TENSE AND ASPECT FOR GLUE SEMANTICS: THE CASE OF PARTICIPIAL XADJ'S

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Abstract

In the first part of this paper, I present a general model for tense and aspect in glue semantics based on Wolfgang Klein's time relational analysis (Klein, 1994). In the second part, I analyse the temporal reference of participial XADJs in Ancient Greek within this system and show how information structure interacts with aspectual marking to constrain temporal relations between secondary events and the event of the main clause.

1 Introduction

Event semantics has proven a very succesful approach to the analysis of tense and aspect phenomena, but it offers many challenges to the traditional Montagovian view of semantic compositionality as a strict rule-to-rule isomorphism between syntax and semantics. Glue semantics, on the other hand, offers a flexible approach to the syntax-semantics interface which is especially suitable to deal with event semantics; but tense and aspect have hardly been analysed in the extant glue semantics literature. In the following I will therefore attempt to provide the outlines of a general framework for treating temporality in glue. The proposed framework is not in itself new, but represents a formalization of Klein's time relational analysis and also builds on earlier formalizations of Klein in Montagovian settings, such as in Paslawska and von Stechow (2003).

According to a common and rather intuitive view, grammatical tense serves to relate events to time. But as pointed out by Klein (1994), this cannot be right. Consider the following exchange

(1) a. Do you know where John is?

b. Well, he was in the garden.

The answerer does not intend to place the situation of the John's being in the garden in the past, but rather to restrict his claim to the past, while leaving open (and perhaps implying) that the claim might still hold. In other words, the speaker makes the assertion about a time in the past to the effect that John's being in the garden includes this time. We will refer to this "time in the past" as the *topic time* of the sentence, since it is the interval the sentence "is about".

Following Klein, then, I will assume that tense serves to relate topic times, and not events or situations, to utterance time. The events themselves, on the other hand, are not linked directly to the utterance time, but only to the topic time. This linking is done by aspect, as we will see in section 2.3.

[†]Sincere thanks go to Ash Asudeh for having evoked my curiosity about glue semantics during a talk in Oslo, and to Ash Asudeh and Mary Dalrymple for having read preliminary versions of this paper. The glossing in this paper follows the Leipzig standard, except that I use the abbreviations AP for aorist participle and PP for present participle. In the Greek examples, participles are underlined.

2 Tense and aspect for glue-based event semantics

2.1 Templates and the event variable

In neo-Davidsonian event semantics, verbs denote sets of events, i.e. they have meanings like $\lambda e.run(e)$, and the arguments of verbs are represented by relations between individuals and events which act as intersective modifiers on such sets of events.

In approaches to compositionality which rely on a strict rule-to-rule correspondence between syntax and semantics, it has proven difficult to model this approach to events while keeping functional application as the only means of combining meanings: the event variable cannot be existentially quantified before the application of event-modifying adverbials since that would make the event inaccessible to the adverbial; on the other hand, the event variable should be quantified *before* the application of the arguments of the verb, since the quantification over the event would otherwise outscope quantifiers in argument positions, leading to nonsensical representations like of 'John killed no one with his shotgun' as $\exists e.\neg\exists x.kill(e) \wedge ag(e, john) \wedge theme(e, x) \wedge with(e, the\ shotgun)$.

Glue semantics, on the other hand, offers several interesting ways of assuring the right scope relations. In this paper, I will adopt the approach of Asudeh et al. (2008) which relies on construction templates to introduce subcategorization frames, i.e. to create slots for the arguments of the verb in the semantic representation, while at the same time quantifying over the event variable. Thus, the transitive template will take a set of events and turn it into a function looking for a subject and an object to produce a meaning for the sentence:

(2) $\lambda R.\lambda x.\lambda y.\exists e.R(e) \wedge agent(e) = x \wedge theme(e) = y :$
$(\uparrow_\sigma \text{ EV}) \multimap (\uparrow \text{ SUBJ})_\sigma \multimap (\uparrow \text{ OBJ})_\sigma \multimap \uparrow_\sigma$

As will be apparent below, we will need to modify (2) slightly to allow it to pass on a temporal variable as well, and to allow us to distinguish between the event variable e and the predicate on events R.

Subcategorization frames are just one, very general type of constructional template. Constructional templates can also be more specific and in (27) in section 4.4 we define a template for predicative participles.

2.2 Events and times

Events clearly have relations to times: they are located in time, and they have duration. From this it follows that they can be ordered by the same relations as times: precedence, simultaneity, proximity, inclusion and others. Events can have such relationships not only to other events, but also to temporal intervals. There is no reason to assume that events and temporal intervals behave differently with regard to temporal relations and I will assume that precedence ($\prec$) and inclusion ($\supseteq$ and $\subseteq$) indiscriminately take times and events as arguments. Possibly, events can also be related via mereological inclusion or ontological part-whole relationships, but this is a different relation which probably presupposes temporal inclusion but is otherwise not related to it. In this paper, $\supseteq$ and $\subseteq$ always stand for temporal inclusion.[1]

2.3 Aspect

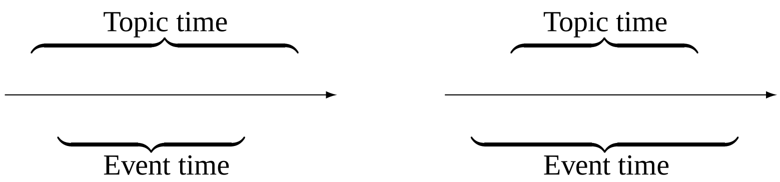
Using the notion of topic time, Klein is able to provide a definition of aspect which is intuitive, captures the insights of traditional, informal definitions and allows for a formalization in terms of the inclusion relation:

(3) a **Perfective** aspect says that the topic time *includes* the event time

b **Imperfective** aspect says that the topic time *is included* in the event time

The difference between *I mowed the lawn* and *I was mowing the lawn* can be illustrated as follows:

(4)



a. *I mowed the lawn* b. *I was mowing the lawn*

This approach neatly reconstructs the classical definition of perfective aspect as viewing the event from outside and imperfective aspective as viewing the event from inside: the topic time represents the speaker's viewpoint which is either internal to the event or lies outside it. Following Paslawska and von Stechow (2003) the contribution of aspect can then be formalized as a function from sets of events to sets of topic times such that they include or are included in the event time.

