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Tense, Reference and Temporal Anaphora

Abstract - In questo intervento viene discussa un'assunzione oggi molto diffusa fra gli studiosi di semantica del linguaggio naturale, e cioè che i morfemi del tempo verbale abbiano una portata referenziale simile a quella di un pronome deittico o anaforico. In realtà, l'analisi di alcuni esempi significativi porta a una considerazione meno restrittiva, in base alla quale ha un ruolo preminente la natura relazionale dei tempi verbali, e cioè la loro capacità di riferirsi a cornici temporali fornite dal contesto linguistico o extralinguistico. Se questo è un primo senso (peraltro generico) in cui si può parlare di relazioni anaforiche a proposito dei tempi verbali, è possibile individuarne anche un altro (che ancora una volta non coincide con la nozione di anafora in senso stretto) tendente ad assimilare tali relazioni al vincolamento, da parte di un quantificatore, di occorrenze diverse di una stessa variabile per eventi e/o tempi. L'ultima parte dell'intervento illustra brevemente la rilevanza dell'aspetto verbale nella determinazione delle opportune strutture quantificazionali.

0. Time and space.

In many languages, the grammatical form of a sentence has the property of encoding some temporal information. This is made possible by the presence of particular morphemes, whose role is (among other things) to locate an event or situation in one of the three temporal dimensions. Each declarative sentence, which states the occurrence of an event or set of events, cannot refrain from presenting this event as past, present or future. For instance, the simple change of the tense morpheme determines the attribution of an event to the dimension of the past (*Leo riparò la sua bici* [Leo repaired his bike]), present (*Leo ripara la sua bici* [Leo is repairing his bike]), or future (*Leo riparerà la sua bici* [Leo will repair his bike]).

This kind of remark does not require, of course, a particularly sophisticated analysis. What is less obvious is the observation that such a pervasive presence is a peculiarity of time that has no counterpart in other cognitive domains. Consider, for instance, the case of space. The three sentences I have just mentioned convey no spatial information, even from a very general point of view like the one which allows the simple attribution of the event to a temporal dimension. These sentences are perfectly in order although they do not say in which broad region of space the event of Leo's repairing his bike takes place. A moment's reflection is enough to realize that this lack of spatial information characterizes many sentences, whilst *no* declarative sentence (in the languages at issue) is devoid of temporal information. Moreover, when present, spatial information is rarely expressed by mere grammatical forms: there is nothing, in grammar, that is related to space as tense is to time. What is the reason for such a

dissymmetry between time and space? Some short considerations on this point can be relevant to the analysis of the referential nature of tense.

It should be noted that, whilst the articulation of time into three main dimensions is quite natural, there are several alternative (and often *unrelated*) ways in which space can be articulated. An event can take place in front of us rather than behind us, on the left rather than on the right, up or down, and so on. No one of these oppositions is more fundamental than the others, so that there is no reason for invoking a fix articulation which should be referred to in each occasion.

An important difference is that there is an inherent *directionality* of time but not of space. Certainly, the notions of past, present and future have an indexical character, in the sense that they depend on the utterance time: what is in the future today can be in the past tomorrow. That's why tensed sentences can change their truth-value. But as time goes by, events pass from the future to the present and, fromÊhere, to the past. If an event is past, it will be forever past. In this sense, the property of being past is *forward persistent*, as specified by the following principle about the directionality of time, which will be formulated so as to allow the comparison with a spatial counterpart:

(FPT) If it is true of my current position t (in time) that the event e occurred in the past of t, then it is true of any future position d that e is in the past of d.

This is a reasonable principle, often endorsed by tense logic and expressed by the axiom '$\mathbf{P}p \rightarrow \neg\mathbf{F}\neg\mathbf{P}p$', stating that if it is true that it was the case that p, then it will always be true that it was the case that p.

But consider a similar principle involving one of the above spatial articulations:

(FPS) If it is true of my current position s (in space) that the event e occurred on the left of s, then it is true of any position d to the right of s that e is on the left of d.

At first sight one might be tempted to say that, if the former principle is plausible, so is the latter. To support this claim, one might invoke the standard way of representing the course of time. On the time axis, if an event e is located before the utterance point, it is obvious that it is located before any later point d:
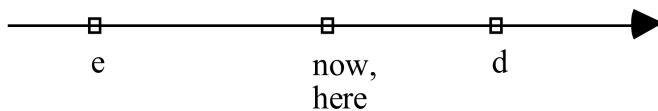
The same representation, one might add, can be used to depict the situation described by the second principle: if e is on the left of the utterance place, then it is located on the left of any other point d on its right.

