes a detailed typology of AA based on semantic criteria, pinpointing five subtypes on the basis of the semantic relation which holds between anaphor and antecedent⁴. The five sub-classes are named as follows: *meronymic*, *locative*, *actantial*, *functional* and *collective*. The vast array of examples proposed by the author is restricted to cases with nominal antecedents, except for the actantial class, which covers predicate-argument relationships (e.g. *cut some bread - the knife*). As far as we have found, Kleiber's examples do not include occurrences of AA in which both the elements involved are event-denoting.

The examples of AA between event-denoting expressions that we will discuss in this paper can be traced back to the meronymic subtype of AA between nominal expressions in Kleiber's taxonomy⁵. However, as Fellbaum (1990) points out, the extension

⁴ The presentation and discussion of the five subtypes are carried on in several previous works by the author (*cf.* Kleiber 1996, 1997 a, 1997 b, 2000, 2001 b), then integrated in Kleiber (2001 a).

⁵ According to Kleiber, the meronymic category exhibits ontological subordination between the entities referred to by the anaphor and the antecedent respectively, as the occurrence of the former can exist only as component of the occurrence of the latter (e.g. *a tree - the trunk*). The detachment of the part from its whole does not prevent it from being considered as a part of the whole: a trunk detached from the tree is always perceived as a tree trunk (see Kleiber, 2001 a: 267-268).

of meronymy to event-denoting expressions is controversial; in her opinion, parthood relations between event-denoting entities always involve the temporal dimension and may be better seen as relations of lexical *entailment* instead of relations of *meronymy* (see *infra*). Lexical entailment is defined as “the relation between two verbs *V1* and *V2* that holds when the sentence *Someone V1* logically entails the sentence *Someone V2*” (Fellbaum, 1990). Fellbaum proposes a fourfold classification of entailment relations, consisting of the following categories: *troponymy*, based on a manner elaboration relation between co-extensive events (e.g. *lisp-talk*); *proper temporal inclusion*, linking events that partially occur in the same stretch of time (e.g. *snore-sleep*); *backward presupposition*, relating an event with a preceding event that acts as a necessary precondition to its occurrence (e.g. *succeed-try*); *cause*, occurring between a causative event and a resultative event (e.g. *give-have*).

In our work, we will model parthood relations in the domain of event-denoting expressions using the notion of *subevent*, as discussed in Pustejovsky (1995). In the next section, we introduce the notion of subevent together with other aspects of the GL framework which are relevant for our analysis.

Associative anaphora between event-denoting expressions

The basic idea behind our work is to model AA between event-denoting expressions using a multi-dimensional model of lexical representation, with the aim of providing a fine-grained taxonomy of the relations licensed by lexical properties of the antecedent. For this aim, we will adopt the model of lexical representation proposed in Pustejovsky (1995), where it is assumed that lexical items may be associated with a set of interconnected informational structures. For our present purposes we will focus on Event Structure (ES), Argument Structure (AS) and Qualia Structure (QS). ES specifies the event type associated with an expression. The primitive event types posited in GL are States (S), Processes (P) and Transitions (T). Processes and Transitions may have subevents, *i.e.* temporal parts associated with different phases of the main event. The model

foresees three possible temporal ordering relations between subevents:

- (i) strictly sequential relation (exhaustive ordered part of, annotated as $<_{\alpha}$)
- (ii) completely simultaneous subevents (exhaustive overlap part of, annotated as o_{α}) or
- (iii) basically simultaneous subevents where one starts before the other (exhaustive ordered overlap, annotated as $< o_{\alpha}$)⁶.

AS encodes the participants in the event which are selected as arguments by the predicate. There are three primitive argument types in the standard theory: arguments which are obligatorily discharged in the syntax (True arguments), arguments which may remain unexpressed under certain conditions (Default arguments) and arguments which cannot be expressed (unless they are further specified) because they are already incorporated in the predicate (Shadow arguments). Finally, QS encodes the most idiosyncratic aspect of the meaning of the word. The standard account of QS foresees four relations: the Formal (F) encoding taxonomic information, the Constitutive (C) encoding the *part_of* relation, the Telic (T) introducing the intended goal or function associated with the object and the Agentive (A) specifying the factors involved in the object's origin. When applied to event-denoting expressions, QS receives a somewhat different interpretation in the model; particularly, F is assumed to introduce the (result) state and A the causing act or process. The skeleton of lexical representation of an event-denoting expression is thus the following, where α indicates the lexical item in question, *EVENTSTR* introduces the subeventual structure (if there is one), *ARGSTR* introduces the associated

