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Contents

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1. Introduction

1.1. The project

This thesis is an investigation into the world- and time-dependence of (mostly nominal) predicates. Two of the most exceptional properties of language are 1.) that it provides us with the means to talk about things that are non-actual (the modal dimension), and 2.) that it allows us to talk about times in the past and the future (the temporal dimension). Language does this by employing devices that can manipulate the modal and temporal interpretation of other expressions in the sentence. (1) and (2) give examples for two of these devices: An attitude verb (for manipulations of modal information) and tense (for manipulations of temporal information).

(1) *A butler* is stealing Marianne's jewelry

(2) Augustus believed that *a butler* stole Marianne's jewelry

In (2), the presence of the attitude verb "believe" has the consequence that the complement sentence is interpreted as a statement about Augustus' (non-actual) belief-worlds (In contrast to (1), which expresses roughly the same content but is interpreted as a statement about the *actual* world). Moreover, the past tense in (2) makes the sentence into a statement about a time in the past of the utterance, while the present tense in (1) requires temporal overlap with the utterance time. Thus, attitude verbs and tenses introduce new pieces of modal and temporal information (i.e. new worlds and times) that can be used for the interpretation of other expressions in the sentence.

This becomes relevant for expressions whose meaning is sensitive to a world or time of evaluation. For instance, if the meaning of "butler" allows the identification of the individuals that are butlers, it is important that the set of butlers changes depending on the world or time of evaluation. That is, the set of butlers in Augustus' belief-worlds might be different from the set of butlers in the actual world (e.g. Augustus might have a false belief). Also, the set of butlers may change over times (butlers get hired, retire, die etc.).

This thesis investigates how the world and time (and sometimes location) information that is available in an utterance influences the interpretation of world- and time-sensitive predicates. The crucial question will be which pieces of the available world- and time-information can be used to determine a predicate's modal and temporal evaluation. Given a set of available worlds and times, this means asking what the *possible* world and time values for a given predicate are. The main goal will be to uncover the restrictions that natural language imposes on the set of possible evaluation worlds/times/(locations).

Potential restrictions will be viewed from two angles: First, it will be asked whether there are any restrictions within a given evaluation dimension (I will call these intradimensional restrictions). For instance, we may ask whether the possible evaluation worlds of a predicate are narrowed down by the world information in its environment (The same can be asked for times, i.e. in what way is the evaluation

time restricted by other times?). Intradimensional restrictions of this type will be the focus of chapter 2 and 4. Second, it will be investigated whether there are any restrictions imposed by information from a different evaluation dimension (i.e. interdimensional restrictions). For example, we could ask whether the possible evaluation worlds of a predicate are in any way restricted by the evaluation time of the same predicate. These types of dependencies between worlds and times will be the main topic of chapter 3.

This thesis presents only a status report on a larger project on (im-)possible evaluation worlds/times/locations. The conclusions drawn in this thesis should thus be viewed as preliminary.

1.2. Outline of the thesis and overview of the main claims

Chapters 2, 3, and 4 can be read (more or less) independently from each other and do not presuppose any knowledge of the chapters that come before them. The chapters thus inevitably contain some redundant information. The redundancy was included on purpose so as to maintain the chapters' independence.

Chapter 2 gives a general introduction into the topic of intensionality and index-dependence. Moreover, the chapter gives a broad outline of the present research project, discusses its motivation and examines the different ways an expression's evaluation index (i.e. its world, time, location) might be constrained. Finally, this chapter discusses various intradimensional constraints from the literature (e.g. *Generalization X*, the *Intersective Predicate Generalization*) and asks whether they hold for all evaluation dimensions (i.e. the modal, temporal and spatial dimension). Based on an overall tendency, the chapter concludes with a meta-generalization over the (intradimensional) behavior of the modal, temporal and spatial dimension that can be stated as in (3).

(3) *Interdimensional meta-generalization about intradimensional behavior*

> If an index-parameter of an index-sensitive expression α is subject to an intradimensional constraint, then all other index-parameters of α must be subject to an intradimensional constraint of the same type.

Chapter 3 turns to the modal and temporal evaluation of nominal predicates. The main question of this chapter is whether the evaluation time of a noun is dependent on the noun's evaluation world (and vice versa). It is shown how different intensional frameworks (i.e. the parameter theory and the index-pronoun theory) make different predictions about which types of world-time interactions a nominal predicate allows. Importantly, non of the standard frameworks of intensionality makes the right predictions. Specifically, the parameter theory undergenerates (it does not derive the available transparent+embedded tense-reading), while the index-pronoun theory overgenerates (it derives the unavailable opaque+utterance time-reading). Several ways to resolve the under- and overgeneration issues are discussed. The second half of the chapter then reconsiders the original data on modal-temporal readings, and argues for more subtle dependency between the modal and temporal dimensions.

Specifically, it is argued that the unavailable opaque+utterance time-reading falls out from a more general constraint on possible temporal relations, which I dub the O+(MT<ET)-constraint.

(4) *Ban on O+(MT<ET)/Upper Limit Opaqueness*

> A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude).

Chapter 4 examines the ways in which the temporal dimension is represented in simple DPs of the type "the student", "every fugitive", "a butler" etc. In this chapter, I attempt to show that the temporality of even simple DPs is complex, involving at least two times that can be temporally disjoint: The evaluation time (ET) of the noun and the resource time (RT) that contributes to the meaning of the implicit domain restriction. I consider a theory that represents ET and RT as independent time pronouns. Then, it is shown that such a theory overgenerates. While there is evidence that the RT can receive a bound variable reading at the same time that ET is some contextually salient context (i.e. 'free') time in the past (the Bound RT+Bound ET-reading), the reverse is not available (the Free RT+Bound ET-reading). Moreover, I argue that the relations between ET and RT is restricted in a way that disallows RT<ET readings.

(5) *No Free RT+Bound ET-Reading*

> The evaluation time (ET) of a noun cannot receive a bound variable reading if the resource time (i.e. the time of the implicit domain restriction of the same DP) receives a free reading (or equivalently: RT cannot be free if ET is bound).

(6) **RT<ET* or *No RT<ET-disjointness*

> The ET of a DP's noun cannot be a time that is both disjoint and into the future (i.e. posterior) to the DP's RT.

Finally, chapter 4 considers a one-time pronoun solution (or one-situation pronoun solution) that derives all the relevant aspects of the ET-RT distinction.