Is this parallel correct? It is not, if one takes into account the fact that such notions as *being on the left* or *being on the right* (but the same holds for the other spatial qualifications mentioned above) depend on the observer's (or the speaker's) orientation. If, at point d, the observer's body undergoes a 180¡ rotation, e is no longer on the left, but on the right, and the second principle is falsified. This is so, of course,

because we can move in space, whilst we cannot move in time, at least in the sense that we are not free to make a past event future (with respect to a given evaluation point). This relative steadiness of temporal notions with respect, for instance, to the spatial characterizations of events can contribute to explaining why the natural articulation of time into its three main dimensions is often part of the *grammatical* equipment of a language. The primary role of tense, from this point of view, is not (and cannot be) to denote the particular time at which an event takes place, but *to select the temporal dimension it belongs in*.

1. Referring.

In Prior's classical analysis, based on the above reconstruction, the task of tense, in a sentence s describing an event e, is to assign e to one of the temporal dimensions determined by the utterance time u. Such a specification, which qualifies e as a past, present or future event, can change if the utterance time changes, and the truth conditions of s mirror this variation, so that the same sentence can have different truth-values at different times. As specified before, this characteristic is determined by the *indexical* nature of tense, which makes the semantic value of a sentence sensitive to a particular contextual parameter: the utterance time.

For example, by reformulating this analysis in terms of event semantics, the past tense can be seen as an operator **P** which, applied to an untensed proposition p, involves a quantification over *temporally situated* events. '**P**p' is read as 'It was the case that p' and its truth conditions are the following:

(1) $|\mathbf{P}p|_t = 1$ iff there is an event e such that e is before t and e is of the type described by p.

This means, for instance, that *Alla fine della lezione il bidello suonò la campana* [At the end of the lesson the janitor rang the bell] is true at t iff there is an event of the janitor's ringing the bell that temporally coincides with the end of the lesson and precedes t.

It is worth noting that the choice of *existential* quantification is not a necessary one. The reason for its predominant use in Prior's analysis is due to his interest in some crucial issues of tense logic, rather than in natural language semantics. But other kinds of quantification are available if we have to face more complex sentences, with different aspectual values. As we shall see later on, in the suitable context no Italian speaker would interpret a sentence such as *Alla fine della lezione il bidello suonava la campana* [At the end of the lesson the janitor used to ring the bell] in terms of an existential quantification, even if the only difference between this latter sentence and the former is nothing but a simple change of aspect (imperfective vs perfective). Roughly speaking, universal quantification would be more appropriate in this case.

In natural language semantics this kind of analysis has often been questioned, on the assumption that tense has a *referential* nature[1] The treatment in terms of quantification over times and/or events, one objects, is inadequate because tense does not simply involve the generic existence of a time at which a certain event takes place, but it refers

to a specific, particular time. Partee mentions the following example. Suppose that, while driving down the freeway, I say:

(2) I didn't turn off the stove.

In this case, Partee observes, the role of tense is not to mean that at some moment or other in the past I did not turn off the stove, but to refer to an understood particular time, made salient by the context. From this point of view, the past tense, in (2), is assimilated to the personal pronoun *she* in:

(3) She blamed me

where the pronoun (unlike a quantified noun phrase such as *someone*) refers to a specific individual identified by the context. In both cases we would have a specific reference to a particular individual of the universe (a particular time or event, and a particular person respectively).

I suspect that treating tense as a *referential* morpheme is based upon a sort of ambiguity of the term *reference*:

(a) According to a more specific or even "technical" sense, we say for instance that in a sentence such as *Leo is running* the proper name *Leo* refers to a particular individual, i. e. Leo. It is in this narrow sense that we say the pronoun *she*, in (3), refers to a given person. On this interpretation, *referring* and *denoting* (an individual in the universe of discourse) are almost synonymous terms.

(b) When we say that in the sentence *All the students bought a textbook of logic* the quantified noun phrase *All the students* refers to a restricted universe (the universe of our department, for instance), we use the word *refer* in a more generic sense. We only mean, in this case, that the noun phrase *all the students* is to be interpreted *relative* to a given *context*, for it is obviously absurd to think that it may involve any student in the world.

