

Tense

- Grammaticalization of Locating Events in Time
- Reichenbach: speech time, event time, reference time
- reference time supplied by context
- *'when my hat blew off, I was quite unhappy'*

- example: past tense ('I lost my hat')



- example present perfect ('I've lost my hat')



Pathways to the future (Bybee, Perkins, Pagliuca)

- Most frequent lexical sources of futures are movement verbs, e.g. 'come (to)', 'go(to)', 'approach'.
- Many languages from Danish to Inuit to Tok Pisin have a future that begins with desire.

(1) ju laik kilim pig.
you want kill pig
'you want to kill a pig'

(2) em i laik wokabaut
he is about-to walk

- DESIRE>WILLINGNESS>INTENTION>PREDICTION
- Inference of Agent's desire/intention leads over time to a predictive usage.

Inuit

(3) quitinniarpunga
dance-try-1.s:IND(INTR)
'I tried to dance'

(4) atuarniarpara
read-try-1s.SBJ-3s.OBJ.IND
'I'm going to read it'

(5) siallirniarpuq
rain-try-S.S.IND(INTR)
'It's going to rain'

- Note that (5) has a non-human (i.e. non-intention forming subject)
- ATTEMPT > INTENTION > FUTURE

Directed motion pathways

The temporal meaning that comes to dominate the semantics of ['be going to V'] is already present as an inference from the spatial meaning. When one moves along a path toward a goal in space, one also moves in time. The major change that takes place is the loss of spatial meaning. Here again the function of expressing intention comes into play. When a speaker announces that s/he is going somewhere to do something, s/he is also announcing the intention to do that thing. Thus intention is part of the meaning from the beginning, and the only change necessary is the generalization to contexts in which an intention is expressed, but the subject is not moving spatially to fulfill that intention.

Acquisition data

- Gerhardt (1985) study of English-speaking children from 3;2 to 4;2 evidences the modal/obligation pathway to the future (and contrasts with *gonna*).
- During play, instances of *will* occurred overwhelmingly (94 percent) in utterances designed to effect interpersonal co-ordination
- e.g. 'If you want I'll help you', 'Will you give this to me?'

Acquisition data

- In contrast, 'gonna' occurred 'most often as a pronunciation of upcoming plans with only a minimal interpersonal dimension.' 'I'm gonna leave now'.
- Only half of 'gonna' utterances carried out, but 90 percent for 'will': truth conditions!
- Further study by O'Neill and Atance(2000) – Children's use of other modals (*maybe, probably, might, etc.*) used first in connection with future *intentions* and only later to express uncertainty about future events.

Data on the future tense

- (6) a. The sun rises at 5.50 a.m.
b. ?The sun will rise at 5.50 a.m.
- (7) a. *It rains tomorrow.
b. It will rain tomorrow.
- (8) a. John flies to Chicago tomorrow.
b. John is flying to Chicago tomorrow.
c. John will fly to Chicago tomorrow.

- (9) a. *I go to Chicago unless my boss forbids me
b. (Google) I am going unless some unknown demand stops me.
c. (Google) I will go unless there is severe or dangerous weather.

- (10) a. *I fly to Chicago if my boss asks me.
b. ?*I am going if you go.
c. I am going if my health allows me/if I am able.
d. (Google) Barak said to Deborah, "I will go if you go with me. I will not go if you don't go with me."

- (11) a. I will/am going to fly to Chicago.
b. I was going to fly to Chicago, but my boss forbade me.

- (12) a. Bill will throw himself off the cliff.
b. Bill is going to throw himself off the cliff.

(13) a. Pieper was going to be Chief Executive Officer of Philips in 2 years time.

b. (From Google) Tony Blair in 1997: 'I am going to be a lot more radical in government than people think'.

(14) If/When you go out/*will go out in the rain, you will get wet.

(15) a. *If it'll rain, you should take your umbrella.

b. If it's going to rain, you should take your umbrella.

(16) a. *Harry moves to Philadelphia.

b. Next Tuesday, Harry moves to Philadelphia.