Chapter 5 brings together the findings from chapters 2, 3, and 4. It is thus the only chapter that cannot be read independently (It presupposes the discussion in all previous chapters, in particular the content from chapter 3 and 4). Chapter 5 attempts to reconcile the revised understanding of DP-internal temporality developed in chapter 4 with the finding on modal temporal readings from chapter 3. It is argued that the Ban on O+(MT<ET)-readings can be viewed as a special subcase of the *RT<ET-generalization. Furthermore, it is demonstrated how the modal-temporal interactions follow directly from the analysis of DP-internal temporality that was developed in chapter 4. Crucially, the success of this analysis is tied to an ontology that uses situations instead of independent worlds and times as the relevant intensional entity.

2. Intensionality: Intra- and interdimensional interaction

2.1. Worlds, times, and space in natural language

Linguistic meaning is context-sensitive. Consider the sentence in (7).

(7) It's raining

Intuitively, the claim expressed by (7) changes with the *time* of utterance. Uttered once in 2011 (at 12pm on June 1st) and a second time in 2019 (at 11am on April 14th), (7) can be (informally) paraphrased by the truth-conditionally distinct statements in (8) and (9).

(8) It rains in 2011 (at 12pm on June 1st)

(Uttered in 2011 at 12pm on June 1st)

(9) It rains in 2019 (at 11am on April 14th)

(Uttered in 2019 at 11am on April 14th)

Importantly, time is not the only contextual factor that interacts with the meaning[1] of (7). Indeed, if a speaker utters (7) in 2011 (at 12pm on June 1st), then it is likely that the paraphrase in (8) does not sufficiently describe her intended meaning. What is missing is information about the *location* of the speaker. That is, if the speaker utters (7) while looking outside the window of her apartment in Paris, then it is plausible to assume that she expresses a claim about the weather *in Paris* (and not a claim about the weather in the whole world[2] or universe). In the described scenario, it would indeed be odd to contest the speaker's claim by pointing out that (at the time of utterance) it is not raining in Vienna. The weather in Vienna seems to be irrelevant for what (7) means in this scenario. Including information about the speaker location, we can now informally paraphrase the meaning of (7) with (10)-(13), depending on the temporal and locational properties of the utterance context.

(10) It rains in Paris in 2011 (at 12pm on June 1st)

(Uttered in Paris in 2011 at 12pm on June 1st)

(11) It rains in Vienna in 2011 (at 12pm on June 1st)

(Uttered in Vienna in 2011 at 12pm on June 1st)

(12) It rains in Paris in 2019 (at 11am on April 14th)

(Uttered in Paris in 2019 at 11am on April 14th)

[1] For introductory purposes, I use the term "meaning" in a loose, informal (and non-technical) sense. The various aspects of what intuitively constitutes the "meaning" of an expression will be made more precise (and formal) as we go along.

[2] Of course, (7) can express this meaning. However, it is a very unlikely reading, in which the relevant location extends to the whole world.

(13) It rains in Vienna in 2019 (at 11am on April 14th)

(Uttered in Vienna in 2019 at 11am on April 14th)

Thus, the exact claim expressed by uttering (7) is sensitive to contextual information regarding the time and location the claim is about[3]. Importantly, there is a third contextual component that is implicit when a speaker claims that (7) is the case: (7) is understood as a claim about how the circumstances *actually* are (and not a claim about how they could be if the world was different from the actual world of utterance). To see how this third factor interacts with the meaning of (7), consider a context in which (7) is not uttered by a real person, but a fictional character from this short scene written by ChatGPT (generated on May 9th, 2023).

(14) *Excerpt from "June in Paris", by ChatGPT*

> The Champs-Élysées on June 1st was bustling with tourists. The sun was shining bright, casting a golden glow on the Arc de Triomphe at the end of the avenue. At noon, a young woman wearing a yellow sundress came out of a café and sat down on a bench near the fountain. She was waiting for someone.
> As she sat there, watching the people go by, clouds suddenly appeared in the sky. She felt a few drops of rain on her skin.
> "**It's raining**," [emphasis added] she said to herself, looking up at the sky.
> Just then, a man in a black suit and carrying a black umbrella came walking towards her. He looked at her and smiled.
> "You're early," he said, sitting down next to her on the bench.
> "I couldn't wait," she replied, smiling back at him.
> The rain began to pour down, but neither of them minded. They sat there, chatting and laughing, enjoying each other's company and the beauty of Paris in June.

When the character from the scene above (ChatGPT names her Marie) uses the sentence "It's raining", the date is June 1st 2011, and she is located in Paris at 12pm. Now, let us assume that there is also a real person (I will call her Antoinette) who actually uttered the sentence "It's raining" while being located in (actual) Paris on June 1st 2011 at 12pm. Did fictional Marie and real-life Antoinette commit to exactly the same claim by uttering (7) (i.e. the claim described by (10))? The answer is no. To see that this is the case, let us consider what facts we need to judge the truth of Marie's and Antoinette's claims. It so happens that the actual weather records show that there was no rain in Paris on June 1st 2011 (in the actual world). Intuitively, this makes Antoinette's claim false. Importantly, the actual weather records of Paris are irrelevant for the truth of Marie's claim. Indeed, the only state of affairs that seems to be relevant for the truth of Marie's utterance is the fictional state of affairs as ChatGPT defines them in its story. Since it is in fact raining in the world of "June in Paris", Marie's claim is intuitively true. Even though Marie and Antoinette both attribute raining to the same location at the same time, the truth conditions of their respective claims are distinct: Marie's claim can be true under the same circumstances that make Antoinette's claim false (and vice versa). Therefore, Marie's use of (7) and Antoinette's use of (7) must express different thoughts. The crucial difference seems to be that Marie and Antoinette

[3] For a more nuanced discussion of how the implicit location contributes to the meaning of "It's raining" (and the use of similar weather predicates), see Elbourne (2022).

relate their claims to different states of affairs. Marie's claim is relative to the non-actual state of affairs in "June in Paris", while Antoinette's claim is about the state of affairs as it is in the actual world. We can thus add a world component ("world" being the term used by semanticists to talk about different possible states of affairs) as another factor that interacts with the meaning of (7). By combining the different pieces of contextual information that we have introduced so far, we arrive at the following paraphrases for (7) when it is used in different temporal, locational, and modal[4] contexts.