My claim is that it is appropriate to speak of the referential nature of tense in the weaker sense mentioned in (b), rather than in the other, more specific sense. As for Partee's example, notice that there is no *particular* time at which the hearer is invited to locate the event at issue (my turning off the stove). What is suggested by the context is simply a temporal framework (characterized by the preparations for my departure, for instance), and it is this background that the past tense in (2) "refers" to. From this standpoint, the "referential" nature of the past tense morpheme, in (2), is to be interpreted in the sense illustrated in (b), based on the notion of a reference to a *restricted* portion of the temporal domain of quantification, and not in the stronger sense, which entails the denotation of a particular time in that domain, exactly as the first pronoun in (3) denotes a particular individual in the usual domain of quantification.

This point can be made clearer by considering the following expansion of sentence (2):

(4) I didn't turn off the stove. Fortunately, Leo turned off the light.

Suppose the past tense morpheme in (2) denotes a particular time made salient by the context, as suggested by Partee. The same should hold for (2) when embedded in sentence (4). Let t be the particular time referred to by the past tense morpheme of (2) in the context of (4). Consider now the other occurrence of the past tense morpheme in (4), i. e. the one in the second sentence *Leo turned off the light*. Its denotation should coincide with t, because t is the time made salient by the context, and it is reasonable to think that the context has not changed when passing from the first sentence to the second. Sure, one might suggest, alternatively, that the time denoted by the second occurrence of the past morpheme is determined by an anaphoric relation, where the first sentence is the linguistic antecedent. But this is not true, because the order of the sentences, in (4), does not entail any particular relation (like coincidence or precedence) between the times of the two events at issue. So, the only alternative we are left with is to conclude that the two occurrences of the past tense morpheme refer to the same particular time made salient by the context, if they refer to anything. Is this correct? It is not, for (4) does not state or entail that the time of the (unrealized) event of my turning off the stove and the time of the event of Leo's turning off the light should have had to coincide.

For the sake of argument, I followed Partee's example, which contains a negated verb phrase. But the same reasoning applies to examples without negation, as for instance:

(5) I turned off the stove. Fortunately, Leo turned off the light.

Here too, for the same reasons as before, the time referred to by the second occurrence of the past tense morpheme should coincide with the one denoted by the first occurrence. But, once again, this is not true.

On the view I am arguing for, the weaker interpretation of the referential nature of tense is based on the idea that quantification must refer to a restricted domain, fixed by the (linguistic or extralinguistic) context. This is why the above situation is not problematic. Both sentences, in (4), refer to the same contextual restriction (say, the temporal framework represented by the preparations for my departure) and not to the same particular time: the first sentence states that in the period of time made salient by the context there is no moment at which I turned off the light, whilst the second states that, in the same period, there is a moment at which Leo turned off the light. Similarly, the first sentence in (5) states that there is a time, in the intended period, at which I turned off the stove, whilst the second states that there is a time (in the same period) at which Leo turned off the light. The temporal frame or background is the same, but the times at which the events occurred do not necessarily coincide, as desired.

If the past tense morphemes, in a sentence like (5), really individuated two particular times (i. e. specific locations on the time axis), a temporal relation between them would follow, and we could decide whether they coincide or one of them precedes the other. But, as we have just seen, this is not true in general, unless some pragmatic considerations based on the order of the sentences, world knowledge and other factors allow us to do that. In the case of (5), to state such a temporal relation between events we need an explicit connective, as in the following sentences:

(6) When I turned off the stove, Leo turned off the light.

(7) After I turned off the stove, Leo turned off the light.

It is worth noticing that even in the last example, where the when-clause contributes to the temporal location of the event described by the main clause, there is no reference (in the strong sense) to a specific moment: in the given context, what (7) states is that, during the preparations for my departures, there is a moment at which I turned off the stove, there is a moment at which Leo turned off the light and the former moment is before the latter. Once more, this is quite compatible with an analysis à la Prior, provided that we distinguish between the temporal background we refer to (where this background determines a suitable restriction of the temporal domain of quantification) and the locating role of the when-clause. This is explicit, for instance, in the following sentence:

(8) Whilst Lia was preparing everything for the departure, when I turned off the stove, Leo turned off the light

where the first when-clause introduces a temporal background, within which the second when-clause locates the event described by the main clause.

