A Mereological Characterization of Temporal and Aspectual Phenomena*

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1. INTRODUCTION

This article provides an account for phenomena in the domain of the temporal and aspectual interpretation of sentences. Aspectual and temporal information is conveyed by the verbal morphology; the morphosyntactic component organises the morphemes in a highly regular way that holds crossliguistically. We do not consider in this work syntactic and morphosyntactic facts in detail and we refer the reader to previous work on these topics [Giorgi and Pianesi, 1991; Giorgi and Pianesi, 1992a; Giorgi and Pianesi,1992b] ; let us only point out that the original contribution of these works consists in the integration of syntax, morphosyntax and semantics, traditionally considered separate levels of description. This article focuses on semantic descriptions and interpretation with a special emphasis on the role of the *part-of* relation.

Section 2 considers present tense phenomena in the Romance and Germanic languages which set apart English with respect to the other languages. Such phenomena turn out to be rather complex and the account we propose can be generalised to other tenses (cf. [Giorgi and Pianesi, 1993], [Franconi, Giorgi and Pianesi, 1993]).

Section 3 considers the question of how to structure the domains for tense and aspect interpretation and introduces a *mereological* framework as the basis of this account. This theory has been independently developed and applied within the framework of terminological logic, where a calculus has been provided [Allgayer and Franconi, 1992a; Allgayer and Franconi, 1992b; Franconi, 1993]. In Section 4, we extend the mereological theory to the event domain, discussing the examples from Section 2.

2. THE PRESENT TENSE

In previous works [Giorgi and Pianesi, 1991; Giorgi and Pianesi, 1992a; Giorgi and Pianesi, 1992b] we adopted a neo-Reichenbachian framework [Reichenbach, 1947] to account for the temporal systems of Romance and Germanic languages. Our aim was to connect temporal semantics to morphosyntax, under the assumption that it is the verbal morphology, which, once associated to a peculiar verb (i.e. combined with a specific *Aktionsart*) determines the array of the possible interpretations.

With respect to the present tense, English differs from all other Germanic and Romance languages; therefore we contrast English and Italian, giving the examples in these two languages.

With accomplishment and activity predicates, English does not allow the ‘continuous’, or ‘imperfective’ reading, whereas the other languages do (we do not consider, here, the progres-

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sive present tense, which in English conveys imperfective meaning, and the so called *reportive* present): [1]

(1) a. John eats a chicken
b. John runs

(2) a. Gianni mangia un pollo
b. Gianni corre

(1)a cannot mean that "John is presently involved in an act of eating a chicken" and analogously (1)b does not mean that "John is presently involved in an act of running". On the contrary, these readings are available in the other languages.

The possibility of imperfective readings disappears in Italian with achievement predicates:

(3) John finds a book

(4) Gianni trova un libro

The only available interpretation is, in fact, the reportive one.

Both in English and in Italian, the present tense of eventive predicates can express *habituality*, for instance *John eats chickens* can mean that John is a chicken-eater and *John runs* that John is a runner.

Finally, the present tense in *all* Germanic and Romance languages does not allow for perfective readings, i.e. it is not possible for a sentence like (1)a or (1)b to mean that at the speech time an act of eating an apple was performed by the subject.

Under a *perfective reading*, an event is seen as a single, complete whole [Smith, 1991]. We take this to entail that the subparts of a perfective event cannot be set apart from it and considered in isolation. When an accomplishment predicate is interpreted perfectively, the realisation of the *telos* (*culmination*) is implied; e.g.. the sentence *John ate an apple* entails that the eating event went on until the apple was finished. On the other hand, *imperfective readings* do not imply the existence of the whole and/or of the culmination, permitting access to the substructure of events.

In previous work [Giorgi and Pianesi, 1992b], the characteristic behaviour of the English present tense with accomplishment and activity predicates was connected with the peculiar status of the English verbal stem. In the terminology of X-bar theory, [Chomsky, 1981; Chomsky, 1986], the English verb is an X^0, i.e. a full word, as for instance run, which can be used for all persons of the present tense paradigm, excluded the third singular where an agreement morpheme, *-s*, is added to yield *run-s*. In the other languages of the Romance-Germanic domain, the verb is an X^{-1}, i.e. it is never a full word by itself, but always needs additional morphemes: for instance in the Italian form *corr-ete* (you-plu run), *corr-* is not a full word.

On the semantic side, the English verbal stem (of eventive predicate) is always associated with a perfective event. With respect to achievement predicates, see Section 3.2.