(15) It rains in Paris in 2011 (at 12pm on June 1st) in the actual world

(Uttered in Paris in 2011 at 12pm on June 1st in the actual world)

(16) It rains in Paris in 2011 (at 12pm on June 1st) in the world of "June in Paris"

(Uttered in Paris in 2011 at 12pm on June 1st in the world of "June in Paris")

(17) It rains in Vienna in 2011 (at 12pm on June 1st) in the actual world

(Uttered in Vienna in 2011 at 12pm on June 1st in the actual world)

(18) It rains in Vienna in 2011 (at 12pm on June 1st) in the world of "June in Paris"

(Uttered in Vienna in 2011 at 12pm on June 1st in the world of "June in Paris")

(19) It rains in Paris in 2019 (at 11am on April 14th) in the actual world

(Uttered in Paris in 2019 at 11am on April 14th in the actual world)

(20) It rains in Paris in 2019 (at 11am on April 14th) in the world of "June in Paris"

(Uttered in Paris in 2019 at 11am on April 14th in the world of "June in Paris")

(21) It rains in Vienna in 2019 (at 11am on April 14th) in the actual world

(Uttered in Vienna in 2019 at 11am on April 14th in the actual world)

(22) It rains in Vienna in 2019 (at 11am on April 14th) in the world of "June in Paris"

(Uttered in Vienna in 2019 at 11am on April 14th in the world of "June in Paris")

(15)-(22) paraphrase the meaning of (7) in specific instances of its use (We can call this the context meaning of (7)). To paraphrase the more general, context-invariant meaning of (7), we need to abstract away from the specific information that each utterance context provides. In other words, we can describe the meaning of (7) with an abstract schema that determines how various variable pieces of contextual information (i.e. at least information about a time, a location and a world) feed into the context meaning.

(23) It rains in the location of utterance *l* at the time of utterance *t* in the world of utterance *w*

(23) explicitly relates the meaning of the sentence to the location, the time and the world of the utterance context. This characterization of the variable content makes sense for the unembedded uses of (7), which in (15)-(22) always picked up the relevant information directly from the immediate context of the speaker. However, once more complex examples are considered, it turns out that (23) is not general enough. Consider (24)-(26).

[4] "Modal context" being another word for the world component.

(24) Antoinette believes that it's raining

(25) It was raining (on May 3rd of 2000)

(26) It's raining in Madrid

(24)-(26) illustrate one of the most remarkable features of natural language: Language provides us with the means to escape the actual here and now and talk about non-actual (i.e. mere possible) worlds, past and future times, and locations that are different (and possibly distant) from the location of utterance. Natural language does this by employing devices that can manipulate the modal, temporal, and spatial information to which the meanings of other expressions are sensitive. One of these devices is the attitude verb "believe" in (24). In (24), the sentence we introduced in (7) ("[that] it's raining") is in an embedded context. In order to examine how the meaning of (7) changes when it appears as the sentential complement of "believe", let us go back to one of the utterance contexts from above: Paris on June 1st at 12pm in the actual world. In this context, we said that the context meaning of the unembedded version of (7) (as uttered by our imagined speaker Antoinette) amounted roughly to the claim stated in (27).

(27) It's raining

= It rains in Paris in 2011 (at 12pm on June 1st) in the actual world

(Uttered in Paris in 2011 at 12pm on June 1st in the actual world)

We further judged that (27) was an intuitively false claim, since the weather records do not give any indication that it actually rained in Paris on the relevant day. Now, what if a second speaker (let us call him Pierre) uttered (24) immediately after hearing Antoinette's (false) claim that it was raining? In this scenario, we would say that Pierre has made an intuitively true claim. Why do we perceive this difference in truth/falsity when we compare these two claims? The reason is that, in contrast to Antoinette's utterance, Pierre's claim is not related to the state of affairs as it is in the utterance world. Instead, Pierre merely states that *Antoinette believes* that it is raining in the utterance world, not that it is actually raining. Put differently, Pierre claims that it is raining[5] *in the world as it appears to Antoinette based on her (real-world) beliefs*. Since Antoinette may very well be mistaken in her beliefs (i.e. the states of affairs as they are in Antoinette's belief worlds do not have to be identical to those in the world of utterance), Pierre makes no commitment about the weather in the utterance world. Roughly, Pierre's claim can be paraphrased with (28)[6].

[5] At the utterance time, at the utterance location.

[6] An important caveat: The paraphrase makes it look as if the meaning of (28) is not at all sensitive to the utterance world. This is not entirely true, since Pierre makes a claim about Antoinette's beliefs in the utterance world (and not her beliefs in some other possible world). This is so because the sentence is complex and contains two world-sensitive expressions: The matrix verb "believe" and the embedded predicate "rain". "Believe" shifts the evaluation world of "rain" away from the utterance world to Antoinette's belief-worlds, but the evaluation world of "believe" remains the utterance world. It seems generally to be the case that the structurally highest verbs get evaluated at the utterance world by default.

(28) Antoinette believes that it's raining

= It rains in Paris in 2011 (at 12pm on June 1st) ***in Antoinette's belief-worlds***

(Uttered in Paris in 2011 at 12pm on June 1st in the actual world)

Thus, the world-sensitivity of an expression's meaning is not always resolved by tying it to the world of utterance. By virtue of their semantics, specialized expressions (I will call them *world shifters*[7]) may shift the world information that interacts with the meaning of other expressions (the so-called *evaluation world* of those expressions) to some non-actual (possible) world that is different from the utterance world. These means for world manipulation untie our speech from the real world and are crucial for our ability to talk and reason about the realm of the non-actual, (im-)possible, hypothetical, or counterfactual.

Similarly, we have linguistic devices that allow us to talk about times that are different from the time of utterance. That is, we can make claims about things that happened in the past or things that will happen in the future. An example of a *time shifter*[8] is the past tense in (25), which situates the time of the raining in the past of the utterance time (Here, the exact time is made more explicit by the temporal adverbial in the brackets).

(29) It was raining (on May 3rd of 2000)

= It rains in Paris ***in 2000 (May 3rd)*** in the actual world

(Uttered in Paris in 2011 at 12pm on June 1st in the actual world)

Finally, (26) (repeated as (30) below) illustrates how the implicit location of the raining-event can be shifted to a place that is distinct from the utterance location. Here, the *location shifter*[9] is a location adverb.

(30) It's raining in Madrid

= It rains ***in Madrid*** in 2011 (at 12pm on June 1st) in the actual world

(Uttered in Paris in 2011 at 12pm on June 1st in the actual world)

To summarize: Language offers means to escape the actual here and now and talk about non-actual (possible) worlds, past and future times as well as locations different from the location of the speaker and hearer. When language uses expressions (e.g. attitude verbs, modals, conditionals) to shift the world

[7] Typical world shifters are attitude verbs (e.g. "believe", "think"), modal verbs (e.g. "may", "must"), conditionals (e.g. if-clauses), and modal adverbs (e.g. "necessarily", "possibly").

[8] Typical time shifters are tense morphemes or auxiliaries (e.g. past tense, future tense), temporal adverbs (e.g. "yesterday", "three years ago", "in two years"), temporal quantifiers (e.g. whenever-clauses, "always"), and aspect (e.g. perfect, imperfect).

