Attention to facts: counterfactuals, the progressive, and *'before'*

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Goals of this talk:

- Take a close look at the relationship between non-veridical (esp. "counterfactual") uses of *'before'*-sentences, the progressive and counterfactual conditionals
- Characterize and compare the notions of "likelihood" involved in the interpretation of non-veridical *'before'*-sentences and counterfactuals
- Connect the interpretation of the progressive to the interpretation of (non-veridical) *before*

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1 *'Before'*

Topics for this talk:
- The interpretation of *'[before B]'* in *'[A [before B]]'*, where *'B'* is a clause.
- The *modal* dimension of the meaning of *'A before B'* and its relation to the counterfactual *'If had been ¬A, would have been B'*

Not in this talk:
- *'Before'* as a preposition with a DP complement.
- The fine details of its *temporal* semantics. See Beaver and Condoravdi (2003) and references therein.

1.1 Entailments of *'before'*- and *'after'*-sentences

The clausal complement of *'before'* is not entailed by the whole sentence. In contrast, the complement of *'after'* is entailed. The matrix clause is always entailed:

(1) a. *'A before B'* ⇒ *B* *'A before B'* ⇒ *A*
b. *'B after A'* ⇒ *B* *'B after A'* ⇒ *A*

***'A before B'* entails *A* but not *B*[1]**

(2) I left the party before I got sick.
a. ⇒I left the party.
b. ⇏I got sick.

(3) Mozart died before he finished the Requiem.
a. ⇒Mozart died.
b. ⇏Mozart finished the Requiem.

'B after A'* entails both *A* and *B

(4) I got sick after I left the party.
a. ⇒I got sick.
b. ⇒I left the party.

(5) Mozart finished the Requiem after he died.
a. ⇒Mozart finished the Requiem.
b. ⇒Mozart died.

Asymmetry between *'before'*- and *'after'*-sentences: *'A before B'* does not entail *'B after A'*, whereas *'B after A'* entails *'A before B'*.[2]

(6) a. *'A before B'* ⇏ *'B after A'*
b. *'B after A'* ⇒ *'A before B'*

'A before B'* does not entail *'B after A'

(7) I left the party before I got sick.
⇏ I got sick after I left the party.

(8) Mozart died before he finished the Requiem.
⇏ Mozart finished the Requiem after he died.

'B after A'* entails *'A before B'

(9) I got sick after I left the party.
⇒ I left the party before I got sick.

(10) Mozart finished the Requiem after he died.
⇒ Mozart died before he finished the Requiem.

[1] What is entailed is of course not merely the truth of the matrix clause, but its truth at a time whose location is restricted by the temporal clause.

[2] The difference in veridicality is one of several well-documented asymmetries between *'before'* and *'after'* (Anscombe, 1964; Heinämäki, 1972, 1974; Valencia et al., 1992; Ogihara, 1995, among others). Beaver and Condoravdi (2003) argue that while these asymmetries hold between sentences involving *'before'* and *'after'*, the two lexical items themselves are nevertheless *converses*.

➽ The truth of *B* (jointly with *A*) is not necessary for the truth of *'A before B'*.
BUT nor is the falsehood of *B* (jointly with the truth of *A*) sufficient for the truth of *'A before B'*, even when the temporal relationship is right:

(11) $A, \neg B \not\Rightarrow$ *'A before B'*

Beaver and Condoravdi (2003):

(12) David never won a gold metal at anything, but he once ate lots of ketchup.
⇏ David ate lots of ketchup before he won all the gold medals in the Sydney Olympics.

➽ Under what circumstances is *'A before B'* true when *B* is false?

1.2 (Non-)veridical uses of *'before'* and their modal implications

'A before B' has three possible interpretations depending on the *context*: *veridical*, *non-committal*, and *counterfactual* (Heinämäki, 1972; Ogihara, 1995; Beaver and Condoravdi, 2003).

Veridical: *B* is implied to be true.

'A before B' has no relevant modal implications.

(13) The police evacuated the airport before the bomb exploded.
⇝ *The bomb exploded.*

Non-committal: *B* is neither implied to be true nor implied to be false.

➽ *B* may be false, but if it is, it was at least *reasonably probable* (Beaver and Condoravdi, 2003).