3. EVENT DOMAINS

Our hypothesis is that it is possible to account for the phenomena discussed in the previous section by means of a formalism that makes statements about collections of events and their parts. According to a recent influential proposal [Bach, 1986], events form an atomic boolean algebra under an (individual) part-of relation (with the relative join operation). A subset of the atoms (the set of *processes*) is structured by another different relation, i.e. the process part-of relation (with the relative join), forming a join semi-lattice. The whole system is connected to this subsystem by an homomorphism mapping events into processes. Bach also introduces a temporal part-of ($\propto$) and an overlapping (O) relation, the former being a strict partial order (i.e. transitive, irreflexive and asymmetric) and the latter reflexive and symmetric (cf. [Kamp, 1979]).

For the purposes of this work, we borrow from Bach the temporal part-of and the overlapping relations and use a mereological approach [Simons, 1987], independently developed for the objectual domain [Franconi, 1993]. The features of this approach relevant to our work are: a) the possibility of defining plural operators and quantifiers and b) the fact that the theory has

[1] Here, we adopt the so called Aristotele-Dowty-Vendler classification of aspectuality; see [Dowty, 1979]. Furthermore, we do not consider the present tense of statives.

already been applied within the framework of terminological logic [Allgayer and Franconi, 1992a; Franconi, 1993], where a calculus was proposed.

3.1. A Mereological Approach

Let us consider now *collective entities*, or *collections* [Sowa, 1991; Link, 1983], adopting a form of *Mereology* [Simons, 1987]. A *collection* is formed by assembling certain objects, called *parts* of the collection. Within this framework, both objects and collections of objects are seen as entities of the domain, i.e. they are represented by means of terms. A *part-whole* partial ordering relation on the domain, ➢ (to be read *has-part*) is introduced, to relate collective entities with their parts. For example, *➢(Beatles, Paul)* means that the entity *Paul* is part of the collective entity named *Beatles*.[2]

To talk about pluralities, let us define the *plural* operator '*':

Definition 1 (Plural Operator)

$*P(a)$ iff $\forall x.\ \succ(a, x) \rightarrow (\exists y.\ P(y) \wedge (\succ(x, y) \vee \succ(y, x)))$

The purpose of Definition 1 is to allow the construction of plural collective entities having singular objects of a certain type as their parts. More specifically, for any subpart *x* of the plural entity, *x* is either a sub-part or a super-part of an object of the given singular type. In this way we can define, for example, the plural predicate *PEOPLE* from the singular predicate *PERSON*: *PEOPLE* ≡ **PERSON*, (cf. Fig.1).

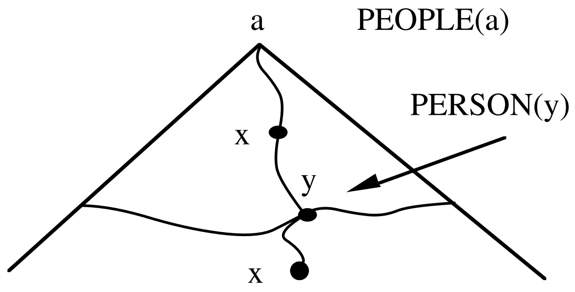

Fig.1

An important feature of this theory is the possibility of defining generic predicates applying to collective entities. In [Franconi, 1993] the $\mathcal{D}$, $\mathcal{K}$ and $\mathcal{G}$ operators - called *plural quantifiers* - were discussed. They introduce the **distributive**, **cumulative** and **group** readings for generic unary predicates having a collection as argument. They are *qualified* in the sense that the elements of actual predications are selected by a qualification predicate *C*. In this way, representational means are introduced to capture the semantics of the (possibly under-determined) reading variants of NL expressions. The plural quantifiers are formally defined as follows.

Definition 2 (Qualified Plural Quantifiers)

$\mathcal{D}$ C.P(a)	iff	$\forall x.(\succ(a, x) \wedge C(x)) \rightarrow P(x)$
$\mathcal{K}$ C.P(a)	iff	$\forall x.(\succ(a, x) \wedge C(x)) \rightarrow (\exists s.\ \succ(s, x) \wedge P(s))$
$\mathcal{G}$ C.P(a)	iff	$\exists x.\succ(a, x) \wedge C(x) \wedge P(x)$

As an example, take the possible "*left*" readings of the sentence *John, Paul, George and Ringo sing Yellow Submarine*. For the *collective reading* all the men together sing the song. The case in which each man sings separately gives the *distributive reading*; it is expressed by means of the $\mathcal{D}$ quantifier which specifies that the relation holds for all the subparts of a certain type *C*. In the case at hand it yields *($\mathcal{D}$PERSON . SING)(Beatles)* which is true iff every subpart of *Beatles* which is in *PERSON* (the qualification predicate) sings (cf. Fig.2).