[9] Typical location shifters (at least in languages like English and German) are location adverbs (e.g. "in Vienna", "next to the supermarket") and locational quantifiers (e.g. "everywhere"). In English or German, there is no verbal inflectional category for the spatial dimension (as we find with tense for the temporal dimension), nor is there a dedicated (semi-)functional category of elements for location-shifting (as we find with modals and attitude verbs for the modal dimension). However, see Deal (2009) for the suggestion that other languages (in Deal's particular case: Nez Perce) may employ verbal inflectional morphology dedicated to spatial shifting (analogous to tense).

of evaluation in order to talk about possible states of affairs that are different from the utterance world, I will call this displacement[10] along the *modal dimension*. Displacement techniques that target the temporal information of a sentence (e.g. tenses, temporal adverbs) are said to manipulate the *temporal dimension* of language[11]. Lastly, displacement that manipulates the evaluation location is displacement along the *spatial dimension*.

Because the paraphrase in (23) explicitly ties the meaning of "It's raining" to the world, time and location of utterance, this meaning description cannot generalize to the shifted cases in (28)-(30). In order to extend to these cases as well, the variable content of (7) must be less specified.

(31) It rains in location l at time t in world w

In the unembedded use of an expression, the variables l, t and w default to values provided by the utterance context. Importantly, however, the variables can also obtain their values through other means, e.g. by interacting with shifters.

At this point, we have to make our assumptions about meaning more precise. By employing an intensional formal semantic framework (e.g. a semantics along the lines of von Fintel & Heim 2021) [12], we can state more clearly what we mean by an expression's sensitivity to a world, time and location. In (31), we informally characterized the meaning of a sentence as a schema that for each combination of a world, a time, and a location determines a definite statement that is true or false in that world, at that time, and at that location (i.e. (15)-(22)). We can formalize this idea by defining the meaning of (7) as a function f_{rain} that takes as its arguments a triple of a world, a time and a location, and returns a truth value.

(32) Let W be the set of worlds, T the set of times, and L the set of locations.

$f_{rain} : W \times T \times L \rightarrow \{0, 1\}$
For all $w \in W$ and $t \in T$ and $l \in L$, $f_{rain}(w, t, l) = 1$ iff it rains in w at t at l

Of course, the function f_{rain} gives by no means an exhaustive account of the meaning of "It's raining". Instead, (32) follows a guiding mantra of Formal Semantics: "In order to say what a meaning *is*, we may first ask what a meaning *does*, and then find something that does that" (Lewis 1970: 22). One thing that the meaning of a sentence does is tell us for a given world, time and location whether the sentence is true in that world, at that time and at that location. (32) models this aspect of sentence meaning by describing a function that defines how the truth value of a sentence is dependent on a collection of contextual factors (i.e. a world, a time, and a location). For the sake of convenience, we will call this

[10] The term *displacement* is used by Hockett (1960) and von Fintel & Heim (2021) to refer to a modal, temporal or spatial shift.

[11] The terms *modal dimension* and *temporal dimension* are based on the terminology in von Fintel & Heim (2021), which also presents a good overview for both dimensions.

[12] Throughout this thesis, I will assume familiarity with the formal semantic system outlined in Heim & Kratzer (1998). Moreover, I will presuppose some background knowledge of intensional semantics, roughly of the kind discussed by von Fintel & Heim (2021) or an equivalent introduction to intensionality.

collection of truth-relevant contextual factors an *index*[13]. Furthermore, we will call the aspect of an expression's meaning that is dependent on an index the *extension* of that expression at that index. As illustrated by (32), the *extension* of a sentence is a truth value. Finally, we will call a function from an index to the extension of an expression (e.g. f_{rain}) an *intension*.

An index-sensitive expression is an expression whose extension changes depending on the value of the index. There are expressions whose extensions do not change with the index-value, e.g. logical expressions such as "and" or "not" (The intensions of these expressions will be constant functions). These expressions will be mostly irrelevant for the concerns of this thesis.

A typical case of index-sensitivity is displayed by the extension of predicates[14]. Again, we can show this by being explicit about what the meaning of a predicate *does*. For instance, the meaning of a one-place predicate allows us to decide under which conditions individuals have the property described by the predicate. That is, by knowing the meaning of the predicate "swim" (a verbal predicate), we can decide for any given individual whether it is among the set of swimmers (or not). The same is true for nominal predicates such as "student": To know what "student" means is to know under what conditions a given individual is in the set of students. Importantly, the set of swimmers and the set of students are not constant across worlds, times and locations. For illustration, let us assume that in the actual world at 12pm on June 1st 2011 there were exactly three people swimming in a local swimming pool in Paris: Pierre, Ann, and John. In this case, the set in (33) characterizes the swimmers in the actual world at the relevant time and place.

(33) {Pierre, Ann, John}
= swimmers (in the swimming pool) in Paris in 2011 (at 12pm on June 1st) in the actual world

Now let us assume that we are looking at the same swimming pool in the same world, but at a different time (e.g. 11am on April 14th in 2019). Since there might be different people swimming at different times, we might be looking at a completely different set of individuals that are swimming in the pool in 2019. Let us assume that the individuals that are swimming in the pool at 11am on April 14th in 2019 are Martha, Pierre, and Lisa. Then, (34) characterizes the relevant set of swimmers.

(34) {Martha, Pierre, Lisa}
= swimmers (in the swimming pool) in Paris in 2019 (at 11am on April 14th) in the actual world

Similarly, we can look at the same time in the same world but change the location. Obviously, the same set of individuals cannot swim at two places at once. Therefore, the people swimming in a pool in Vienna

[13] So far, the index is defined as a triple of a world, a time and a location. In principle, however, there could be additional factors that are part of the index (see Lewis 1970 for suggestions about factors other than worlds, times and locations).

[14] Indeed, the index-sensitivity of "It's raining" is a direct result of the index-sensitivity of the verbal predicate "(to) rain". It is generally the case that the meaning of a sentence is index-sensitive because it contains expressions that are index-sensitive (e.g. verbal and nominal predicates). That is, the index-sensitivity of a sentence is inherited via compositionality because the meaning of a sentence is derived by the meaning of its (potentially index-sensitive) parts.

on April 14th 2019 must be different people from those swimming in Paris at the same time. (35) describes the relevant set.

(35) {Peter, Daniel, Magdalena}
= swimmers (in the swimming pool) in Vienna in 2019 (at 11am on April 14th) in the actual world

Finally, the set of swimmers changes depending on the world under consideration. For instance, let us ignore for a moment who the swimmers actually are (i.e. the swimmers in the actual world) and consider instead what Antoinette believes about swimmers. I assume that Antoinette has very particular beliefs about the individuals that are swimming in a Viennese pool at 11am on April 14th 2019 (She saw pictures on social media that she mistakenly thought were taken at that time). Specifically, she wrongly believes that only her friends Pierre, Stefan and Chris are swimming in the relevant pool at that time. If this is the case, then the set of swimmers in Antoinette's belief-worlds differs from the set of swimmers in the actual world.