In formalizations of Klein's theory of tense and aspect it is standardly assumed that the aspect operator quantifies over the event variable. In the template approach to subcategorization, however, we need to pass on the event variable to the template so it can bind the thematic roles to the event correctly. We therefore modify the approach of Paslawska and von Stechow (2003) slightly and model aspect as a function from events, to pairs of events and topic times, to sentence meanings. Perfective aspect will then be:

(5) $$\lambda P.\lambda\langle e \times t\rangle.P(e) \wedge e \subseteq t : ((\uparrow_\sigma \text{EV}) \multimap \uparrow_\sigma) \multimap (((\uparrow_\sigma \text{EV}) \otimes (\uparrow_\sigma \text{TT})) \multimap \uparrow_\sigma)$$

[1] I have chosen not to use *proper* inclusion in the definition of aspect since in many languages (including Ancient Greek), it is marginally possible to use the imperfective aspect to refer to complete events, which means that there is a certain overlap in the semantics of perfective and imperfective aspect. In most cases, though, this use of the imperfective is blocked by the competing perfective aspect.

This necessitates some changes in the meaning constructor for the subcategorization template. TRANSITIVE will now be:

(6) $\lambda R.\lambda x.\lambda y.\lambda t.\exists e.R(\langle e \times t \rangle) \wedge agent(e) = x \wedge theme(e) = y :$
$(((\uparrow_\sigma \text{EV}) \otimes (\uparrow_\sigma \text{TT})) \multimap \uparrow_\sigma) \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow_\sigma \text{TT}) \multimap \uparrow_\sigma$

Instead of taking a simple event description and returning a function from the verbal arguments to a truth value, it now takes pairs of events and topic times which stand in some relationship defined by aspect, and returns a function from the verbal arguments and the topic time to a truth value.

To see how this works, consider a verb like *read*. This denotes a set of reading events. If imperfective aspect is applied to this meaning, we get a set of pairs of reading events and times which are included in these events. Note that these times need not include a reading event at all: they could just be intervals in which a page is turned. The transitive template then takes this set of pairs of events and times and returns a set of times, agents and themes of a particular reading event.

This approach requires that all verbs have aspect, since aspect is the crucial factor which relates events to time. For an explanation of how the model works in cases where there is no overt aspect, see Bohnemeyer and Swift (2004): essentially, the default aspect operator chooses the minimal interval for which the predicate is true, unless there is information to the contrary. This leads to a default interpretation of atelic predicates as imperfective and telic predicates as perfective.

2.4 Tense

Tense serves to place the topic time in relation to the utterance time. We can model its contribution as a simple intersective modifier on sets of topic times. For example, past tense will be:

(7) $\lambda P.\lambda t.P(t) \wedge t \prec u : ((\uparrow_\sigma \text{TT}) \multimap \uparrow_\sigma) \multimap ((\uparrow_\sigma \text{TT}) \multimap \uparrow_\sigma)$

where u is the utterance time. In our example with *read* above, the transitive template gave us a set of topic times, agents and themes; past tense would restrain the set of topic times to those preceding the utterance time.

2.5 Sample derivation

We are now ready to consider the derivation of a simple sentence like *John had left*. For expository purposes we will adopt Klein's semantics for the perfect, regarding it as an aspect which says that the event time precedes the topic time. This analysis is more or less like Reichenbach's classical account (Reichenbach, 1947), with the topic time in the role of Reichenbach's reference time. A past perfect, then, says that the event precedes a topic time which itself precedes the utterance time.

The analysis is in some respects too simple, since it does not take into account the interaction between perfect and other aspects (as in *John had been leaving*), but it is sufficient for the present purposes. As we will see in the next section, the perfect also provides particularly clear examples of how temporal adverbials can interact both with the topic time and the event time.

The semantic derivation is shown in figure 1 in the appendix. In the first step, *leave* combines with aspect, in this case PERFECT, to produce a set of pairs of events and temporal intervals such that the event precedes the temporal interval. Next, the intransitive template is applied, existentially quantifying over the event variable while leaving the topic time slot open and introducing an agent slot. Next, the agent and the past tense are applied. The result is a function from topic times to sentence meanings, and the declarative sentence-type feature turns this into a sentence-type meaning by existentially quantifying over the topic time.

3 Temporal adverbials and information structure

Consider now the same sentence augmented with a temporal adverbial: *John had left at ten*. Temporal adverbials like *at ten* are modifiers and on the most salient reading of this sentence it modifies the event time, i.e. it acts as an intersective modifier on sets: $\lambda P.\lambda a.P(a) \wedge at(ten, a)$. The variable a can range over all kinds of entities which can bear temporal relations, most obviously events and intervals. In this particular sentence, it restricts the set of events:

(8) $\lambda P.\lambda a.P(a) \wedge at(ten, a) : ((\uparrow_\sigma \text{ EV}) \multimap \uparrow_\sigma) \multimap ((\uparrow_\sigma \text{ EV}) \multimap \uparrow_\sigma)$

But in the sentence *At ten, John had (already) left*, the more natural reading is that *at ten* modifies the topic time, i.e. it gives the time *before which* John had left. Still, the *meaning* of the adverbial is the same: it still restricts a set of entities to those which are 'at ten' in some sense. It is just that it now combines with a set of topic times instead of a set of events, i.e. we have something like

(9) $\lambda P.\lambda a.P(a) \wedge at(ten, a) : ((\uparrow_\sigma \text{ TT}) \multimap \uparrow_\sigma) \multimap ((\uparrow_\sigma \text{ TT}) \multimap \uparrow_\sigma)$

On the meaning side, these are identical. But the glue side now tells us to apply the modifier to sets of topic times instead of sets of events.

How do we get from (8) to (9)? The key difference between the two sentences lies the scope of the adverbial, which in example (9) restricts not the run time of the event but rather the topic time, i.e. the "interval the sentence is about". In other words, we have exactly one of Chafe's "scene-setting expressions"(Chafe, 1976): "a spatial, temporal or individual framework within which the main predication holds". Such expressions have variously been called scene-setters, frame-setters and stage topics. I will adopt the latter term here. Their precise status within a complete theory of i-structure and their relation to "normal" ("aboutness") topics is beyond the scope of this paper. I will just assume that any adequate theory of i-structure will have to include a stage topic attribute: adverbials which are the value of this attribute are marked in several different ways in c-structure (e.g. by adjunction to IP in English) or prosodic structure (deaccentuation): for example, if *John* *had left at ten* is pronounced with stress on the nonfinite verb and corresponding destressing of the adverbial.