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[2] Note that our mereological relation is not *extensional* in that a collection may not be equal to the sum of its proper parts. In other words, two collections having the same parts may *not* be equal. As a consequence, the ➢ relation cannot be equated to the ⊇ relation of set theory, since the counterpart of the extensionality axiom does not hold.

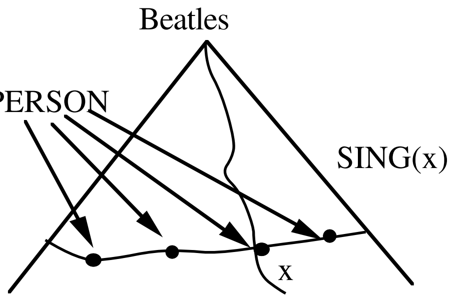

Fig.2

The *cumulative reading* can describe the mixed situations in which one sings alone, and the others sing together. It will be expressed by means of the $\mathcal{K}$ quantifier specifying that the relation holds for some subparts including all the subparts of a certain type *C*. The example gives *($\mathcal{K}$PERSON . SING)(Beatles)*, which is true iff every subpart of *Beatles* which is a *PERSON* belongs to (is part of) an entity that sings, (cf. Fig.3).

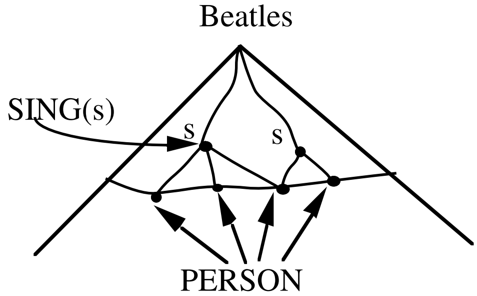

Fig.3

Finally, the *group reading* covers the case in which possibly only some of them sing; it is conveyed by the $\mathcal{G}$ quantifier which specifies that the relation possibly holds for some subpart of a certain type *C*; i.e. it expresses the group reading [Landman, 1989a; Landman, 1989b] as a sort of weakened collective reading. In our case, we have *($\mathcal{G}$PERSON . SING)(Beatles)* (cf. also Fig.4).[3]

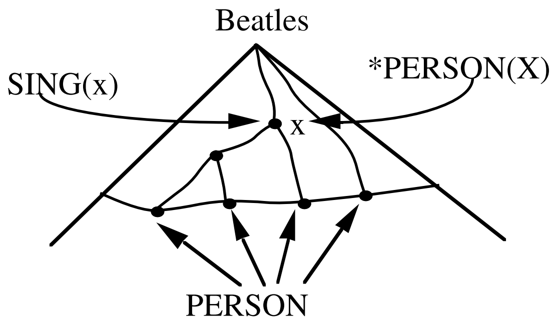

Fig.4

3.2. More on the theory of events

Consider, now, an action, e.g. *eating*. Despite the fact that in this theory it can be (almost indefinitely) decomposed into smaller actions, there is a level below which we do not recognise

[3]From (Definition 2), it follows that cumulative plural quantified expressions are more general than non-quantified (i.e. collective) expressions and distributive plural quantified ones:

$\forall x.\ P(x) \rightarrow \mathcal{K} C.P(x)$ and $\forall x.\ \mathcal{D} C.P(x) \rightarrow \mathcal{K} C.P(x)$.

In this way ambiguities in the readings can be maintained by using the cumulative operator.

eating events any more but particular movements of the jaws or of the tongue, swallowing, etc.... which do not intuitively qualify as actions of eating. Therefore, we assume that the extension of a predicate like *eat* in the domain of events (E_e) has *qualified* atoms, i.e. there are $e \in f(eat)$ (the denotation of *to eat*) such that for every $e' \in f(eat)$, $e \succ e' \rightarrow e=e'$. Furthermore, for a given event, all its (qualified) atomic subparts are mutually non-overlapping and linearly ordered by $\propto$. Concerning the perfective/imperfective distinction, we pointed out above that perfective readings present events as wholes. Whole-ness and integrity can be analysed in terms of relational closure (cf. [Simons, 1986]) and, in our case, it is a natural move to define wholeness by means of the closure of the subpart relation. This way, the denotation of a perfective sentence is an event with all its subparts. Concerning imperfective readings, for the moment let us only say that they pick up qualified atoms (but see below).