(36) {Pierre, Stefan, Chris}
= swimmers (in the swimming pool) in Vienna in 2019 (at 11am on April 14th) in Antoinette's belief-worlds

The index-sensitivity of a nominal predicate like "student" works in the same way: The set of students changes depending on what world, what time, and what location we consider. Again, we can capture the index-sensitivity by defining an intension for (one-place) predicates, i.e. a function from an index to the set of individuals that have the predicate-property (e.g. being a swimmer) at that index. From this point on, I will adopt the standard practice of using lambda functions instead of sets to define the intension and extension of expressions. Hence, the extension of "swim" will not be defined as the set of swimmers, but as the characteristic function of that set. Concretely, the extension of a (one-place) predicate will be defined as a function of type <e,t>[15], i.e. a function from an individual to a truth value. The intension of a predicate must then be a function that returns an <e,t>-type function (the extension) once the slots for

[15] To make our assumptions precise, we can spell out the details of our type system. Since we are still at a stage of exposition, the specific assumptions underlying this type system should not be taken too seriously. For instance, the choice of defining basic types for worlds, times and locations is – at this point of the discussion – arbitrary. It should not be understood as an explicit rejection of systems that exclude basic types, e.g. Montague (1970), von Fintel & Heim (2021: 12-13). The introduction of a type system at this stage has the sole purpose of allowing us to make use of types without being guilty of sloppiness.

Semantic Types
a. e, t, s, i, l are semantic types
b. If σ and τ are semantic types, then $<\sigma,\tau>$ is a semantic type
c. Nothing else is a semantic type

Semantic Domains
a. $D_e = D$ (the set of all individuals)
b. $D_t = \{0, 1\}$ (the set of truth values)
c. $D_s = W$ (the set of all possible worlds)
d. $D_i = T$ (the set of all time intervals)
e. $D_l = L$ (the set of all locations)
f. If σ and τ are semantic types, then $D_{<\sigma,\tau>}$ is the set of all functions from D_σ to D_τ

the world-, time- and location-argument have been filled. The function f_{swim} in (37) gives an impression of what a predicate's intension might look like. f_{swim} is a function of type <s,<i,<l,<e,t>>>>[16].

(37) Let *D* be the set of individuals, *W* be the set of worlds, *T* the set of times, and *L* the set of locations.

f_{swim} = $\lambda w : w \in W . \lambda t : t \in T . \lambda l : l \in L . \lambda x : x \in D$. *x* swims in *w* at *t* at *l* [17]

Having laid the groundwork for the discussion of index-sensitivtiy, we can now introduce the empirical concerns at the heart of this thesis.

2.2. A classification of intra- and interdimensional (in-)dependence

In the last section, we have seen that the meaning of some expressions is sensitive to an index, i.e. an information package consisting of at least a world, a time, and a location of evaluation. Additionally, we have seen that there are expressions that can manipulate the world-, time-, and location-parameter[18] of index-sensitive expressions (so-called *shifters*).

This thesis investigates to what degree the index of an expression is dependent on the index-information that is available in the immediate (linguistic and non-linguistic) context of its use. Consider the sentence (38), which contains a world shifter ("think"), a location shifter ("at her house in Vienna"), and two time shifters (The matrix and the embedded tense, which, in order to avoid unnecessary complications, are supposed to be read as shifting time to the same past time in 2011).

(38) At her house in Vienna (in 2011), Marie thought that a *student* was *swimming*

Let us focus on the index-sensitivity of the two predicates in the embedded clause: "student" and "swimming". When (38) is uttered, each predicate needs to find a world, a time and a location that can determine its extension. Presumably, a predicate takes the relevant information from the modal, temporal and spatial information that is made available by its linguistic and non-linguistic environment. For one thing, this means that the world, time and location of utterance are potential candidates for an expression's index parameters. Moreover, shifters may introduce additional worlds, times and locations that can be used to construct a predicate's index. Given these options and assuming for the moment that there are no further conditions imposed on the choice of index, the two predicates in (38) may receive the following evaluations.

[16] By using lambdas, intensions are strictly speaking no longer direct mappings from an index (a world-time-location triple) to an extension (i.e. a 3-place function like f_{rain} as defined in (32)). Instead, (37) describes a 1-place function from a world to another 1-place function from a time to another 1-place function from a location to another 1-place function from an individual to a truth value.

[17] Henceforth, I will use the equivalent, abbreviated version of this function (and similar functions): f_{swim} = $\lambda w_s.\lambda t_i.\lambda l_l.\lambda x_e$. *x* swims in *w* at *t* at *l*

[18] I will use the term *index parameter* (or specifically: world parameter, time parameter and location parameter) to pick out individual coordinates that make up an index.

(39) The set of *students/swimmers* …

a.) *at the utterance location (UL) at the utterance time (UT) in the utterance world (UW)*
b.) **in Vienna in 2011 in Marie's thought-worlds**
c.) **in Vienna** *at UT in UW*
d.) **in Vienna in 2011** *in UW*
e.) **in Vienna** *at UT* **in Marie's thought-worlds**
f.) *at UL* **in 2011 in Marie's thought-worlds**
g.) *at UL at UT* **in Marie's thought-worlds**
h.) *at UL* **in 2011** *in UW*

Assuming further that the indices for "student" and "swimming" are picked independently from each other, then[19] (38) should be able to express 64 distinct claims[20] in any given utterance context. (40) lists these 64 possibilities.

(40) At her house in Vienna (in 2011), Marie thought that a *student* was *swimming*

(Uttered in Paris in 2019 in the actual world)

Claim Nr.	Evaluation of "student"		Evaluation of "swim"
1	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming **in Vienna in 2011 in Marie's thought-worlds** *(as they are for Marie's thoughts at her house in Vienna in 2011 in the actual world)*[21]]
2	A student *in Paris in 2019 in the actual world*		
3	A student **in Vienna** *in 2019 in the actual world*		
4	A student **in Vienna in 2011** *in the actual world*		
5	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
6	A student *in Paris* **in 2011 in Marie's thought-worlds**		
7	A student *in Paris in 2019* **in Marie's thought-worlds**		
8	A student *in Paris* **in 2011** *in the actual world*		
9	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming *in Paris in 2019 in the actual world*
10	A student *in Paris in 2019 in the actual world*		
11	A student **in Vienna** *in 2019 in the actual world*		
12	A student **in Vienna in 2011** *in the actual world*		
13	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
14	A student *in Paris* **in 2011 in Marie's thought-worlds**		
15	A student *in Paris in 2019* **in Marie's thought-worlds**		
16	A student *in Paris* **in 2011** *in the actual world*		
17	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming **in Vienna** *in 2019 in the actual world*
18	A student *in Paris in 2019 in the actual world*		
19	A student **in Vienna** *in 2019 in the actual world*		
20	A student **in Vienna in 2011** *in the actual world*		
21	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
22	A student *in Paris* **in 2011 in Marie's thought-worlds**		
23	A student *in Paris in 2019* **in Marie's thought-worlds**		
24	A student *in Paris* **in 2011** *in the actual world*		

[19] Even when we ignore the evaluation choices for the matrix predicate "think".