Crucially, then, information structure can change the meaning of a sentence by providing manager resources (Asudeh, 2004) which guide semantic composition without influencing meaning. In particular, when the i-structure marks temporal adverbials as stage topics, it will provide the following semantic resource:

(10) $\lambda P.P : (((\uparrow_\sigma \text{ EV}) \multimap \uparrow_\sigma) \multimap ((\uparrow_\sigma \text{ EV}) \multimap \uparrow_\sigma)) \multimap$
$(((\uparrow_\sigma \text{ TT}) \multimap \uparrow_\sigma) \multimap ((\uparrow_\sigma \text{ TT}) \multimap \uparrow_\sigma))$

Figure 2 in the appendix shows how the semantic derivation proceeds when the i-structure provides such a manager resource, which assures that the adverbial modifies the topic time and not the event.

The ability to modify either the event or the topic time is not limited to temporal adverbials. We find a similar phenomenon with participles:

(11) Jumping on a horse, grandma rode off to her dad's house.
$jump \prec ride$ (temporal adjunct, sequential events)

(12) Grandma rode off to her dad's house jumping on a horse.
$jump \supseteq ride$ (manner adjunct, overlapping events)

These examples show a complex interaction with the aspect of the participle, which seems to be perfective in (11) and imperfective in (12), but there is also a clear intuition that the first participle is a sentence-level temporal adjunct and the last one an event modifier. Similar effects are found in other languages, like Russian:

(13)

xlopnuv	*dver'ju,*	*on*	*vyšel*
slamming.PFV.GRD	door.ACC	he.NOM	went out.PFV.PST

He slammed the door and went out.
$slam \prec$ *go out*

(14)

on	*vyšel,*	*xlopnuv*	*dver'ju*
he.NOM	went out.PFV.PST	slamming.PFV.GRD	door.ACC

He went out slamming the door.
$slam \subseteq$ *go out*

Iconicity cannot be the whole story: while it could conceivably explain precedence it cannot explain inclusion. Nor does the lexical semantics of the verbs explain everything since it is possible to construct minimal pairs with the same verbs. This suggests that there is a semantic component to the effect and not just pragmatic inferencing of temporal relations. In particular, we will argue that fronted participles act as stage topics or frame-setters for the rest of the sentence.

A glue semantics implementation of Klein's theory of tense and aspect is well equipped to handle the generality of these phenomena, since it allows us to associate the event and the topic time with two different semantic structures $(\uparrow_\sigma \text{EV})$ and

($\uparrow_\sigma$ TT), to control the application of adjuncts to these via manager resources provided by the i-structure (itself presumably projected off c-structure and prosodic structure) and to assure the correct scope relations without relying on a one-to-one correspondence with linear order or c-structure.

The relationship between information structure and semantic composition is known from other areas of the grammar as well. For example, it is known that i-structure influences scope relations between quantifiers in argument position. Sæbø (1997) argues that focal object QPs cannot scope over topical subject QPs but a topical object QP can scope over a focal subject QPs as in:

(15) - How many candidates attended the meetings?

- $[\text{SEVERAL}]_F$ candidates attended $[\text{EVERY}]_T$ meeting.

In the approach of Sæbø (1997), topicality triggers quantifier raising, whereas in glue semantics it would be natural to have information structure provide a manager resource which ensures the correct scoping of the quantifiers.

4 Predicative participles in Ancient Greek

We are now ready to study Ancient Greek examples similar to examples (11)-(14) in more detail. Ancient Greek offers interesting data since it makes extensive use of predicative participles which have overt aspectual marking and interacts with information structure via word order which is generally very free. Also, a corpus of Hellenistic Greek with syntactic annotation is available, which is based on the well-studied and understood text of the New Testament.[2] Thus, while the sometimes intangible phenomena of information structure can be hard to capture in a dead language (and even a living one), its manifestation in temporal relations between events is in most cases easy to interpret.

4.1 Ancient Greek word order

Ancient Greek has a very free word order: all six permutations of major constituents are permissible and phrases can be discontinuous. These discontinuities are hard to capture in terms of syntactic movement since the "landing sites" would often be ill-defined sentence-internal positions. For the same reason, a purely discourse configurational approach fails (Welo, 2008), since it proves impossible to define precise c-structural positions that would assign discourse functions. Rather, c-structure seems to be governed by several i-structural constraints whose interplay is at present not fully understood. Despite the difficulties, it is commonly agreed (Dik (1995), Matić (2003), Welo (2008)) that backgrounded material, whether thematic or rhematic, tends to come after the finite verb, whereas foregrounded (i.e.

[2] `www.hf.uio.no/ifikk/proiel/corpus.html`. The corpus is under creation and was accessed on September, 2, 2008.

topical and focal) material precedes the verb. As we will see, this corresponds to a major divide in the distribution of participles.

4.2 The data

The corpus used in this article contains the New Testament in Ancient Greek as well as translations into Latin, Gothic and Old Church Slavic (eventually also Classical Armenian) marked up with morphological as well as syntactic annotation. The syntax is dependency based, and similar to LFG in its set of relations as well as in the use of secondary dependencies to capture structure sharing. The corpus makes it easy to retrieve all constructions of interest here, since all relevant participles bear an XADV-relation (corresponding to LFG's XADJ) to the main verb; the participles also have a secondary edge pointing to their subject. All words have linearization indices, which make it easy to retrieve their positions relative to other sentence constituents.

The Greek part of the corpus consists of 88400 lexical tokens and 10271 sentences. These sentences offer 2271 cases of predicative participles, showing how productive the construction is in Ancient Greek and offering a more than sufficient sample to study its function. Here are two examples from the corpus:

(16) *ekeinoi* *de* *exelthontes* *ekêruxan*
they.NOM.PL PTC going out.AP.N.PL preach.3.PL.AOR
They went out and preached.

(17) *husteron* *anakeimenois* *autois* *tois* *endeka*
later be at table.PP.DAT.PL they.DAT.PL ART.DAT.PL eleven
ephanerôthe
appear.3.SG.AOR.
Afterward, as they were at table, he appeared to the eleven.

These two examples behave rather as expected: the perfective participle denotes an event preceding that of the matrix verb, and the imperfective participle denotes a simultaneous event. Moreover, the perfective participle refers to a completed event: (16) clearly asserts that there was a complete event of going out, whereas in (17), it is not clear that the state of being at table is finished. As the narration proceeds to the next sentence, *and he told them that* . . . , the eleven are still at table, so to speak.

