

TEL AVIV UNIVERSITY
LESTER AND SALLY ENTIN FACULTY OF THE HUMANITIES
DEPARTMENT OF LINGUISTICS

**VERIDICALITY, MODALITY AND ACCEPTABILITY:
SEMANTICS AND PRAGMATICS OF *BEFORE***

MA THESIS SUBMITTED BY
YUVAL PINTER

PREPARED UNDER THE GUIDANCE OF
DR. NIRIT KADMON

AUGUST, 2014

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I dedicate this work to my daughter, Inbal, who insisted on being born *before* I submit it.

ABSTRACT

A main characteristic of the sentential complementizer *before* is that it allows a false statement to act as its subordinate clause (when analyzed as *A before B*, this would be the *B-clause*). Such an instance of its use, as in (1), is called *nonveridical*.

(1) Mozart died before he finished the Requiem.

In other cases, though, merely having a false *B-clause* does not make a sound sentence. A sentence like “David ate lots of ketchup before winning all medals in the Olympics” rings bad to English speakers.

Beaver & Condoravdi’s (2003) work, and several following papers, attempt to capture both these facts within a possible-worlds-based account. Under their conditions, a *before-sentence* is true if and only if the time at which the *A-clause* occurred in our world precedes all times where the *B-clause* occurred in alternative worlds which “branch out” of ours at a time minimally preceding the *A-occurrence* of our world. If no *B-occurrences* exist in the alternative set of worlds, the sentence is judged to have no truth value, thus accommodating the “ketchup sentence”.

This work claims that this analysis leads to undesirable consequences. By systematically going over its truth conditions when calculated for sentence (1), I show that on the assumption that worlds where Mozart managed to work faster and finished the Requiem early are judged to be close enough to ours, which I claim they are, then Beaver & Condoravdi (2003) & followers’ account leads to a false prediction.

Next I offer my analysis – by reverting to earlier truth conditions for *before-sentences* (specifically, those in Heinämäki (1974)) and adding a felicity constraint which captures multiple aspects of nonveridicals, we arrive at the desired results. Following Landman’s (1992) account of the progressive, I offer a supplementary analysis which makes use of the notions of events and processes.

I then turn to a subclass of nonveridical sentences where interesting phenomena occur. A fine-grained scale of situations is constructed, differing from each other by the degree to which the *B-clause* has been considered a possibility if the *A-clause*, always an interruption to the completion of *B*, had not happened in the way it did in our world (defined as **Hypothetic Possibility**). As a means of dealing with this richer scale I devise an expansion of the common notion of acceptability: **Operator-Affected Acceptability**. It is the result of calculating the basic felicities of the sentence and a version of the sentence with a sentential operator (in this case, the modal *could*). The main result of this chapter is that the notions of Hypothetic Possibility and *Could*-Affected Acceptability are positively correlated: as one grows, so does the other.

The rest of the work is dedicated to further discussion of certain aspects that have not received full formal attention, such as how Hypothetical Possibility is calculated, and the observed phenomena of noncommittals and veridicality coercion.

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INTRODUCTION: NONVERIDICAL *BEFORE*

A main characteristic of the sentential complementizer *before* is that it allows a false statement to act as its subordinate clause. Such an instance of its use, as in (1), is called *nonveridical*.

- (1) Mozart died before he finished the Requiem.

This sentence conveys the information that Mozart did not finish the Requiem – his death prevented this from happening.

With that in mind, note that this particular property does not allow felicity for every *before*-sentence in which the subordinate clause (from now on it will be referred to as the *B*-clause, taken from the general form *A before B*) is false. Beaver & Condoravdi (2003) introduce the following:

- (2) # David ate lots of ketchup before winning all medals in the London Olympics.¹

This sentence, and others like it, will be henceforth referred to as *ketchup sentences*.

Of course, we can't forget that *before* can be veridical as well:

- (3) I brushed my teeth before I went to bed.

This work will deal with the differences between sentences like (1) and (2), examining the solution proposed in Beaver & Condoravdi (2003) and its existing modifications, and suggesting a revision.

¹ Beaver & Condoravdi are not completely consistent on the judgment of this type of sentences. When introduced (on p. 7) they are criticized as being “predicted true” but are not preceded by an asterisk or any other mark; on p. 16 they are simply referred to as “odd”.

1. AN EXISTING ANALYSIS OF *BEFORE*: CONDORAVDI AND FOLLOWERS

Beaver & Condoravdi (2003) wish to uniformly account for the veridical cases of *before* such as (3), the true nonveridical *before* (1), and the impossible nonveridical *before* (2). It also aspires for a compositional treatment of *before* sentences and *after* sentences (the latter being always veridical), a feat achievable by requiring a single, minimal transformation to distinguish the two. Unlike some other works dealing with temporal connectives (for example, Partee (1984)), this account does not deal with repeating events by means other than restricting within context (so (3) refers to a specific teeth-brushing event and a specific bed-going event which followed it, rather than the habitual occurrences).

Three main amendments were made to Beaver & Condoravdi (2003): Panzeri (2005) and Condoravdi (2007) enrich the account in a way which better predicts *before*'s licensing of Polarity Items and conforms with existing theories of them; Smets (2009) corrects a logical flaw in the definition of one of the constructs, a flaw which caused some of Beaver & Condoravdi (2003)'s claims to be false. Seeing as the combination of the four papers generates a cohesive account, I will hereafter use the shorthand form **CBPS** (**C**ondoravdi-**B**eaver-**P**anzeri-**S**met) to refer to it.

I will now lay out the CBPS formalization in a systematic manner. Some complications which are not relevant to the question of veridicality have been omitted, at no loss for our purposes.

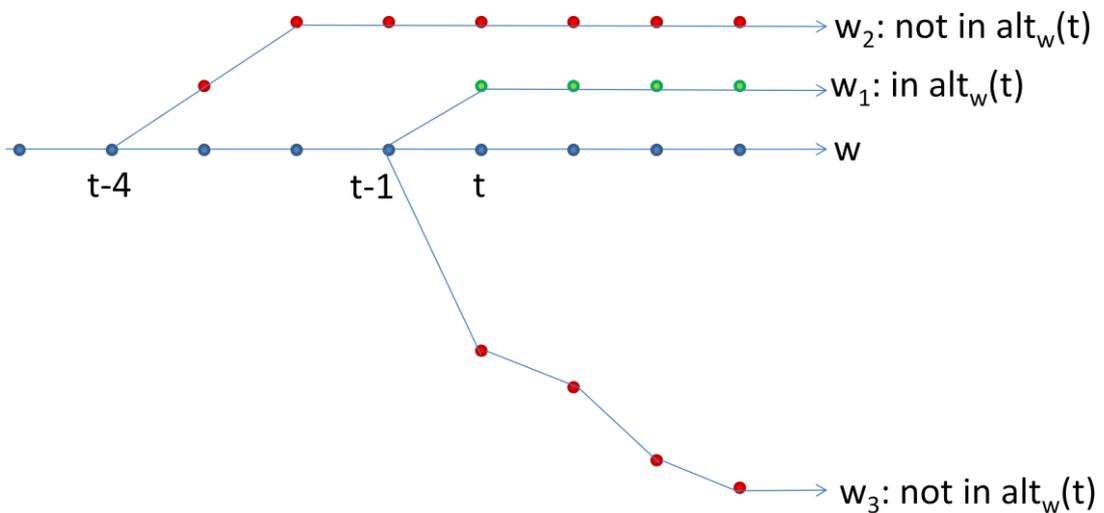
(4) *Definitions and notations:*

- a. If T is a linearly ordered set of times (instants), and $t \in T$ is some instant under consideration, define $t - 1$ to be a minimally-preceding instant, in a contextual manner:
 - i. $t - 1 < t$
 - ii. For all $t' \in T$, if $t' < t \wedge t'$ is contextually relevant, then $t' \leq t - 1$.
- b. A proposition X may be identified with the set of ordered pairs of the form $\langle w, t \rangle$, each representing a world and a time where X is true. When restricted to a world w , $\llbracket X \rrbracket_w$ is interpreted to be the set of times where X is true in w .

- c. For a proposition X and a world w , define $earliest_w(X)$ to be the minimal $t \in \llbracket X \rrbracket_w$ if $\llbracket X \rrbracket_w \neq \emptyset$, or \perp (undefined) if $\llbracket X \rrbracket_w = \emptyset$ ². For a **set** of worlds W , $earliest_W(X)$ is defined to be the minimal of all times in which X occurs in any $w \in W$. It will be undefined only if X does not occur in **any** $w \in W$.
- d. Branching-based alternative set: given a world w , we define a set of alternative worlds to w at time t , $alt_w(t)$ as following:
- i. All $w' \in alt_w(t)$ are identical to w at all times $t' \leq t - 1$.
 - ii. Starting at t , the worlds may diverge, in a “normal” manner (the verbal account translates this to “reasonably probable” alternative worlds).

A graphic example for this final construct is given below: if w is our world of evaluation, we see that only w_1 is sufficiently close to it to be in $alt_w(t)$: w_2 branches off too early, and w_3 branches off “too far away”³. Note that it is always the case that $w \in alt_w(t)$.

(5) *An example of alternative sets.*



² A necessary assumption (which Beaver & Condoravdi (2003) explicitly point out) for this definition of *earliest* is that the underlying temporal ordering relation is left-closed, i.e. every left-bounded set of times contains a minimal time (no left-open intervals exist).

³ “Too far away” is of course context-dependent and speaker-defined. But the graphic may steer us towards a desired formulation: if indeed the amount of divergence of worlds at a certain time t may be translated into such a graphic (with a distance metric between worlds, d), our guiding measure could be the *slope* of change of w_2 as seen from w : if for any two times $t + n, t + m$ ($n > m \geq 0$), the value of $\frac{d(w(t+n), w_2(t+n)) - d(w(t+m), w_2(t+m))}{n-m}$ exceeds a given threshold, w_2 is excluded from $alt_w(t)$.

Before giving CBPS's truth conditions I note that it is, for simplicity, a tense-agnostic account. While in reality the time of A and B relative to the time of evaluation does play a role⁴, CBPS (and this work following it) treats (1) as if it said: "our world is such that Mozart dies before finishing the Requiem". The truth conditions remain the same, regardless of the time of evaluation. I will use the verbal template " X is **tenselessly true** in a world w " to convey this, and will formally use the notation t_0 to indicate the time of evaluation, which may be any time and does not affect the truth conditions.

Given these definitions, the analysis for A before B is presented:

- (6) A before B is tenselessly true in a world w if and only if there exists a time t such that A occurs at t in w , and t precedes the earliest of all B times in $alt_w(t)$.

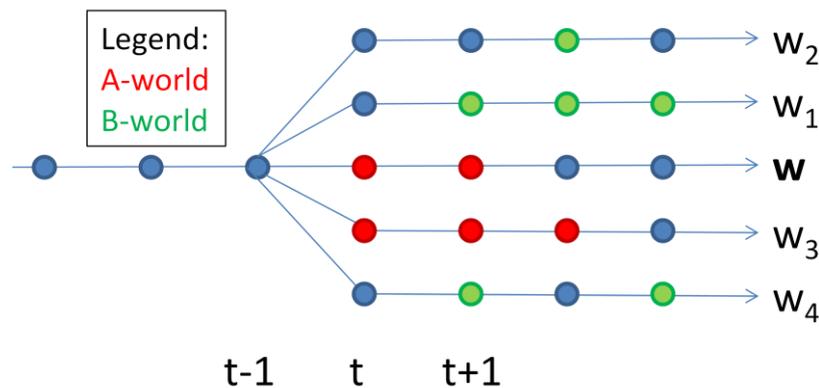
In full notation:

$$\begin{aligned} \llbracket A \text{ before } B \rrbracket_{w,t_0} = 1 &\Leftrightarrow \\ \exists t \in T. t \in \llbracket A \rrbracket_w \wedge t < \text{earliest}_{alt_w(t)}(B) \end{aligned}$$

Where, if $\text{earliest}_{alt_w(t)}(B)$ is undefined, the sentence has no truth value.

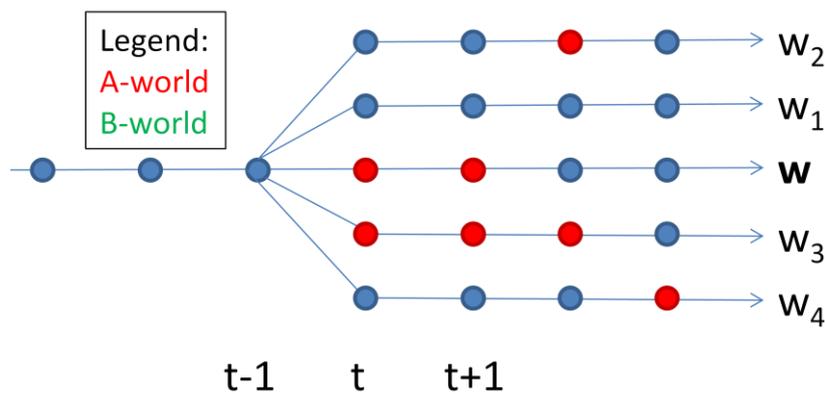
Graphic examples for nonveridical statements are given below:

- (7) Representations of various nonveridical statements according to the CBPS account. In all examples, the alternative set consists of the world of evaluation w and 4 additional worlds: $alt_w(t) = \{w, w_1, w_2, w_3, w_4\}$.
- a. A true nonveridical (*Mozart*). The minimal occurrence of B in $alt_w(t)$ is at $t + 1$, which indeed follows t .

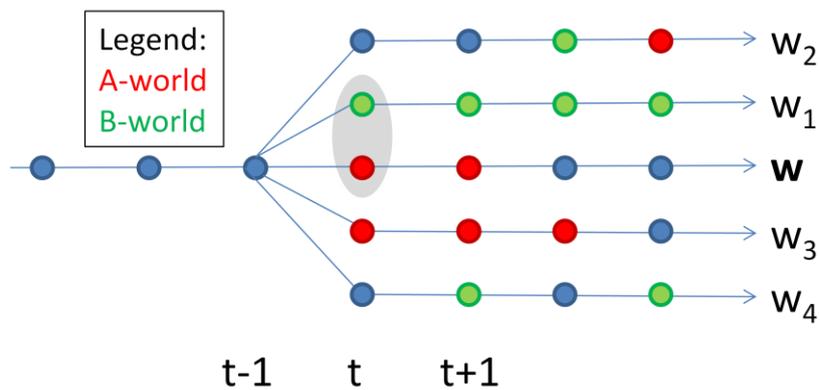


⁴ All examples avoid this issue by being in past-tense narrative form, anyway.

- b. *An undefined nonveridical (ketchup)*. B never occurs in any of the worlds in $alt_w(t)$, so $earliest_{alt_w(t)}(B)$ is undefined and the statement has no truth value.



- c. *A false nonveridical (no example in CBPS)⁵*. B does occur in some worlds in $alt_w(t)$, but the earliest of these occurrences is t itself, a moment which does not follow t .



⁵ We will not be returning to this exact situation as it seems to capture a rather negligible set of cases. Some exploration lands us with the example of Schrödinger's cat, locked in a box and either dead or alive. Opening the box reveals his state, so both outcomes are certainly represented in the alternative set worlds no matter what our own world turns out to be. Let's say the cat turned out alive. In a later recounting of the experiment's result, it would be false (or very odd in the least) to utter:

The cat was found alive before he was found dead.

2. REQUIEM TO AN ANALYSIS

On the face of it, the truth conditions set by CBPS seem to capture correctly the true nonveridicals such as the Mozart example in (1) vs. those like the ketchup example in (2). However, once we take a closer look at the necessary steps needed to calculate the truth conditions, it will become apparent that the mechanism in its entirety doesn't add up. We will start by identifying those contextually-available worlds whose inclusion in the alternative set would result in a false prediction. After making sure that such an inclusion is indeed a threat under CBPS's conditions, we will attempt to avert it by taking apart some of the vague definitions given by CBPS, leading to the conclusion that the temporal system put forth in this account cannot sustain the desired prediction for the Mozart example. In the next chapter, I'll show how Landman's (1992) account of the progressive may offer us a viable alternative for the basis to an account of *before*.