(14) Having seen several suspicious pieces of luggage, I left the the airport before any of them exploded.
⇝ *An explosion seemed likely and may or may not have occurred.*

(15) I left Trafalgar Square about half an hour ago and it started to look scary. The happy crowd that had made its way towards the square for some reason got cut off by the police and the Trade Union Congress march was prevented from getting in for their planned meeting. I gather that McDonalds has been trashed. Tourists seemed to be mingling curiously with the demonstrators in the square, but there was no violence at that time. Yet the police seem to be blocking off all the exits. I decided to leave before there was any trouble. [Google]
⇝ *Trouble looked likely before I left and may or may not have come about.*

Counterfactual: *B* is implied to be false.

➽ *B* was reasonably probable (Beaver and Condoravdi, 2003).

(16) The police defused the bomb before it exploded. And a good thing too, because they saved the lives of a trainful of commuters.
⇝ *There was no explosion.*

➽ The modal implications we are interested in are most clearly observable in contexts which give rise to the "counterfactual" reading of *'before'*.

Analysis of non-veridical readings

In the analysis of Beaver and Condoravdi (2003), the time contributed by the temporal clause is specified in terms of an *earliest* operator applied to the denotation of the temporal clause. When *earliest* is undefined at the world *w* of evaluation, it is relativized to a set of alternative worlds:

- Trace *w* back to the reference time t_A of *'A'* (when *'not A'* was still possible)
- Look at those courses of events that were *reasonably probable* at w, t_A
- Check whether *'B'* is consistent with those courses of events
- If consistent, then *earliest* is defined at *w*
(as the earliest occurrence of *'B'* among the courses of events that were reasonably probable at w, t_A)

(Non-)veridical implications as contextual entailments

- The definedness of *earliest* is not a pragmatic presupposition
(i.e., need not be satisfied at all worlds in the context set in order for the interpretation to succeed).
- *Point-wise* evaluation at worlds in the context set: those where *earliest* is undefined are discarded
(i.e., where *B* did not happen and was unlikely at the relevant time).

➽ *'before/after'*-clauses can be informative.

- Only those worlds survive the update at which *B* either happened or was *reasonably probable*.
Note that if *B* happened, it need not have been likely!
- For consistent update, it is sufficient that there be *some* such worlds in the context set.

➽ Veridical and non-veridical readings are *contextual entailments*
(i.e., they result from updating particular types of context with a *'before/after'* sentence).

Most important for our purposes:

- "For the counterfactual reading, the input context has to entail that A's occurrence makes B's later occurrence impossible and that prior to A's occurrence there was a process that made B's occurrence at least reasonably probable." (Beaver & Condoravdi 2003:51)
- Facts at times later than the reference time of *'A'* are given up in the process of "rerunning history."
- An intuitively plausible and often observed parallelism links the truth of "counterfactual" *'A before B'* with that of the corresponding counterfactual conditional *'If had not been A, would have been B'*.

(17) a. The police defused the bomb before it exploded.
b. If the police had not defused the bomb, it would have exploded.

Questions:

- What does "reasonably probable" mean?
- What is the relationship between (17a) and (17b)?
- Are posterior facts (later than the reference time of *A*) ignored in both?

2 Counterfactual conditionals

A first hypothesis based on the preceding section:

- Counterfactual *'A before B'* and the counterfactual conditional *'not-A □→ B'* go hand in hand.
  I.e., whatever makes one true (false) also makes the other true (false).
- Likelihood at the relevant past time is crucially involved in both.

2.1 *'Before'*-sentences and counterfactuals

Problem for the first hypothesis: While *'A before B'* on its counterfactual reading implies that *B* was/is likely, counterfactual conditionals *do not* generally imply this.

(18) *'A before B' ⇝ 'If had been ¬A, would have been B'*

(19) *'A', 'If had been ¬A, would have later been B' ↛ 'A before B'*

Scenario 1
You are on the bus from San Francisco to Los Angeles. You get off at Santa Barbara; the bus travels on. The next day you hear that the bus had an accident and everyone on board was injured or killed. Consider now the following sentences:

(20) If I hadn't gotten off the bus, I would have been injured. *[true]*

(21) I got off the bus before I got injured. *[infelicitous/false]*[3]

- Intuitively, (21) is false because the accident *was not foreseeable* at the time I got off – i.e., likelihood.
- But (20) is true even though the accident was unlikely!