We might think that simultaneity with the main verb entails incompleteness, but this is not necessarily so. Consider the following example:

(18) *Petros* *êgeiren* *auton* *legôn*
Peter.NOM.SG wake up.AOR.3SG him.ACC.SG saying.PP.NOM.SG
'anastêthi'
stand up.IMPV
Peter woke him up (by) saying 'stand up'.

Here, the event of saying ‘stand up’ is clearly simultaneous with the waking up; the latter event seems to be an achievement without duration, so the saying-event probably includes it temporally. However, the event of saying ‘stand up’ is clearly completed: unlike in (17), the narration cannot go on to describe more things that Peter did while saying ‘stand up’. The saying-event is incomplete within the event time of *êgeiren*, but it is completed within the topic time of the whole sentence.

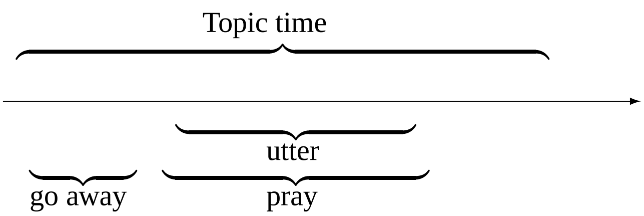
Perhaps even more striking is what can happen to perfective participles:

(19) *ti* *gar* *ofeleitai* *anthrôpos* *kerdêsas*
what for gain.3SG.PRS man.NOM.SG winning.AP.NOM.SG
ton kosmon holon
the whole world.ACC.SG
What does a man gain by winning the whole world?

In such examples, the perfective participle does not refer to an event preceding that of the main verb, but rather a *simultaneous* event, though one which is certainly completed, not only within the topic time of the sentence, but even within the event time of the main verb. The contrast is neatly brought out by the following example:

(20) *kai* *palin* *apelthôn* *prosêuxato* *ton auton logon*
and again going.away.AP.NOM.SG pray.3SG.AOR the same word.ACC
eipôn
saying.AP.NOM
He again went away and prayed saying the same words.

Although both *apelthôn* and *eipôn* are perfective participles, the first one refers to a preceding event and the second one to a simultaneous event so that we get the following temporal relations:[3]



(21)

Traditional grammar of Ancient Greek would in fact have us expect an imperfective participle for *eipôn* in (20), just like in (18). But this ignores that fact that in (18), the saying event *includes* the event of waking someone up, whereas in (20) it *is included* in the event of praying.

In other words, word order interacts with the temporal structure in subtle ways. A preliminary investigation of the examples shows that the most important factor is

[3]Assuming that the event of uttering the same words does not entirely coincide with the praying event, which could also include kneeling etc.

the position of the participle relative to its matrix verb: a perfective verb refers to a preceding event if it precedes the main verb, but to a simultaneous event if it comes after the main verb. Since by far the most common use of a perfective participle is to refer to a preceding event, this shows up in the distribution of aspectual stems:

(22)

	Before the verb	After the verb	Total
Perfective	1238	100	1338
Imperfective	203	647	850
Perfect	22	55	77
Future	1	5	6
Total	1464	807	2271

Thus, the traditional rule that aorist participles refer to preceding events is not completely off the mark, but it does not capture all the facts: exceptions are found among the 7.5% of perfective participles which occur post-verbally.

4.3 Syntax

Participles in Ancient Greek have two major functions, as noun modifiers and as secondary predicates, which is the function we concentrate on here: in LFG terms they are either ADJuncts of f-structures headed by nouns or XADJuncts of f-structures headed by verbs.[4]

As noun modifiers they normally form phrases with their nouns; as secondary predicates they appear to be sisters of their verbs. Though it is hard to demonstrate phrasehood in a language with such free word order as Greek, the difference shows up in statistics on their distribution:

(23)

	Average distance (words)	Standard deviation
ADJ ptcpl and noun	2.72	2.37
XADJ ptcpl and noun	4.06	4.19
XADJ ptcpl and verb	3.73	4.10

We see that attributive participles cluster around their nouns to a much higher degree than predicative ones. A further syntactic difference is that as adnominal modifiers, participles can attach to all kinds of nouns bearing all kinds of functions. As XADJs, however, they are more restricted in that the subject must bear an argument role in the matrix clause: overwhelmingly, this is the SUBJect of the matrix clause, but OBJects and OBLiques are also found:

(24) SUBJ (1019) $>$ OBJ (121) $>$ OBL (35)

[4]Theoretically, the participial adjuncts of nouns could also have functionally controlled subjects. On such an analysis we would have to alter the conditions on the ATR-PART and PRED-PART templates in (26).

Unfortunately, the design of the corpus does not make it possible to find the grammatical relations of pro-dropped controllers of the participle subject, a case which is very frequent.As subjects are pro-dropped more often than other arguments, it is likely that the subject relation is in reality even more dominant than these numbers suggest.

4.4 Semantic analysis

In this section we are going to analyse the meaning of example (20). Its f-structure is:

(25)
$$\left[\begin{array}{ll} \text{PRED} & \text{'pray}\langle\text{SUB}\rangle\text{'} \\ \text{SUB} & \left[\text{PRED} \quad \text{'pro'}\right] \\ \text{ASP} & \text{perfective} \\ \text{TENSE} & \text{past} \\ \text{XADJ} & \left\{ \begin{array}{l} \left[\begin{array}{ll} \text{PRED} & \text{'utter}\langle\text{SUB, OBJ}\rangle\text{'} \\ \text{SUB} & [\quad] \\ \text{OBJ} & \left[\begin{array}{ll}\text{PRED} & \text{"same word"} \\ \text{DEF} & + \end{array}\right] \\ \text{ASP} & \text{perfective}\end{array}\right] \\ \left[\begin{array}{ll} \text{PRED} & \text{'go away}\langle\text{SUB}\rangle\text{'} \\ \text{ASP} & \text{perfective} \\ \text{SUB} & [\quad] \end{array}\right] \end{array}\right\} \\ \text{STYPE} & \text{declarative}\end{array}\right]$$

As we saw in (21), the example means ‘He went away and prayed, uttering the same words’ - so the two participles clearly have different temporal relationships to the main verb. However, the f-structure does not contain information which distinguishes these. This is as it should be, I argue, since the there is nothing to prove that there is any difference is syntactic status between the two participles.