WHAT WORLDS MAKE UP THE ALTERNATIVE SET

The first question we face given the Mozart example is what the worlds are that $alt_w(t)$ is made of, those worlds from which we extract the earliest time of B 's hypothetical completion. For the ketchup case, since the worlds are all "reasonably similar" to ours it is obvious none of them are ones where David wins all medals in the Olympics, leaving the sentence with an undefined truth value, predicting its infelicity. Matters in Mozart's case, though, are more delicate. It being the case that the sentence is true, some $alt_w(t)$ worlds need to be such that Mozart completed the Requiem in them.

Let us assume, for the remainder of this work, the following context for (1):

- (8) *Added context to the Mozart example.*
- a. Mozart's death (on December 5, 1791) was not sudden: he had been increasingly ill for a while (since May of 1791).
 - b. Mozart started composing the Requiem shortly prior to the beginning of this illness.

Next, let us partition the worlds where Mozart does in fact finish the Requiem (from here on, " B -worlds") into two types: (i) worlds where B occurs later than t ; (ii)

worlds where B occurs at t or earlier. It is clear that in order for the sentence to be predicted true, $alt_w(t)$ cannot contain worlds of type (ii).

But that means that the worlds realizing the following scenarios would have to be excluded: (I) Mozart gets better in July, managing to complete the Requiem in November; (II) Mozart, feeling impending death, speeds up his pace at an early stage of his illness, and manages to finish the piece in October (perhaps the added effort even contributes to his deterioration, killing him a month earlier than in our world); (III) Mozart ends up writing a shorter Requiem than he planned to in our world, completing it in November and dying on December 5. Can it be claimed that such worlds are indeed excluded? Given the context in (8), at least scenarios (I) and (II) are reasonable enough compared to our world. This means the only way to exclude them from $alt_w(t)$ is, in accordance with its definition in (4)d, to prove that they diverge from our world at a time preceding $t - 1$. This will require an inspection of the definition of $t - 1$, to see where that point in time falls when t is Mozart's death on December 5, 1791, in hopes that the resulting time is indeed later than the divergence points for scenarios (I) and (II).

FINDING $T - 1$

The conditions in (6) leave the exact definition of $t - 1$ vague. It is the “maximal contextually-relevant moment” preceding t , in our case December 5, 1791.

One interpretation of contextual relevance may lead us to set $t - 1$ as the beginning of Mozart's decline in health (May 1791). By this time he had already started writing the Requiem, and now the story is that he is writing the Requiem while death becomes more and more imminent. This setting of $t - 1$ would enter the worlds from scenarios (I) and (II) above into the alternative set, leading us to **false truth conditions**.

Our next attempt would be to set $t - 1$ at the moment his fate is sealed, that day in November 1791 where it is clear he will not survive the illness. From this moment, however, we're left with too few available reasonable branches, and it is safe to say that there is no world in the alternative set where the Requiem is completed **at all**. This brings us again to a wrong prediction – this time the sentence is predicted to have no truth value, like the ketchup sentence.

Finally, we may turn to setting $t - 1$ as the last point when Mozart is able to recover from his illness. By this point, is it too late for Mozart to hasten his work and

finish the Requiem prior to December 5? It may seem, intuitively, that it is not too late (maybe Mozart can hasten his pace shortly after his health begins to improve). If so, we have not eliminated scenario (I), and the sentence is incorrectly predicted to be false. But even if we assume that by the last point of possible recovery it **is** too late for Mozart to finish the Requiem prior to December 5 (which would lead to the desired truth conditions, as it provides a reasonably branching world where Mozart can recover, then complete the Requiem at a time following December 5), it is now the formal definition of $t - 1$ that is not followed to the letter. If the last point of possible recovery is contextually relevant, surely the later moment in which his fate is sealed is contextually relevant as well. Since it is later, it must supersede our choice of $t - 1$, bringing us to the situation discarded previously.

REVISING THE CONTEXTUAL RELEVANCE REQUIREMENT IN THE DEFINITION OF $T - 1$

Having failed under the exact definition given for $t - 1$, we might attempt to revise the definition by replacing the fairly vague “last contextually relevant moment” with a more specific characterization. If such a moment is to apply to *A before B*, it would seem appropriate to base its definition on clausal operators applied to *A* and/or *B*.

First, building on the predicament faced by the second attempt above, in which the possibility for recovery was excluded from the alternative set because of too-late branching, we can try and redefine $t - 1$ to be **the last moment preceding t where A** (here, Mozart’s death) **still has a chance of not happening** (or at least of not happening the way it did, when it did). A possible motivation for this modification is that we see *A* as preventing the occurrence of *B*, and we want available some world where this prevention is removed (this motivation, let’s call it **de-prevention**, is the same one underlying analyses for two other sentential formulae: **counterfactuals** and **the progressive**; we shall indeed turn to them for inspiration in due time). This idea may work for the Mozart example, but only if we assume that he would not have been able to hasten his pace had he recovered at this point, not a trivial assumption. However, if we take a more “stubborn” event which is not that easily changed counterfactually, it runs into serious difficulties. Such an event can be taken from the realm of celestial absolutes, physical occurrences such as the setting sun, which

cannot change without resulting in too different a reality. For the following example, this redefined $t - 1$ would not exist under any sensible interpretation, and even the modified truth conditions would give a wrong prediction, by way of inability to compute the alternative set (since it relies on an incomputable $t - 1$).

(9) The sun set before I completed charging my solar battery⁶.

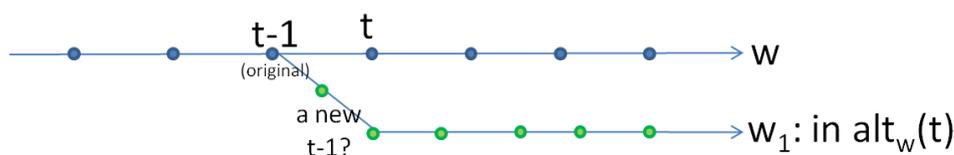
Alternatively, we can approach the matter from the opposite direction – that of B – and try to redefine $t - 1$ as **the last moment preceding t where B is still a future possibility**. Even if we ignore a somewhat problematic underlying aspect of this definition (t is defined by the occurrence of A in a world where B may have never occurred, yet $t - 1$ is defined by referencing B), the dead-end is near. For B to be a future possibility in the world of evaluation w at this new $t - 1$, there must presumably be some reasonable alternative world branching at this time in which either B occurs earlier than it does in w , or else A is removed or postponed. So $alt_w(t)$, since it includes all reasonable alternative worlds, will necessarily contain either a world where B happens earlier or one where A is removed or postponed. But if a world where B happens earlier is included, there is a wrong prediction (as explained above, when we tried to define $t - 1$ as the beginning of Mozart’s decline in health). Since there is nothing to prevent such a world from being included, our central problem is not solved. Furthermore, suppose we do somehow disallow including such a world in $alt_w(t)$. Then, for $alt_w(t)$ to still be consistent with the definition of $t - 1$ here considered, it will have to include a world where A is removed or postponed. But we have already seen a problem with ensuring the existence of such a reasonable world, viz., the problem with sentences like (9).

Our attempts at shifting $t - 1$ for correcting CBPS’s misprediction have failed. The next chapter will turn to related theories to figure out how their “reasonable difference” construct may be interpreted to align the alternative set from a different angle, but first I will make a short formalistic digression.

⁶ I hold with confidence that this type of events is perceived as truly unchangeable by all parties. I suggest as support for this assumption the oddity of a sentence like “we were charging the battery when the sun unexpectedly set”, in contrast with the acceptable “we were charging the battery when clouds unexpectedly covered the sky”.

In the truth conditions (6), the point in time where $t - 1$ is fixed is crucial for the identification of the alternative set of worlds. From the order in which the definitions were presented it is implied that $t - 1$ is defined in regards with the context in our world of evaluation, w (the limitations of $t - 1$'s definition are *contextual*). However, once the alternative set of worlds is computed and the worlds in it gain importance, time-continuum nuances might be lost: all of a sudden, a point of time residing between t and $t - 1$ (which was set before the worlds in $alt_w(t)$ played any part in the calculation) could have contextual relevance in a world $w_1 \in alt_w(t)$.

- (10) *World-relative $t - 1$ vagueness.* The dots are contextually relevant points in time (in our example, the “new $t - 1$ ” could mean a turn for the better of Mozart’s disease, one which does not occur in our evaluation world w)⁷.



This is where the vagueness lies: we cannot tell which of the following possible resolutions is what CBPS have in mind.

- (11) *Possible resolutions to the world-relative $t - 1$ vagueness:*
- a. Continue using $t - 1$ as an invariant, contextualized only within w ;
or
 - b. Adjust $t - 1$ to be the latest time before t which is contextually-relevant time in *any* world in $alt_w(t)$, once this set has been computed. (This seems to be equivalent to a third “omniscient” resolution which can define $t - 1$ by considering, *a-priori*, all relevant points in time in all relevant worlds.)⁸

⁷ Also, remembering the implicit assumption (4)b, where sets of world-time ordered-pairs are what define propositions in CBPS, each new time introduced in such a world requires an immediate calculation of all relevant assertions at that time in all other worlds, so the world-new time pair can be added (or not) to their corresponding propositions.

⁸ Without further diving into formality, it’s worth noting that this definition runs the risk of looping without convergence to a finite set of times, as new branching worlds may emerge with every recomputed $t - 1$.

As demonstrated so far in the section, this point is moot as neither interpretation can yield a $t - 1$ which would not lead to a false prediction.

3. EXAMINING THE “REASONABLE DIFFERENCE” REQUIREMENT

Our final path in trying to resolve the problem in CBPS’s prediction of the Mozart example is by allowing some freedom in interpreting the phrase “reasonably different” appearing in their definition of the alternative set of worlds⁹. Although it is given for a uniform analysis of all types of *before*-sentences, it is made relevant only for nonveridicals (in fact, Beaver & Condoravdi (2003) introduce this set specifically for dealing with nonveridicals), so modal-based analyses for similar types of propositions can serve as a fair frame of reference. I will present two of them (counterfactuals and the progressive, already mentioned earlier), introduce an existing analysis for each, and try to apply some insights from these analyses to the case at hand. Finally, I will show how Landman’s (1992) event-based treatment of the progressive might solve most of the problem, but at the price of adding an assumption which is controversial.

COUNTERFACTUALS: LEWIS’S ANALYSIS

The immediate suspect is the **counterfactual**, seeing as the classic nonveridical in (1) (Mozart) contains a very strong implication of the counterfactual below:

- (12) Had Mozart survived that particular 1791 illness, he would have finished the Requiem.

David Lewis (1973) treats counterfactual sentences of the form $A \rightsquigarrow B \stackrel{\text{def}}{=} \text{“If } A \text{ had taken place, then } B \text{ would have taken place”}$ ¹⁰ by the following account: within a possible-worlds framework, construct a system of spheres surrounding the world of evaluation, w . Call the system S_w . The spheres represent *similarity* of worlds to w ,

⁹ An opposite direction would be to keep only the requirement for world similarity to our own, removing the requirement of identity until $t - 1$. This is the road followed by Sharvit (2013)’s appendix, where the CBPS intensional dimension is realized as simply “worlds accessible from the world of evaluation”. This, based on the evidence so far, only makes things worse: the worlds in which Mozart finishes the Requiem earlier than his death in our world are even more easily admitted into the alternative set, and the sentence is predicted false.

¹⁰ This is not the exact arrow Lewis uses in his notation. His is a box with an arrow sticking out.

meaning each sphere¹¹ contains worlds which are similar to w up to some degree. The system is *nested* (i.e. closed under intersections and unions, and for each two spheres in the system one is a subset of the other), and *weakly centered* (i.e. the innermost sphere includes w itself, illustrating that w is maximally similar to itself). We can assume S_w does not have to include all worlds (Lewis calls the negation of this condition *Universality*¹²) and posit that all non- $\cup S_w$ worlds are all treated as maximally dissimilar to w (and “farther away” from any world which is in a sphere). The truth conditions of the counterfactual are as follows:

- (13) $A \rightsquigarrow B$ is true iff:
- a. A never occurs in S_w (the *vacuous* case); **or**
 - b. There is a sphere $s \in S_w$ where an A -world exists, and where every A -world is also a B -world.

Since the system is nested, if we assume every descending sequence of spheres has a minimal sphere (Lewis’s *Limit Assumption*), it’s best to try for s as the minimal A -sphere. If no bounded endless ascending sequences of spheres occur (meaning that some spheres are not reachable by enumeration), a way of checking the truth value of the counterfactual could be: start at the minimal sphere, check for A -worlds in it. If none are found, move one sphere outwards and repeat. When in an A -permitting sphere, check all A -worlds in it for B ’s truth value. $A \rightsquigarrow B$ is true iff in all of them B is true. There’s no need to keep moving outwards, as we have met the condition.

Applying this to (12) as an example, Lewis requires for its truth that either:

- a. In no reasonably-similar world to ours did Mozart avert death on December 5; **or**
- b. The most similar worlds where Mozart doesn’t die are all such that he finishes the Requiem (at any time).

As it does not seem to be that (a) is the case, we may check the applicability of (b) alone to *before*.

¹¹ There seems to be no real advantage to using this multi-dimensional term. For visualization, there should be no harm in replacing all “spheres” with “rings”, where partialness of the order is preserved.

¹² Here’s an argument supporting getting rid of the Universality condition: the Hebrew saying “If my grandmother had wheels, she’d be a taxicab”. This is considered true by speakers, and is obviously a vacuous case of counterfactuality. Otherwise one wonders whether there is no world in the minimal wheeled-grandmother sphere where she is a bus, or a motorcycle, or a plain old car. In fact, stating these options will ring just as well for Hebrew speakers.

Given this analysis, we could take CBPS's "reasonable difference" to be similarly motivated to Lewis's set of spheres, and posit that the relevant worlds for inclusion in $alt_w(t)$ are a minimally-near set including some worlds where *A* is removed. Now we can use Lewis's interpretation for world proximity to assess which worlds are valid for inclusion in $alt_w(t)$.

However, Lewis offers no such interpretation. He, just like CBPS, treats world proximity as a primitive property. Other analyses of counterfactuals (Stalnaker 1975, Kratzer 1981b, Veltman 1986) seem to resort to similar assumptions. It appears that the analogy to counterfactuals will not suffice in formulating an account of *before*.

THE PROGRESSIVE: LANDMAN'S ANALYSIS

Our next step will be to visit analyses for another related type of construction, namely that of the **progressive**. The discussion so far has focused on the ways in which worlds differ when a process (Mozart's writing the Requiem) is being interrupted (by his death). The literature on the progressive aspect deals with such examples as the following:

- (14) Mozart died while he was writing the Requiem.

Coupled with the fact that the process of writing the Requiem never finished, i.e. no final result was produced, the interest lies at the claim being uttered that Mozart was, in fact, **writing** the piece¹³. Following a summary of Landman's account for the progressive, I will attempt to apply its insights to the matter of *before*.

Fred Landman (1992) provides an analysis for sentences employing the progressive which can account for several seemingly-paradoxical pieces of data:

- (15)
- a. The imperfective paradox: *Mary was pushing a cart* entails *Mary pushed a cart*, but *Mary was building a house* does not entail *Mary*

¹³ This connection has not escaped Fernando (2008) in his account of the progressive. In addition to using various constructions of B&C's 2003 analysis, he proposes a similar implication from *before* to the progressive, which would translate in our case into *Before Mozart died, he was going to finish the Requiem*.

built a house. Since building a house is an accomplishment-type event, it can only be completed (allowing the past simple form) if some acceptable form of a house exists at its end, but the progressive is admissible even if no such product came to be.

- b. Interruption: *Mary was crossing the street, when the truck hit her* is felicitous. Even if we add to the context a second truck in the next lane, one which hits her if the first is removed (in a “nearest-world”-type attempt for analysis), the sentence is still fine.
- c. Contra-interruption: *Mary was swimming across the Atlantic Ocean when she drowned* is infelicitous, keeping in mind that crossing the Atlantic by swimming is deemed impossible by us, drowning being inevitable. If, however, the state of affairs is such that Mary miraculously managed to swim across, *Mary was crossing the Atlantic* becomes good, perhaps with some hedging (such as *I wouldn't have believed it at the time, but...*).