Tense (more formally)

- First stab with Present Perfect ($R=S$), ($E < R,S$)
(17) I have caught the flu.
- The event of infection lies in the past, but the temporal viewpoint (R) is identical to the utterance time.
- So set the scenario to be only
(18) *Initiates*(e,f,t)
- Set S to a constant *now* (interpreted on the reals) and then add to the scenario to get at the Present Perfect meaning
(19) *HoldsAt*(f,now)

By completion we want to derive the 'catching the flu' event
i.e. for some $t < now$, *Happens*(e,t)

- Then, by completing the axioms of EC plus Scenario [(18) and (19)] one would want

$$(20) \text{ Happens}(e,t) \wedge \text{Initiates}(e,f,t) \wedge t < t' \wedge \neg \text{Clipped}(t,f,t') \\ \leftrightarrow \text{HoldsAt}(f,t')$$

- (20) along with (19) gives us the desired result.
- Alas! The actual completion gives us instead:

$$(21) [\text{Happens}(e,t) \wedge \text{Initiates}(e,f,t) \wedge t < t' \wedge \neg \text{Clipped}(t,f,t')] \\ \vee [\text{now}=t'] \leftrightarrow \text{HoldsAt}(f,t')$$

- Unfortunately, nothing can be derived from (21).
- Therefore, we need another way to compute tense.
- Note, it is also (cognitively) desirable to keep general lexical information (i.e. *sense* of a VP) separate from tense contributions (declarative memory vs. working memory).

Integrity constraints

- An *integrity constraint* in a database expresses obligations and prohibitions that states must satisfy if they fulfil a certain condition.
- In a family relationship database there may be an obligation that everyone has a genetic father and prohibition that no one is both father and mother.
- Every time the database is updated the constraints must be checked.
- In EC, the integrity constraint is used to request an update (e.g. an update that a particular action has indeed been performed)

Integrity constraints

- The ‘obligation’ to carry an umbrella while it is raining could be formalized by the following constraint:

$$(22) \textit{ HoldsAt}(\textit{rain}, t) \rightarrow \textit{ HoldsAt}(\textit{carry-umbrella}, t + \epsilon)$$

- But, this cannot be an ordinary program clause, as the addition of $\textit{ HoldsAt}(\textit{rain}, t)$ would trigger the consequence $\textit{ HoldsAt}(\textit{carry-umbrella}, t + \epsilon)$ (even if there is no umbrella!).
- Moreover (22) does not capture the meaning of an obligation (defeasability)
- Instead, think of the integrity constraint for an obligation as viewing the consequent as a constraint that the database must satisfy if the antecedent holds.
- Similarly, a constraint expressing a prohibition should be taken to mean: if the antecedent holds then the database should not satisfy the consequent.

Integrity constraints

- Generally, then, the database needs to be *updated* with a true statement about the world.
- For example, we can use the action *take-umbrella* and add the following clause to the database:

(23) *Initiates(take-umbrella, carry-umbrella, t)*

- Now, suppose the database is updated with *HoldsAt(rain, now)*
- The integrity constraint then requires us to look for ways to satisfy the statement:

(*) *HoldsAt(carry-umbrella, now + ϵ)*

- there are many ways of doing this, but the *minimal* way to do this is to use the database itself and start a backwards search for updates leading to the satisfaction of (*)

Integrity constraints

- By an instance of Axiom 5 ($Happens(e,t) \wedge Initiates(e,f,t) \wedge t < t' \wedge \neg Clipped(t,f,t') \rightarrow HoldsAt(f,t')$) (*) reduces to:
- $?Happens(take-umbrella,now), \quad \neg Clipped(now,carry-umbrella,now+\epsilon)$
- This has the pleasant property that we need only add the following clause (taken honestly from the world)
- $Happens(take-umbrella, now)$ as the above then reduces to
- $\neg Clipped(now,carry-umbrella,now+\epsilon)$
- which succeeds by applying closed world reasoning, i.e. the completion, to *Clipped*
- The subject now (+ ϵ) is fulfilling their umbrella-carrying obligation.