Intuitively, participles are rather similar to relative clauses, both in their syntax (the adnominal use corresponding to restrictive relative clauses and the predicative one to non-restrictive relative clauses) and also in their semantics. They are both event descriptions with one free argument slot to be filled (always the subject in the case of participles); bearing aspect (as well as tense in the case of relative clauses), they also need reference to a set of times. This is difficult to achieve in a traditional rule-to-rule approach to semantic compositionality; but on the glue approach we can have the participle access for example the event time of the main clause.

It is reasonable to assume that participles should start out denoting sets of events like all verbs; they then undergo modification in the normal way, aspect is applied and the result is inserted into a subcategorization template and combines with its arguments except the subject, which is unexpressed. The result is an expression of type $(\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{TT}) \multimap \uparrow_\sigma$, i.e. a function from subjects and topic times to truth values.

From this point attributive and predicative participles differ, depending on the construction they are inserted into. Exploiting the approach of Asudeh et al. (2008) we can model as constructional meaning, i.e. as template calls. The ability to enter into such constructions is part of what it takes to be a participle in Greek, so we will assume that is part of the lexical entry, i.e. :

(26) **eipôn**

CASE = NOMINATIVE

$\lambda e.utter(e) : (\uparrow_\sigma \text{EV}) \multimap \uparrow_\sigma$

@ TRANSITIVE

$(\text{ADJ} \in \uparrow) \rightarrow$@ATR-PART

$(\text{XADJ} \in \uparrow) \rightarrow$@PRED-PART

We will not go into the @ATR-PART-template here. The @PRED-PART will need to be:

(27) $((\text{XADJ} \in \uparrow)\{\text{SUBJ}|\text{OBJ}|\text{OBL}\}) = (\uparrow \text{SUBJ})$

$(\uparrow \text{SUBJ CASE}) = (\uparrow \text{CASE})$

$\lambda\langle y \times P\rangle.\langle y \times \lambda Q.\lambda t.(P(y))(t) \wedge (Q(t)\rangle$:

$((\uparrow \text{SUBJ})_\sigma \otimes ((\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{TT}) \multimap \uparrow_\sigma)) \multimap$

$(\uparrow \text{SUBJ})_\sigma \otimes (((\text{XADJ} \in \uparrow)_\sigma \text{EV}) \multimap (\text{XADJ} \in \uparrow)_\sigma) \multimap$

$(((\text{XADJ} \in \uparrow)_\sigma \text{EV}) \multimap (\text{XADJ} \in \uparrow)_\sigma)$

The meaning constructor part of @PRED-PART takes the conjunction of a participle construction without a subject and a subject as input. It returns a pair whose first member is a copy of the subject and the second member is a modifier of the matrix event. This modifier is obtained by applying the subject to the participle ($P(y)$) so that we get a function $\lambda t.R(t)$ (where $R = P(y)$): this defines a set which is made to intersect with the set of events defined by the matrix predicate.

The composition of a meaning for the main verb then proceeds in the same manner: aspect is applied and then a subcategorization template, leading to a glue term $(u \text{ SUBJ})_\sigma \otimes (p \text{ SUBJ})_\sigma \multimap (p \text{ TT}) \multimap p_\sigma$. But because of the structure sharing, $(u \text{ SUBJ})$ and $(p \text{ SUBJ})$ are just different names for the same f-structure which projects to a unique semantic structure. So we can apply the second conjunct on the first one, yielding the last stage of the derivation presented in figure 3.

At this point we have a set of topic times; if no other lexical elements of the sentence remained, existential closure would give us a sentence type meaning. But we still need to consider the meaning of the second participle, *apelthôn* 'going away'.

4.5 Information structure and predicative participles

I will argue that the key to understanding the semantics of *apelthôn* in this sentence is to see that it functions as a frame setter or a stage topic, i.e. it restricts the time interval that the sentence is about. How this is actually marked in the Ancient Greek sentence structure is an intricate question which cannot be fully answered here — and perhaps never, since we do not have access to the Ancient Greek prosody. But the correlation with position before or after the verb, as shown in table (22), is rather clear. It also corresponds to the widespread view that the finite verb marks the beginning of the background domain of the Greek sentence: topics and foci precede the verb, whereas other material follows it. This is a simplification, since topics can certainly be found in post-verbal position (just like in English when combined with deaccentuation), but it is sufficient for our purposes, where we focus on the semantic effects of this marking. These are so clear that they are easy to agree on, even when there is disagreement about how the actual marking happens.

The semantic derivation of a stage topic meaning for a participial XADJ is illustrated in figure 4. First, the normal meaning of a predicative participles is derived in the same way as in figure 3, yielding a pair consisting of a subject and a modifier of the matrix event. Then the meaning constructor of the stage-topic construction is applied to the second member of this pair, changing it into a modifier of the matrix clause topic time instead.

This modifier can apply to the calculated meaning of the matrix clause (the final line of figure 3), as illustrated at the top of figure 5. This yields a pair consisting of a subject and a function from topic times to sentence meanings. However, the derivation of the second member of the pair depends on a hypothetical subject (1 in figure 3); this hypothesis can now be discharged to create a dependency on a subject resource. Again, all the subjects are identical because of the structure sharing, so we can apply the dependency on $(u\ \text{SUBJ})_\sigma$ to $(g\ \text{SUBJ})_\sigma$. We then discharge the hypothesised subject from 2 in figure 4 and apply the real subject resource provided by the pro-dropped subject of the main verb. Finally, the declarative sentence operator existentially closes the topic time.

The semantics thus yields the temporal relations $g \subseteq t \wedge u \subseteq p \wedge p \subseteq t$ which are compatible with the relations we suggested in (21). On the other hand it is obvious that our semantics is underspecified, since it allows for numerous other configurations than the one in (21): g and p are only linked to the topic time and not to each other, although it is clear that in example (20) g precedes p.

However, it is not obvious that $g \prec p$ derives from the semantics of the construction with a predicative participle as stage topic. In our corpus we also find examples like the following:

(28)	*kai*	*pempsas*	*autous*	*eis*	*Bethleem*	*eipen*
	and	send.AP.NOM.SG	them.ACC.PL	to	Bethlehem	say.AOR.3SG

And he sent them to Bethlehem and said

Here, it is obviously not the case that he (Herodes) first sent them (the wise men) away and then spoke to them, so there is no precedence relation. If anything, it is rather the case that saying-event is part of the sending-event, which could have included other parts such as giving directions to Bethlehem etc.