The analysis introduces a construct named **the continuation branch** of an event e in a world w :

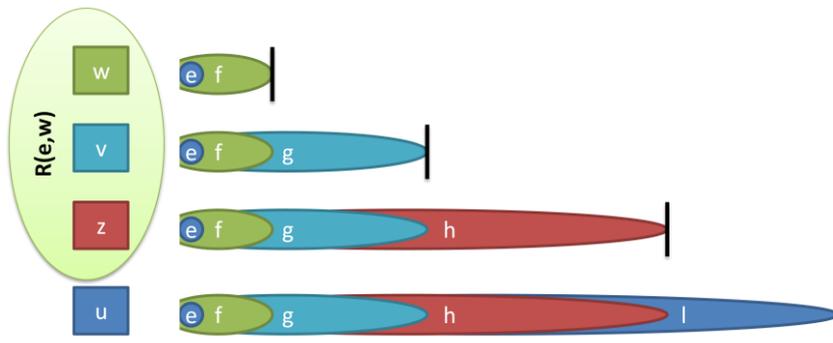
(16) Landman's definition of a continuation branch, along with some necessary pre-definitions and clarifications (variable symbols: e and f are events, w and v are worlds; e always goes on in w):

- a. e is a **stage** of f if it is understood to be the same event at a less developed phase. Crucially, the time interval of e 's occurrence is contained in that of f 's.
- b. The set of **reasonable options** for e in w , marked $R(e,w)$, is defined to be the set of worlds v such that 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 .
- c. The continuation branch, $C(e,w)$ is the smallest set of pairs $\langle f, v \rangle$ such that:
 - i. If f goes on in w and e is a stage of f , $\langle f, w \rangle \in C(e, w)$. These elements put together are the **continuation stretch** of e in w . By axiom, they have a maximal element.
 - ii. If the continuation stretch stops in w , take its maximal element f and consider the nearest world v where f does not

stop¹⁴: if $v \notin R(e, w)$ the continuation branch stops; otherwise, $\langle f, v \rangle \in C(e, w)$ and the step is repeated (for e 's continuation stretch in v).

The dependence of any new iteration of this continuation algorithm on reasonability with respect to the original world w keeps us from venturing into too remote possibilities, such which will endanger the prediction for contra-interruption situations.

- (17) Explaining the continuation branch (adapted from Landman (1992); black bars indicate event ends): $\langle g, v \rangle$ and $\langle h, z \rangle$ are part of it, but even though $e - f - g - h$ evolves into l in u it is not included, because u does not reflect a reasonable continuation of e from the viewpoint at w .



This construct is then employed in a straightforward way to solve the dilemmas introduced earlier regarding the progressive: for a progressive statement such as *Mary was building a house* to be true, there needs to be some event e in the past (of the evaluation world w) for which there is, on its continuation branch, some event f in a world v which is the building of a house. In other words, e is a stage of a complete house-building event f in v .

APPLYING LANDMAN TO *BEFORE*

Now we have Landman's continuation branch¹⁵ at our disposal. Is it possible to apply it to the CBPS account in the right place, namely that of "reasonable worlds", to allow for the judgments so far to be accounted for? That is, perhaps the CBPS account

¹⁴ Such a world exists, by assuming the interpretation introduced in Stalnaker (1968)'s analysis of conditionals.

¹⁵ Or tree, as suggested by Szabó (2004) based on Bonomi's (1997) observation that several continuation worlds may be equally near (in which case all of their branches are considered as the algorithm progresses). This distinction is moot for our needs.

can be revised such that, instead of constraining the worlds in $alt_w(t)$ to diverge from our own “in a normal manner” (or to be “reasonably probable” or “reasonably similar to our world”, etc.), they will be constrained to include only worlds occurring in the continuation branch of an event e which encompasses whatever beginnings of B have occurred in the world of evaluation. The role of “reasonably close” worlds will come in through Landman’s definition of the continuation branch, which determines that only in this kind of worlds may we look for events of which our original event e is a stage, when forming e ’s continuation branch relative to the world of evaluation.

Since in our case e is the event of Mozart’s intended writing of the Requiem, from its start to his death, and due to the interval containment requirement in (16)a, the continuation branch is formed solely by events that end (in their respective worlds) after December 5, 1791. So restricting $alt_w(t)$ to worlds contained in the continuation branch of e makes sure that $alt_w(t)$ will not contain any worlds where Mozart finished the Requiem prior to or on December 5, 1791. That is a welcome result, since as we have seen above, the inclusion of such worlds in $alt_w(t)$ yields the incorrect predictions that sentence (1) is false. This approach would be motivated by positing the following: our judgment that (1) is true stems from the fact that we assume, intuitively, that there is a world which is both identical to our own in all respects and processes until $t - 1$, and reasonably close **to our own**, in which there is a complete process of Requiem-writing, of which our world’s writing is viewed as a stage. That world is in the continuation branch of our world’s writing, so: (i) it is in $alt_w(t)$; and (ii) the complete process of Requiem-writing in it ends after December 5, 1791. Hence, sentence (1) comes out true.

Note that $t - 1$ ’s definition is still subject to the reservation made in earlier subsections: it may not result in too small an $alt_w(t)$ which would leave us with no desirable alternative world, let alone one in the continuation branch. This, in effect, makes $t - 1$ meaningless. Removing the second obstacle, the worlds where B happens too early, by the notion of the continuation branch, allows us to drop $t - 1$ altogether and redefine $alt_w(t)$ as simply the worlds in the continuation branch where B has occurred and a process being interrupted at t in w is a stage of it.

A handsome result, but there is still one obstacle to overcome: I would claim that worlds where B happens early should **not** be left out of the alternative set after all.

Let us digress (temporarily) from the context we've considered so far by adding the following detail, moving evaluation to a world w_a where the following took place:

- (18) On the night of December 5, 1791, the Austro-Hungarian Empire was burnt to the ground. There were no survivors.

Under these circumstances, where it's clear to us there was no way of Mozart's escaping the cataclysm had he not succumbed to the illness, (1) remains true. Mozart indeed died before finishing the Requiem. It was the illness that killed him. We need, as was the case until now, to remove the illness, and look for a continuation branch, treating the massive fire as a "second truck", to use nomenclature from Landman's street-crossing example.

But there is a difference between the destruction of the empire and the second truck. If there are reasonably close worlds where the first truck doesn't hit, then, presumably, there can just as easily be reasonably close worlds where the second truck is removed too (and where the street-crossing might be completed). On the other hand, we might be reluctant to think of the destruction of the empire as something that can be as easily removed in a way which would result in a world which we still consider reasonably close (where the Requiem-writing is to be completed).

If in all reasonably close worlds to w_a the destruction occurred, there is no culminated writing of the Requiem of which w_a 's writing is a stage, and thus $alt_w(t)$ remains empty and the sentence is predicted to be odd, as a ketchup sentence. We are left with one of two options: either the destruction of the Empire is indeed a "second truck" after all, and we somehow save the not-ill Mozart from it in a reasonable world (relative to w_a) and get him to complete the Requiem; or we need to find a different source of felicity for (1) (and its progressive counterpart (14), which shares its acceptability and its prediction under this theory) and alter the treatment accordingly.

The first approach provides an easy way out, but it hinges on a notion of "reasonability" which is getting farther and farther from our mental grasp. It requires us to determine, intuitively, whether or not a world diverging from a world very different from ours to begin with, is reasonably close to it. Since I believe the second option relies on a clearer intuition, that by which the source of the problem is that worlds where Mozart hastens his pace are being left out, it is the one I would like to explore. I posit that the reason that sentences (1) and (14) are not odd in the scenario

given, but are simply judged true in it, is that we judge it on the assumption that there are, indeed, relevant possible scenarios where Mozart does finish the Requiem. But they are not “continuations” in the strict sense. They are exactly those worlds where Mozart finishes the Requiem early – by getting better or hastening despite the illness – and is then obliterated along with the rest of the Empire (or even dies of the somewhat-transformed illness).

We have reached the end of the line for CBPS’s analysis. Under the assumption that the destruction of the Empire is not a “second truck”, meaning that any “reasonably different” alternative world at the time near Mozart’s death under the destruction premise must include the destruction, and considering that the sentence remains felicitous, it is imperative that a world where Mozart finishes the Requiem early is included in the alternative set. Since CBPS requires such worlds to not be included in the alternative set, we have reached a contradiction and must use a different approach¹⁶.

¹⁶ While Landman’s account also seems to fail here, on the progressive counterpart sentence, that is much more readily solvable. In fact, it only hangs on which interpretation we take for a few of Landman’s terms. This will be shown near the end of the next chapter.

4. A NEW ANALYSIS: FELICITY, NOT TRUTH

Having shown the CBPS account unsatisfactory, and explored some related analyses of other phenomena which bear resemblance to *before* and nonveridicality, I now give my suggestion for an account. In this chapter, I will show that the CBPS convolution of truth and felicity is not necessary, and once the two are separated it becomes easier to find a working solution. I will thus revert to simpler truth conditions, based on Heinämäki (1974). I will propose a felicity condition, formulated in terms of the CBPS primitives, which encodes two requirements on nonveridical *before* sentences – roughly, *B* being pursued, and *A* preventing *B* from happening. As an addendum, I propose slight adjustments of two elements in Landman's account of the progressive, which allow me to offer an alternative, event-based, formulation of my felicity condition. The alternative condition is parallel to the CBPS-based one (in ensuring pursuit and preventativity), but formulated in terms of continuation branches.

NO NEED FOR RIGID PRECEDENCE

What deeper solution can be found to the difficulties which arise from CBPS's truth conditions? After all, even if we find the best point in time for branching and plug it in CBPS's formula, we can't use the simple, mathematic literality of *before* as a basic precedence relation while quantifying over all reasonable resulting worlds within the same time reference. This would lead to wrong truth conditions, since we will either remain with no worlds in the alternative set (under the Empire destruction scenario), or there will be worlds in that set where Mozart picks up his pace to finish the Requiem prior to the time of his death in the world of evaluation.

This issue can be resolved using a surprising modification: removing the constraint over **when** *B* occurs (within the scope of alternative worlds) altogether. Ridding the account of this requirement allows us to search more freely for the point where worlds may diverge from the world of evaluation. It would be enough to require that *B* occurs **at all** in this alternative set of worlds, and then *A*'s occurrence prior to *B* **in the world of evaluation** (if *B* occurs there at all) would be enough to declare the sentence true¹⁷.

¹⁷ This would align part of the account with that of Anscombe (1964) and Heinämäki (1974) as “normalized” by Beaver & Condoravdi (2003). The alignment (with a slight modification) will become explicit later in the chapter.

GETTING PAST TRUTH CONDITIONS

This observation can now be joined by a new doubt concerning whether the discussion lies completely within the realm of truth conditions.

Recall that we need an account that both predicts that (1) is felicitous because Mozart finishing the Requiem was a future possibility at some point, and that (2) is infelicitous because David's winning all the gold medals in the London Olympics never was. In the CBPS account, whether or not *B* was ever possible in *w* affects the felicity of the *before* sentence **via its truth conditions**, since it determines whether *B*-worlds are included in $alt_w(t)$ or not. If not, the *before* sentence comes out undefined. I would like to suggest that this factor should not enter the truth conditions, but rather be treated as a **felicity constraint** on the use of *before*.

CBPS's conditions result in sentences like the ketchup example (2) being undefined in truth value, **not false**. This agrees with the intuition that they are merely **infelicitous**. Compare (2) to the sentences in (19) (the first under a normal everyday context, the second under the continuing context defined earlier), which really are judged as **false**.

(19) *False before-sentences*

- a. I went to bed before I brushed my teeth.
- b. Mozart finished the Requiem before he died.

Furthermore, consider the negation of (2): it should be the case that the truth value of a sentence is reversed when it is negated. But while this indeed happens in Mozart's case (see (20)a), the negated ketchup-sentence (20)b is not as straightforward. To the extent that (20)b is felicitous, that seems to be because the negation can be interpreted as metalinguistic. It doesn't seem like the negation is there to dispute the truth of (2), but rather to dispute the relevance of *B*, the medal-winning (or of *B*'s uninstatiation). It is natural to pronounce (20)b with the intonation typical of metalinguistic negation.

(20) *Negated before-sentences*

- a. (False) It is not the case that Mozart died before he finished the Requiem.
- b. (?) It is not the case that David ate a lot of ketchup before he won all Olympic medals in London.

So if sentences like (2) are infelicitous rather than false, why treat their oddity via the truth conditions?

Let's examine what is really needed for a *before*-sentence to ring false. (19)a is false because it exhibits discrepancy with the facts, by means of reversing the order of the events. Only the order of events in the world of evaluation is relevant, as was suggested in the previous subsection. (19)b is factually wrong as well, simply because the *A*-clause is uninstantiated, which we know must not happen in a *before*-sentence.

The above considerations lead us to the conclusion that nonveridical *before* sentences do not necessarily introduce a modal factor directly into the truth conditions. A suitable solution to the problems they pose could be to revert to a working non-modal analysis for truth conditions, and impose additional **felicity constraints**. These constraints may very well contain modal elements, of course.

FINDING THE RIGHT MOMENT IN TERMS OF *A* AND *B*

The core of the difference between the felicitous cases (Mozart) and the infelicitous cases (ketchup) appears to be, as already stated, the fact that Mozart's finishing the Requiem is a matter of interest, possibility and relevance at the time of his death, whereas the matter of winning all medals at the Olympics satisfies none of these requirements at the time of the hefty ketchup consumption. Some contextual connection between *A* and *B* must exist in order for the nonveridical to be accepted into a conversation.

What should the nature of this connection be? A responsible approach would be to start in the path taken not only by CBPS, but also by Lewis and Landman in their treatments of counterfactuals and the progressive, respectively. That would be to find a **minimal** change in the world of evaluation that introduces new worlds where something happens that is "interestingly" different. CBPS and Landman converge in that they both take, in effect, minimal steps **back in time** from the crucial moment at the world of evaluation (the interruption, which is *A* in the case of nonveridical *before*), while Lewis's sphere-expansion adds very little content to the nature of the change being considered. Part of CBPS's mistake, as pointed out in the previous chapter, is that they fix the divergence point at $t - 1$ and only then make certain requirements of *B*; the set of alternative worlds is defined rigidly by the external properties of the interruption and the world of evaluation alone. With Lewis's approach this will not happen – construction of the alternative-worlds set (based on

world similarity in the domain of counterfactuals, which we can translate to temporal precedence of world divergence for our domain) continues until we've arrived at a sphere where the antecedent is missing in some world. In the temporal domain, instead of setting our "time of interest" rigidly by *A*'s actual occurrence, let it be set by taking incremental steps until we reach a suitable set of modally-accessible worlds where either *A* (as we know it) is removed, or *B* (as we may accept it) is admitted.

This translates to several possible courses of action: searching for (i) the last moment (in the stretch of time preceding *t*, the starting point of *A* in our world) where $\neg A^{18}$ was a future possibility; (ii) the last moment where *B* was a future possibility; or a combination of both: (iii) the earlier among the two, or (iv) the later. For Mozart, these could be (i)=(iii) the moment in October of 1791 where he last could recover from his illness; or (ii)=(iv) a moment during his unrecoverable phase where he could still speed up his pace and finish writing the piece in time (if such a moment doesn't exist, we default to the same possible-recovery moment as (i)). Intuition cannot help much in deciding between these moments, but let's take a look at the respective moments for the infelicitous ketchup example: these are (i) just seconds before the ketchup-eating, or even during the ketchup eating itself (if we assume David was in doubt over whether or not to eat *a lot*); and (ii) **nowhere in the imaginable past**, the last time from where, had things progressed differently, David would have won all medals in the London Olympics. This (ii) is a data point that immediately attracts our attention (in addition to rendering (iii) and (iv) indefinable, or at least meaningless): using the fact that it is such an outlier when an infelicitous example is considered can help devise the felicity constraint we are seeking. "The last moment preceding *t* where *B* was still a (future) possibility" seems to be a good starting point.

Does it make sense to have this calculation, whatever we may use it for in our constraint, depend only on *B* and not on *A*? In fact, *A* is already included, since *A* defines the time *t* from which we start searching for the last possible-future *B* time. Since *A* is never challenged by nonveridicality, the time of its occurrence is a plausible anchor for this calculation.