⁶ Besides being temporally ordered, subevents may be headed (annotated as e^*); the mechanism of event headedness provides a way of indicating foregrounding or backgrounding of event components and their associated event arguments in the syntax. We will not consider this parameter in the following.

arguments and the QUALIA introduce lexical components such as causing act, process, result state.

$$\left[\begin{array}{l} \alpha \\ \text{EVENTSTR} = \left[\begin{array}{l} E1 = e_1 \\ E2 = e_2 \\ \dots \\ \text{RESTR} = \dots \\ \text{HEAD} = \dots \end{array} \right] \\ \text{ARGSTR} = \left[\begin{array}{l} \text{ARG1} = x \\ \text{ARG2} = y \\ \dots \end{array} \right] \\ \text{QUALIA} = \left[\begin{array}{l} \text{FORMAL} = \textit{result_state}(e_2, y, \dots) \\ \text{AGENTIVE} = \textit{causing_act}(e_1, x, \dots) \\ \dots \end{array} \right] \end{array} \right]$$

Fig. 1. Lexical template for event-denoting expressions in GL

In our analysis, we use ES, AS and QS as heuristic and taxonomic tools to classify the various types of associative anaphoric relations that can be observed between event-denoting expressions⁷.

Data and analysis

In this section we present the analysis of AA between event-denoting expressions we performed using the model described in 3. The data discussed in this section are taken from two different corpora: the *ifTenTen* corpus, queried through the *Sketch Engine* query system (Kilgarriff *et al.* 2004) and a subsection of the Italian section of the *ICOCP (Italian Constituent Order in a Contrastive Perspective)* corpus⁸. We start our analysis with cases such as (6),

⁷ In a recent computational work, Im & Pustejovsky (2009) exploit the notions of Event Structure and subevent in order to build a lexical resource supporting automatic recognition of event implicatures. This work is not focused on AA; however, the semantic relations it highlights have much in common with the ones that license AA between event-denoting expressions.

⁸ The ICOCP corpus has been created at the University of Basel within the FNS project under the same name, directed by Anna-Maria De Cesare (De Cesare, 2011).

where the antecedent can be said to be in a troponymy relation with the anaphor (Fellbaum, 1990)⁹:

6) Il rimedio principale per risolvere il problema è **camminare**, perché **il movimento** favorisce la circolazione [...].

“The main remedy for solving the problem is **to walk**, because **movement** [lit. **the movement**] helps the blood flow [...]”.

From the point of view of discourse structure, it is questionable whether the anaphor *il movimento* introduces a new entity with respect to the one introduced by the antecedent *camminare*; it might be argued that the anaphor refers to the same event, although at a higher level of generality. According to this analysis, examples such as (6) cannot be classified under the heading of AA, and should instead be regarded as instances of event coreference (for this terminology, see Chen *et al.* 2009)¹⁰. Nevertheless, in GL terms, the relation between the two expressions can be captured at the level of both QS and ES. To understand how, consider the representation proposed below for the antecedent *camminare*:

⁹ Note that, according to Fellbaum, troponymy is a relation between verbs; we extend it here to the analysis of relations between a verb and a deverbal noun.

¹⁰ Computational works such as Chen *et al.* (2009) use a broad notion of (co-)reference, extended to VPs, mainly due to the practical needs of the discipline: automatic treatment of linguistic data does not require a fine-grained analysis of formal features of anaphora and of interpretive differences associated with them. Coreference is broadly applied to event mentions, which can be realised equally by “a sentence or phrase that mentions an event” (Chen *et al.*, 2009).

$$\left[\begin{array}{l} \text{camminare} \\ \text{EVENTSTR} = \left[\begin{array}{l} \text{E1} = e_1 : \text{process} \\ \text{E2} = e_2 : \text{process} \\ \text{RESTR} = e_1 < \circ_{\infty} e_2 \end{array} \right] \\ \text{ARGSTR} = \left[\begin{array}{l} \text{ARG1} = x : \text{animate_ind} \\ (s)\text{ARG2} = y : \text{legs} \\ (s)\text{ARG3} = z : \text{body} \end{array} \right] \\ \text{QUALIA} = \left[\text{AGENTIVE} = \text{move}(e_1, x, y) \wedge \text{move}(e_2, x, z) \right] \end{array} \right]$$

Fig. 2. *camminare*

In the representation above, the antecedent *camminare* is analyzed as an expression denoting an efficient motion of the legs (s-arg2) by an animate individual (arg1), which causes a subsequent motion of the body (s-arg3). This information is introduced at the level of the Agentive quale by the predicate *move* and its associated arguments, and reflected in the ES of *camminare*, which is analyzed as being composed of two processes linked by an exhaustive ordered overlap relation, according to which *e1* and *e2* are basically simultaneous subevents where one (*e1*) starts before the other (*e2*) (Pustejovsky, 1995: 71). In fact, one cannot walk without necessarily moving at the same time. On the basis of the representation in Fig. 2, the anaphor NP *il movimento* can be said to be licensed by the QS of its antecedent. Consider now the following example:

7) Non ci sarà, invece, Gary Lineker: ha già fatto sapere di non potere giocare **la partita** pur avendo accettato di dare **il calcio di inizio**.