2. Anaphora.

If a tense morpheme is not a referential expression as the deictic pronoun is in (2), an alternative suggestion is that it has such a characteristic insofar as it can be assimilated to *anaphoric* pronouns. The idea is that in a sentence like (6) the past tense morpheme of the main clause is anaphoric to the time referred to by the when-clause, which is the linguistic antecedent of the anaphor. But it is not difficult to see the problems raised by such an assimilation of tense morphemes to anaphoric expressions stricto sensu. From this point of view, the two tense morphemes would be co-referential exactly as the proper name and the anaphoric pronoun in the sentence *I met Leo at the station. He was really angry*. Is this really so?
First of all it should be noted that the relation between the tense morpheme and its alleged linguistic antecedent is not as definite as we would expect from a real anaphor. For instance, in (6) what is assumed to be the linguistic antecedent can move, salva congruitate, to the final position in the sentence, as witnessed by:

(6') Leo turned off the light when I turned off the stove.

Shall we say that in (6') the second occurrence of the past tense morpheme is anaphoric to the first one? This would be highly counterintituive, for the temporal location of the event described by the main clause is still parasitic to the temporal specification introduced by the when-clause. So, the only way out is to say that (6') is a case of

backward anaphor, which is not so usual in the case of pronouns, as shown by the impossibility of preserving the anaphoric relation when passing from:

(9) If Leo wrote the paper, he used the computer

to

?(10) He used the computer, if Leo wrote the paper.

But suppose we still want to maintain that (6) is based on a real anaphoric relation. So, we are led to say (as Partee does) that this characteristic is shared by the following sentence:

(11) At 3 p. m. June 21st, 1960, Mary had a brilliant idea

where the linguistic antecedent should be represented by the time adverbial. Once more, the interchange between the time adverbial and the main clause raises no problem, as shown by:

(12) Mary had a brilliant idea at 3 p. m. June 21st, 1960.

The same kind of permutation can be noticed when passing, for instance, from:

(13) On the bus Mary had a brilliant idea

to:

(14) Mary had a brilliant idea on the bus.

Yet, only a very vague notion of anaphor would allow us to say that the last two sentences instantiate anaphoric relations.
Or consider this other example, also taken from Partee (1984):

(15) Sheila had a party last Friday and Sam got drunk.

Saying that in (15) 'a time is specified in the first clause and the second clause is most naturally understood as referring to the same time' and that 'the past tense can be viewed as an anaphoric element' (Partee 1984: 245) can be misleading, because it might be understood as meaning that the past tense morpheme is referential in the strong sense discussed above. But this is not so. The first sentence just creates a temporal background *within* which the event described by the second sentence is to be located. Sure, this phenomenon has to do with the rules that guarantee the "connectedness" of a discourse, but we cannot characterize it as a case of an anaphoric relation any more than we can with a similar phenomenon, illustrated by the following sentence:

(16) I met Leo in Rome and I discussed Jarry's pataphysics with him.

Here, the natural intepretation requires that the first sentence in (16) determines a spatial background which leads the hearer to locate in Rome the event described by the second sentence, exactly as the first sentence in (15) creates a temporal background.

3. Utterance time and temporal locations.

Since we have so far ignored any aspectual specification, the characterization of tense we have been developing does not depart from an indexical analysis à la Prior: the main role of tense as such is to embed the event at issue in one of the three temporal dimensions originating from the utterance time, i. e. past, present and future. This preliminary location can be further specified by other means, in particular by temporal adverbials and when-clauses. From this point of view, past and future share some peculiarities that the present tense lacks. As a first approximation, it might be said that the temporal qualification introduced by a past or future tense is (coeteris paribus) less specific than the kind of temporal location determined by the present tense. (Since in Italian the simple present tense also has a habitual reading and a "futurate" reading, we will refer to its progressive form.) This is evident if you consider the co-occurrence of the past (or future) tense with other temporal indicators like time adverbials or when-clauses. It is easy to see that there are no restrictions at all. A sentence such as:

(17) Leo ha ascoltato (ascolterà) un pezzo di Satie [Leo listened (will listen) to a piece by Satie]

can have a quite natural expansion by specifying the time of the event:

(18) Alle due Leo ha ascoltato (ascolterà) un pezzo di Satie [At two o'clock Leo listened (will listen) to a piece by Satie].