The branching point we've reached is thus **the last moment preceding *t* where the future occurrence of *B* is possible**. Using the earlier notation of X_w as the set of times where *X* is true in *w*; adding $\mathbb{F}(X)$ to denote "in the future, *X*" (as defined

¹⁸ "*A*" should be taken in a rather strict manner here. The desired interpretation, carefully following the path we laid so far, would be "*A* as it happened in our world, when it did" (with some fuzziness allowed). Later chapters state this more explicitly.

below); and interpreting *max* mathematically over a set of times T to be the maximal (= latest) time in it¹⁹, or negative infinity if $T = \emptyset$ ²⁰, we may formally define **br** (for “branching point”) as

$$(21) \quad \mathbf{br}_w(t, X) := \mathbf{max}\{t' \mid t' < t \wedge \llbracket \diamond F(X) \rrbracket_{w, t'} = \mathbf{1}\}$$

$$\text{where } \llbracket F(X) \rrbracket_{w, t} = 1 \Leftrightarrow \exists t' > t. t' \in \llbracket X \rrbracket_w$$

$$\text{and } \llbracket \diamond X \rrbracket_{w, t} = 1 \Leftrightarrow \exists w' \in \mathit{alt}_w(t + 1). \llbracket X \rrbracket_{w', t} = 1. \text{ } ^{21}$$

Derivation of this formula will assure us that we have achieved the desired definition:

$\llbracket \diamond F(X) \rrbracket_{w, t'} = 1 \Leftrightarrow$ there is a $w' \in \mathit{alt}_w(t' + 1)$ where $\llbracket F(X) \rrbracket_{w', t'} = 1$;

\Leftrightarrow there is a world w' identical to ours until t' and branching off reasonably, where $\exists t'' > t'$ such that $\llbracket X \rrbracket_{w', t''} = 1$;

\Leftrightarrow there is a world w' identical to ours until t' and branching off reasonably, where there is a t'' following t' such that X is true in w' at t'' .

So: $\mathbf{br}_w(t, B)$ is the latest time preceding t s.t. there is a world reasonably branching off from ours at that time, where there is a later time at which B is true. If no such time exists, then $\mathbf{br}_w(t, B) := -\infty$.

Which is what we were looking for: the latest point in time preceding t where B was considered a future possibility relative to w .

FORMALIZING THE CONSTRAINT

Now we have the desired moment, but still need to decide how to use it in our felicity constraint. The gap between our felicitous and infelicitous nonveridical

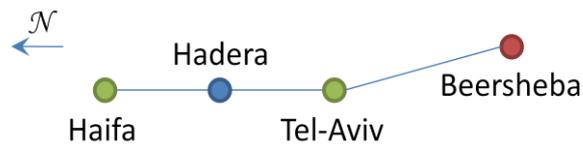
¹⁹ For the scope of this work we assume **right-closure**: all bounded sets of times have a maximum (and right-unbounded sets receive ∞ as their *max*). An immediate extension of this to include infinite, non-right-closed bounded sets would be to replace the maximum with the supremum $\sup(T)$, with no apparent harm.

²⁰ One of two reasonable options, the other being \perp . $-\infty$ is reasonable because, among other things, it conserves set inclusion with maximality precedence: $\forall A. \emptyset \subseteq A$ and $\forall A. \max(A) \geq \max(\emptyset)$.

²¹ By the definition in (4)d, $\mathit{alt}_w(t + 1)$ is simply the set of worlds which are **identical to w until t** and may branch in a reasonable manner later. It adds a prerequisite to our model: for every t there is a $t + 1$, and $(t + 1) - 1 = t$. This is not harmful considering our earlier restrictions (discreteness of T being the main one).

examples so far is pretty wide, and so a less trivial case is needed for a sound formalization. Introducing the Hadera example (Landman, p.c):

(22) An extremely schematic map of some of Israel.



Suppose I'm driving on my way from Tel Aviv to Haifa (to visit my family for a few hours), and my car runs out of gas just south of Hadera. The lengthy resolution of the problem forces me to eventually abandon the trip altogether and return home. When recounting the events, uttering the first two of the following sentences makes sense ((23)a is maximally informative, (23)b is more relevant if my intended target is known to the listener). Uttering (23)c does not:

(23) *Gasless in Hadera.*

- a. The car ran out of gas before I reached Hadera.
- b. The car ran out of gas before I reached Haifa.
- c. # The car ran out of gas before I reached Beersheba.

In each of these cases, of course, the *B*-phrase is false. The difference seems to be that had the car not run out of gas, I could be expected to have reached Hadera, and later Haifa, but not Beersheba.

For the felicitous sentences, the branching point $br_w(earliest_w(A), B)$ is probably the last chance I had to fill my gas tank; for the Beersheba case it's more open to debate: under a strict physical interpretation of the possibility operator in the definition of *br*, it's the last time where I could still fill up my tank, turn around, and drive to Beersheba. Under a more lenient epistemic interpretation, it's the later of the times between the last time I travelled to Beersheba and the last time when I was contemplating a trip there. Since the latter both requires an extra constraint and brings us to a less-interesting point in time which is outside the scope of the discussed trip, I'll assume the former. Returning to the original question, what stands between the last time I could fill my tank and drive to Haifa, and the last time I could fill my tank and turn around to Beersheba? These points in time may even coincide. The main difference I see is what I did **following** that time. In the scenario described, my later actions followed my grasp of how to accomplish getting to Haifa (where getting to Hadera is an intermediate goal of that task). I was going to fail; but I did not realize it

at the time. I, as an agent, was pursuing the goal of reaching Haifa. No agent/cause²² was pursuing a goal of me reaching Beersheba. It is this **pursuit** that distinguishes one from the other. I formalize this as:

$$(24) \llbracket \text{Pursued}(X) \rrbracket_{w,t} = 1 \Leftrightarrow \exists d \in D^{[+c]}. \llbracket \diamond_d \mathbb{F}(X \wedge d \in \theta(X)) \rrbracket_{w,t} = 1$$

where: $D^{[+c]}$ is the domain of causing forces in the universe;
 $\theta(X)$ is the set of theta role assumers in X ;
and \diamond_d is possibility under the modal base defined by d (for individuals – their epistemic state; for inanimate forces – physical modality).

In words, pursuit of X at time t is defined to be the existence of an individual or other force d , for which the future occurrence of X with d taking part in it is perceived as a possibility by d 's defined modal base. This “other force” will typically be the physical world itself, which is responsible for objects falling, people dying, the sun setting, and other such events where a sentient agent cannot be identified.

Is pursuit enough for *before* felicity? Sadly, not quite. Our cases are still not comprehensive enough. Consider the case of the Apollo 13 mission to the moon, which failed to land due to an unexpected problem and ended up orbiting the moon and returning to Earth. On board the vessel, there were two varieties of Tang-brand juice mix: orange-flavored and grape-flavored. Let's compare the two following statements, with the knowledge that both A -clauses occurred at roughly the same time.

- (25) *EnTanglement*.
- a. The Apollo 13 astronauts noticed a problem before they landed on the moon.
 - b. # The Apollo 13 astronauts finished the orange Tang before they landed on the moon.

These judgments show that the causal link between A and $\neg B$ has an undeniable effect on the felicity of the *before*-sentence. Pursuit of B is not enough, it needs to be pursued in a manner that wishes A not happens. Indeed, finding a nonveridical which is both felicitous and not **preventative** (i.e. A 's occurrence did not prevent B from happening) seems to be an impossible task.

This observation must enter the felicity requirement. However, conflating it with the notion of pursuit will not succeed: just as the astronauts pursued the moon-landing

²² Using theta role terminology, and applying notation based on the observation (Reinhart 2000) that agents and causes share the property of making events happen, [+c].

in both of the sentences in (25), so did my car’s running out of gas prevent me from reaching either Haifa or Beersheba. The two properties are independent, and they will mandate separate constraints.

Lastly, I would like to make the case that these two felicity requirements should be conditioned on nonveridicality itself. Is **veridical before** always felicitous? In an attempt to claim that it is not, the following piece of evidence may be presented:

(26) ? The dinosaurs became extinct before the Cuban missile crisis.

(26) appears to be true, veridical, and infelicitous. Closer scrutiny of this example, however, shows that it is not on par with our infelicitous nonveridicals. We may construct a “minimal pair” consisting of it and a nonveridical parallel, (27), to see that this is not the same type of infelicity.

(27) # The dinosaurs became extinct before the World War which was caused by the Cuban missile crisis.

In the veridical example, infelicity is cancellable given a healthy amount of context: the preceding statement by the addressee may have been the following: *The Cuban missile crisis is to blame for everything. That’s why the world looks the way it does today*, to which the speaker’s reply is, *Well, not for **everything**. For example, the dinosaurs became extinct before the Cuban missile crisis*. Nothing of this sort can be posited to save (27) short of an alternative world where the crisis did spark a world war. In conclusion, felicity is ensured by veridical *before*.

At last, a working formulation is ready:

(28) Proposed treatment of <i>A before B</i> :
a. Truth conditions (based on Heinämäki, 1974) ²³ :
$[[A \textit{ before } B]]_{w,t_0} = 1 \Leftrightarrow \exists t \in T. t \in [[A]]_w \wedge t < \textit{earliest}([[B]]_w)$ <p style="text-align: center;"><i>where earliest</i>(\emptyset) := $+\infty$²⁴</p>

²³ These truth conditions, as stated in several works, are limited to specific event-types, just as are CBPS’s. For example, if we choose to use them for a repeating action, such as (3), the entire formula needs to be encased in a temporal limitation, a relevance interval of sort.

²⁴ An undefined “earliest” time, as is the case in nonveridical statements (making it the earliest of an empty set of times), can be construed logically as being **later than all times**: in every point in time we’re “still waiting for it to occur”. Mathematically, this is precisely infinity (which is not an actual

b. Felicity constraint:

$$\begin{aligned} & \llbracket \neg B \rrbracket_{w,t_0} \Rightarrow \\ & (\exists t' \in [br_w(earliest(\llbracket A \rrbracket_w), B), earliest(\llbracket A \rrbracket_w)]. \llbracket Pursued(B) \rrbracket_{w,t'} \\ & \quad = 1 \\ & \wedge \forall w' \in alt(br_w(earliest(\llbracket A \rrbracket_w), B)). \llbracket \neg A \rightarrow B \rrbracket_{w',t_0} = 1) \end{aligned}$$

In words: *A before B* is tenselessly **true** in our world if and only if for some time *t* where *A* is true in our world, *t* precedes all times where *B* is true in our world (or if no such times exist); false otherwise.

It is **felicitous**, where nonveridical, only if:

(1) At some point in the half-open interval starting at the last time preceding *A*'s earliest occurrence in our world when *B*'s future occurrence was possible relative to our world, and ending at *A*'s earliest occurrence in our world, *B* was pursued by some agent or cause;

(2) Any alternative world (computed from the same branching point) where *A* doesn't happen is one where *B* does happen. In other words, it is a preventative.

Two minor points in the felicity constraint still need addressing: first, the reason why the definition of the pursuit interval is dependent on *A*; next, the restrictive antecedent scoping over the preventative clause. The answer to both of these issues is veridicals: a pursuit starting point defined only by reference to *B* might result, in the veridical case, with an undefined interval (since the last time in which *B* is possible can well follow the earliest *A*-time), and this is to be avoided; as for the preventative requirement, it simply does not hold for veridicals (which we already proved to be inherently felicitous): if Apollo 13 had managed to land on the moon after all, (25)b is fine despite its unrelatedness.

point in time). For our purposes, it guarantees truth of all nonveridicals (seeing as all *t*'s precede their earliest time, ∞). This of course fits nicely with the claim in footnote 20.

We can now look back at our examples under discussion and see how they fare in respect to the new truth conditions and constraint.

Veridical before: cases like (3), *I brushed my teeth before I went to bed*, are pretty trivial, and thoroughly accounted for. A moment of brushing my teeth does indeed precede the earliest moment of going to bed (within some relevance interval²⁵), and the felicity constraint is satisfied trivially, as the antecedent is false.

Its converse, the false *I went to bed before I brushed my teeth*, is predicted false by the truth conditions: no moment of going to bed precedes the earliest teeth-brushing (again, within the relevance interval).

In all of the nonveridicals the truth conditions are satisfied since *A* took place and *B* didn't, setting $earliest_w(B)$ to $+\infty$. We need only check the felicity constraint (28)b. Furthermore, we can now refer to $br_w(earliest_w(A), B)$ as “the branching moment” without hesitation: we know the instantiation of *B* takes place in a world other than the world of evaluation, one which branched out of it at $br_w(earliest_w(A), B)$.

In the Mozart example case, as already discussed, the branching moment is some time during his final illness, a moment from which he was (still) actively pursuing the completion of the Requiem. Preventativity is also evident – had Mozart not died, we're pretty sure he would have completed the Requiem.

The ketchup example is also accounted for. The branching point is either a very distant point in the past or $-\infty$. In either case, there is no agent or cause actively pursuing the ridiculous goal of David's winning all gold medals in London at any point time. Furthermore, an alternative world where David doesn't eat all that ketchup is not one where he wins the medals.

The battery example (9), *the sun set before I completed charging the solar battery*, is correctly predicted to be felicitous. The branching point is the last time I could have

²⁵ See footnote 23.

started charging the battery so it would complete charging by sunset (but didn't). Nevertheless, from my perspective I was still going to end up with a fully-charged battery, and still considered it possible until sunset. Preventativity is accounted for – had the sun not set when it did (if such an alternative world even exists), the battery would have successfully completed charging.

In the gas tank examples, (23), the branching point is the time prior to the running out of gas where reaching Haifa/Hadera/Beersheba was last a future possibility. As agreed, this is probably the last point of being near a functional gas station. Since this was while the trip was underway, it is clear that I was in pursuit of reaching Hadera on the way to Haifa, and there was no pursuit of a Beersheba arrival. All cases are preventative, though, as already pointed out.

The “inanimate cause” part of the felicity constraint is necessary for inanimate causes. Consider the following: a pencil is rolling ominously across the table.

(29) I stopped the pencil before it fell on the floor.

This is a felicitous nonveridical. A moment minimally preceding my stopping the pencil is one where its fall is a future possibility, and it's only the force of gravity which is pursuing the fall (with physical modality as its base).

In both the Apollo examples (25) pursuit is clearly there. The astronauts themselves, assuming the moon landing is going to happen, were actively steering the craft towards the moon since the last moment it was possible to reach it – say, a time when the problem could have been detected and fixed without harming the mission. In the first case there is also prevention – had the problem not been there, the landing would have happened; in the second, there is none – even without depleting the orange Tang supply there is no landing.

COMPOSITIONAL POWER: A COMMENT ABOUT *AFTER*

The main strength of CBPS's account was the unification of *before*'s truth conditions with those of *after*, a unification which we now need to make sure still exists. The compositional power of the CBPS conditions was that a mere reversal of the temporal connective gave the truth conditions for the opposite lexical item. In my new conditions, we need to ensure that simply replacing the '<' with a '>' in the truth

conditions is enough, as was in CBPS for exchanging *before* and *after*. As for the felicity constraint, since *after* is always veridical, it will need to be reduced to some triviality. The resulting account can be:

(30) The symmetric account for A after B:

a. Truth:

$$\llbracket A \text{ after } B \rrbracket_{w,t_0} = 1 \Leftrightarrow \exists t \in T. t \in \llbracket A \rrbracket_w \wedge t > \text{earliest}(\llbracket B \rrbracket_w);$$

b. Felicity: $\llbracket \neg B \rrbracket_{w,t_0} \Rightarrow (\dots)$

Or in words: *A after B* is tenselessly true in our world if and only if for some time t where A is true in our world, t follows the earliest time where B is true in our world; it is felicitous when, if B is uninstantiated, the conditions in (28)b hold.

Are these sound formulae? The truth conditions part is again identical to those of Heinämäki (1974), and in particular force veridicality: if the earliest time of B 's occurrence is undefined, it is treated as infinity and thus no time follows it, counter to the $t > \text{earliest}_w(B)$ requirement. Further reasons for why this condition is satisfactory are given in Beaver & Condoravdi (2003).

The felicity constraint is irrelevant right from its start: the antecedent is always false (due to the constant veridicality of *after*), and so all true *after*-sentences are correctly predicted to be felicitous.

While working out the CBPS-based account, two main observations were added to our set: to be felicitous, nonveridical *before* needs to (1) involve pursuit; and (2) be preventative. Armed with these observations, can we now make a Landman-based account (that is, one for which we will have to dismiss CBPS's primitive set) work as well? Recall that we seem to have reached a dead-end when assuming that, in the Destruction of the Empire scenario, the destruction is not easily dismissible (it is not a mere "second truck"). If we manage to avoid this dead-end lurking in the event/process ontology, perhaps we can find a simpler formulation of the felicity constraint.