Our proposal differs from many current ones (e.g. [Kamp and Reyle, 1993]) according to which imperfective sentences denote states. Actually, it can be argued that imperfectives and statives only share some properties (e.g., the possibility of taking *for-* adverbials) but not others and therefore they must be kept conceptually distinct [Smith, 1991] (for instance, states are divisive with respect to time, whereas imperfectives need not be so: e.g., the truth of *John loved Mary* at an interval *t* entails the truth of the same sentence at every sub-interval of *t*., but this is not so for *John was running*).

We assume that the objectual domain, E_O, can be given a mereological characterisation similar to that of E_e, and hypothesise that, in certain circumstances, a homomorphism *h* maps elements of E_O into elements of E_e in such a way that the structure of the event domain is influenced by the structure of the objectual one [Krifka, 1992]. The existence of this homomorphism depends on the kind of thematic relations defined by the verb; the direct object of an accomplishment verb is such an example. Dowty [Dowty, 1991] calls it an *incremental theme*). According to this view, *telicity* is determined by a) the existence of a perfective form; b) the existence of a particular thematic relation and c) the kind of object that enters this relation with the predicate (i.e. mass vs. count). This way, the difference between accomplishment and activity sentences reduces to (b) and (c).

Achievements differ from both: crucially, even in languages like Italian the present tense of achievement predicates can never be imperfective. Since we cannot give a full account of the verbal classes here, we simply consider achievements as perfective events.[4]

3.3. Time

With respect to times, we use an interval domain *I* whose connection with E_e is explicitly provided by means of a function τ assigning every event a time interval minimally containing it. We assume that the set of relations given by Allen [Allen, 1983] can be defined on *I* .

4. APPLYING THE THEORY

In previous work [Giorgi and Pianesi, 1991; Giorgi and Pianesi, 1992a; Giorgi and Pianesi, 1992b] it was proposed that each tense morpheme bears a precise *relational* temporal meaning. It was also shown that Italian and English differ with respect to the semantics of the present tense. For the purposes of this work, it is assumed, simplifying, that the meaning of the present tense is S=E, where *S* is the speech (or utterance) time and *E* is the event time.

First, consider the impossibility for present tense to convey a true perfective meaning (cf. Section 2). It has been suggested that this is so because of the punctual, i.e. durationless, nature of the speech time [Dowty, 1979] and the consequent impossibility of accommodating durative events within *S*. This explanation is unsatisfying since, at least within our approach, imperfective readings are truly eventive, i.e. denote events that would have to be somehow durationless in order to comply with this view (in the present tense). More generally, if the speech time is without duration then there are events, e.g. speech events, which do not have duration, a fact that contrasts with our intuition. We follow Kamp [Kamp, 1979] in defining *punctuality* directly on the eventive domain to overcome these problems. A qualification is added to avoid

[4] Actually, the only *part-of* relation may not suffice for characterizing verbal classes but other concepts (e.g., drawn from topology) may be needed (cf. [Pianesi and Varzi, 1993])

picking up unwanted elements (i.e. events below qualified atoms). More precisely, an event e is punctual with respect to an event predicate, Q, iff there are no events partitioning ei n the extension of Q :

$$\bullet_Q(e) \text{ iff } \forall\, e_1,e_2.(e\,O\,e_1 \wedge e\,O\,e_2 \wedge Q(e_1) \wedge Q(e_2) \rightarrow e_1\,O\,e_2)$$

Let us now assume that the speech event, s, is punctual with respect to whatever predicate is given by the verb of the sentence. If the VP is perfective, it denotes an event e together with all its subparts. From the meaning of the present tense, we obtain $S=\tau(s)=\tau(e)$ iff $s\subseteq e$ and $e\subseteq s$ (here $\subseteq$ is the relation of temporal containment on events; it can be defined as in [Kamp, 1979]). Ife_1 and e_2 are atomic subparts of the perfective event then they overlap s and do not overlap each other, contradicting the punctuality of s. In an imperfective sentence, assuming that it denotes Q-atomic events $e_1, \ldots, e_n$ and choosing one of them, e_i, there are no subparts of e_i in Q that may conflict with the punctuality of s, hence $\tau(s)=\tau(e_i)$ can be asserted.