But this is not possible in the case of the (genuine) present tense, as proved by the oddity of the expansion that you get when passing from:

(19) Leo sta ascoltando un pezzo di Satie [Leo is listening to a piece by Satie]

to:

? (20) Alle due Leo sta ascoltando un pezzo di Satie [At two o' clock Leo is listening to a piece by Satie].

The reason for this discrepancy is quite simple. In the case of the past or the future, the indexical nature of tense only entails the location of the event *somewhere* in that part of the time axis which extends backward (forward) from the utterance time. This temporal qualification is indefinite enough to allow further time indications, possibly

specifying *exactly where* that event is to be located. With the present tense the situation is different. Indexicality entails, in this case, *coincidence* with the utterance time, and not a simple location of the event in a temporal dimension originating from the utterance time. As a consequence, there is no room for further specifications.

This means that, in the case of the past or the future, some temporal indicator is needed for the individuation of the relevant time (if any). Without the *explicit* presence of such expressions there is no reference to specific times. When-clauses are among those expressions, and their role is to establish a temporal connection between two events, so that one of them can be located with respect to the other. There is nothing peculiar in this, at least nothing that requires the intervention of special anaphoric links (based on co-referentiality) any more than other subordinate constructions do. Take for instance the following sentence:

(21) Leo ha ordinato la biografia di Proust dove ha comprato la *Recherche* [Leo ordered Proust's biography where he bought the *Recherche*].

Here, the spatial location of the event described by the main clause is made possible by connecting this event with the one described by the subordinate clause. This account perfectly matches the temporal counterpart of (21), where spatial location is replaced by temporal location:

(22) Leo ha ordinato la biografia di Proust quando ha comprato la *Recherche* [Leo ordered Proust's biography when he bought the *Recherche*].

An approximate paraphrase of these sentences in terms of an event-based ontology might be something like this: There is an event e of Leo's ordering Proust's biography and an event e' of Leo's buying the *Recherche* such that e and e' occurred at the same place (time). Notice that (21) is temporally indeterminate (for we do not know whether the two events at issue are simultaneous or not) exactly as (22) is spatially so (did they occurred at the same place?). It is by means of a subordinate clause - or a locative adverbial, for that matter - that the relevant spatial (temporal) information is added. As we have just seen, it is possible to account for both situations by using quantification over events, times and places and suitable *relations* between them. If the temporal case were based on the special status of tense as a referring or anaphoric morpheme, the parallel between (21) and (22) would sound mysterious (for there is no such morpheme in the spatial case). But there is nothing puzzling in this parallel. In (21) the connective *where* establishes a spatial relation between two events otherwise unrelated, and (22) does the same with respect to time. The relation at issue is introduced by a specific connective (*where* or *when*), and not, in the case of (22), by some special anaphoric properties of tenses. No one would speak of anaphor (stricto sensu) in the case of (21). The same should hold for (22). The only reasonable sense in which we can speak of the "referential" nature of tense is a very generic one, based on its context-dependence. In the same vein, speaking of its "anaphoric" character is nothing more than a suggestive way of emphasizing the relational nature of temporal notions.

It might be objected that, at least in the case of the so-called "anaphoric" tenses, this kind of reconstruction is not possible. The reasoning might be the following. In a sentence like (5), repeated here for convenience:

(5) I turned off the stove. Fortunately, Leo turned off the light

it can be plausible to maintain that the role of the two past tense morphemes is only to assign the events at issue to the temporal dimension of the past, made less indeterminate by the reference to a context (the preparations for our departure). In fact, as I emphasized before, (5) entails neither a more specific individuation of the events described by its sub-sentences nor any particular temporal relation (like coincidence or precedence) between them. But what about the following sentence, where we have two occurrences of an "anaphoric" tense:

(23) Leo arrivò alle tre. Lia era (già) uscita. Anche Lea era (già) uscita [Leo arrived at three o'clock. Lia had (already) left. Lea had (already) left, too].

It is obvious that the representation of the temporal relations between the events described by the sentences in (23) is richer that the one described in the case of (5). Don't we need a different kind of analysis?