Interestingly enough, I claim that two small clarifications of Landman's account are enough for avoiding said dead-end – one of the definition of the continuation branch, and one of the strictness of the intrinsicness requirement. I will now show how these two clarifications, still consistent with the main body of Landman's framework, will solve the problems not only for *before* (and allow a simpler felicity constraint), but also for the analogous progressive sentences (such as (14)).

CONTINUATION

A process and its stages, two notions paramount to the analysis under discussion, may be defined from several angles. Landman takes a rather strict approach for his definitions: *Mary building a house* pertains to a specific house-building process (and the related event), which may take place simultaneously in different worlds, but is identical in all of them up to the point of interruption, which may differ across worlds²⁶; a stage of our world's *Mary building a house* is an event which takes place at a time interval contained in that of the whole process. This is the root property which blocks the early-finishing Mozart alternatives from their inclusion in the alternative set.

I think this approach is *too* strict. Let's say Mary's process was interrupted in our world at the point of completing one side of the house, upon late discovery of the fact that the land on the plot is unstable and the foundations are bound to cave in. Is an

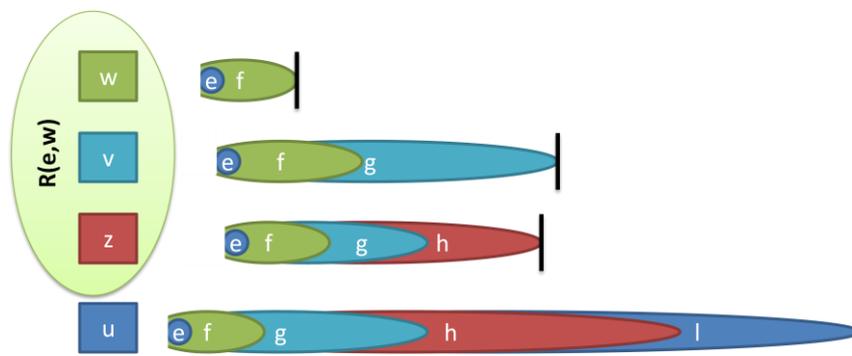
²⁶ I found no explicit mention of this in Landman's work, but it may be the case that inter-world instances of the same process may also differ in the location (in time) and length of pause stages, as long as the process stages remain congruent.

alternative process, where, instead of her actual plot, Mary buys the next plot over, and completes the same design of a house, perhaps even with the same exact materials, not sufficient to declare that “Mary was building a house” is true in *our* world? What about one where the land is exceptionally good on Mary’s plot and all pieces fit together quickly, bringing the house to an early completion? This last scenario is the analogue to the problematic Mozart scenario, as it cannot be included in the continuation branch for the technicality of not being a “continuation”. I suggest we dispense of this condition:

- (31) Slight redefinition of Landman’s continuation branch (from (16)a):
- a. e is a **stage** of f if it is understood to be the same event at a less developed phase. If e and f are in the same world, the time interval of e ’s occurrence is contained in that of f ’s.

Now we may make the world-jumps (as described in (16)c.ii) based on stages that occur at different time intervals in the different (but reasonable enough) worlds, while keeping progression within the event under a natural temporal continuation interpretation. Updating the diagram in (17), this may now also be an acceptable continuation branch:

- (32) Added acceptable continuation branch after redefinition of stage ($R(e, w)$ still defines the set of worlds reasonably close to w based on what is internal to e , of which u is not a member). Note how the processes start and end at more arbitrary times in each world, while in fact the more advanced process in z , which has more stages than the counterpart in v (= is more developed than it and is further along the continuation branch), takes less time and ends earlier:



With this out of the way, the early-finishing Mozart worlds are indeed considered as alternatives to both our own world and to the Empire-annihilating world, and as long as we agree that cross-world identity of a stage of a Requiem-writing process is defined by the Requiem being at the same level of completion (e.g the same number

of bars, or if a different Requiem is being written then the same ratio of written to not-yet-written material) rather than the overall time Mozart spent writing it, we're free to use the continuation-branch based approach.

INTRINSICNESS

Further justification for use of Landman's apparatus in analyzing *before* as described until now is needed vis-à-vis the notion of **intrinsicness**. Landman's account stipulates that changes between worlds on the continuation branch need to leave all matters "intrinsic to *e*" as they are. So when we're saying Mary was crossing the street (in the run-over-by-a-truck scenario described in (15)b), we take into consideration worlds where the seemingly-independent event of the truck's movement is altered (or removed altogether), but we shouldn't allow a transfer to a world where Mary turns around mid-crossing, avoiding the truck. Such a move would compromise the cross-world identity we seek between the event *e* in the world of evaluation and its counterpart *f* (of which it is a stage). How then, when we adapt Landman's framework to *before*, can we turn to alternative worlds where the *B*-process (Mozart's Requiem-writing) is being changed to a point where this principle is in obvious jeopardy? We're moving it backwards and forwards in time, shortening it and even hastening more advanced stages than the one reached in our world. Can this be done without harming the intrinsicness principle?

While there is a general argument to be made here, that outside circumstances which set worlds apart may be such that they entail time-shifts which are necessary in order to preserve matters which are intrinsic to the process, in the case of *before* matters are even more straightforward: the construction itself contains both an *A* and a *B*. In fact, *A* even holds the more syntactically-powerful position of being the main clause of the sentence. Given what we observed regarding the necessity of a preventative relation between *A* and *B* in felicitous nonveridicals, a sound account will need to build on this connection and encourage cases where the two are intricately related. This can be achieved by relaxing the required intrinsicness of *B*'s acceptable alternatives to cases where the change in its process may be attributed to the change in the event described by *A*²⁷.

²⁷ For regular unaccomplished progressives, this relaxation can also save the same problem as observed earlier. It will be less elegant, though: the interrupting event (equivalent to *A* in the *before* case) will

For our case, and under the given context, Mozart’s death was not a truck coming out of nowhere. It was an ongoing, steady process of decline, and it undoubtedly affected the Requiem-writing process. We know that Mozart was a diligent composer, and pressed for cash. It should be safe to assume that barring the physical process that led to his death on December 5, he would have been able to write more every day, accelerating the writing process to an early culmination. Alteration of the dying process frees up time, for which the natural fill is a more productive writing process. If we agree that a property of the Requiem-writing process, like all of Mozart’s writing, is that it takes every available interval in a consecutive period of time (“Mozart wrote whenever he could”), it becomes clear that intrinsicness is kept under removal of the dying process. An alternative to this property would be a stable-writing-pace property, and I argue that of the two, the former is more fitting to the context.

A PROCESS-BASED FELICITY CONSTRAINT

Given these two slight re-interpretations of the original Landman plan, the advantage in utilizing it for an account of *before* becomes significant. I will try to reformulate a new felicity constraint on an event-basis, thus enriching the primitive ontology, but reaching a much simpler and smoother result, that will have no less power than the complex one in (28)b. The new version of continuation will avoid the problems the Mozart sentence faces with the Empire’s annihilation scenario; the new *A*-relaxed intrinsicness will give us a way to deal with preventativity: the Tang example in (25)b will be incorrectly predicted as felicitous only if outer-space soft drink consumption (*A*) can be convincingly argued to be intrinsic to the process which would have led to a successful moon-landing (*B*).

Let us formulate the following:

(33) A sentence of the form *A before B* is felicitous in *w* (given uninstantiation of *B* in *w*) iff there is an event *e* which goes on in *w* and extends at least until *A*’s occurrence, and there is a world *v* ≠ *w* s.t. *A* does not precede *B* in *v*, and the continuation branch of *e* includes an event *f* in *v*, which embodies an instantiation of *B*.

need to be extracted from context, usually within a sentence or two away from the progressive itself (sometimes less: *Mary was crossing the road when she got hit by a truck*).

This does indeed seem less clumsy²⁸, and it is more intuitive in the way it grasps the notion of what we expect *B* to be in the crucial time leading up to *A*: a *B*-process underway.

Taking a look at the examples from the previous chapters we can see that this constraint works:

The parenthetical remark restricts us to nonveridicals, so all veridicals are predicted to be felicitous in the same way they were in (28)b.

The Mozart example is predicted to be felicitous, as shown in the discussion leading to the formulation of this constraint.

The ketchup example is predicted to be infelicitous because any world with a complete gold-medal winning streak is not reasonable and will not fit in the continuation branch.

In the Beersheba example, the process which was interrupted is clearly not one which in an alternative world culminates in arriving at Beersheba. Any such turn of events can easily be argued to be a separate process starting once I change my destination, or a different one altogether (from the moment I started driving).

The battery example is fine if we consider a case where I started charging the battery earlier, knowing that the sun's expected setting puts me in jeopardy of the battery not finishing the charge (note that a world where the battery finished charging is one where the sun didn't set earlier, fulfilling the "A does not precede B" requirement on *v*).

The falling pencil is more straightforward than this – since it was rolling on the table, it is an event which given me not stopping the pencil would have resulted in a fall.

The Apollo example is the reason the "A does not precede B" requirement was added: while the process of making a successful landing can be admitted in an alternative world on the continuation branch, there is no reason why in that world the

²⁸ An alternative, more minimalistic way of turning the CBPS-based felicity constraint to an event-based one would be to leave it as is and change only the definition of *pursuit*. This can be the following: $\llbracket Pursued(X) \rrbracket_{w,t} = 1 \Leftrightarrow \exists e \in E_w. t \in time_w(e) \wedge \exists \langle f, v \rangle \in CON(e, w). \llbracket X \rrbracket_v(f) = 1$; where E_w is the domain of events taking place in w ; $time_w(e)$ is the (continuous) set of times where e takes place in w ; $CON(e, w)$ is the continuation branch of e in w formulated as ordered pairs of events and the world they happen in; and $\llbracket X \rrbracket_w(e)$ is interpreted as "e is an X-event taking place in w".

This sets aside the agent/cause-selected modality base, but the modal is very much present in the resulting constraint, via the continuation branch. It restricts us to alternative worlds which are reasonably far away from ours, but now allows early culmination of *B* as required by the Empire destruction scenario.

orange Tang consumption should be different; if we are indeed looking for a *nearest* world in which the *B*-seeking process continues (as (16)c.ii dictates), then one where the orange Tang is finished prematurely should be the one chosen in every step in the process-lengthening. The sentence thus fails on the last requirement, and a correct prediction is achieved. A devil's advocate may now suggest that the Tang problem was connected to the landing problem, to which I will reply that in that case, the sentence is felicitous to begin with.

To sum up, a Landmanesque event-based felicity constraint for nonveridical *before* is definitely possible, and is even easier to swallow than a non-event-based one. I will not suggest clear-cut empirical advantages for either one, but from here on I will refer to the event-based when needed, due to its simplicity.

5. DISSECTING THE PRAGMATIC CONSTRAINTS ON FELICITY OF *BEFORE*

So far we have discussed the extent to which a *before*-statement can be considered true and felicitous, with special attention to the nonveridical cases. In a subclass of these, the ones where the subject's death prevents the accomplishment of a task, we only looked at one example, namely that of Mozart and the Requiem. In the present chapter, an extended set of "morbid nonveridicals" will be examined. As will become apparent shortly, minor adjustments to the situation in which the deceased was prior to his death, as well as adjustments to the nature of the task attempted, have an effect on **how** felicitous the *before*-statement is. An extra twist for this class of examples will be that the effect of an added modal operator, *could*, to each of the *B*-clauses will also be examined.

The chapter is organized as follows. First, I will introduce eight scenarios, each with its two sentences (with and without an added *could*) and their respective acceptability judgments, and a brief explanation of its contribution to this class of examples. Then I will define a metric based on the hypothetical possibility of *B* under the assumption that the protagonist in the scenario does not die when he does, thus extending the limited version of this notion which appeared in the previous chapter. Then, I will show the link between how acceptable the sentences are judged and this suggested metric, leading to discussion of some interesting findings. Since there is some departure from the concepts defined in the previous chapters, an intermediate section will be devoted to bridging the gap between the two analyses.

INTRODUCING AN EXTENDED SET OF “MORBID NONVERIDICALS”

Raw acceptability data for the following examples was collected from several native English speakers of differing backgrounds and showed consistency among the judgments.

FOUR DEAD ARTISTS: MOZART THE UNLUCKY; KAFKA THE AGNOSTIC;
SCHOENBERG THE UNABLE; SCHUBERT THE UNWILLING

Mozart’s illness: this scenario has been amply presented already, yet for the sake of completeness I repeat a summary of it here:

Mozart’s illness started in May of 1791, shortly after he began composing the Requiem. He continued writing while his situation got worse and worse, and eventually he died in December, Requiem unfinished.

Both sentences, with or without *could*, are fine:

(34) (= (1)) Mozart died before he finished the Requiem.

(35) Mozart died before he could finish the Requiem.

Moreover, it seems the two versions are almost interchangeable within the context. Are nonveridical *before* sentences immune to the modal effects of *could*? As the following examples will show, that is not the case.

Kafka’s apathy: Kafka set aside his unfinished work *The Castle* a few years prior to his death, and it is not known whether he intended to finish it or not.

(36) Kafka died before he finished *The Castle*.

(37) Kafka died before he could finish *The Castle*.

Both sentences are felicitous in the context described, yet the *could*-free (36) is more acceptable by the informants. It is possible that since Kafka technically **could** complete the work within his lifetime but chose to postpone it, it makes less sense to utter (37).

Schoenberg’s writers’ block: Schoenberg wanted to finish *Moses und Aron* and intended to do so for decades, but didn’t have the right inspiration.

(38) Schoenberg died before he finished *Moses und Aron*.

(39) Schoenberg died before he could finish *Moses und Aron*.

Again both sentences are felicitous in the context described, only here the *could*-form (39) is preferred by speakers. Here it appears that the modal operator acts in the way we would predict if we assume its effect over morbid *before* nonveridicals to be purely compositional – from *A before B* to *A before ◊ B*. On that assumption, the felicity constraint is easier to fulfill for (39) than for the plain (38), because the conditions under which the bare *B*-sentence may be true in our world are weaker: seeing as all modal relations we are dealing with are reflexive, “Schoenberg WILL finish M&A”_{w,t} entails “Schoenberg CAN finish M&A”_{w,t}²⁹, but not vice versa. Considering the context, assessing the likelihood of Schoenberg’s being able to complete the piece is more convenient than assessing the likelihood of his actual completing it (both while assuming his death has been delayed).

Schubert’s lack of desire: Schubert abandoned writing his 7th Symphony years prior to his death in 1828, with no real intent of ever finishing it.

We finally find an infelicitous example, the one in (40).

(40) # Schubert died before he finished the 7th.

It seems that even with removal of Schubert’s death, his completing the 7th is not likely. An alternative scenario where Schubert changes his mind later on in life, for some unpredictable reason, is deemed too unreasonable.

Will adding *could* make the situation better or worse?

(41) (F) Schubert died before he could finish the 7th.

To our surprise, this question cannot be answered conclusively. On the one hand, the sensation is that (41) is a felicitous thing to say given what we know, but on the other hand, it is a **false** claim to make. Schubert *could* have finished the 7th, well before his death. He simply *didn’t want to*.

It would seem that the *modal base* plays a crucial role here. (40) is infelicitous, we feel, because Schubert’s death was not the leading cause for the symphony’s not being completed. There was no *physical* inability to complete, but a *volitional* one. (41) coerces us into addressing the issue of physical ability. Since we know Schubert was at a state of physical ability to complete the 7th prior to his death, we must judge the sentence to be false.

²⁹ The subscripts indicate the world and time relative to which the utterance’s truth conditions are evaluated.

THREE DEAD MATHEMATICIANS: FERMAT THE PROVABLE; GÖDEL THE UNPROVABLE; RIEMANN THE UNKNOWN

Proving Fermat's Last Theorem: Scheuler, the renowned German mathematician, died in 1990. His lifelong dream was to prove Fermat's Last Theorem, an effort to which he devoted his life, with no success. The theorem was eventually proven by Andrew Wiles in 1996.

(42) Scheuler died before he proved Fermat's Last Theorem.

(43) Scheuler died before he could prove Fermat's Last Theorem.

Both sentences are acceptable, though the second is slightly easier to accept. We do not know how close Scheuler was to a proper proof when he died, but it seems reasonable to accept that he was in the midst of a process which would ultimately lead to a proof.

Proving mathematical completeness: renowned French mathematician Chalois died in 1918, having failed his ambitious goal of trying to prove the consistency of Peano arithmetic³⁰. Little did he, nor did most contemporary mathematicians, know that this feat was unachievable. Gödel proved the impossibility of proving the consistency of Peano arithmetic in 1930.