Main difference: The truth of the counterfactual depends on "posterior" developments (i.e., ones after the reference time of *'A'* whereas the *'before'*-sentence does not.

2.2 Posterior counterfactuals and prior indicatives

The difference between counterfactuals and *'before'*-sentences is reminiscent of their relation to their indicative counterparts. Counterfactuals are not generally associated with likelihood, whereas indicatives are.

Pro equivalence

(22a) is false (unlikely) *now* because (22b) *was* false (unlikely) *then*.

(22) a. If Oswald had not killed Kennedy, someone else would have. *[now]*
b. If Oswald does not kill Kennedy, someone else will. *[Nov 22, 1963]*

Examples like (22a,b) have led many authors to the believe that counterfactuals are basically past-tense indicatives.

[3] In the analysis of Beaver and Condoravdi (2003) (21) would be undefined at individual worlds and false with respect to the given context, leading to an inconsistent update.

Contra equivalence

In the above scenario, (23a) is true, but (23b) is false.

(23) a. If I hadn't gotten off the bus, I would have been injured. *[is true now]*
b. If I don't get off the bus, I will get injured. *[was false then]*

Scenario 2
I was on my way to the airport this morning when my car broke down.[4] *Now I am back home, upset because I believe:*

(24) If I had not missed my plane, I would be on my way to Vancouver now.

The next morning, however, it turns out that the plane crashed and everyone on board was killed. So I was lucky, for

(25) If I had not missed my plane, I would be dead now.

Q: But maybe what matters is that the plane crash was likely, not from the speaker's subjective perspective, but somehow "objectively," i.e., with respect to facts that held at the time unbeknownst to the speaker?

A: Not likely. Very similar effects are observed with posterior facts that happen purely by chance, and therefore *cannot* have been predictable. Here's another example from the philosophical literature on the counterfactuals:

Scenario 3
Time 1: A fair coin is about to be tossed, and you are asked to make a bet. Since the coin is fair, (26) is false.[5]

(26) If I bet on tails, I will lose. *[was false then]*

Time 2: You bet on heads. The coin is tossed and comes up heads. You win. Now (27) is true:

(27) If I had bet on tails, I would have lost. *[is true now]*

The counterfactual (27) is now true. But there was no earlier time at which the indicative (26) was true.

Examples like these suggest that the *'before'*-sentence is more closely related to the past indicative than to the present counterfactual.

- *'A before B'*:
  B was predictable/likely at the time of *A*;
  'If not-A then B' was true at the time.
- *'If had been not-A, would have been B'*:
  B may have been very unlikely at the time of *A*;
  Does not imply that *'if not-A then B'* was true at the time.

[4] This scenario is due to Edgington (2003))
[5] This example was attributed to Sidney Morgenbesser by Slote (1978) and was also discussed by Bennett (1984, 2003); Edgington (1995); Barker (1998); Kaufmann (2005) and others.

2.3 Consequences for the analysis of counterfactuals: Holding on to the facts

Naïve strategy

To evaluate a counterfactual *'If had been A, would have been B'*, where *'A'* is false and the reference time of *'A'* precedes that of *'B'*.[6]

- Hypothetically "rerun history" from a past time at which *'A'* was still a "live possibility"
- Restrict this hypothetical exploration to those courses of events in which *'A'* does occur.
- The counterfactual is true iff all of those courses of events lead to *'B'*.
- Modify the preceding clause if some weaker notion of necessity is called for (e.g., Kratzer's "human necessity" relative to an ordering source).

➽ Facts at times later than the reference time of *'A'* are given up in the process of "rerunning history." But that's what we said above for *'before'*! Something else is called for to account for the differences.

Proper strategy

Make reference to a relation of *causal (in)dependence*. Hold on to facts that are causally independent of the antecedent.

- *Bus example:* Whether the accident occurs does not causally depend on my presence or absence on the bus.

➽ The accident was unlikely, but it did occur. This fact is held constant.

- *Coin example:* Whether the coin lands heads or tails does not causally depend on the bet.

➽ The coin's coming up heads was not predictable, but it did occur. This fact is held constant.

Counterfactuals *vs.* *'before'*:

- Posterior facts that are causally independent of *'A'* are held constant in the interpretation of the counterfactual *'if had been ¬A, would have been B'*.
- Such posterior facts are given up in the interpretation of *'A before B'*.