In fact the ambiguity of the stage topic construction as we derive it here is reminiscent of the ambiguity of finite temporal clauses with underspecified subjunctions such as *when*. As observed by Kamp and Reyle (1993) this is compatible with numerous temporal relations:

(29) a. When they built the new bridge, they placed an enormous crane right in the middle of the river.

b. When they built the new bridge, a Finnish architect drew up the plans.

c. When they built the new bridge, the prime minister came for the official opening.

In both (28) and (29) it is therefore wise to leave the semantics of the construction underspecified. The temporal relations are instead inferred by pragmatic principles similar, although probably not identical, to the ones that operate between sequential main clauses. These rely heavily on the lexical semantics of the relevant verbs and should probably be dealt with within an SDRT framework (Asher and Lascarides, 2003).

But note that the truth-conditions which derive from the semantics cannot be overridden by pragmatic inferencing. The possibility of creating minimal pairs such as (11)-(14) show that particular constructions can lock the temporal relations. And the temporal relations can influence the inferred event relations, so that we get a manner adjunct reading of the participles in (12) and (14). In Ancient Greek, we are not able to construct such minimal pairs, but there is no reason believe they could not exist, since the distribution is otherwise so clear.

5 Conclusion

We have seen how Klein's time relational analysis of tense and aspect can be used within the glue semantics. The flexibility of this framework allows fine-tuned control over the access to the event and time variables.

To account for the semantic interpretation of adverbials and participial adjuncts, we let i-structure provide semantic resources. Typically such resources will only affect composition, and not the meaning itself. Again this is something which is easily modeled in glue semantics, with its separation of composition and meaning.

Having i-structure introduce semantic resources directly also has the advantage of abstracting away from the surface representation of i-structure features. Typically, strategies for expressing information structural categories are very complex, and different constructions, like fronting and prosodic deaccentuation, can sometimes express the same meaning, viz. topicality. To avoid having to postulate different semantic analyses of such constructions, we need to base our semantics on something more abstract than c-structure — and glue semantics provides an excellent way of doing so.

leave
$\lambda l.leave(l):$
$(l\ \text{EV}) \multimap l_\sigma$

PERFECT
$\lambda P.\lambda\langle e \times t\rangle.P(e) \wedge e \prec t:$
$((l\ \text{EV}) \multimap l_\sigma) \multimap (((l\ \text{EV}) \otimes (l\ \text{TT})) \multimap l_\sigma)$

$\lambda\langle l \times t\rangle.leave(l) \wedge l \prec t:$
$((l\ \text{EV}) \otimes (l\ \text{TT})) \multimap l_\sigma$

INTRANS
$\lambda R.\lambda x.\lambda t.\exists l.R(\langle l \times t\rangle) \wedge ag(l) = x:$
$(((l\ \text{EV}) \otimes (l\ \text{TT})) \multimap l_\sigma) \multimap ((l\ \text{SUBJ})_\sigma \multimap (l\ \text{TT}) \multimap l_\sigma)$

$\lambda x.\lambda t.\exists l.leave(l) \wedge l \prec t \wedge ag(l) = x:$
$(l\ \text{SUBJ})_\sigma \multimap (l\ \text{TT}) \multimap l_\sigma$

John
$j:$
$(l\ \text{SUBJ})_\sigma$

$\lambda t.\exists l.leave(l) \wedge l \prec t \wedge ag(l) = j:$
$(l\ \text{TT}) \multimap l_\sigma$

PAST
$\lambda P.\lambda t.P(t) \wedge t \prec u:$
$((l\ \text{TT}) \multimap l_\sigma) \multimap ((l\ \text{TT}) \multimap l_\sigma)$

$\lambda t.\exists l.leave(l) \wedge l \prec t \wedge t \prec u \wedge ag(l) = j:$
$(l\ \text{TT}) \multimap l_\sigma$

DECL
$\lambda P.\exists t.P(t)$
$((l\ \text{TT}) \multimap l_\sigma) \multimap l_\sigma$

$\exists t.\exists l.leave(l) \wedge l \prec t \wedge t \prec u \wedge ag(l) = j:$
l_σ