Both perfective and imperfective sentences are here considered as examples of group reading. Consider (1)a and (2)a above. (7)i and (7)ii give (part of) the logical forms of the perfective and imperfective readings, respectively:

(7) i. $\lambda y.((\mathcal{G}\,{}^h\mathrm{Id}_y\,.\,\mathrm{V}) \cap {}^h\mathrm{Chicken})(y)$

ii. $(\mathcal{G}\,{}^h\mathrm{Ed}\,.\,\mathrm{V}) \cap {}^h\mathrm{Chicken}$

where:

- V is the verbal predicate $\exists t.\ (\tau(e)=t \wedge eat(e) \wedge t=\tau(s) \wedge \bullet_{eat}(s))$ (we neglect the contribution of the Agent argument)

- ^{h}Q(e) iff there is a y such that $(h(Q))(h(y))$ and $e=h(y)$, where y ranges in E_o

- Id_y in (7.i) is $\lambda x.(y=x)$ for some term y; Ed in (7)ii is an objectual predicate denoting the set of edible things and is contributed by the lexical semantics of the verb.

(7)i can be applied to an event e iff: - e is the homomorphic mapping of the relevant chicken under h, i.e. e is a generic event of doing something with a particular chicken; - every subpart of e that satisfies ${}^h\mathrm{Id}_y$ is an eating event. But ${}^hId_y(x)$ iff x$=h(y)=e$, and ultimately (7)i is true iff e is an event of *doing-something-with-the-chicken* which is an eating.

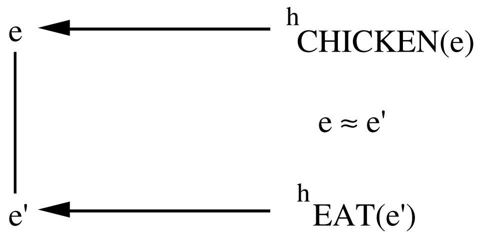

Fig.5

Consider now applying (7)ii to an event e. In this case e must be an event of doing-something-with-the-chicken having some subparts that are both a doing something with an edible part of the chicken and eating events (cf. Fig.6).

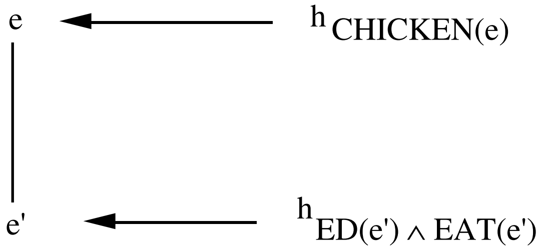

Fig.6

Note that a) the presence of ^{h}*Chicken* in the second conjunct of both (7)i and (7)ii is due to the fact that the direct object of *to eat* (*mangiar*e) is an incremental theme. b) the semantic contribution of the tense morpheme are embodied into the predicate V. As we saw, (7)i entails the existence of a complete event of eating a chicken, *e*. When *e* is related with the speech event *s*, by means of the present tense (cf. the meaning of V above), the Q-atomic subparts of *e* temporally overlap *s* even though they do not mutually overlap each other, violating the statement on punctuality given above. This explains the generalised impossibility of having present tense events interpreted perfectively. Nothing of this sort is entailed by (7)ii, where Q-atomic subpart are accessible.

In Section 2 it was argued that the English stem of an eventive verb may only refer to perfective events, due to the morphosyntactic properties of English. Therefore, the contribution of an English verb is always $(\mathcal{G}^{h}Id_{y}\,.\,V)$, which captures the fact that English present tense does not allow imperfective readings. When a verbal form is imperfective (or, possibly, not marked for perfectivity), its contribution is $(\mathcal{G}^{h}Lex\,.\,V)$, where *Lex* is the restriction on the direct argument coming from the lexical semantics of the verb. As we saw above, no identity of the selected part with the whole is now forced, with the result of making possible present tense eventive (imperfective) readings, as it happens in languages like Italian, French, German, etc...

Finally, note that (7)i entails (7)ii in the sense that whenever we have a complete event of eating a chicken we also have its subparts. In this sense, (7)ii is more general that the (7)i. Therefore, (7)ii does not entail the non-existence of a complete event, simply it does not **focus** on it, as (7)i does. Often the perfective/imperfective contrast has been seen as a matter of perspective, where perfective corresponds to a sort of external view on events and imperfective to an internal one. The account given here seems to be compatible with suggestions coming from the "perfective as perspective" theory [Smith, 1991].