3 *'Before'* again

A second hypothesis in contrast to the findings on counterfactuals:

- What matters for the question whether *'A'* happened "before *B*" or not is whether *'B'* was likely at the time.
- ignore everything that came after *'A'*;
- consider *all and only* the facts of the world at the reference time of *'A'*.

But this is still not enough: Certain facts about the state of the world at the reference time of *'A'* must be given up as well.

[6] Variants of this idea have informed many approaches in philosophy and linguistics (Downing, 1959; Adams, 1975; Ellis, 1978; Thomason and Gupta, 1981; Tedeschi, 1981; Dudman, 1994; Strawson, 1986; Bennett, 1988; Mellor, 1993; Edgington, 1995; Dahl, 1997, among others).

3.1 Likelihood and *'before'*

Problem for the second hypothesis: Counterfactual *'A before B'* does not always imply that *'B'* is (was) probable at the time in question.

In (28) the use of *before* is felicitous even though the meteor was unlikely to reach the ground.

(28) a. *[As meteors usually do / As scientists expected,]* the meteor burned up before it hit the ground.
b. If the meteor had not burned up, it would have hit the ground.

- The context given in (28) explicitly denies that the meteor was likely to hit the ground. Still, there is no problem with (28a).
- Notice that the counterfactual (28b) is true as well. This is for a somewhat different reason, though (see below).

Likewise, (29a) is felicitous even though Bill's books were never likely to become overdue.

(29) a. *[As he always does / as people around here always do,]* Bill returned his books to the library before they became overdue.
b. If Bill hadn't returned his books to the library, they would have become overdue.

A still better strategy for interpreting *'before'*-sentences

- Causally independent facts are not just "given up" in the interpretation of *'before'*-sentences
  - Giving up facts means "opening up" the question of whether those facts were likely to hold.
  - The answer may well be affirmative.
  - That's not what we want in cases like (28a), (29a).
- Rather, the very question of whether they occur or not is *disregarded*.
  - Intuitively, focus on a part of the world: the process that is/was (at the relevant time) bound to bring about the truth of the *'before'*-clause.
  - Don't even think about things external to that process.

A potential objection

Q: But the counterfactuals in (28b) and (29b) are also true! Doesn't that (somehow) explain the truth of the *'before'*-sentences?

A:
- The counterfactuals are true because their antecedents are causally (though not logically) inconsistent with the events that interfered with the truth of *B* (the friction in the atmosphere; the books' becoming overdue).
- Conditional antecedents "win" over unmentioned conflicting facts (see Hiddleston, 2005, for a theory which takes this into account)
- In *'before'*-sentences, we want to know whether a given time lies "before B," regardless of what happens at that time.
- In *'before'*-sentences, on the other hand, we want to know whether the reference time of *A* was "before *B*," regardless of what *A* is.
- In a fully compositional account, the interpretation of *'before B'* should not even have access to *A*.

➽ Our interpretation of *'before B'* cannot make reference to (the negation of) *A*.

4 The Progressive

Topic for this talk:
- The modal dimension of the progressive on the 'event in progress' interpretation.

4.1 The Imperfective Paradox

- How to relate the meaning of the progressive to the meaning of the non-progressive
- Account for the entailment patterns of activity vs. accomplishment predicates

Activity predicates

(30) John was swimming in the lake.
⇒ John swam in the lake.

(31) *Past*(*Prog*(John swim in the lake))
⇒ *Past*(*Prfc*(John swim in the lake))

Accomplishment predicates

(32) John was swimming across the lake.
⇒ John swam across the lake.

(33) *Past*(*Prog*(John swim across the lake))
⇒ *Past*(*Prfc*(John swim in the lake))

Implications of continuation and (non-)completion

(34) Mozart was working on the Requiem when he died.
⇝*Had he not died when he did Mozart would have continued working on the Requiem.*

(35) Last time I saw her, she was writing her thesis.
⇝ *She may or may not have finished.*

(36) Last time she was seen, she was crossing a minefield. She most likely never made it across.

(37) Last time she was seen, she was climbing the mountain in a blizzard. She most likely never made it all the way up.