[20] The combinatorial possibilities for the distinct values for "student" and "swim" as listed in (39): 8 possible extensions for "student" times 8 possible extensions for "swim" = 64.

[21] The part in the brackets assigns an explicit evaluation to the matrix predicate "thought". To keep the descriptions simpler and more readable, I will omit this part for all the other occurrences of *in Marie's thought worlds*. The reader should take *in Marie's thought worlds* to be an abbreviation for *in Marie's thought worlds as they are for Marie's thoughts in the actual world*.

25	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming **in Vienna in 2011** *in the actual world*
26	A student *in Paris in 2019 in the actual world*		
27	A student **in Vienna** *in 2019 in the actual world*		
28	A student **in Vienna in 2011** *in the actual world*		
29	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
30	A student *in Paris* **in 2011 in Marie's thought-worlds**		
31	A student *in Paris in 2019* **in Marie's thought-worlds**		
32	A student *in Paris* **in 2011** *in the actual world*		
33	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming **in Vienna** *in 2019* **in Marie's thought-worlds**
34	A student *in Paris in 2019 in the actual world*		
35	A student **in Vienna** *in 2019 in the actual world*		
36	A student **in Vienna in 2011** *in the actual world*		
37	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
38	A student *in Paris* **in 2011 in Marie's thought-worlds**		
39	A student *in Paris in 2019* **in Marie's thought-worlds**		
40	A student *in Paris* **in 2011** *in the actual world*		
41	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming *in Paris* **in 2011 in Marie's thought-worlds**
42	A student *in Paris in 2019 in the actual world*		
43	A student **in Vienna** *in 2019 in the actual world*		
44	A student **in Vienna in 2011** *in the actual world*		
45	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
46	A student *in Paris* **in 2011 in Marie's thought-worlds**		
47	A student *in Paris in 2019* **in Marie's thought-worlds**		
48	A student *in Paris* **in 2011** *in the actual world*		
49	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming *in Paris in 2019* **in Marie's thought-worlds**
50	A student *in Paris in 2019 in the actual world*		
51	A student **in Vienna** *in 2019 in the actual world*		
52	A student **in Vienna in 2011** *in the actual world*		
53	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
54	A student *in Paris* **in 2011 in Marie's thought-worlds**		
55	A student *in Paris in 2019* **in Marie's thought-worlds**		
56	A student *in Paris* **in 2011** *in the actual world*		
57	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming *in Paris* **in 2011** *in the actual world*
58	A student *in Paris in 2019 in the actual world*		
59	A student **in Vienna** *in 2019 in the actual world*		
60	A student **in Vienna in 2011** *in the actual world*		
61	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
62	A student *in Paris* **in 2011 in Marie's thought-worlds**		
63	A student *in Paris in 2019* **in Marie's thought-worlds**		
64	A student *in Paris* **in 2011** *in the actual world*		

An obvious question is whether all of the 64 claims are *in fact* expressible by (38). Considering the fact that we could have easily chosen a more complex example that contains even more predicates and shifters (e.g. "At her house in Vienna (in 2011), Marie thought that a *student* had *met* a *teacher* in Madrid (in 1990)", which contains three embedded predicates, two location shifters, and two time shifters that do not shift to the same time), it becomes clear that an unrestricted system of index-selection might pose a severe communicative challenge: If a single utterance (of not even the most complex type) is compatible with the expression of (at least) 64 claims, then how can a hearer ever decide which claim was intended by the speaker? It would thus be surprising if natural language actually allowed all the readings listed in (40). Indeed, it is not hard to find readings from the list that are not expressible by (38). For instance, (38) cannot express a claim in which the predicate "swim" is evaluated relative to the utterance world. Consider (41).

(41) *Intended reading*

A student **in Vienna in 2011 in Marie's thought-worlds** was swimming **in Vienna in 2011** *in the actual world*

(Reading 25)

Context

In 2011, Peter visited Marie at her house in Vienna. Marie's house was located next to a public pool and a schoolyard. Marie was always complaining about the noise made by the students on the schoolyard. While they were sitting in Marie's living room on the day of Peter's visit, a person was shouting somewhere outside. For Marie, the source of the shouting was clear: "These damn students. The person that is shouting right now is definitely a student, I'm telling you. It's unbearable. I wish the students were as quiet as the people from the pool. There is never any disturbance coming from them". However, when Peter looked outside the window to identify the source of the shouting, he noticed that it did not come from a student, but from a middle-aged man who was swimming in the nearby pool (He was screaming something at his child that was swimming next to him). In 2019, Peter reports on his past visit:

#(At her house) in Vienna (in 2011), Marie thought that a *student* was *swimming*

(Uttered in Paris in 2019 in the actual world)

The readers can confirm for themselves that the intended reading of (41) (i.e. reading 25 from the list) would express a coherent thought. Roughly, the reading corresponds to the claim that the set of actual swimmers (in Vienna at the relevant date) includes a person that Marie thought was a student at that time (but who might not have been a student in actuality). In principle, there is nothing wrong with making a claim of this kind. However, even though it might be a coherent (and in the context of (41) true) thought to have, it is not one that can be expressed by using (38). The unavailability of reading 25 reflects a more general restriction on the index selection of verbs: A verbal predicate that is embedded under one or more world shifters *must* take its evaluation world from its structurally most local[22] shifter (In the literature, this restriction is known as *Generalization X*, see Percus 2000). If correct, this generalization alone reduces the set of readings that are compatible with (38) by half. Concretely, the restriction eliminates claims number 9-32 and 57-64, narrowing down the candidate readings to 32. Without further evidence, one might object that we did not show conclusively that the unavailability of (41) was the result of a restriction on the world-parameter of the verb, and not the result of some other factor (e.g. a restriction on one of the other index-parameters). This is true. However, the point of this section is not to argue in favor of Generalization X. The goal of this section is merely to demonstrate that the set of potential evaluation indices would be unrealistically large if the choice of parameter values was entirely unconstrained. It is thus necessary to define the set of *possible* (i.e. empirically attestable) index-values, which must be a proper subset of the world-time-location triples that can be constructed on the basis of freely combining the modal, temporal and spatial information from the utterance (This free combination resulted in the 64 readings from (40)). Defining the set of possible indices effectively means defining the ways in which the values of index parameters are dependent on various other factors. Since the values for index parameters are always determined based on the linguistically or contextually