The present approach can be extended to many other phenomena, e.g., the contrast between the simple past tense of languages like German and Dutch (cf. Dutch *John at een appel* (=John ate an apple)), which can give rise to both perfective and imperfective readings, and the simple past of languages like Italian (*Gianni mangio' una mela* (= John ate an apple)) that only permit perfective ones. In the first case, the tense morpheme simply specifies the temporal relation between the speech time and the temporal index of the VP, and the logical form looks like (7)ii. In Italian, the simple past morpheme (or, possibly, a separate perfectivity morpheme) constrains the range of events provided by the verb, selecting the perfective ones and giving rise to a logical form close to (7)i.

Consider, now, intransitive forms.

(8) a) John runs
Gianni corre
$(\mathcal{G}\mathsf{T}_{run}\,.\,V) \cap \mathsf{T}_{run}$

b) John eats
Gianni mangia
$(\mathcal{G}^{h}Ed\,.\,V) \cap {}^{h}Ed$

As expected, both sentences have an imperfective reading in Italian that is impossible in English. With intransitive activity verbs (*to run* in (8)a), the qualifying predicate is the top of the collection of the events of running (or a similar restriction brought in by the verb). In (8)b, where the intransitive form of a verb having an incremental theme is present, the homomorphic image of the set of edible objects shows up in the second conjunct as well as in the first one. This way it is possible to account for the effects of the intransitivization process in a natural way, by means of the lexical semantics of the verb.[5]

Our approach performs well not only when the incremental theme is divisive [Krifka, 1992] as in (1.a) and (2.a), but also when it is not. Consider, for example, the following sentence:

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[5] It is tempting to maintain a strict correspondence between the logical forms used in the text and the syntactic structures of the corresponding sentences. For example, the interpretation of the theme, under the homomorphic mapping, would invariably appear in its full form in the second conjunct. The first conjunct would contain indirect contribution from the theme, in the form of some lexical restriction for imperfective readings, and in the form of identity statements for perfective ones (in both case, under the homomorphic mapping). This proposal might be unsufficient for intransitives, where it is not clear what the source of the relevant information can be. However, it has been argued [Kayne, 1993] that even intransitive verbs have direct arguments. If this is true, the syntax-semantics mapping would be quite regular.

(9) i. John drinks wine
ii. Gianni beve vino
iii. $(\mathcal{G}\, {}^{h}Dr\, .\, V) \cap {}^{h}Wine$

The (imperfective) reading of the Italian sentence in (9) concerns an event *e* of doing something with a given (and not better specified) quantity of wine such that there are subparts of *e* that are both doing something with drinkable (the predicate *Dr*) subparts of that quantity of wine, and drinking them. Actually, given that *Wine* is divisive (at least in a qualified sense, i.e. down to a certain level) we could substitute *Wine* for *Dr* in the first conjunct, obtaining $(\mathcal{G}\, {}^{h}Wine\, .\, V) \cap {}^{h}Wine$, i.e. there are subparts of *e* that are drinking wine subparts of the given quantity. This statement is obviously equivalent to the previous one. The perfective, and impossible, reading of (9) would correspond to $\lambda y.((\mathcal{G}\, {}^{h}Id_y\, .\, V) \cap {}^{h}Wine)(y)$, as expected.

An interesting point is the following. Consider an event *e* which is imperfective and whose theme is divisive. Then (9.iii) applies to *e*. However, this is possible iff there is a subpart of *e*, call it *x*, such that ${}^{h}Dr(x) \wedge EAT(x)$. But if this is true, then, given that the theme is divisive and that the event inherits divisivity from the theme, we have that $(\lambda y.((\mathcal{G}\, {}^{h}Id_y\, .\, V) \cap {}^{h}Wine)(y))(x)$ is true, i.e. that *x* is perfective. Therefore, an imperfective divisive event implies the existence of a corresponding perfective one. This pattern of entailment is interesting since it may serve as the basis for an account of the so called *perfective paradox* [Dowty, 1979]. It is well known, in fact, that a sentence like *John is running* entails the truth of a statement like *John has run*. This effect is not limited to activity predicates, but extends to intransitivised accomplishments (e.g., *John is eating* $\rightarrow$ *John has eaten*) and to accomplishment predicates with a divisive incremental theme (e.g., *John is drinking wine* $\rightarrow$ *John has drunk wine*). According to the discussion above, these cases may be seen as instances of a general pattern of entailment to the effect that every time an imperfective event is given that is divisive then there exists a perfective subpart of the very same kind.