Integrity constraints: general procedure

- Start a backwards search with the consequent of the integrity constraint as the top formula (e.g. *HoldsAt(carry-umbrella, now+ ϵ)*)
- Apply database clauses for as long as possible.
- This will normally end with a formula to which no further database clauses can be applied (e.g. *Happens(take-umbrella, now)*)
- Use that formula to suggest a database addition.
- This has the effect of making the minimal update to ensure the top query's success.

Application to Present Perfect: 'I have caught the flu.'

- can be represented in the scenario as
- $Initiates(get-flu, have-flu, t)$
- Instead of adding tense information to the scenario as before, try to resolve the query
- $?HoldsAt(have-flu, R), R=now$
- By Axiom 5, this resolves down to asking for the additional input of $Happens(get-flu, t) \wedge t < R$
- This is the computational meaning of the (present) perfect
- more generally the Reference time is an integrity constraint $?HoldsAt(f, R), \dots, HoldsAt(f_n, R)$ with the contribution of the perfect being added to the context.

So Far...And

- Scenario contributes lexical information, which is general and does not talk about specific times.
- So, one must add temporal information to construct a sentence out of the lexical material
- As seen earlier, one cannot simply add a reference time to the scenario.
- Instead, reference time is formulated as an integrity constraint in terms of *fluents*, which constrain the possible temporal locations of *event types*.

Back to the Future

- Recall (voluminous) data to the effect that there are 4 types of 'future' tenses for English all manifesting subtly different properties regarding plans, goals and expectations.
- Syntactic present tense (used for future time reference) applies to events *per se* abstracting away from planning or epistemic attitudes. Used for scheduled events with specific temporal reference of some sort required (comparable with English simple past tense).

(24) a. *Harry Moves to Philadelphia. b. Harry moves to Philadelphia soon.

- Formally we can represent this by an integrity constraint that ensures that both the event should happen and that it does not happen prior to now.

Definition:

For all Aktionsarten except states, the future use of the syntactic present tense is represented by an integrity constraint of the form: if $\exists t \text{Happens}(e,t)$, then the query $(? \text{Happens}(e,R), R \leq \text{now})$ must fail.

Here e is either derived from an activity or an accomplishment by hierarchical planning, or the canonical event of achievement or point.

If the fluent f represents a state, the future use of the present tense is defined by the integrity constraint that the query $(? \text{HoldsAt}(f,R), R \geq \text{now})$ must succeed.

Be going to V

- Ties in nicely with both the planning formalism of the EC (via 'intention') as well as the spatial origins of the EC (path planning for robots).
- Unlike *will*, allows obstacles (i.e. prematurely terminating events) to be taken into account.
- (25) a. Bill will throw himself off the cliff.
b. Bill is gonna throw himself off the cliff.
c. I was going to fly to Chicago, but my boss forbade me.
- Since there is sense of intentional movement toward a goal, we use the *Trajectory* predicate.

Definition(*be going to V*): The future use of *be going to V* can apply either to a fluent f (if V is a state) or an event e (all other cases):

Consider the case where V is an event e (e.g. 'fly to Chicago'); then *be going to V* requires the presence of a plan, comprising

- a fluent f_1 representing the preparatory activity
- a parameterized fluent $f_2(x)$ representing the result of that activity
- a certain stage $f_2(c)$ of $f_2(x)$ which triggers e via a formula $HoldsAt(f_1, t) \wedge HoldsAt(f_2(c), t) \rightarrow Happens(e, t),$
- the fluents $f_1, f_2(x)$ are linked by a dynamics of the form $HoldsAt(f_2, t) \rightarrow Trajectory(f_1, t, f_2, d)$
- the reference point is given by the integrity constraint $?HoldsAt(f_1, now)$ (or possibly by the antecedent of a conditional)

Definition (cont')

In order to apply be going to V to a stative verb (e.g. 'be CEO') represented by a fluent f, we need an event e, such that f is consequent upon e, and e can be seen as the culmination point of a preparatory f_1 as above. This forces an inchoative reading of be going to V as applied to states.