By contrast, Gary Lineker will not be there: he has already said he won't be able to play in **the match**, even though he has agreed to take **the kick-off**¹¹.

¹¹ A reviewer pointed out that example (7) shows an apparent inconsistency; if the kick-off is an intrinsic part of a match, it is not clear how taking the kick-off and not playing in the match are compatible. As a matter of fact, a participant *x* can take the kick-off of a match, thus causing the match start to start, and then leave the match immediately. In this case, speakers could accept the statement “*x* did not play in the match” as true, even if taking the kick-off actually involves playing (the initial subevent of)

In this case, the anaphor *il calcio di inizio* denotes a specific temporal part of the event denoted by the antecedent *la partita*, namely the subevent which is necessary for the game to start, so that we can properly speak of AA linking the whole event to its first subevent. We propose to represent this as follows:

$$\left[\begin{array}{l} \textit{partita} \\ \text{EVENTSTR} = \left[\begin{array}{l} \text{E1} = e_1 : \textit{causing_act} \\ \text{E2} = e_2 : \textit{process} \\ \text{E3} = e_3 : \textit{end_state} \\ \text{RESTR} = e_1 \subset_{\alpha} e_2 <_{\alpha} e_3 \end{array} \right] \\ \text{ARGSTR} = \left[\begin{array}{l} (d)\text{ARG1} = x : \textit{game} \\ (d)\text{ARG2} = y : \textit{animate_ind|group} \\ (d)\text{ARG3} = z : \textit{animate_ind|group} \end{array} \right] \\ \text{QUALIA} = \left[\begin{array}{l} \text{FORMAL} = \textit{played}(e_3, x) \\ \text{AGENTIVE} = \textit{kickoff}(e_1, x, y) \wedge \textit{play}(e_2, x, y, z) \end{array} \right] \end{array} \right]$$

Fig. 3. *partita*

La partita lexically denotes a bounded process, *i.e.* a process (e_2 , *i.e.* playing the match) delimited by an end state which is determined by the rules of the game (e_3 , *i.e.* having played the match). We argue that the introduction of *il calcio di inizio* as an associative anaphor is licensed by both ES and QS values of the antecedent. Particularly, as regards ES, we analyze the kick-off as a necessary part of a match, corresponding to the causing act (e_1) that initiates the process of playing (e_2); we propose to represent this relation as a relation of temporal inclusion ($e_1 \subset_{\alpha} e_2$, *i.e.* e_1 is included in e_2), adding this relation to the array of relations of the original model (*cf.* section 2); from the point of view of QS, the kick-off is encoded as first predicate introduced by the Agentive role. Now consider the example in (8):

- 8) Nel film “Ghost – Fantasma” di Jerry Zucker, il protagonista Sam Wheat è **ucciso** a bruciapelo da un uomo che ha appena tentato di

the match. In any case, the appearance in the text of an AA linking *la partita* and *il calcio di inizio* is not affected by this aspect.

derubarlo. Dopo **la morte**, l'uomo diventa un fantasma dai contorni luminescenti [...].

'In the film "Ghost" by Jerry Zucker, the main character Sam Wheat **is killed** point blank by a man who has just tried to rob him. After **his death** [lit. **the death**], the man becomes a ghost with a glowing profile [...]'.

The example (8) displays a similar pattern compared to (7), but the associative anaphoric subevent has a different position on the temporal interval denoted by the antecedent, as it is the last subevent. This can be represented as follows:

$$\left[\begin{array}{l} \textit{uccidere} \\ \text{EVENTSTR} = \left[\begin{array}{l} \text{E1} = e_1 : \textit{causing_act} \\ \text{E2} = e_2 : \textit{end_state} \\ \text{RESTR} = e_1 <_{\infty} e_2 \end{array} \right] \\ \text{ARGSTR} = \left[\begin{array}{l} \text{ARG1} = x : \textit{animate_ind} \\ \text{ARG2} = y : \textit{animate_ind} \end{array} \right] \\ \text{QUALIA} = \left[\begin{array}{l} \text{FORMAL} = \textit{dead}(e_2, y) \\ \text{AGENTIVE} = \textit{kill_act}(e_1, x, y) \end{array} \right] \end{array} \right]$$