Two views on the progressive

intensional view: the progressive relates an event in progress and a corresponding complete event that may be non-actual (Dowty 1979, Landman 1992, Bonomi 1997, Portner 1998, Zucchi 1999, Higginbotham 2004, Fernando 2008 among others)

extensional view: the progressive turns a complete event into an incomplete event, an event in progress (Parsons 1989, 1990, Van Geenhoven 2005, Szabó 2008, among others)

4.2 Normality

Dowty (1979):

(38) *Prog*(ϕ) is true at $\langle I, w\rangle$ iff for every $w' \in Inr(\langle I, w\rangle)$, there is an interval I' with I as a non-final subinterval, $I \subset_{nf} I'$, and ϕ is true at $\langle I', w'\rangle$.

- For an accomplishment predicate like *swim across the lake* whether the sentence in the progressive entails the sentence in the perfective depends on whether $w \in Inr(\langle I, w\rangle)$.
- Activity predicates like *swim in the lake* satisfy the subinterval property so the sentence in the progressive entails the sentence in the perfective.
- For an activity predicate whether the sentence in the progressive entails that the described event went on past the reference time depends on whether $w \in Inr(\langle I, w\rangle)$.

Normality and Interruptions

Inr **is too global:** all the facts of w at time I determine $Inr(\langle I, w\rangle)$

- Suppose that the most likely course of events given everything that holds true at the reference time is for the interruption to occur
- Suppose that if both Mary's crossing and the truck moving follow their natural course, then collision is inevitable. Still (39) is judged to be true in that situation
- In a two truck scenario (40) and (41) both can be judged true.

(39) Mary was crossing the street when the truck hit her.

(40) Mary was crossing the street when the first truck hit her.

(41) If the first truck hadn't hit her, the second truck would have.

4.3 Actual Facts and Reasonable Options

Landman 1992:

> "Thus, if an accomplishment manages to get completed, it is unproblematic to assume (in retrospect) that the progressive is true during the development stage . . . This is the case even if the event gets completed *against* all odds." (p. 14)

- Scenario 1: no miracle, Mary drowns. Scenario 2: miraculously, Mary swims across the Atlantic.
- (42) is false on Scenario 1 but true on Scenario 2.
- The fact that Mary actually manages to cross the Atlantic is taken into account in the evaluation of the progressive.
- Landman argues that some form of normality is necessary to distinguish between (39), on the hand, and (43), (42), on the other.

(42) Mary was crossing the Atlantic. *[false on Scenario 1/true on Scenario 2]*

(43) Mary was wiping out the Roman army.

Landman's Event Stages

- An event e is a stage of another event e_1 if e_1 can be regarded as a more developed version of e, that is, if e_1 is the same event in a further stage of development.
- Let e be an event that goes on at i in w. Let e_1 be an event that goes on at j in w and $i \subset j$.
  - e_1 is a continuation of e iff e is a stage of e_1.
- Let j be a non-final interval [*sic*].
  - e_1 stops at j in w iff no event of which e_1 is a stage goes on beyond j in w.
- Let P be an activity or accomplishment predicate, where $P(e_1)$, and e a stage of e_1.
  - e is a process stage of e_1 iff e has the same process characteristics as e_1.

Event Stages and Reasonable Options

- The set of reasonable options for e in w, $R(e,w)$, is such that $v \in R(e,w)$ iff there is a reasonable chance on the basis of what is internal to e in w that e continues in w as far as it does in v.
- in determining what chance a stage has of continuing ignore facts about the world that are external to the stage
- within a world look just at what happens
- construct a continuation branch by considering continuation in a given world plus counterfactual reasoning
- *PROG* as a relation between events and event properties

(44) $PROG(e,P)$ is true in w iff $\exists e' \exists v$: $\langle e', v\rangle \in Cont(e,w)$ and $P(e')$ in true in v.

Issues with Landman's analysis

- The notions of stage and continuation/development are ultimately a primitive in the theory
- The same event can be a stage of different types of possible developments in a way that is relevant to the meaning of the progressive (Bonomi 1997)
- Multiple Choice Paradox (Bonomi 1997)
- Context sensitivity and perspectives (Landman 1992, Asher 1992, Bonomi 1997)

Incompatible developments

Suppose that at 10am of June 21 I am on a boat that goes from the port of Rafina to the islands of Andros, Naxos, Paros with the intention of getting off at the Naxos port.