Figure 1: Semantic derivation of *John had left*

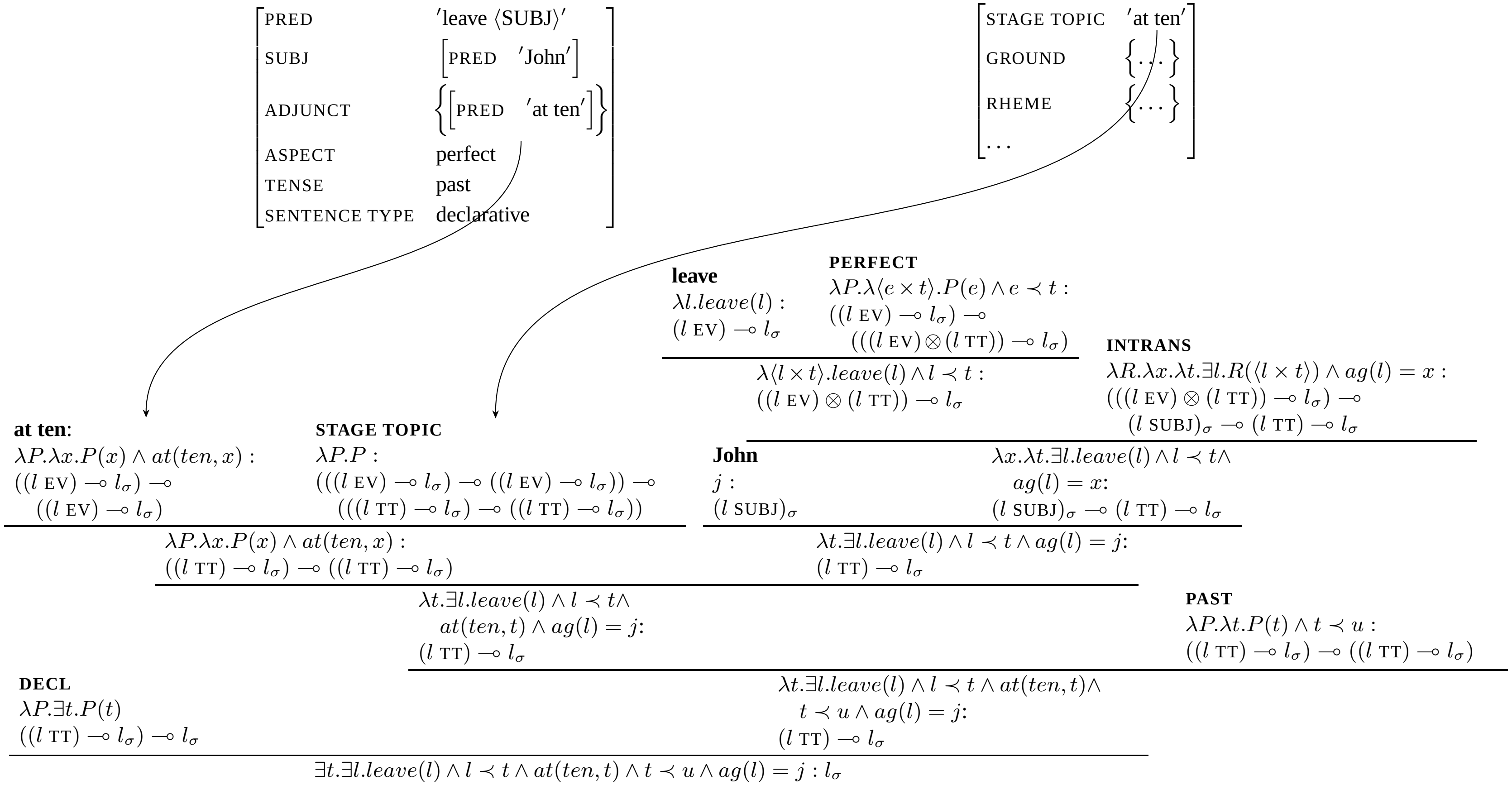


Figure 2: f-structure, abbreviated i-structure and semantic derivation of *At ten, John had left*

eipôn

$$\lambda u.utter(u) : (u\ \text{EV}) \multimap u_\sigma$$

PERFECTIVE

$$\lambda P.\lambda\langle e \times t\rangle.P(e) \wedge e \subseteq t : ((u\ \text{EV}) \multimap u_\sigma) \multimap (((u\ \text{EV}) \otimes (u\ \text{TT})) \multimap u_\sigma)$$

$$\lambda\langle u \times t\rangle.utter(u) \wedge u \subseteq t : ((u\ \text{EV}) \otimes (u\ \text{TT})) \multimap u_\sigma$$

TRANSITIVE

$$\lambda R.\lambda x.\lambda y.\lambda t.\exists e.R(\langle e \times t\rangle) \wedge theme(e) = x \wedge agent(e) = y : (((u\ \text{EV}) \otimes (u\ \text{TT})) \multimap u_\sigma) \multimap (u\ \text{OBJ})_\sigma \multimap (u\ \text{SUBJ})_\sigma \multimap (u\ \text{TT}) \multimap u_\sigma$$

$$\lambda x.\lambda y.\lambda t.\exists u.utter(u) \wedge u \subseteq t \wedge theme(u) = x \wedge agent(u) = y : (u\ \text{OBJ})_\sigma \multimap (u\ \text{SUBJ})_\sigma \multimap (u\ \text{TT}) \multimap u_\sigma$$

ton auton logon

$$w : (u\ \text{OBJ})_\sigma$$

$$\lambda y.\lambda t.\exists u.utter(u) \wedge u \subseteq t \wedge theme(u) = w \wedge agent(u) = y : (u\ \text{SUBJ})_\sigma \multimap (u\ \text{TT}) \multimap u_\sigma$$

$$[y_1 : (u\ \text{SUBJ})_\sigma]^1$$

$$\langle y_1 \times (\lambda y.\lambda t.\exists u.utter(u) \wedge u \subseteq t \wedge theme(u) = w \wedge agent(u) = y)\rangle : (u\ \text{SUBJ})_\sigma \otimes ((u\ \text{SUBJ})_\sigma \multimap (u\ \text{TT}) \multimap u_\sigma)$$

PRED-PART

$$\lambda\langle y \times P\rangle.\langle y \times (\lambda Q.\lambda t.P(y)(t) \wedge Q(t))\rangle : ((u\ \text{SUBJ})_\sigma \otimes ((u\ \text{SUBJ})_\sigma \multimap (u\ \text{TT}) \multimap u)) \multimap ((u\ \text{SUBJ})_\sigma \otimes ((p\ \text{EV}) \multimap p_\sigma) \multimap ((p\ \text{EV}) \multimap p_\sigma))$$

$$\langle y_1 \times \lambda Q.\lambda t.\exists u.utter(u) \wedge u \subseteq t \wedge theme(u) = w \wedge agent(u) = y_1 \wedge Q(t)\rangle : (u\ \text{SUBJ})_\sigma \otimes (((p\ \text{EV}) \multimap p_\sigma) \multimap ((p\ \text{EV}) \multimap p_\sigma))$$

proseuxato

$$\lambda p.pray(p) : (p\ \text{EV}) \multimap p_\sigma$$

$$\langle y_1 \times \lambda p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_1 \wedge pray(p)\rangle : (u\ \text{SUBJ})_\sigma \otimes ((p\ \text{EV}) \multimap p_\sigma)$$

PERFECTIVE

$$\lambda P.\lambda\langle e \times t\rangle.P(e) \wedge e \subseteq t : ((p\ \text{EV}) \multimap p_\sigma) \multimap (((p\ \text{EV}) \otimes (p\ \text{TT})) \multimap p_\sigma)$$

$$\langle y_1 \times \lambda\langle p \times t\rangle.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_1 \wedge pray(p) \wedge p \subseteq t\rangle : (u\ \text{SUBJ})_\sigma \otimes (((p\ \text{EV}) \otimes (p\ \text{TT})) \multimap p_\sigma)$$

INTRANSITIVE

$$\lambda R.\lambda x.\lambda t.\exists e.R(\langle e \times t\rangle) \wedge agent(e) = x : (((p\ \text{EV}) \otimes (p\ \text{TT})) \multimap p_\sigma) \multimap (p\ \text{SUBJ})_\sigma \multimap (p\ \text{TT}) \multimap p_\sigma$$

$$\langle y_1 \times \lambda y.\lambda t.\exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_1 \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = y\rangle : (u\ \text{SUBJ})_\sigma \otimes ((p\ \text{SUBJ})_\sigma \multimap (p\ \text{TT}) \multimap p_\sigma)$$

$$\lambda t.\exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_1 \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = y_1 : (p\ \text{TT}) \multimap p_\sigma$$