My idea is that all that is required is just a generalization of the same type of account we resorted to when discussing (5). First of all, it should be remarked, once more, that the morphemes of the compound tense (a pluperfect) are not referential in the stronger sense mentioned above: (23) entails no particular temporal relation between the event of Lia's leaving and the event of Lea's leaving, as it should do if those morphemes denoted two particular times thanks to a real anaphoric relation with a linguistic antecedent. The right interpretation of (23) is that the event of Lia's leaving is in the past of an evaluation time determined by the first sentence, and the same holds for the event of Lea's leaving. No information is provided by (23) about the precise temporal locations of these two events and their relations. So, exactly as in the case of (5), the role of the past tense morpheme (a pluperfect, this time) is to assign an event to the temporal domain of the past, without further specifications. What changes, in (23), is just the evaluation time which the usual temporal dimensions originate from: it is not the utterance time, but the moment denoted by the adverbial in the first sentence. From this point of view, a tense morpheme is anaphoric, not in the sense of a relation of co-referentiality, but only in the (very general) sense of a systematic dependence on the linguistic context, as witnessed by (23). In the next section we will see how the aspectual features encoded in the tense system of Italian can illustrate another aspect of the "anaphoric" character (broadly speaking) of tense. We will remark that in the following sentence:

(24) Quando Lia entrava, Leo usciva [Whenever Lia came in, Leo went out]

the imperfective aspect determines a universal quantification which *binds* variables for times and/or events.

What will emerge from this picture is, at least in languages such as Italian, a better definition of the roles of tense and aspect with respect to quantification over events and/or times. Since three distinct temporal dimensions originate from the utterance time (or, more generally, from the evaluation time), tense specifies *which* of these dimensions the events or time we are quantifying over belong to. Tense morphemes as such do not allow for more specific locations. To get the suitable restrictions, when-clauses, temporal adverbials and the like are required. As for aspect, we will ascertain that one of its functions is to select the type of quantification that is needed each time. To conclude these preliminary remarks on the role of when-clauses (and time adverbials in general) in temporal quantification let me introduce a further distinction. On the "referential" account, the idea that a tense morpheme is always anaphoric to a referent (i. e. a specific individual of the temporal domain of quantification) provided by a when-clause has obscured an interesting characteristic of these expressions. Consider the following when-constructions:

(25) Quando era giovane, Leo fu punto sulla lingua da una vespa [When Leo was young, he was stung on his tongue by a wasp]

(26) Quando apr" la bocca, Leo fu punto sulla lingua da una vespa [When Leo opened his mouth, he was stung on his tongue by a wasp].

It is evident the when-clause in (25) has not the same role as the one in (26). The former just introduces a temporal *background*, whilst the latter gives the event described by the main clause a specific temporal *location*. The relevance of this distinction is confirmed by the possibility of expanding a sentence such as (25) by adding a specific temporal location, as in:

(27) Quando era giovane, alle tre del pomeriggio del 21 giugno 1960 Leo fu punto sulla lingua da una vespa [When Leo was young, at 3 p. m. June 21st 1960 he was stung on his tongue by a wasp]

whilst the same expansion is not acceptable if applied to (26):

?(28) Quando apr" la bocca, alle tre del pomeriggio del 21 giugno 1960 Leo fu punto sulla lingua da una vespa [When Leo opened his mouth, at 3 p. m. June 21st 1960 he was stung on his tongue by a wasp].

The reason why (28) is out (unless, thanks to a particular intonation, we give the time adverbial a parenthetical interpretation) is that the temporal location introduced by the time adverbial conflicts with the one already provided by the when-clause. In (27), where the when-clause has a different role, such a problem does not arise.
I will not, here, discuss the functional distinction of when-clauses any further. In the last two sections I will consider the when-clauses only as restrictice clauses and concentrate, in particular, on the relevance of aspectual factors in determining which quantifier has to bind the temporal variables occurring in the when-clauses.