(45) *Said at 10am on June 21:*
  a. I am going to Naxos on the boat from Rafina. *[true]*
  b. I am going to Paros on the boat from Rafina. *[false]*

Now suppose that there was a problem at the port of Naxos so the boat couldn't stop and, as a result, I ended up on Paros.

(46) *Said on June 22:*
  a. Yesterday at 10am I was going to Naxos on the boat from Rafina. *[true]*
  b. Yesterday at 10am I was going to Paros on the boat from Rafina. *[true]*

Suppose the same scenario as before except that at 10am I have not made up my mind yet which port to get off on.

(47) *Said at 10am on June 21:*
  I am going to a Cycladic island. *[true]*
  $\rightsquigarrow$*There is no particular Cycladic island I am going to.*

(48) *Said at 10am on June 21:*
  a. I am going to Andros. *[false]*
  b. I am going to Naxos. *[false]*
  c. I am going to Paros. *[false]*

Context sensitivity and perspectives

Suppose I board a plane headed to NYC but which is hijacked and ends up in Washington: both (49a) and (49b) can be judged true.

(49) a. I was flying to NYC.
  b. I was flying to Washington.

The set of reasonable options is too restrictive and absolute

- The counterfactual alternatives in the continuation branch of a world w are determined based on a local/limited view of the facts in w at a given time.
- ➽ But we need to allow for alternatives in which the 'event in progress' in w develops and culminates in different ways.
- ➽ We also need to introduce context sensitivity in the semantics of the progressive.

5 Outline of a formal analysis

Goals of this section:

- Start with an off-the-shelf semantic framework for the interpretation of counterfactuals (in our case, Kratzer's (1981) premise semantics)
- Add a prinicipled (and also off-the-shelf) way to deal with (many) counterfactual conditionals
- Against this background, propose a principled way to deal with *'before'*-clauses and with the progressive which highlights the contrast.

5.1 Premise semantics, similarity, and human necessity

Main points (accepted here largely without argument):

- Counterfactuals and *'before'*-sentences alike call for a modal interpretation in terms of what's likely, necessary, etc.
- The standard interpretation of necessity as truth at *all* A-worlds is too strong for our purposes.
  For instance, if *'B'* was likely but did not happen, its likelihood cannot have been truth at all possible courses of events. Similar arguments abound for conditionals.
- "Human necessity" is a weaker notion of (roughly speaking) truth at all "relevant" worlds, e.g., all worlds following the "normal" course of events.

➽ Goal: Encode the difference between counterfactuals and *'before'*-clauses in terms of different conditions on the "relevant" worlds to consider.

Some formal background

Let us adopt the formal tool of an *ordering source* imposing a relation of *relative likelihood* on the possible worlds (or states of affairs). For details, see Kratzer (1981).

- A *proposition* is a set of possible worlds.
- A *modal base* is a function f from worlds to sets of propositions. For concreteness, let $f(w)$ be the set of those propositions that are contextually taken for granted. Their intersection, $\bigcap f(w)$, is the set of those worlds which, are compatible with everything that is taken for granted.
- An *ordering source* is a function o from worlds to sets of propositions. Intuitively, in our case, $o(w)$ is the set of those propositions that are "normally" true (or more likely to be true than not) given the facts at w.
- At each world w of evaluation, $o(w)$ induces an order between worlds: world u is (at least) as relevant as world v iff all the propositions in $o(w)$ that are true at v are also true at u.

(50) $$u \leq_{o(w)} v \iff \{p | p \in o(w) \wedge v \in p\} \subseteq \{p | p \in o(w) \wedge u \in p\}$$

- This offers a new notion of "human" necessity that is weaker than "simple" necessity. Simplifying, p is a human necessity at w relative to f and o iff those worlds in the modal base that are most likely under $o(w)$ are p-worlds.

(51) $$\forall u \in \bigcap f(w) \exists v \in \bigcap f(w)[v \leq_{o(w)} u \wedge \forall z \in \bigcap f(w)[z \leq_{o(w)} v \rightarrow z \in p]]$$

5.2 Counterfactuals

Main idea:

- In the evaluation of *'If had been A, would have been B'* at world w, the "relevant" worlds are those which satisfy two conditions:
  - A is true at them; and
  - they are at least as similar to w as any other A-worlds.
- Roughly: The counterfactual is true at w iff among all A-worlds, those that are most similar to w are C-worlds (Stalnaker, 1968; Lewis, 1973).[7]

- $f(w) = \emptyset$ for all w. Thus $\bigcap f(w) = W$, the set of all worlds.
- Since the relevant ranking is based on *relative similarity to w*, $o(w)$ contains propositions that are true at w.