Figure 3: Partial semantic derivation of example (20)

apelthôn
$\lambda g.go\ away(g)$:
$(g\ \textsc{ev}) \multimap g_\sigma$

PERFECTIVE
$\lambda P.\lambda\langle e \times t\rangle.P(e) \wedge e \subseteq t$:
$((g\ \textsc{ev}) \multimap g_\sigma) \multimap$
$(((g\ \textsc{ev}) \otimes (g\ \textsc{tt})) \multimap g_\sigma)$

$\lambda\langle g \times t\rangle.go\ away(g) \wedge g \subseteq t$:
$((g\ \textsc{ev}) \otimes (g\ \textsc{tt})) \multimap g_\sigma$

INTRANSITIVE
$\lambda R.\lambda x.\lambda t.\exists e.R(\langle e \times t\rangle) \wedge agent(e) = x$:
$(((g\ \textsc{ev}) \otimes (g\ \textsc{tt})) \multimap g_\sigma) \multimap$
$(g\ \textsc{subj})_\sigma \multimap (g\ \textsc{tt}) \multimap g_\sigma$

$\lambda x.\lambda t.\exists g.go\ away(g) \wedge g \subseteq t \wedge agent(g) = x$:
$(g\ \textsc{subj})_\sigma \multimap (g\ \textsc{tt}) \multimap g_\sigma$

$[y_2 : (g\ \textsc{subj})_\sigma]^2$

$\langle y_2 \times \lambda x.\lambda t.\exists g.go\ away(g) \wedge g \subseteq t \wedge$
$agent(g) = x\rangle$:
$(g\ \textsc{subj})_\sigma \otimes ((g\ \textsc{subj})_\sigma \multimap (g\ \textsc{tt}) \multimap g_\sigma)$

PRED-PART
$\lambda\langle y \times P\rangle.\langle y \times (\lambda Q.\lambda t.P(y)(t) \wedge Q(t))\rangle$:
$((g\ \textsc{subj})_\sigma \otimes ((g\ \textsc{subj})_\sigma \multimap (g\ \textsc{tt}) \multimap g_\sigma)) \multimap$
$((g\ \textsc{subj})_\sigma \otimes (((p\ \textsc{ev}) \multimap p_\sigma) \multimap ((p\ \textsc{ev}) \multimap p_\sigma)))$

$\langle y_2 \times \lambda Q.\lambda t.\exists g.go\ away(g) \wedge g \subseteq t \wedge$
$agent(g) = y_2 \wedge Q(t)\rangle$:
$(g\ \textsc{subj})_\sigma \otimes (((p\ \textsc{ev}) \multimap p_\sigma) \multimap ((p\ \textsc{ev}) \multimap p_\sigma))$

STAGE-TOPIC
$\lambda P.P$:
$((p\ \textsc{ev}) \multimap p_\sigma) \multimap (p\ \textsc{ev}) \multimap p_\sigma) \multimap$
$(((p\ \textsc{tt}) \multimap p_\sigma) \multimap ((p\ \textsc{tt}) \multimap p_\sigma))$

$\langle y_2 \times \lambda Q.\lambda t.\exists g.go\ away(g) \wedge g \subseteq t \wedge$
$agent(g) = y_2 \wedge Q(t)\rangle$:
$(g\ \textsc{subj})_\sigma \otimes (((p\ \textsc{tt}) \multimap p_\sigma) \multimap ((p\ \textsc{tt}) \multimap p_\sigma))$

Figure 4: Semantic derivation of stage topic participle apelthôn in example (20)

$$\lambda t.\exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_1 \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = y_1 : (p\ \text{TT}) \multimap p_\sigma$$

$$\langle y_2 \times \lambda Q.\lambda t.\exists g.go\,away(g) \wedge g \subseteq t \wedge agent(g) = y_2 \wedge Q(t)\rangle : (g\ \text{SUBJ})_\sigma \otimes (((p\ \text{TT}) \multimap p_\sigma) \multimap ((p\ \text{TT}) \multimap p_\sigma))$$

$$\langle y_2 \times \lambda t.\exists g.go\,away(g) \wedge g \subseteq t \wedge agent(g) = y_2 \wedge \exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_1 \wedge pray(p) \wedge (p) \wedge p \subseteq t \wedge agent(p) = y_1\rangle : (g\ \text{SUBJ})_\sigma \otimes (((p\ \text{TT}) \multimap p_\sigma))$$

(1)

$$\langle y_2 \times \lambda x.\lambda t.\exists.ggo\,away(g) \wedge g \subseteq t \wedge agent(g) = y_2 \wedge \exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = x \wedge pray(p) \wedge (p) \wedge p \subseteq t \wedge agent(p) = x\rangle : (g\ \text{SUBJ})_\sigma \otimes ((u\ \text{SUBJ})_\sigma \multimap ((p\ \text{TT}) \multimap p_\sigma))$$

$$\lambda t.\exists g.go\,away(g) \wedge g \subseteq t \wedge agent(g) = y_2 \wedge \exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = y_2 \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = y_2 : ((p\ \text{TT}) \multimap p_\sigma)$$

(2)

$$\lambda x.\lambda t.\exists g.go\,away(g) \wedge g \subseteq t \wedge agent(g) = x \wedge \exists p.\exists u.utter(u) \wedge u \subseteq p \wedge p \wedge theme(u) = w \wedge agent(u) = x \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = x : (g\ \text{SUBJ})_\sigma \multimap ((p\ \text{TT}) \multimap p_\sigma)$$

pro: $(p\ \text{SUBJ}) : j$

$$\lambda t.\exists g.go\,away(g) \wedge g \subseteq t \wedge agent(g) = j \wedge \exists p.\exists u.utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = j \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = j : (p\ \text{TT})_\sigma \multimap p_\sigma$$

DECL $\lambda P.\exists t.P(t)$ $((l\ \text{TT}) \multimap l_\sigma) \multimap l_\sigma$

$$\exists t.\exists g.\exists p.\exists u.go\,away(g) \wedge g \subseteq t \wedge agent(g) = j \wedge utter(u) \wedge u \subseteq p \wedge theme(u) = w \wedge agent(u) = j \wedge pray(p) \wedge p \subseteq t \wedge agent(p) = j : p_\sigma$$

Figure 5: Combining stage topic and main predication in the semantic derivation of in example (20)

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