(44) # Chalois died before he proved the consistency of Peano arithmetic.

Obviously, even if Chalois hadn't died when he did, he never would have been able to prove an unprovable conjecture. But adding the modal achieves some improvement:

(45) #? Chalois died before he could prove the consistency of Peano arithmetic.

This sounds better, though the facts are the same: no conceivable alternative turn of events is one where the conjecture is provable, so it is impossible that had Chalois not died, he would eventually have succeeded in proving it. But the modal does seem to add some felicity, regardless of the *B*-clause being false under every set of circumstances.

³⁰ Accuracy dictates this be "proving the consistency of Peano arithmetic *from within itself*". This last part will be omitted from now on for brevity.

Proving Riemann's Hypothesis: renowned Italian mathematician Scernoulli dedicated his life to proving Riemann's Hypothesis, but he died in 1956. The provability of Riemann's Hypothesis is unknown to this very day.

As (44) in the previous scenario was infelicitous, so is (46):

(46) # Scernoulli died before he proved Riemann's Hypothesis.

But this time, adding the modal generates the *felicitous* (47):

(47) Scernoulli died before he could prove Riemann's Hypothesis.

This is the only scenario where a sharp felicity contrast is created depending on the presence of *could*. This property will be covered in the discussion later in this chapter.

ONE DEAD ORDINARY MAN: THE OBLIGATORY

John's birthday: John was born on June 2, 1934. He died on June 1, 2004.

(48) John died before he turned seventy.

(49) ? John died before he could turn seventy.

(48) is excellent. (49) is a bit odd, but on the whole acceptable. Still, there's no doubt that the former is preferred, and the reason should be clear: John is necessarily headed towards turning seventy. If all alternative worlds lead there, softening the *B*-clause with a modal seems unmotivated and unpragmatical. We don't even have to venture to *before* for this conclusion: adding a modal to any such strong necessity is bizarre: ??*John can turn seventy tomorrow*, judging under an assumption that we all know it's going to be his birthday and his health is fine.

FINDING A GENERALIZATION

The above scenarios, though only briefly introduced, seem to create a varied range of differing behaviors, one which we would like to be able to predict. Two scales of difference are apparent: the first is how possible the completion of the task at hand, assuming removal of the untimely death, is considered; the second is an acceptability scale, which involves both (i) different degrees of felicity of the bare *before*-sentences and (ii) differences in the relationship between the degree of felicity of the bare sentence and that of the version where the modal *could* is added to the *B*-clause. I will now formalize these two scales using two new analytical elements: **Hypothetical Possibility** for the first; **Operator-Affected Acceptability** for the second.³¹

GRADED MODALITY AND HYPOTHETICAL POSSIBILITY

Given a proposition X , a constant set F of all epistemically accessible possible worlds and a constant set G of all the worlds “reasonably similar” to ours^{32 33}, define the following unary modal operators (the last five introduced by Kratzer (1981a), the first added here).

(50) Grades of Modality:

- a. $\Box_p X$ denotes **Physical/Logical Necessity**, manifested in natural language as “definitely, X ”: no matter what our knowledge of the state of affairs is, X is true in any world which is at a logical (or even physical) consistency with ours.³⁴

³¹ As noted in the introduction to the chapter, these notions focus on different aspects of the examples than the ones focused in the previous chapters (for example, the temporal dimension is not treated in the same way). The next section will reconcile these differences.

³² I posit that F and G are “constant” because I do not wish to dispute or change the truth values of modal propositions in the course of this chapter, where I provide the context as part of the data. The theory, of course, applies to contextually-selected F s and G s just as well.

³³ G is formally constructed by extending a similarity sphere from an *ideal world* i , which may or may not be consistent with ours. As we wish $F \cap G$ to never be empty, we will require G to be at least as wide as to contain our world (which F contains by definition).

³⁴ $\Box_p X$ is my contribution. Note that it does not make use of either F or G . A formal definition for it in the vein of the grades to follow would be “ $W \subseteq X$ ”, where W is the set of all worlds, or at least all physically accessible ones.

- b. $\Box X$ denotes **Epistemic Necessity**, manifested as “necessarily, X ”: our knowledge of the universe and of the state of affairs entail X , or formally $F \subseteq X$.
- c. $\Box_h X$ denotes **Human Necessity**, manifested as “probably, X ”: X is true in any world which is both reasonably similar to ours and epistemically accessible from it. Formally, $(F \cap G) \subseteq X$.
- d. $\diamond_h X$ denotes **Human Possibility**, manifested as “it can well be that X ”: X is true in at least one world which is both reasonably similar to ours and epistemically accessible from it. Formally, $F \cap G \cap X \neq \phi$.
- e. $\diamond X$ denotes **Possibility**, manifested as “possibly, X ”: X is true in at least one world which is epistemically accessible from ours. Formally, $F \cap X \neq \phi$.
- f. $\diamond_s X$ denotes **Slight Possibility**, manifested as “it is slightly possible that X ”: X is true only in worlds which are not reasonably similar to ours. Formally, $G \cap X = \phi$. A very strong implication in this case is that X is possible, i.e. $\diamond X$, so we will add this as an explicit condition to our formal definition:
 $G \cap X = \phi \wedge F \cap X \neq \phi$.

Using the specified natural language manifestations, speakers may intuitively assess the modal grade of any proposition X .

Side note: For symmetry’s sake we may argue for a physical possibility operator \diamond_p , which would turn out to be equivalent to (or at least would strongly imply) \diamond_s : X is possible, but only in a “technical” manner. The speaker does not feel comfortable having to state that X is possible and is doing so in a very non-committed way. A completely symmetric \diamond_p , however, will need to be independent of F , as \Box_p is.

Observation: The modal grades defined above satisfy the following chain of entailments (for any proposition X): $\Box_p X \Rightarrow \Box X \Rightarrow \Box_h X \Rightarrow \diamond_h X \Rightarrow \diamond X$, in effect forming a modality strength scale (to which $\diamond_s X$ may be added at the bottom even if there is no entailment, because it is more restrictive on X than $\diamond X$ in an obvious manner). In addition, the equivalence $\Box_h \neg X \Leftrightarrow \diamond_s X$ holds.

Next, the application of these grades of modality to our domain:

(51) Given a nonveridical sentence of the form *A before B*, define its **Hypothetical Possibility** (HP) to be the strongest modal value (under the scale defined in (50)) of *B* when removing *A*'s occurrence as manifested in our world³⁵.

HP and the event-based account: using this device within the Landman framework as described so far is straightforward and does not require additional constructs: as we recall, the construction of the continuation branch for an event *e* which occurs in *w* relies on continuation worlds being included in the set of “reasonable options”, $R(e, w)$. In the *before* case (see (33)), the existence of a *B*-instantiating event *f* in a continuation world *v* is what grants the sentence felicity.

I now suggest a stipulation under which the contents of the set $R(e, w)$ are determined by the **same ordering source** from which we infer the Hypothetical Possibility of a *before*-sentence: such an ordering source is present in the definition of *G* as the set of worlds which are close to the ideal, which is in turn necessary for determining most of the grades which define HP. $R(e, w)$ and *G* may now be compared in terms of set inclusion, since both are centered in the ideal *i* (and after intersection with *F*, in *w*) and both expand according to the same source.

Having stipulated the above, the notion of HP now corresponds to a gradation of $R(e, w)$, with the different modal grades corresponding to $R(e, w)$'s of varying “diameter”. As $R(e, w)$ is enlarged the chances of finding a world *v* where a *B*-fulfilling continuation of *e* occurs increase, but our findings lose force as we must now see worlds further from the ideal as “reasonable” enough for the purpose of creating the continuation branch: when the HP is $\Box_p X$, a singleton $R(e, w)$ (comprising of the ideal itself) is enough. For $\Box X$ and $\Box_h X$, extend $R(e, w)$ to include the nearest epistemically-consistent world and the continuation will be found³⁶. For \diamond_h

³⁵ Meaning, if *A* culminates a lengthy process (like a long fatal disease) the entire process is removed or substantially reduced in scope; if *A* is a momentary event (like a truck hitting someone), it is removed altogether. The point is to allow *B* (or the process leading to it) to continue without interference from *A*. As the two get more and more interconnected, or if *A* is believed to be inevitable, the amount of change we allow in *A* compared to our world's manifestation of it may decrease.

For now, we will leave open the means by which *A* is removed from our frame of reference.

³⁶ The difference between these two grades reduces to a measure of “caution” – extending $R(e, w)$ beyond *G* does not affect $\Box X$, but decreases the proportion of worlds suitable for $\Box_h X$.

further extension of $R(e, w)$ is probably in order, but it is upper-bounded by G . For \diamond it might extend beyond G , and \diamond_s it definitely will.

Scenario evaluation: the property defined in (51) will allow us to order the scenarios above, from most hypothetically-possible to least:

(52) Preventative *before* scenarios ordered by Hypothetical Possibility:

a. Bare form (no *could*):

Scenario (+ judgment of bare form, no <i>could</i>)	Strongest modal grade of B if A 's occurrence is removed
Turn 70 (mandatory)	$\Box_p B$
Mozart (fervent pursuit)	$\Box_h B$
Kafka (willingness unknown)	$\diamond_h B$
Fermat's Last Theorem (proof possible)	$\diamond B$ ³⁷
Schoenberg (writers' block)	$\diamond_s B (\Leftrightarrow \Box_h \neg B)$
# Riemann Hypothesis (proof availability unknown)	\perp (undefined) ³⁸
# Schubert (unwilling)	$\Box \neg B$ ³⁹
# Mathematical completeness (proof impossible)	$\Box_p \neg B$

b. Form with *could*:

Scenario (+ judgment of <i>could</i> form)	Strongest modal grade of <i>could</i> B if A 's occurrence is removed
(?) Turn 70 (mandatory)	$\Box_p (\text{could}(B))$
Mozart (fervent pursuit)	$\Box (\text{could}(B))$
(F) Schubert (unwilling)	$\Box (\text{could}(B))$
(?) Kafka (willingness unknown)	$\Box_h (\text{could}(B))$
Schoenberg (writers' block)	$\diamond_h (\text{could}(B))$
Fermat's Last Theorem (proof possible)	$\diamond (\text{could}(B))$
Riemann Hypothesis (proof availability unknown)	$\diamond (\text{could}(B))$
# Mathematical completeness (proof impossible)	$\Box_p \neg (\text{could}(B))$

The judgments in (52)b are murkier than (52)a due to the added complexity of the assessed situation, and some of them clearly refer to different modal bases than the others, but the picture they paint is clear: while the plain forms' HP correspond nicely

³⁷ While we do not know whether Kafka intended to finish *The Castle*, we are sure of his ability to do so. For the proof of Fermat's Last Theorem more is needed than will, and we are less sure of Scheuler's ability to get on the right path. As it is less up to the protagonist, I believe the gap between the HP assessments for these cases is justified.

Further discussion of HP-assessment matters will take place in the next section.

³⁸ A way of formalizing our (current, epistemic) lack of ability to determine the (physical) possibility of proving the Riemann Hypothesis can be $\diamond (\diamond_p B) \wedge \diamond (\neg \diamond_p B)$, but this does not translate to a rank in the HP scale.

³⁹ This judgment is based on the given context, where Schubert's unwillingness is described as very strong.

to their acceptability value, making an extension to the previous chapter's results immediate, the *could*-sentences' acceptability cannot be explained by HP. Specifically, consider the following pairs of *could*-sentences, in which the basic acceptability ordering contradicts their hypothetical possibility ordering:

John could turn seventy is surely a necessity if his death is postponed (the modal does nothing to the basic possibility value), and *Schoenberg could finish M&A* is a human possibility (at best) if his death is postponed. But *Schoenberg died before he could finish M&A* is judged as more felicitous than *John died before he could turn seventy*.

Likewise, *Mozart could finish the Requiem* is a (perhaps human) necessity when removing his death, yet *Mozart died before he could finish the Requiem* is better than *John died before he could turn seventy*.

Kafka could finish The Castle, in turn, is a more probable outcome had he not died compared to *Schoenberg could finish M&A*. Yet once again, it appears that *Schoenberg died before he could finish M&A* is better than *Kafka died before he could finish The Castle*.

Adding to this the Schubert example, for which the observation that it is felicitous but false does not make its ranking stand out in any way, I propose the hypothesis that the base-form sentences and the *could*-sentences are tied in ways that affect their acceptability, but it is some **joint** acceptability notion which must be defined in order for this connection to show. I offer such a notion in the following section.

Given a sentence X and an overt sentential operator (such as addition of a modal lexical item to the sentence's subordinate verb phrase) Op , define the **Operator-Affected Acceptability** $OAA(X, Op)$ to be a function of the bare acceptability degrees of X and $Op(X)$ inducing the following ordering relation⁴⁰:

(53) $OAA(X, Op) > OAA(Y, Op)$ if, and only if:

- a. X is acceptable and Y is not; or
- b. Both X and Y are unacceptable, and $Op(X)$ is more acceptable than $Op(Y)$; or
- c. Both X and Y are acceptable, but X is preferred to $Op(X)$ more than Y is preferred to $Op(Y)$.

In our case, as the introduction of the scenarios has suggested, we shall assign to Op the addition of the modal *could* to the subordinate verb phrase of X , and denote it \mathcal{C} (so the examples in the chapter were introduced by the forms X , “Mozart died before he finished the Requiem” and $\mathcal{C}(X)$, “Mozart died before he could finish the Requiem”). The objective of this metric is to express the perceived differences between the scenarios, based on the different interactions that were observed between the two sentence versions (with and without *could*), while **generalizing the classic notion of acceptability**. The latter goal is obtained via the intuition that (a) if the plain sentence versions of two scenarios differ in acceptability, this is a powerful enough preference to keep (ensuring the desired generalization of classic acceptability); (b) if both plain forms are not acceptable, default to the *could* version for a tie-break; and (c) if both plain forms are acceptable, pick the scenario which least needs the *could* version to anchor its acceptability. Namely, the one where the plain version is more preferred to the *could* version.

As this is a strict ordering definition, it will create an ordered scale for our scenario octet.

⁴⁰ I am interested only in the ordering of various sentences according to the proposed scale, but an equivalent numeric metric may be defined for evaluation of a single sentence-operator pair, while making sure it induces the described order.

It turns out OAA gives us exactly what was missing in the initial attempt to predict acceptability using HP. In the following table, the scenarios are ordered by OAA, with \mathcal{C} assigned to Op , from most (top) to least (bottom). The rightmost column will show the hypothetical possibility of the plain-version *before*-sentence of the scenario (i.e. no *could*), as already shown in (52)b.

A legend for acceptability marks: ‘✓✓’ denotes an excellent sentence with no problems; ‘✓’ denotes a felicitous sentence; ‘#’ denotes one which is senseless (in that our perception of B makes *before* unacceptable); ‘✓?’ means judgment tends towards felicity but remains odd. One example is felicitous but false: we know that Schubert very well *could* finish the 7th prior to his death, but *chose* not to.

(54) *Before* scenarios ordered by *Could*-Affected Acceptability, with their dual judgments and (previously-found) hypothetical possibilities:

Scenario	Judgments			Hypothetical Possibility
	Plain form: <i>A before B</i>	With <i>could</i> : <i>A before C(B)</i>	OAA(\mathcal{C}) Summary	
Turn 70 (mandatory)	✓✓	✓?	Plain form much preferred	$\Box_p B$
Mozart (fervent pursuit)	✓✓	✓	Plain form preferred	$\Box_h B$
Kafka (willingness unknown)	✓	✓?	Plain form somewhat preferred	$\diamond_h B$
Fermat’s Last Theorem (provable)	✓	✓	Forms equivalent	$\diamond B$
Schoenberg (writers’ block)	✓?	✓	<i>Could</i> form much preferred	$\diamond_s B$
Riemann Hypothesis (provability unknown)	#	✓	Only <i>could</i> form acceptable	\perp
Schubert (unwilling)	#	✓? (False)	Only <i>could</i> form acceptable, but less than RH	$\Box_{\neg} B^{41}$
Mathematical completeness (unprovable)	#	#	Neither form acceptable	$\Box_p \neg B$

⁴¹ As already noted, this judgment is based on the given context, where Schubert’s unwillingness is described as very strong. Were it judged to be $\Box_h \neg B$, I would argue that the plain form sentence might become acceptable, as in Schoenberg’s case.