In both cases, the scenario to which the above statements are added should not imply that f_1 is terminated before e happens. This does not preclude the possibility that terminating events are introduced after these statements are added.

Meaning extensions

- Though historically the *be going to V* construction evolved out of intentions and planning towards a goal, it is semantically 'bleached' enough to ignore these constraints. Similarly, the EC modelling is not confined to actual, human plans.

- (26) a. If the universe is going to contract, then 98 percent of the universe must not be visible.
- b. At this rate of development, then Paris is going to look like London, and London like New York.
- c. The tank is going to overflow from the rain.

- (26) (c) can be described by the normal EC physical dynamics.
- (26) (b) as a physicists model of physics (also allowing for a terminating event)
- (26) (a) is an observers take on *increasing* development activity that will (if unterminated) lead to an event e that triggers a *looking like london* fluent, etc.
- Nevertheless, in all these uses of *be going to V* is a common formal structure, which is a goal-plan structure in the case of animate agents forming intentions.
- Finally note that like the progressive (to be done next week), e will happen in minimal models, and like the present progressive, this will occur in the future.

Will

- *Will* shares with *be going to V* planning and intentional aspects.
- Unlike *be going to* unforeseen obstacles may not arise
 - (27) a. I will fly to London tomorrow
 - b. I am going to fly to London tomorrow.
- (27)-a is false if I do not fly to London, but (27)-b is true in virtue of a plan to fly to London.
- Nevertheless, *will* is compatible with foreseen preconditions.
 - (28) a. I will go unless there is severe or dangerous weather.
 - b. I'll go if you go.

Definition (*will*) The semantic contribution of *will* is defined as that for *be going to* except that the following integrity constraint is added: for any e , if $\exists t \text{Happens}(e,t)$, the the query $? \text{Terminates}(e, f_1, t)$ must fail, where f_1 is the fluent representing preparatory activity as in Definition for *be going to*.

- Plans still play a role, but the additional constraint captures the ‘non-default’ flavour of *will*
- As plans take time to execute, the event triggered is located after *now*
- stative precondition in (28) (a) can be represented by a fluent (for bad weather) and conjoined with the normal preparatory fluent. Thus the dynamics only work if the precondition holds.

Futurate Progressive

- Also can be seen from a planning perspective.
- Differs from *be going to* in that reference time must be *now*

(29) a. ?I'm going if you go.

b. If it's going to rain that night, then make sure your tent is made waterproof.

- Differs from *will* in that the plan needn't achieve the goal but the sentence may still be true.
- Shares many of the same conditions as the 'ordinary' progressive, except that the progressive now applies to a preparatory activity rather than the main activity. This can be seen as a form of coercion.

Definition (*futurate prog.*): The futurate progressive requires the presence of an activity fluent f_1 , and a parameterized fluent $f_2(x)$ which are linked by a dynamics of the form

$$\text{HoldsAt}(f_2, t) \rightarrow \text{Trajectory}(f_1, t, f_2, d),$$

and a condition for the occurrence of the culminating event e of the form

$$\text{HoldsAt}(f_1, t) \wedge \text{HoldsAt}(f_2(c), t) \rightarrow \text{Happens}(e, t)$$

where c is some constant. The event e triggers an activity fluent f_3 via a condition of the form $\text{Initiates}(e, f_3, t)$.

The reference point is given by the integrity constraint the the query

$$? \text{HoldsAt}(f_1, \text{now})$$

must succeed.

The scenario to which the above statements are added should not imply that f_1 is terminated before e happens

Finally

- (30) a. Tomorrow, I am flying to Chicago, unless my boss forbids me.
b. ??Tomorrow, I am flying to Chicago, if my boss allows me.
c. Tomorrow, I am flying to Chicago if my health allows me.

Since in all cases $R=now$ (as required) what is wrong with (30) (b)?

If we assume that preparation does not start without permission, then the constraint $?HoldsAt(preparation, now)$ will not succeed (as this requires the preparations to have already started).