Q: Which true propositions?

How the relevant worlds are chosen (reconstruction of similarity)

Much recent work in philosophy, psychology and artificial intelligence has explored the role of *causal (in)dependencies* in the interpretation of counterfactuals (Spirtes et al., 1993; Pearl, 2000; Hiddleston, 2005; Schulz, 2007, among many others)

(52) *[I bet on heads, the coin came up heads, I won]*
If I had bet on tails, I would have lost.

- True if the speaker's bet has no (causal) influence on the outcome of the toss.
- False if it does (e.g., if a different fair coin is used depending on the bet).

(53) *[I got off the bus, the bus had an accident, I was uninjured]*
If I hadn't gotten off the bus, I would have been injured.

- True if the speaker's presence or absence on the bus has no (causal) influence on the accident.
- False if it does.

➽ If a relation of *causal dependence* (or causal influence) is given as basic, then the interpretation of counterfactuals can be explained in terms of it.

Lots of people nowadays think that this is a more fruitful approach than Lewis's attempt to go the other way and reduce causality to counterfactual (in)dependence.

[7] The above presupposes that there is a set of most similar A-worlds. In fact, neither Stalnaker nor Lewis make exactly that assumption. Stalnaker: iff *the* most similar A-world (to w) is a C-world. Lewis: iff any sequence of A-worlds whose similarity to w grows monotonically, ends in a sequence of C-worlds.

Main idea reconstructed:

- In the evaluation of *'If had been A, would have been B'* at world w, the "relevant" worlds are those which satisfy two conditions:
  - A is true at them; and
  - True propositions at w that are causally independent of A are true at them.
- The counterfactual is true at w iff among all A-worlds, the most relevant ones are B-worlds.

This is a simplified picture. The causally most relevant worlds should be ranked further by likelihood or normalcy. We ignore this here.

Some formal background

- Causal dependence is a relation between *variables* (in the statistical sense).
- The relation is transitive and asymmetric (often given as a *directed acyclic graph*).
- In our framework, a "variable" is a *partition* of the set of all worlds (like a question denotation).
- For simplicity, assume that these variables are binary (i.e., yes-no questions): Each corresponds to a proposition and its negation.
- At each world, all relevant variables take some value or other.

  (54) Let X_w be the cell in partition X that contains world w.

- Impose the following constraint on ordering sources for counterfactuals:

  (55) For all X, Y such that $X \rightarrow Y$ (i.e., X causally influences Y), and all w, $o_{cf}(w)$ contains only $Y_w \cap X_w$ (not Y_w).

  Intuitively, the partition Y does not really play a role in the intepretation; only its refinement by X does.

Upshot:

- Suppose X, Y are both true at w.
- Without causal dependence: Among the worlds at which X is false, those at which Y is true are more similar to w than those at wich Y is false.
- With causal dependence $X \rightarrow Y$: Among the worlds at which X is false, Y does not count towards relevance at w.
- ➽ We derive the following asymmetry:

  (56) a. If Y were false, X would (still) be true.
  b. If X were false, Y might not be true.

Back to our examples

(57) If I had stayed on the bus, I would have been injured.

- Suppose my presence or absence on the bus had no causal bearing on whether there would be an accident.

- ➽ At worlds w at which the accident happened, $o(w)$ contains the proposition that the accident happened. This proposition is consistent with the antecedent of (57), hence (57) is true.
- Suppose my whereabouts did have an influence on the accident.
- ➽ At worlds w at which the accident happened, $o(w)$ does not contain the proposition that the accident happened, but only the proposition that I got off and the accident happened. This proposition is not consistent with the antecedent of (57), hence (57) is false.

5.3 *'Before'*-clauses

(58) If I had stayed on the bus, I would have been injured.

(59) The meteor burned up before it hit the ground.

Main idea:

- What mattered for counterfactuals was a kind of "similarity to w." Since the accident happened, accident-worlds are more relevant than others.
- What matters for *'before'*-clauses is not similarity.
- *Nor* is it (overall) likelihood, however!
  (59) may be true even if the meteor never had a chance to hit the ground.
- ➽
  - Not only do we not hold on to the fact that the meteor burned up;
  - We even disregard the question of whether it would burn up nor not.