Finally, let us turn to habituals. They can be interpreted as stating the existence of an unspecified quantity of events, which apply to an unspecified quantity of objects (when an incremental theme is defined; cf. the SQA - Specified Quantity of A - feature of [Verkuyl, 1987; Verkuyl, 1989]; for habituals, see [Kearns, 1990]). We propose to represent habituals by means of the cumulative operator. Consider the following example (cf. also Fig.7):

(10) i. John eats chickens
ii. Gianni mangia polli
iii. $(\mathcal{K}\, {}^{h}Chicken\, .\, V) \cap {}^{h}{*}Chicken$

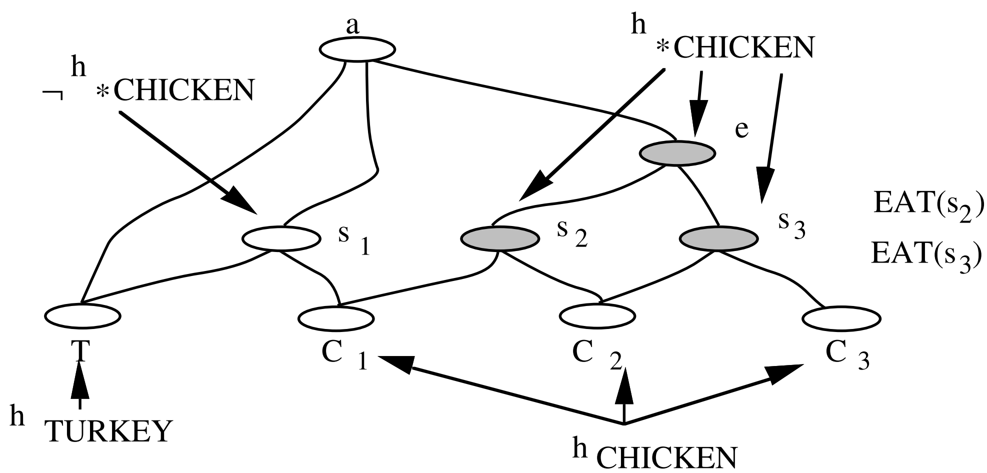

Fig.7

(10)iii can be applied to an event *a* iff *a* is an event of doing-something with an unspecified quantity of chickens (note the plural operator in the second conjunct) and every subpart of *a* which is a doing-something with one of those chicken is part of an event of eating, e.g. e, s_2 and s_3 in (Fig.7). Note that the semantics of the $\mathcal{K}$ operator permits *a* to include also spurious events, e.g. the eating of the turkey, as illustrated in (Fig.7), without actually quantifying on them.

Differently from the representation of perfective and imperfective readings, the V in (10) is simply *EAT*, i.e. it includes only the contribution of the verb. The temporal information conveyed by tenses, is not part of it, as it was in (7i) and (7ii), but is to be added to (10).[6] In this case we obtain:

$$\lambda t.((\mathcal{K}^{h}\text{Chicken . EAT}) \cap {}^{h*}\text{Chicken})(a) \wedge t \subseteq \tau(a))(S)$$

I.e. a temporal predicate is built out of (10.iii). Such a predicate denotes the set of subintervals of the time of *a*.[7] The contribution of the present tense amounts to requiring that the speech time *S* is one of them. No contradiction due to the punctual nature of s arises since it is not required that $S=\tau(s)=\tau(e_i)$ for any e_i which is a part of e; hence, both (10.i) and (10.ii) are possible in English and in Italian respectively.

REFERENCES

[Allen, 1983] Allen, J., F., Maintaining Knowledge about Temporal Intervals. In *Communications of the ACM*, 26, 1983.

[Allgayer and Franconi, 1992a] Allgayer, J. and Franconi, E., Collective Entities and Relations in Concepts Languages. In *Working Notes of the AAAI Fall Symposium "Issues on Description Logics"*, pages 31-35, Cambridge MA, October 1992. Also in *Workshop Notes of the ECAI Workshop on Theoretical Foundations of Knowledge Representation and Reasoning*, pages 1-5, Vienna, Austria, August 1992.

[Allgayer and Franconi, 1992b] Allgayer, J. and Franconi, E., A semantic Account of Plural Entities within a Hybrid Representation System, In *Proc. of the 5.th Intl. Symposium on Knowledge Engeneering*, pages 305-312, Seville, Spain, October 1992.

[Bach, 1986] Bach, E., The Algebra of Events. *Linguistics and Philosophy*, 9:5-16, 1986.

[Chomsky, 1981], Chomsky N., *Lectures on Government and Binding*, Foris, Dordrecht, 1981.

[Chomsky, 1986], Chomsky N., *Knowledge of Laguage*, Praeger, New York, 1986.

[Dowty, 1979] Dowty, D., *Word Meaning and Montague Grammar*. Reidel, Dordrecht, 1979.