Fig. 4. *uccidere*

The antecedent VP is headed by the verb *uccidere*, which in its literal meaning denotes a transition composed of an initial subevent introducing the causing act (e_1 , *i.e.* the act of killing someone) followed by a subevent introducing the end state (e_2 , *i.e.* someone being dead). The anaphor of (8) is licensed by QS and ES: the end state of *uccidere* is introduced by the Formal quale and available as an associative anaphor, realized in (8) by a NP headed by a deverbal noun. Yet a different example of AA is the one reported in (9):

9) Nel 1954 fece parte della spedizione italiana che **conquistò il K2**: per anni fu al centro di polemiche per il ruolo ricoperto durante **la scalata** [...].

'In 1954 he was part of the Italian expedition that **conquered K2**: for years he was embroiled in controversies about the role he played during **the climb** [...]'.

In this case, we propose that the relation is between an event and its preconditions: the event expressed by the anaphor precedes the

event expressed by the antecedent, and is not included in it. This analysis is supported by the syntactic test in (10), which confirms that the predicate *conquer* denotes an instantaneous event, which can only be construed as occurring at a point in time:

- 10) a. Ha conquistato il K2 il 31 luglio 1954.
 ‘He conquered K2 on July 31st, 1954’.
 b. *Ha iniziato, finito di conquistare il K2.
 *‘He started, finished conquering K2’.

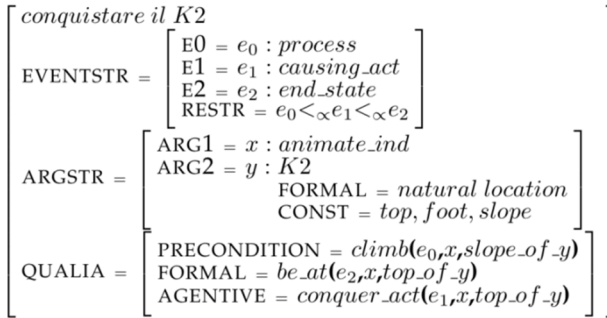


Fig. 5. conquistare il K2

According to the representation proposed in Fig. 5, the antecedent is a VP, *i.e. conquistare il K2*, denoting a transition composed by an initial state (e1) followed by an end state (e2, *i.e. being at the top of the mountain*). The prominent event for the interpretation is e2. The AS introduces the agent (x), which is an animate individual, and the end location (y), corresponding to the mountain K2. We propose that the introduction of *la scalata* as an associative anaphor is licensed once again by both ES and QS values of the antecedent. Particularly, *la scalata* can be analyzed as encoding the process (e0) corresponding to the prerequisite of the whole event: one cannot conquer a mountain without having first climbed it. Furthermore, the Constitutive role of the object K2 is exploited in verb-object composition, giving rise to the interpretation of the VP we have highlighted.

The inclusion of *scalata* in the representation as a precondition is supported by the grammaticality of uses such as “Ha conquistato il

K2 in una settimana” ‘He conquered K2 in a week’, where the scope of the adverbial appears to coerce the reading from punctual to durative, thus exploiting this particular piece of the semantic representation of the predicate.

Conclusion and further research

In this paper, we identified different classes of associative anaphoric relations between event-denoting expressions. We modelled these relations using the GL multilayered system of lexical representation. The interplay between ES, AS and QS has proved to be useful for distinguishing what aspect of the antecedent licenses AA. The analysis confirms the semantic complexity of event-denoting expressions and the strong potential reflected by this property on textual associative anaphoric uses.

We have limited our study to relations licensed by lexical properties of the antecedent, but the analysis of corpus evidence has brought about a reconsideration of the controversial boundary between lexical and encyclopaedic dimension. The last example of AA we analyzed in section 4 (*conquistare il K2* ‘to conquer K2’ – *la scalata* ‘the climb’) is particularly significant from this viewpoint: the proposed notion of precondition acts here as a bridge between lexically encoded information (QS) and commonsense knowledge (Jezek forth.). The rich lexical representations we have employed clearly show the difference between temporal parthood relations, close to Kleiber’s (2001a) meronymic subclass applied to nouns, and relations of precondition, close to Fellbaum’s (1990) relations of backward presupposition.

Further work is needed to refine the taxonomy we have proposed. A first step in this direction has been taken through the distinction between examples (7) and (8): relations of temporal parthood might be further distinguished according to the position of the anaphoric subevent in the temporal interval along which the antecedent event occurs.

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