4. Types of quantification.

In Italian, a when-clause can contribute to the temporal location of the *single* event denoted by the main clause, or it can locate each event in a whole sequence or *collection* of events. For instance, in the sentence:

(29) Quando depose un uovo, Berta fece coccodè [When Berta lay (past, perfective) an egg, she cackle (past,perfective) = When Berta (in a particular circumstance) laid an egg, she cackled]

the event described by the when-clause is used to locate a single event of Berta's cackling. But in the sentence:

(30) Quando deponeva un uovo, Berta faceva coccodè [When Berta lay (past, imperfective) an egg, she cackle (past,imperfective) = Whenever Berta laid an egg, she cackled]

each event in a collection of events of Berta's cackling is temporally located by associating them with an event of Berta's laying an egg.
If we compare the last two sentences we easily realize that, on the one hand, they *only* differ in aspect and, on the other hand, their meanings are quite distinct. (29) involves just a particular circumstance, and states that, in this circumstance, an event of Berta's laying an egg temporally coincides with an event of Berta's cackling. (From now on we will ignore the past tense.) As for (30), it concerns a whole collection of circumstances, by stating that in each of these circumstances an event of Berta's laying an egg temporally coincides with an event of Berta's cackling. As a conclusion, (29) and (30) have something in common, since both of them can be reconstructed in terms of a quantificational structure, but they also show an essential difference, because the type of quantification required in each case is *not* the same. Roughly speaking, the former sentence can be properly paraphrased by an existential assertion (as is usual in the tradition of analysis originating from Prior's tense logic), whilst the latter involves a universal quantification (which is quite unusual in that tradition).
Let us assume that the connective 'quando' introduces a temporal relation between two events, and that in our examples this relation is coincidence (in a broad sense), expressed by the symbol '$\asymp$'. The idea that (29) and (30) share a quantificational structure but involve different types of quantification can be accounted for by associating them with the following logical forms:

(29') $\exists e([\text{Berta-lay-an egg}(e)]_R \rightarrow [\exists e'(\asymp(e,e') \wedge \text{Berta-cackle}(e'))]_M)$
(30') $\forall e([\text{Berta-lay-an-egg}(e)]_R \rightarrow [\exists e'(\asymp(e,e') \wedge \text{Berta-cackle}(e'))]_M)$[2].

The first formula means that there is (in the past) an event of Berta's laying an egg and this event temporally coincides with an event of Berta's cackling, whilst the second

says that every event of Berta's laying an egg temporally coincides with an event of Berta's cackling. As desired, the two sentences have the same logical structure, which, as pointed out in Frege's theory, consists of a quantifier, a restrictive clause (specifying a property that identifies a set of objects) and a main clause (specifying the property that is attributed to these objects). But they have different quantifiers, as required by the role of aspect in Italian.

5. Restrictive Clauses and Matrices

This kind of analysis accounts for one of the two "weak" senses in which it is reasonable to assimilate tense morphemes to anaphoric expressions (broadly speaking), that is when some variables for times and/or events are bound by a suitable quantifier. To realize that this is not an ad hoc solution and that it can be generalized to other related phenomena, we can proceed as follows.
First of all consider these other sentences:

(31) Quando fece coccodè, Berta depose un uovo [When Berta cackle (past, perfective) an egg, she lay an egg (past,perfective) = When Berta (in a particular circumstance) cackled, she laid an egg]

(32) Quando faceva coccodè, Berta deponeva un uovo [When Berta cackle (past, imperfective), she lay (past,imperfective) an egg = Whenever Berta cackled, she laid an egg].

The only surface difference, between (30) and (32), concerns the position of the main clause with respect to the when-clause. However, this shifting has important effects. If the intonation is not marked, (32) has a possible or even favourite meaning (given by (32')) that (30) *cannot* have (assuming, once again, that the intonation is not marked). The interaction between the aspectual configuration and the order in which the restrictive clause and the main clause follow each other is crucial in this case: if this order is reversed, the restrictive clause and the when-clause exchange their roles. In fact, we obtain the following structure:

(32') $\forall e([\text{Berta-cackle}(e)]_R \rightarrow [\exists e'(\asymp(e,e') \wedge \text{Berta-lay-an-egg}(e'))]_M)$

This formula means that every event of Berta's cackling temporally coincides with an event of Berta' s laying an egg, whilst (30') expresses the converse statement: every event of Berta laying an egg temporally coincides with an event of Berta's cackling. Thus, the difference in meaning between (30) and (32) is correctly reconstructed in terms of an interchange between restrictive clause and matrix . From a structural point of view, the effect of this interchange can be represented in the following terms:

(I) If the when-clause and the main clause are in the imperfective form, then to 'Quando E_1, E_2' corresponds the structure: $\forall e([E_1]_R \rightarrow [E_2]_M)$ and to 'Quando E_2, E_1' corresponds the structure: $\forall e([E_2]_R \rightarrow [E_1]_M)$