[22] As is common practice, "structurally most local" should be understood in terms of *closest c-command*.

given modal/temporal/spatial information, we may for instance describe the ways in which index parameters may (or may not) depend on the available index information in the utterance. Generalization X does just that. It describes how the world parameter of a verb depends on the world information introduced by the closest world shifter. Put more abstractly, Generalization X describes a dependency between an index parameter of type *A* (*A* being a variable standing for an arbitrary index dimension, i.e. for either *world*, *time* or *location*) and a shifter of the same type (an *A*-shifter). I will call a generalization of this type (i.e. a dependency where the value of an index-parameter depends on the value introduced by a shifter) *shifter dependence*. Importantly, Generalization X describes a particular subtype of shifter dependence, namely a type of shifter dependence where the relevant shifter introduces index information that is from the same index dimension as the dependent parameter (i.e. a *world* parameter depending on a *world* shifter). In principle, however, one could imagine other types of shifter dependencies where, for instance, the value of a particular world parameter is dependent not on a world shifter, but on a time or location shifter[23]. I will thus further distinguish between two types of shifter dependencies: Those where the dependency holds between a parameter and a shifter from the same dimension (i.e. a parameter value of type *A* is dependent on an *A*-shifter, e.g. Generalization X), and those where the dependency holds between a parameter and a shifter from two different dimensions (i.e. a parameter value of type *A* is dependent on a *B*-shifter). I will refer to dependencies of the first kind by the term *intradimensional dependence* (or *A-dependence*, for short). For dependencies of the second kind, I will use the term *interdimensional dependence* (or *B-dependence*).

(42) *Intradimensional Shifter Dependence* (short: S(hifter)/A-dependence)

The value of an *A-parameter* depends on an *A-shifter*

(where "depends on an *A*-shifter" translates to: The set of possible values of the *A*-parameter is restricted by the values of type *A* that are *introduced* by the *A*-shifter[24])

(43) *Interdimensional Shifter Dependence* (short: S/B-dependence)

The value of an *A-parameter* depends on a *B-shifter*

(where "depends on an *B*-shifter" translates to: The set of possible values of the *A*-parameter is restricted by the values of type *B* that are *introduced* by the *B*-shifter)

Shifter dependence[25] is not the only way the set of possible index-values of an expression might depend on the modal, temporal, or spatial information associated with another expression. For example, the

[23] If, let us say, the world evaluation of an embedded predicate would (for whatever reason) be restricted by the presence of a matrix past tense, this would be a shifter dependence of the relevant (interdimensional) type.

[24] For example, the possible values for the evaluation world EW of a predicate (the values for the *A*-parameter) are restricted by the possible worlds AW that are introduced (i.e. quantified over) by an attitude verb (the *A*-shifter), so that the set of possible values for the predicate's EW will change depending on the values of AW.

[25] Simplifying somewhat, I will treat the utterance context (or more precisely: the utterance parameter-determining functions of the utterance context) as a collection of a special subtype of shifters, i.e. the shifters that introduce the world, time, and location of utterance (At least metaphorically, one can conceptualize the utterance shifters as silent expressions occupying the topmost regions in the constituent structure of a sentence). As such, cases where the set of parameter values of an index-sensitive expression is restricted by the index of utterance (e.g. the evaluation of indexicals) are treated as a subtype of shifter dependence. Importantly, this should be treated as

value of an *A*-parameter of a given index-sensitive expression might depend on the value we select for the *A*-parameter (or *B*-parameter) of another index-sensitive expression. Concretely, this type of dependency would (for instance) hold if the possible values for the evaluation time of a predicate α were constrained by the evaluation time of a second predicate β. Again, this type of dependency (which I will term *neighbor dependence*, where the term *neighbor* picks out index-sensitive expressions that occupy the same sentence) has an intradimensional and an interdimensional variant.

(44) *Intradimensional Neighbor Dependence* (short: N(eighbor)/A-dependence)

The value of the *A-parameter* of an index-sensitive expression α depends on the *A-parameter* of a (neighboring) index-sensitive expression β

(where "depends on the *A-parameter* of a (neighboring) index-sensitive expression β" translates to: The set of possible values of the *A*-parameter of α is restricted by the value of the *A-parameter* of β)

(45) *Interdimensional Neighbor Dependence* (short: N/B-dependence)

The value of the *A-parameter* of an index-sensitive expression α depends on the *B-parameter* of a (neighboring) index-sensitive expression β

(where "depends on the *B-parameter* of a (neighboring) index-sensitive expression β" translates to: The set of possible values of the *A*-parameter of α is restricted by the value of the *B-parameter* of β)

In section 2.4., we will see that some well-known restrictions on the evaluation world (and time) of predicates (e.g. the *Intersective Predicate Generalization*) might be good candidates for neighbor dependencies (N/A-dependencies, in particular).

Lastly, there is a third way that an index parameter of an expression might depend on other parameters: The value of an index parameter might depend on the value of a different index parameter that *evaluates the same expression*. I will call this type of dependency *host dependence* (where the host is the index-sensitive expression that is evaluated relative to the relevant parameter values under consideration). Such a dependency would hold interdimensionally, for example, if the set of possible values of a predicate's evaluation time were somehow conditioned on the evaluation world of that same predicate. In section 3, we will discuss potential examples of this kind. Importantly, a host dependency could (at least potentially) hold intradimensionally as well. That is, one could imagine that there are index-sensitive expressions that are sensitive to not one but *two* (or more) index parameters of the same type. Such an expression would have an intension with two (or more) world (or time or location) arguments. Since this would effectively mean that such an expression establishes a relation between two worlds/times/locations, one could imagine that the values of the two relevant parameters are not entirely independent of each other. I will postpone discussion of these cases (at least for the moment), but it

a (preliminary) simplification and it might very well be sensible to classify these cases as a separate type of *utterance dependence*.

might be reasonable to think of certain shifters (e.g. tense, which expresses a relation between two times) as expressions of the relevant kind.