The most obvious observation from the table above is that the OAA scale (by which the rows are ordered) precisely matches the entailment scale of “probability of *B* if *A* as it is in our world is removed”. Leaving the Riemann Hypothesis scenario aside for now (it does in fact fit in the scale, as we’ll see shortly), I propose:

(55) The Modal Generalization of Nonveridical *before* Felicity:

The more probable *B* would be if *A*’s occurrence as it is in our world is removed, the more *Could-Affected Acceptable A before B* is, and vice versa.

Formally: let *X*, *Y* be nonveridical *before*-sentences. Then $HP(X) > HP(Y) \Leftrightarrow OAA(X, C) > OAA(Y, C)$.⁴²

Next, collecting the cases where the plain form is acceptable yields:

(56) The Fine Modal Requirement for Preventative *before* Felicity:

For preventative *A before B*, without overt modal operators, to be felicitous, the removal of *A*’s occurrence as it happened in our world should make *B* at least **slightly possible**.

I believe the Modal Generalization (55) carries meaning: Hypothetic Possibility on the plain form has been reasonably isolated as a variable between the example sentences, between which judgments differ. It is not too bold to suggest that this construct (which is intuitively calculable from each sentence) indeed plays a role in a speaker’s assessment of the sentence’s acceptability, and even more under the explicit connection which was earlier suggested between HP and the event-based account of *before*. Since OAA is a finer notion of acceptability than the basic single-sentence one (yet consistent with the relations between its values), and since it aligns so convincingly with HP in this case, it proves itself to be well-founded as well. As the

⁴² In keeping with the model where propositions are equated with the sets of worlds which verify them, this generalization indicates there is a link between felicity of a nonveridical *before*-proposition and the set of worlds where *B* would be true if *A* is removed; or of the connection between two such propositions – let *X*, *Y* be nonveridical *before*-sentences and define *Hyp*(*X*) to be the set of worlds where *A* as it happened in our world is removed and *B* is true, then one side of the generalization becomes $Hyp(X) \subset Hyp(Y) \Rightarrow OAA(X, C) < OAA(Y, C)$.

OAA mechanism is applicable to any sentential operator, future research may find this notion useful for other classes of sentences as well.

As for the Fine Modal Requirement (56), we have seen how it can be placed in line with the felicity constraint formulated for general *before*-sentences in the previous chapter. Assuming the event-based approach described in (33) is embraced, including the connection between the event-based interpretation of *before* and the definition of HP which was suggested following (51), this new requirement merely states that the reasonable set of worlds $R(e, w)$, used to calculate the continuation branch when we look for a completed *B*-event in a non-*A*-interruptive world, is allowed to be wide enough to include worlds in the **slight possibility** realm, i.e. worlds that are compatible with our epistemic state to a reasonable degree, without insisting too much on their distance from the ideal. Do note, however, that this has been demonstrated to be the case only for a restricted set of preventative *before* sentences, where the interruption is death. While I do not believe there is a reason it should not apply to other cases, I will not include discussion of that in the present work.

We do have one loose end to tie in the current wording of (56): the Riemann case is still in an undefined position. Today, proving the Riemann Hypothesis is not at least slightly possible, as (56) dictates, nor is it the converse. An **epistemic barrier** exists which bars us from assigning it the necessary value, forcing us to reword the requirement to the following:

(56') For preventative <i>A before B</i> , without overt modal operators, to be felicitous, the removal of <i>A</i> 's occurrence as it happened in our world should make <i>B</i> known to be at least slightly possible. ⁴³

The Riemann example is now covered, and correctly predicted to be infelicitous.

⁴³ A formal paraphrasing of this new version could be: in plain nonveridicals, an epistemic HP value must exist, and it must be equal to or greater than slight possibility.

DISCUSSION

Arriving at the formal results above was the key objective of this chapter. However, due to the limited scope of discussion given to each scenario upon its introduction, some issues were left unresolved, together with other points available for analysis only now, when the whole gamut of scenarios has been unfolded. These will now be addressed, and though some may seem only tangent to the main discussion, I believe each one contributes something to our understanding of the connection between *before* and modality.

THE PROCESS BEING INTERRUPTED AND WHATEVER IS BLOCKING IT

A common trait of all examples in (34)-(49) is that they deal with processes of various length and status being interrupted by the death of the person who was to complete them. One involves the mere physical requirement of living (thereby turning 70), four others involve a work of art that needs to be finished (Mozart is working on it, Schoenberg is mentally blocked, Schubert is volitionally blocked, Kafka is taking his time), and the other three are mathematical proofs which differ in their level of achievability, in a very strong logical-physical sense (the consistency of Peano arithmetic is known not to be achievable, Fermat's Last Theorem is known to be, Riemann's Hypothesis might still turn out either way). Each of these give different answers to the following questions: Is there a process at the time of death?; Is it the process described by the B-clause?; Is the death really what stopped it from culminating?.

I will address each of the questions shortly, but first it is important to note that these are not questions directly related to the acceptability of the sentences, as formalized in the results section. Instead, they pertain to a more primitive construct, the **Hypothetical Possibility** of the situations (or in the Landman framework, deciding whether or not the continuation branch extends to worlds which continue the supposed process), so answering them should help understand how the construct is assessed and reduce its seeming arbitrariness. Having this discussion will not completely save us from individual bias in judgment of a scenario's HP level (or inter-world stage relations of events), but it will give us tools to explain our choices.

In any event, conclusions reached in this section will not affect the results from previous ones.

The first question (*Is there a process at the time of death?*) is challenged by Schubert's example. Since he had already given up on the 7th symphony years prior to his death, it was a process in an enduring state of pause, if a process at all. Finishing the symphony is no longer an issue at the time preceding his death, and it is not far-fetched at all to claim that indeed there was no process.

Schoenberg's writers' block example is a lesser challenge to this question: we know that for him, the process has never ended. To us as speakers, the protagonist is the most important factor in a creative process, and will is a strong force, so imagining a possibility where Schubert "all of a sudden" wants to complete his 7th symphony rings worse than a possibility where Schoenberg's writers' block is lifted.

The second question (*Is it the process described by the B-clause?*) is relevant to all three mathematical examples. On the face of it, all three mathematicians are in the middle of a mathematical process. Each believes he is on the way to proving the theorem (as given in the context), but we have more information. While further context can help determine whether Fermat's Last Theorem was really on the way to being proven at the time of Scheuler's death (for example: Wiles used some of Scheuler's interim results for his 1996 proof), the Peano consistency case is much more straightforward in that we know for sure a process of Chalois proving it was not taking place. In the scientific realm, laws of nature and logic are more powerful to us than the protagonist and his skills and mental state.

The Riemann-proving Scernoulli is in limbo. Until we know whether the Hypothesis is true or false, he could either have been in such a process or not. Any further context regarding the nature of his work is useless until this epistemic barrier is lifted, leaving us with a "meta-epistemic" question left unanswered.

The third question (*Is the death really what stopped it from culminating?*) brings together our artists and our mathematicians (needless to say, in the "turning 70" example the answer to this question is the clearest affirmative, justifying its place on top of our Hypothetical Possibility scale). Here we may find another rough connection to the ordering of modality from table (54). With Mozart it can be stated with some certainty that the death is the only blocker, and even if not so – it is the major one. No information we have regarding Mozart's writing process leads us to think of another.

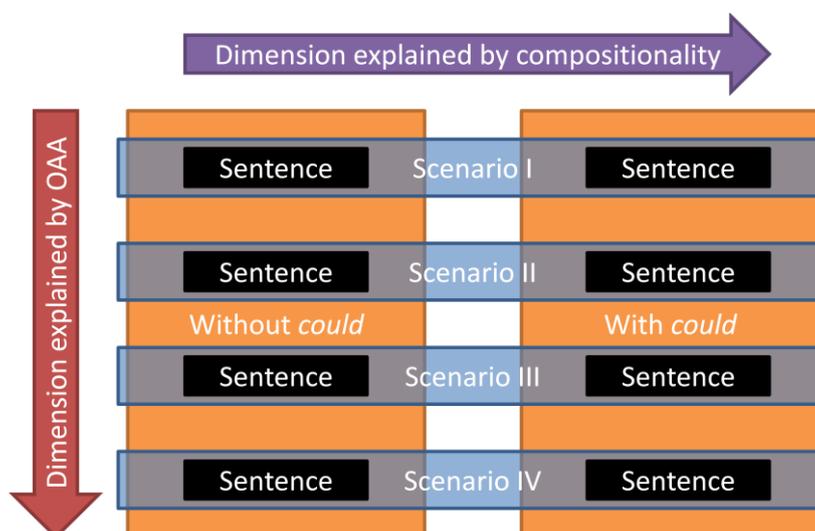
Our discussion of Schubert and Schoenberg earlier applies here as well: their blocks (volitional or creative, respectively) are significant and may be just as much at fault regarding the pieces' incompleteness as their deaths. Peano's proof-attempter faces a blocking force stronger than death itself, and (leaving Riemann's Scernoulli aside once more) we are left with Kafka and Fermat's Scheuler, for whom we can answer this question with "we don't know", given our context. Table (54) orders the answers to this question neatly: first "of course", then "probably", then "we don't know", then "it's hard to determine" and lastly "certainly not".

THE MODALS' ROLE IN SENTENCE EVALUATION

In the same manner that the previous discussion dealt with assigning Hypothetical Possibility to situations based on properties of the processes they deal with, it seems the underlying facets of *could*-affected-acceptability may be uncovered via a closer scrutiny of how the placement of *could* in each of the *before*-sentences affects its meaning (and through it, its acceptability).

In the previous section it was shown that a completely compositional treatment of *could* as simply a modal modification of *B* cannot explain the relative raw acceptability of the *could*-sentences when taken as a separate set. But this might not be the case for the relationships **between each plain-form sentence and its *could* counterpart**. These interactions were only briefly mentioned, in the introduction of the scenarios, and now that we have a fuller mechanism and the whole set of examples we may address each more seriously.

(57) *Relations and explanatory theories along the example sentences (schematic):*



In order to explain the effect of *could* in each scenario, the underlying assessment of HP needs to be more thoroughly analyzed. If first we understand what it is that the definition in (51) calls “removing *A*’s occurrence as manifested in our world” (which is clear enough to form judgments but not well-defined enough to study them), we may then proceed to finding the way by which the overt modal *could* influences the process of assessing a scenario compared to the situation where only a covert modal is present, in the form of *before* as analyzed so far.

The first question which arises from the definition of HP is in what way *A*’s occurrence is “removed” in order to produce the modality grade judgments. One option is to find the nearest world to ours in which *A* does not happen as it does in ours (*w*), and relative to this world (call it w_{-A}) assess the modality grade of *B*. Another option is to modify our universe – the set of worlds which forms the basis of modality grade assessment, that set from which we extract *F* and *G* – to contain only those worlds in it where *A* does not happen as in our world. This second option appears to better represent the hypothetical “if *A* hadn’t happened, how likely would *B* have been?”, if only for the fact that w_{-A} is fairly close to ours and so making the assessment relative to it might include *A*-worlds (e.g. *w* itself), which would result in assessing the hypothetical with access to *A*-worlds, which is clearly not intended by the quoted phrasing. We’ll call the resulting world sets *F*’ and *G*’, for no-*A*-modified *F* and *G*, respectively.

Having decided *A*’s removal mechanism, we can try and explain the judgments for a sample of bare sentences, as presented in table (52)a.

John’s turning 70 (sentence (48)) is straightforward. In all worlds minimally different from our own world, enough to ensure that John does not die in them as he did in ours, but otherwise consistent with it, he turns 70. Its judgment as $\Box_p B$ is well-predicted.

Mozart finishing the Requiem in (1) is also clear enough. Under the no-death minimal alteration, Mozart finishes the piece in all worlds that are consistent with everything else that we know and that are still close to the ideal: Mozart’s composition capabilities, the fact that he was highly motivated to finish (both artistically and financially), etc. In worlds which do not share these properties culmination is not guaranteed, and so a level of HP higher than $\Box_h B$ cannot be granted.

In the case of Kafka in (36), in contrast with Mozart, we are missing the motivation factor in the ordering source. Since Kafka may or may not be willing to

finish the work, there are worlds which are both in F' and in G' where he finishes, but others where he does not. This indeed translates to the judged HP level of $\diamond_h B$.

The Mathematical Completeness proof scenario (44) shows that our logical truths are cemented into the set of worlds under consideration. With or without the death of Chalois, none of them is a world in which he proves an unprovable theorem. Our epistemic state and what we perceive as ideal don't enter into our considerations. Its judgment as $\Box_p \neg B$ is accounted for.

We now turn to the hardest nut in the case: the Riemann Hypothesis proof scenario in (46) receives an HP assessment of \perp , undefined. A unique data point, we would like it to be explained by the fact that speakers' knowledge when assessing the possibility is lacking in the fundamental properties of the Riemann Hypothesis itself: its truth value, or more accurately – its provability⁴⁴. This strongly suggests that the universe of worlds we use to determine HP contains only worlds in which the provability of the Riemann Hypothesis is the same as in ours (i.e. mathematically consistent), and as a result our ignorance of what this provability value is bars us from creating a judgment for B happening (Scernoulli proving the hypothesis) in any of them. This leads to B being dependent on an unknown value in worlds which are pertinent to each modal grade: in the set of mathematically possible worlds (pertinent to \Box_p), in $F' \cap G'$ (pertinent to \Box , \Box_h , \diamond_h and \diamond_s), and in $F' \setminus G'$ (pertinent to \Box , \diamond and \diamond_s), making each grade impossible to assess because it would hinge on a essential condition – provability – being undefined. This in turn renders the HP judgment itself undefined, as attested.

The evidence for the essentialness of the provability condition is the difference between the judgments of the scenarios of Fermat's Last Theorem and Mathematical Completeness, in both of which able mathematicians attempt to prove a theorem and die prematurely. They differ only in this aspect of provability, and while the former is judged as possible ($\diamond B$), the latter is judged as impossible as available in the modal scale ($\Box_p \neg B$). When dealing with unknown provability as in the Riemann case, in trying to assess each modal grade we are faced with a set of worlds where either the Hypothesis is provable or not, and while Scernoulli has enough skill and circumstance to complete a proof of this magnitude, we just can't tell whether or not he does.

⁴⁴ I will refer henceforth to provability as the crucial aspect, since it is a more accurate constraint on Scernoulli's attempts to produce a proof, but it should be noted that true theorems that are known to be unprovable are rather rare in Mathematics. In fact, such a revelation would result in reclassifying the theorem as an axiom.

What does it mean for the universe of worlds we use to determine HP to only contain worlds mathematically consistent with ours? So far, the set of epistemically consistent worlds F' does not adhere to this requirement: it contains worlds where the Hypothesis is provable, as well as worlds where it is not. So does G' , but that's fine – we only ever evaluate based on worlds in G' if they are also in F' , so placing a restriction on F' is all we need. Such a restriction, in effect a re-stating of the prelude to definition (50) of the modality grades on the scale, is available and simple: instead of simply setting F (and by corollary, F') to the set of worlds epistemically accessible from ours, we need to set it to the set of worlds that are both epistemically accessible from our world **and mathematically consistent with it**. This will yield the desired result, as well as another one which was already stated in passing but is only entirely correct following the current stipulation: the position of \Box_p at the top of the modal grade scale, by virtue of the newly-deduced entailment $\Box_p X \Rightarrow \Box X$ for all X . It does not infringe on any aspect of the analysis so far⁴⁵.

Now that it is clearer what the process by which HP is computed is, we may look at the effect *could* has on assessing HP in the different scenarios. A compositional approach would call for replacing B for $\diamond B$ as the proposition to be assessed in all pertinent worlds for each modal grade. But \diamond is in this case underspecified for dimension (i.e. in what way the accessible worlds from the ones in the assessed set may differ from it), and our desire is now to specify this dimension in as uniform a way possible, so as to explain the myriad of HP assessment changes we see in (52)b, compared to each scenario's equivalent in (52)a.