The non-equivalence of the two logical forms at issue is simply a matter of first-order logic.
Let us now turn to the perfective form. This time, the interchange between restrictive clause and main clause does not have the same effect. As for truth conditions, there is no change at all when passing from (29) to (31). If one keeps in mind that the perfective determines an existential quantification, the explanation is, once more, very simple. This time the relevant principle is the following:

(P) If the when-clause and the main clause are in the perfective form, then to 'Quando E_1, E_2' corresponds the structure: $\exists e([E_1]_R \wedge [E_2]_M)$ and to 'Quando E_2,E_1' corresponds the structure: $\exists e([E_2]_R \wedge [E_1]_M)$.

Thus, the resulting first order logical forms are logically equivalent, as can be easily seen by comparing (29') and the following formula:

(31') $\exists e([\text{Berta-cackle}(e)]_R \wedge [\exists e'(e \!\gtrless\! e' \wedge \text{Berta-lay-an-egg}(e'))]_M)$

which is the logical form of (31). The equivalence of (29') and (31') explains the invariance of truth-conditions when passing from (29) to (31)[3].
Such a relationship between aspect and types of quantification over events is not confined to when-constructions but is quite general and systematic. For instance, we can observe the same phenomenon in sentences where a locative adverbial replaces the when-clause. As concerns truth conditions, there is no difference between these two sentences:

(33)   Al cinema Leo mangiò noccioline [At the movie theater Leo eat (past, perfective) peanuts = At the movie theater Leo ate peanuts]
(34)   Leo mangiò noccioline al cinema [Leo eat (past, perfective) peanuts at the movie theater = Leo ate peanuts at the movie theater]

On the contrary, truth-conditions are not the same in the case of these other two sentences:

(35)   Al cinema Leo mangiava noccioline [At the movie theater Leo eat (past, imperfective) peanuts = Whenever Leo was at the movie theater, he ate peanuts]
(36)   Leo mangiava noccioline al cinema [Leo eat (past, imperfective) peanuts   at the movie theater = Whenever Leo ate peanuts, he was at the movie theater].

As in the case of when-constructions, the reason for this discrepancy between (33)-(34) on the one hand and (35)-(36) on the other is to be searched in the connection between aspectual configuration and type of quantification. The perfective form determines existential quantification both in (33) and (34), so that we obtain equivalent logical forms:

(33') $\exists e([\text{Leo-be-at-the-movie-theater}(e)]_R \wedge [\exists e'(><(e,e') \wedge \text{Leo-eat-peanuts}(e'))]_M)$

(34') $\exists e([\text{Leo-eat-peanuts}(e)]_R \wedge [\exists e'(><(e,e') \wedge \text{Leo-be-at-the-movie-theater}(e'))]_M)$.

But the logical forms we obtain in the case of (35) and (36) are not equivalent:

(35') $\forall e([\text{Leo-be-at-the-movie-theater}(e)]_R \rightarrow [\exists e'(><(e,e') \wedge \text{Leo-eat-peanuts}(e'))]_M)$

(36') $\forall e([\text{Leo-eat-peanuts}(e)]_R \rightarrow [\exists e'(><(e,e') \wedge \text{Leo-be-at-the-movie-theater}(e'))]_M)$.

Once more, the explanation for such phenomena resides in the systematic role of aspect in the determination of the relevant quantificational structures.

Notes

[1] This point of view is adopted in two papers by B. Partee: *Some structural analogies between tenses and pronouns in English,* 'Journal of Philosophy', 70, 601-609; 'Nominal and temporal anaphora', *Linguistics and Philosophy*, 7, 243-286. A similar position can be found in E. Hinrich's paper *Temporal anaphora in discourse of English,* ÒLinguistics and PhilosophyÓ, 9, 63-82. For a general discussion, see M. Moens, *Tense, Aspect and Temporal Anaphora*, ms, University of Edinburgh, 1987.

[2] To see how such formulas can be systematically derived in a formal machinery cf. A. Bonomi, *Aspect, Quantification and When-clauses in Italian*, Dipartimento di Filosofia, Università di Milano, 1994. Once more, it should be noted that to simplify things tense is ignored here.

[3] This invariance does not mean that the two sentences are also interchangeable "salva congruitate" in any context of use, for example as answers to particular questions.