Implementation

- Assume again that we are given information on causal independence.
- Consider some relevant fact, such as the fact that the meteor was falling (along a certain trajectory, with a certain velocity) at time t.
- Worlds at which it burns up in the atmosphere are *more likely* than worlds at which it doesn't.
- This follows from a "stereotypical" ordering source of the usual kind:

  (60) For all X, Y such that $X \nrightarrow Y$, and all w, $o_l(w)$ contains Y_w or its negation, whichever is more "normal" at w.

- BUT the atmosphere presents an external intervention on the meteor's fall.
- Impose the following constraint on ordering sources for *'before'*:

  (61) For all X, Y such that $X \nrightarrow Y$, and all w, $o_b(w)$ contains neither Y_w nor its negation.

- *'A before B'* will be defined in world w relative to a partition X only if there is a cell in which *'B'* is a human necessity.
- Condition (61) will remove any partitions Y that are causally independent of X, that is, it will make ordering sources $o_l(w)$ for $w \in X_B$ irrelevant.
- Consequently, even though in both (62a,b) the *'before'*-clause is not only false but unlikely as well, (62a) is infelicitous (there is no X relative to which David's making a clean sweep of all the gold medals in the Sydney Olympics is a human necessity) while (62b) is felicitous.

(62) a. David ate lots of ketchup before he made a clean sweep of all the gold medals in the Sydney Olympics.
b. Mozart, fatally ill, died before he finished the Requiem.

5.4 The Progressive

- Similar idea as for *before*
- Have a partition that tracks the development of an event of type *P* and disregard any causally independent issues.
- Use Piñón's 2008 notion of the degree of realization of an event type.
- The realization of *P* (realization of *P* to degree 1) is a human necessity relative to ordering sources of two different kinds:
  - ordering sources based on prior intentions, plans, schedules etc.
  - realistic ordering sources based on what actually happened
- Thus, posterior facts need not be given up in the interpretation of the progressive; they would be relevant if the progressive is interepreted relative to a (totally) realistic ordering source

The Context Dependence of the Progressive

- Make the interpretation of the progressive dependent on:
  - a contextually determined ordering source of the appropriate type
  - a contextually supplied standard for event type degree of realization

Piñón's aspectual composition with degrees

Piñón 2008, p. 203:

> what is measured by degree functions is the degree to which x qua type O is affected (or effected) in e with respect to the verbal property in question. Thus, the incremental degree function eat_δ does not measure the degree to which x as a 'bare individual' or quantity gets eaten in e but instead measures the degree to which x as an individual of type O gets eaten in e.

Perspectives

- In the hijacking scenario, (63a) is judged true if the ordering relative to which the realization of *I fly to NYC* is a human necessity is determined by e.g. the schedule of the flight;
- (63a) is judged true if the ordering relative to which the realization of *I fly to NYC* is a human necessity is determined by the actual course of events

(63) a. I was flying to NYC.
b. I was flying to Washington.

Activity predicates

Piñón 2008, p. 205–206:

> the incremental degree function eat_δ does not measure the degree to which x as a 'bare individual' or quantity is eaten in e. Instead, it measures the degree to whihc x qua type 'applesauce' is eaten in e, and so a sensible answer seems to be that if x qua type 'applesauce' is eaten at all in e, then the degree to which x qua type 'applesauce' is eaten in e is 1. Although, naturally, eating more of x would mean that a larger quantity of applesauce is eaten, it would not change the degree to which x qua type 'applesauce' is eaten. To harp on this point, we are not measuring quantities of applesauce that are eaten – we are measuring the degree to which the event type 'eat applesauce' is realized.

5.5 Conclusions

- Causal (in)dependence is at work in *'before'*, the progressive, and counterfactuals.
- Given a set of relevant variables, counterfactuals are interpreted rather differently from *'before'* or the porgressive: Hold independent facts constant for counterfactuals, give them up for *'before'* and the progressive.
- But the set of relevant variables is generally small (and likely subject to contextual and general cognitive factors), and variables that are not included are ignored.

➽ This idea, as well as its implementation in terms of disregarding partitions, sounds a lot like *awareness*, though outside the epistemic realm we should probably prefer to call it *attention* (Franke and de Jager, 2008).

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