[Dowty, 1991] Dowty, D., Thematic Proto-Roles and Argument Selection. *Language*, 67:547-619, 1991.

[Franconi, 1993] Franconi, E., A Treatment of Plurals and Plural Quantifications based on a Theory of Collections. *Minds and Machines (3) 4*, special issue on Knowledge Representation for Natural Language Processing, November 1993.

[Franconi, Giorgi and Pianesi, 1993], Franconi, E., Giorgi, A. and Pianesi, F. Tense and Aspect: A Mereological Approach, in *Proceedings of the 13th. International Conference on Artificial Intelligence*, Chambéry, 1993.

[Giorgi and Pianesi, 1991] Giorgi, A. and Pianesi, F., Toward a Syntax of Temporal Representations. *Probus*, 2:187-213, 1991.

[Giorgi and Pianesi, 1992a] Giorgi, A., and Pianesi, F., On Verbal Morphology in Germanic and Romance. In Fava, E. (ed.) *Proc. of the 7th Meeting of Generative Grammar*, Rosenberg & Sellier, Torino, 1992.

[Giorgi and Pianesi, 1992b] Giorgi, A., and Pianesi, F., *Tense Interpretation and Morphosyntactic Structures in Germanic and Romance*, talk givern at CGS8, Tromsø

[Giorgi and Pianesi, 1993] Giorgi, A., and Pianesi, F., *From Semantics to Morphosyntax: the case of the Imperfect*, Technical Report n.9309-01, IRST, Trento, 1993

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[6] We could say that in the case of habituals time has wide scope on events .

[7] Note that, in general, $\tau(a)$ is the convex sum of the time intervals of the subparts of *a*.

[Kamp, 1979] Kamp, H., Events, Instants and Temporal Reference. In Bäuerle, R., Egli, U., von Stechow, A., (eds.), *Semantics from Different Points of View*, Springer, Berlin, 1979.

[Kamp, 1991] Kamp, H., The Perfect and Other Tenses in French and English. In Kamp, H., (ed.) *Tense and Aspect in English and French*, Dyana Deliverable, R2.3.B, 1991.

[Kamp and Reyle, 1993] Kamp, H. and Reyle, U., *From Discourse to Logic*, University of Stuttgart, (forthcoming).

[Kayne, 1993], Kayne, R., Toward a Modular Theory of Auxiliary Selection, in *Studia Linguistica*, 47, 1993.

[Kearns, 1991] Kearns, K., S., *The Semantics of the English Progressive*. Ph.D. Thesis, MIT, Cambridge MA 1991.

[Krifka, 1992] Krifka, M., Thematic relations as Links between Nominal Reference and Temporal Constitution. In Sag, I., Szabolcsi, A., *Lexical Matters*, Chicago University Press, 1992.

[Landman, 1989a] Landman, Fred, Groups, I. *Linguistics and Philosophy*, 12:559-605, 1989.

[Landman, 1989b] Landman, Fred, Groups, II. *Linguistics and Philosophy*, 12:723-744, 1989.

[Link, 1983] Link, G., The Logical Analysis of Plurals and Mass Terms: a Lattice-Theoretical Approach. In Bauerle, R., Schwarze, C., von Stechow, A., (eds.), *Meeaning, Use and Interpretation of Language*, Walter de Gruyter, pages 302-323, 1983.

[Pianesi and Varzi, 1993] Pianesi, F. and Varzi, A., *The Mereo-Topology of Event Structures*, Technical Report n. 9308-06, IRST, Trento, 1993.

[Reichenbach, 1947] Reichenbach, H., *Elements of Symbolic Logic*. MacMillan, New York, 1947.

[Simons, 1987] Simons, P., *Parts: A study in Ontology*. Clarendon Press, Oxford, 1987.

[Smith, 1991] Smith, C., S., *The Parameter of Aspect*. Kluwer, Dordrecht, 1991.

[Sowa, 1991] Sowa, J., F., Towards the Expressive Power of Natural Language. In Sowa, J., K., (ed.) *Principles of Semantic Networks*, Morgan Kaufmann, pages 157-189, 1991.

[Verkuyl, 1987] Verkuyl, H., J., Non durative Closure of Events. In Groenendijk, J, A., G., de Jong, D., and Stokhof, M., J., B., (eds.), *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers*. Foris, Dordrecht, 1987.

[Verkuyl, 1989] Verkuyl, H, J., Aspectual Class and Aspectual Composition. *Linguistics and Philosophy*, 12:39-94, 1989.