Addressing this problem by starting with the “hardest nut” from earlier, Scernoulli's attempt to prove Riemann's Hypothesis, might actually be a good idea. The transformation that the HP value undergoes in this scenario, from \perp to \diamond , forces us to focus on a rather small set of options. The *could*-version (47)'s HP being judged as \diamond means that in the set of worlds F' , all of which are mathematically consistent with our world and in which Scernoulli's death is removed, there exists a world (call it w_F) from which another world is modally accessible (call it w_p , for “proof”) where Scernoulli himself proves Riemann's Hypothesis. It immediately

⁴⁵ This is true regardless of whether or not we choose to apply this redefinition to all scenarios or only those where mathematical truths are relevant: I hold that mathematical truths are important enough in our grasp of the world surrounding us that it is justifiable to hold them out, if any dimension is to be held out when performing such manipulations. Hence, in order to maximize consistency in the proposed theory, the redefinition will apply to **all** scenarios.

follows that the Hypothesis is true and provable in w_p . Since provability is not guaranteed for any world in F' , including w_F , we reach the conclusion that worlds in F' have access to worlds where mathematical consistency with ours is not guaranteed. The accessibility relation signified by *could* must allow for a leap which was forbidden in the first modal move, that which created F' : it grants access to worlds where minimal changes occur (relative to each source world in F') so as to guarantee truth and provability to Riemann's Hypothesis. When considering these newly accessible worlds, while knowing that for any mathematician reaching a proof even for a provable theorem is difficult enough, \diamond seems like a plausible judgment.

The other examples appear to support the “**minimal change that causes removal of the major blocker of B** ” base for accessibility granted by *could*. Mozart's HP is raised from \square_h in the bare form to \square in *could*-augmented (35). Presumably, the worlds in $F' \setminus G'$ in which Mozart doesn't finish the Requiem are such that an outside factor interferes with the otherwise smooth writing process – perhaps death from a different illness, or a change in the commission for the piece (changes which are not inconsistent with what we know, but are not particularly reasonable considering the ideal); these are easily removed via any reasonable accessibility relation, a removal which surely leads to a world where the piece is indeed finished.

Similarly, the Schoenberg *could* in (39) raises the HP from \diamond_s to \diamond_h , meaning that at least one $F' \cap G'$ world is a $\diamond B$ -world (but not a B -world). Under the working hypothesis, it is a world from which there is access to one where Schoenberg's writers' block is lifted. The fact that the judgment does not rise to an even higher grade, such as \square_h , implies that there still worlds in $F' \cap G'$ from which no accessible world is such that the block is successfully lifted. The argument for the similar phenomenon in the Scernoulli case applies here as well: the writers' block's removal does not automatically guarantee the completion of *Moses und Aron*. In different worlds it may happen at different times, depending on how the minimal change in the world affected it (and in some it may prove to be too late); some of the $F' \cap G'$ worlds may yet contain other problems for the piece's finish, ones that are still reasonable and compatible with what we know in our world.

In the Fermat example, the HP retains its value of \diamond under the addition of *could* in (43). This is also consistent with the theory, but a slight clarification is in order. Aside from Scheuler's death, we can't really pinpoint a blocker to the proof. Whatever doubts we had about his mathematical skills and the tools he had to complete a proof remain regardless of when he dies; this is a blocker which appears to be resistant to

our change mechanism. The reason for this is simple to justify: it relates to **the internal state of the protagonist**. Changing this state is, I argue, construed as so inherent in the creative process that modifying it loses the cross-world relation between the processes. They no longer involve the same agent. To make this explicit, the accessibility relation of *could* should be restated to the one which allows for **minimal change that causes removal of the major external blocker of B** ⁴⁶. Note that the available change can only go so far: for a known unprovable proposition like the Consistency of Peano Arithmetic, *could* does not license the negation of mathematical truths. The degree to which such a world would differ from ours must be too much to allow accessibility even from worlds far from G' . If we remember that for a mathematical proposition of unknown provability, Riemann's Hypothesis, we allowed for variability under the *could* operator, we can summarize and say that it is bounded by **epistemic consistency** (whereas the bare modal element was also bound by mathematical truths): a known mathematical falsehood cannot be undone; an unknown mathematical proposition may be set to a value which is consistent with what we know.

The final interesting case we are left with is Schubert, unwilling to finish the 7th Symphony. His *could* sentence (41) is judged felicitous but false, and its HP as \square . Since the HP changed under *could*, we conclude that the lack of will is not an internal factor like Scheuler's capabilities. The worlds in F' have access to worlds in which Schubert has the will to finish the piece, and in all of them he finishes it indeed, as his capability to do so is not under dispute.

As for the falsehood of the statement, that should be explained by referring to the truth conditions in (28)a, rather than to the felicity constraint or the notion of HP which is closely tied to it. Here, a distinction must be made between the role of the overt modal *could* in the HP assessment and its role in the truth conditions. Since HP and its primitives view the modal operator in a tenseless perspective (meaning, it relates to worlds which are accessible to the reference world irrelevant of time), the

⁴⁶ One may argue that a writers' block is also an internal blocker. I disagree, and offer the following means of differentiating between the two situations: Scheuler's capabilities have been with him all through the proof-attempt process; if he acquired new intellectual tools, it means his character has developed. Schoenberg, on the other hand, clearly started the writing process without a block. I perceive it as a transient situation, one which has been thrust upon him and may be unthrust just as arbitrarily. "World-class level for his time Scheuler" is a firm denotation of an agent; "writer-blocked Schoenberg" is not.

same definitions cannot hold for propositions which are evaluated relative to a <world, time> pair, as warranted by the truth conditions. Luckily, an intuitive interpretation of *could* in a tense-dependent perspective will succeed in predicting the Schubert *could*-sentence being false: recalling the definition of $\llbracket \diamond X \rrbracket_{w,t}$ from (21): $\llbracket \diamond X \rrbracket_{w,t} = 1 \Leftrightarrow \exists w' \in alt_w(t+1). \llbracket X \rrbracket_{w',t} = 1$, the denotation of *could*(*X*) uttered in world *w* at *t* is simply the set of times τ preceding *t* where $\llbracket \diamond X \rrbracket_{w,\tau}$. Taking as the source of the **alternative set** of worlds alt_w one which **leaves the dying process as is** will complete the requirements both for falsehood prediction: it aligns with our intuition that Schubert was not at all pressed for completing the 7th prior to his death, and in fact his unwillingness was the only blocker; ergo, there exists a time prior to Schubert's death from which an alternative world branches away where Schubert is willing to finish the piece, regardless of the dying process remaining identical to that in our world, and so the truth conditions are violated.

In addition to making the correct prediction, this interpretation is perfectly coherent with the rest of the discussion in this section, as it strengthens the dichotomy we developed between the two modals: the dying process is removed by the covert one (introduced by *before*), the second blocker is removed by the overt one (introduced by *could*).

6. LEFTOVERS: NONCOMMITTALS AND VERIDICALITY

COERCION

In this chapter, I will present and explore two phenomena not yet discussed regarding the veridical properties of *before*: noncommittals and veridicality coercion. Using the apparatus developed so far, each of these will be easily reduced to the basic veridicality-nonveridicality dichotomy, and explained by the theory.

NONCOMMITTALS

Beaver & Condoravdi (2003), as well as others, mention a class of *before*-sentences which they refer to as **noncommittals**. Lying between veridicals and nonveridicals, these are sentences where the truth value of the *B*-clause is, on some level, unknown. A simple example is:

(58) I left the party before it got too crowded.

The sentence is completely felicitous, even though the speaker does not know whether or not the party actually got too crowded after her departure. This observation is what led to its categorization apart from veridicals and nonveridicals, as a third class of veridicality. But if we can prove, with some deeper inspection of (58), that this supposed status is unnecessary, we remain with the clean dichotomous veridicality property and reduce the complexity of any full analysis *before* requires.

First, some justification is needed for choosing this example, as it is not a potential preventative, i.e. the speaker's leaving the party is not an action which bears consequence to the party's eventual crowded state⁴⁷. The reason for this is that preventative sentences are **trivially nonveridical**: it cannot be argued that the speaker remains unaware of whether or not *B* happened, when the mere occurrence of *A* prevents *B* from happening. It appears that noncommittals such as (58) are the only way of creating non-preventative *before* sentences which may be read as nonveridical. So the creation of a separate class for sentences like this is justified, but it is enough to define it in terms of preventativity, if we prove that it always reduces to one of the main two classes.

⁴⁷ Setting aside a very precise scenario in which one person is the difference between the party being non-crowded and crowded, but this is an unreasonable notion to begin with.

Let us start by isolating the source of uncertainty within the alleged noncommittal. (58) can be assessed from several perspectives. The first is the time when the speaker left: at this point, she was under the impression that the party is about to become crowded, or more formally “in the future, probably *B*”. From a relevance-driven point of view, *B* may be interpreted as “I am attending a too-crowded party”, as this is the matter of consequence to the speaker, in which case the sentence becomes a felicitous preventative nonveridical, in line with the constraint in (28)b: the branching point is a point in time minimally preceding the act of leaving the party, since there appears to be a process of crowding taking place.

Another perspective we may choose to assess (58) from is the speaker **at the time of speech**. Two ways of testing her (post-) assessment of *B*'s probability at this point are available, and both lead to the conclusion that she must hold the same belief that she held at the time of leaving (i.e. that the party was about to become crowded).

The first, an utterance by another partygoer, one who knows the party never in fact got crowded. He talked to our deserter when she was about to leave, and heard her reason for leaving. But my informants agree that for this character to say the following is infelicitous,

(59) # She left the party before it got too crowded.

proving that it cannot be said given knowledge of the actual eventual outcome.

The second experiment involves the speaker herself. I, the listener, know the party never in fact got crowded. After hearing (58), I tell her this fact. She will not be able to tell the story using the same sentence again: she would have to either immediately follow it by “... but I heard it never really got crowded”, or better yet – embed the sentence in an explicit subjective formation like in (60):

(60) I thought I'd leave the party before it got too crowded.

We see that a noncommittal exists only in the contextual environment where the speaker is not aware of *B*'s ultimate occurrence **during speech**. To borrow from the Schrödinger's Cat analogy, once the “box” of whether *B* happened or not is “opened” in the speaker's context, the sentence becomes either veridical or nonveridical.

Another odd behavior can be observed in cases where the prevention of *B* by *A* is less than trivial (as was in our morbid class in previous chapters). Consider the following scenario:

Mafia collector: I'm a mafia debt collector, which of course implies I am fond of violence (at least the sort where I'm on the giving end). I was assigned Luigi, a debtor who was not expected to pay on time. I share my experiences from the mission with you by uttering either (61)a or (61)b.

(61)

- a. Luigi gave me a check before I could beat him up.
- b. Luigi gave me a check before I beat him up.

(a), with *could*, seems to convey the message that I didn't beat Luigi up, as he managed to pay the debt at the last minute. On the other hand, (b) is judged felicitous only under the condition that I actually beat Luigi up, ignoring his payment. Detaching the beating-up from the payment, it merely recounts a succession of events (i.e. a veridical *before*). The sentence still makes sense, as we can interpret it as if I was treating my mission from the start as beating Luigi up, not as recovering the debt⁴⁸. Still, given the contrast between the two sentences, there is something about (61)b which needs further scrutiny. This phenomenon, not yet mentioned in literature, I dub **veridicality coercion**.

In the same way that a noncommittal's skin peels easily, so does coercion's. Seeing as our framework is tenseless, what the scenario really needed when introduced was a full recounting of the progression of events. The speaker knows whether or not the beating up took place. If it did, (61)b (without *could*) is a felicitous veridical and (61)a is a bad choice because it implies there was no beating, though in a perfectly cancellable way (simply by adding "... but I did anyway!"). If the beating up didn't take place, (61)a (with *could*) is a felicitous nonveridical under the conditions derived in previous chapters (assuming a mafia-deontic modal base, removal of the check-giving grants the speaker the ability to beat Luigi up); and (61)b is also a felicitous nonveridical, again well-predicted by the veridicality conditions. It is less preferred than the *could*-version, as were some of the examples we saw in the morbid

⁴⁸ An informant noted, and rightly so, that this message is also conveyed by ((61)a): stating "before I could" implies disappointment at my failure to beat Luigi up for a good reason.

class (e.g. Schoenberg's writers' block), but it is not really pushed away by the veridical reading, unless some context is missing.

To conclude, both noncommittals and veridicality coercion can be traced back to semantic ambiguities originating in epistemic deficiencies of their contexts, deficiencies whose removal admits them into one of the classes already discussed.

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המילה האנגלית before, בתפקודה כמתארת קשר זמנים בין שתי התרחשויות, מתאפיינת במספר תכונות המבדלות אותה מהמילה שלכאורה מייצגת את ההיפך ממנה, after. אחד מהבדלים אלה הוא האפשרות להשתמש בה גם כאשר ההתרחשות המשועבדת על-ידיה (להלן "פסוקית ב'") לא התרחשה כלל. לדוגמה, כאשר ההתרחשות הראשונה ("פסוקית א'") מונעת מפסוקית ב' להתקיים: מאמירת המשפט Mozart died before he finished the Requiem, "מוצרט מת לפני שסיים את הרקוויאם", ברור כי מוצרט מעולם לא סיים לכתוב את הרקוויאם. משפטים כגון זה נקראים nonveridicals (נון-ורידיקאליים, או אל-אמתניים).

קיימים בספרות מספר ניסיונות להידרש לתופעה זו. בעבודתי אני מתמקד בניתוח של Beaver & Condoravdi (2003) ומספר מאמרים משלימים, המנסים להביא לידי ביטוי את העובדה כי לא כל משפט before-אל-אמתני הינו תקין. הניתוח, הפועל במסגרת פרדיגמת העולמות האפשריים, מבקש להתבונן ברגע שקודם לזה שבו התרחשה פסוקית א' בעולמו ו"לפצל" החל ממנו עולמות שקרובים לשלנו במידה סבירה. אם באחד מהם התרחשה פסוקית ב', אזי המשפט אמיתי אם ורק אם התרחשות זו קורית מאוחר יותר מאותו רגע בו התרחשה פסוקית א' בעולמו. אם באף עולם כזה לא התרחשה פסוקית ב', המשפט נטול ערך אמת ולכן אינו תקני. בעבודתי אני מראה כי תנאי-אמת אלו אינם נכונים. הגדרת קבוצת העולמות הקרובים, יחד עם העמימות שבניסוח הגדרת "הרגע הקודם", מביאים אותנו בהכרח לידי מצב בו "משפט מוצרט" לעיל מנובא כמשפט שקרי (אם מניחים רגע פיצול מוקדם מדי ואז ייתכן שמוצרט מסיים את הרקוויאם קודם למותו בעולמו) או חסר ערך אמת (אם מניחים פיצול מאוחר מדי ואז אין לו זמן להחלים ממחלתו ואין עולם קרוב במידה סבירה בו הוא מסיים את היצירה). הצעתי היא לחזור לתנאי אמת פשוטים יותר (על-בסיס Heinämäki (1974), שאינם כוללים התייחסות מפורשת לעולמות אפשריים, ולהוסיף **תנאי תקינות** שמתבסס על הזמן האחרון טרם התרחשות פסוקית א' שבו עדיין נדמו ההתרחשויות של א' ו-ב' כאפשרות עתידית. הדוגמאות הנדונות נבדקות תחת התנאים החדשים ונמצאות מנובאות כהלכה.

בהמשך אני שואף לחדד את התנאי שנמצא עבור תת-קבוצה של משפטי before בהסתייע באבחנה כי קבילותו הנשפטת של משפט אינה בינארית, אלא נעה על רצף. מודגם כי באמצעות הוספת הביטוי המודאלי could לפסוקית ב' ושיפוט המשפט החדש ניתן להבחין בין רמות שונות של קבילות. בפרק זה אני מוצא קשר שיטתי בין רמת הקבילות על-פי הגדרה חדשה המשלבת בתוכה את קבילות המשפטים עם תוספת אופרטור (במקרה הזה, could) לבין האופן שבו נשפטת מידת קבילותה של התקיימות פסוקית ב' אלמלא התרחשה פסוקית א' כפי שקרתה בעולמו. את מסקנת הפרק הזה אני משלב לתוך תוצאות הפרקים הקודמים כסעיף נוסף בתנאי האמת והתקיינות של משפטי before.

מספר רב של דוגמאות מעלות סוגיות שאינן מקבלות התייחסות באופן פורמלי מלא, כגון הבסיס המודאלי הנדרש בכל משפט, או הקשר בין מידת הסבירות ההיפותטית הנשפטת לבין השאלה האם בעת התרחשות א' מתקיים תהליך שאמור בסיומו להוביל ל-ב', או מקרים בהם השמטת המילה could מוציאה מכלל אפשרות קרי אל-אמתני. להן מיוחדים דיונים בסוף העבודה.

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