(46) *Intradimensional Host Dependence* (short: H(ost)/A-dependence)

The value of an *A*-parameter *j*[26] of an index-sensitive expression α depends on an *A*-parameter *k* (where $j \neq k$) of the same expression α

(where "depends on an *A-parameter* of the same expression α" translates to: The set of possible values of the *A*-parameter *j* is restricted by the values of an *A*-parameter *k* (where $j \neq k$), where both *j* and *k* are evaluation parameters of the same expression α

(47) *Interdimensional Host Dependence* (short: H/B-dependence)

The value of an *A*-parameter *j* of an index-sensitive expression α depends on a *B*-parameter *k* of the same expression α

(where "depends on a *B*-parameter of the same expression α" translates to: The set of possible values of the *A*-parameter *j* is restricted by the values of a *B*-parameter *k*, where both *j* and *k* are evaluation parameters of the same expression α

The table below gives a summary of the different types of dependencies.

(48) *Intra- and interdimensional dependencies (for a given A-parameter)*

	Dependent on		
Dimensionality	*Shifter (S)*	*Neighbor (N)*	*Host (H)*
Intradimensional (A)	S/A-dependence	N/A-dependence	H/A-dependence
Interdimensional (B)	S/B-dependence	N/B-dependence	H/B-dependence

One of the main goals of the present research project is to find out which of the dependency types in (48) are relevant for determining the set of possible indices. Particular focus will be given to interdimensional dependencies, since generalizations of this kind are usually not considered in the literature on index constraints. In section 2.4., we will see how various (mostly intradimensional) generalizations from literature map onto the categories in (48). The reason for creating a taxonomy along the lines of (48) is twofold: First, by systematically laying out the logical possibilities for how an index parameter *might* depend on other factors, we can better identify the empirical gaps in our understanding of index constraints (For instance, a quick survey of the relevant literature will suffice to show that most research has tried to find index constraints by looking at S/A-dependencies alone). Second, the discovery of what kinds of abstract index dependencies are empirically relevant has direct ramifications for how we construct theories of intensionality. For instance, if we find that generalizations about shifter dependence are highly predictive when it comes to the set of possible parameter values, then ideally this fact should be reflected in the mechanisms we use to analyze index dependence. That is, a system of intensionality that incorporates shifter dependence among its most fundamental properties might then

[26] *j* should be understood as the name of the parameter, not its value.

have an advantage over a theory that needs additional assumptions or stipulations to derive shifter dependence. As we will see in the upcoming sections, the two most popular frameworks of intensionality (the parameter approach and the variable approach) do indeed differ in how readily their most fundamental mechanisms derive (or do not derive) shifter dependence. Moreover, if we find that a certain type of abstract dependency never plays a role in limiting the set of possible indices, then this fact should also fall out as a natural property of our theory of intensionality. For example, if we find that there are no substantive interactions between parameters of different dimensions (i.e. if there is no evidence for B-dependencies), then our system should not be set up in a way that predicts correlations between the values of e.g. a world and a time parameter. In chapter 3, we will see that existing theories of intensionality are (unintentionally) committed to very specific predictions about what types of interdimensional interactions should exist. In essence, then, a system of intensionality may be characterized by how its most fundamental assumptions make commitments with respect to the intra- and interdimensional dependencies in (48). By making these commitments explicit, we can judge how well they align with the intra- and interdimensional generalizations that describe the empirical patterns. Our taxonomy of index dependence can thus be used as a basis for evaluating different theories of intensionality.

In order to evaluate the assumption of theories of intensionality, we must first introduce them. This will be done in the next section.

2.3. Theories/Frameworks of Intensionality: Parameters vs. variables

For the most part, I will limit my discussion to two frameworks of intensionality (including their various variants and extensions): The parameter approach and the index-pronoun approach. In this section, I will outline only the basic idea of these two approaches. As we move forward and the data becomes more intricate, I will go into the details of their systems to see how they fare when confronted with various challenges (in particular, see chapter 3 for a more in-depth discussion).

Starting with the parameter system, this approach is directly adopted from earlier modal and intensional logics, and has been a popular framework since the earliest days of formal semantics (e.g. Montague 1973). The basic idea of this approach is that the interpretation (function) is relativized to an index of evaluation, consisting (among other things) of a world, a time, and a location. For instance, if we take the interpretation (or more precisely: the extension) of a sentence to be a truth value, then this truth value is now determined relative to the particular world, time and location that is represented as a parameter on its interpretation function (the default for these parameters is always the world, time, and location of utterance). The same goes generally for the analysis of index-sensitive expressions, whose index-sensitivity is now resolved directly in the interpretation process.

(49) *Interpreting sentences and predicates in the parameter approach*

a. $[\![\text{It's raining}]\!]^{w,t,,l,g}$ = 1 iff it is raining in w at t in l
b. $[\![\text{swim}]\!]^{w,t,,l,g} = \lambda x_e$. x is a swimmer in w at t in l

The role of shifters is exactly as their name suggests: They *shift* (i.e. manipulate) an index parameter of the expression they combine with. If we give this expression the name ϕ, then we could roughly define world, time, and location shifters in the following way.

(50) *Shifters in the parameter approach*

a. $[\![\text{Antoinette believe } \phi]\!]^{w,t,l,g} = [\![\phi]\!]^{w_{\textit{Antoinette's belief}},t,l,g}$ (world shifter)
b. $[\![\text{PAST } \phi]\!]^{w,t,l,g} = [\![\phi]\!]^{w,t_{\textit{Past}},l,g}$ (time shifter)
c. $[\![\text{inVienna } \phi]\!]^{w,t,l,g} = [\![\phi]\!]^{w,t,l_{\textit{Vienna}},g}$ (location shifter)

Accepting some simplifications, (51) derives the meaning for the sentence "Antoinette believes that it was raining in Vienna" based on the parameter system.

(51) *"Antoinette believes that it was raining in Vienna" in the parameter approach (simplified)*[27]

a. $[\![\text{Antoinette believe [PAST [inVienna [it's raining]]]}]\!]^{w,t,l,g}$
$= [\![\text{PAST [inVienna [it's raining]]}]\!]^{w_{\textit{Antoinette's belief}},t,l,g}$
$= [\![\text{inVienna [it's raining]}]\!]^{w_{\textit{Antoinette's belief}},t_{\textit{Past}},l,g}$
$= [\![\text{it's raining}]\!]^{w_{\textit{Antoinette's belief}},t_{\textit{Past}},l_{\textit{Vienna}},g}$

In the index-pronoun theory, in contrast, the index-information is not introduced as part of the interpretive process (i.e. interpretation functions are only relativized to the assignment function g). Instead, the evaluation of index-sensitive expressions is resolved by combining them with (silent) pronominal expressions that denote worlds, times, and locations. These world/time/location pronouns receive their value from the assignment g but can be bound by index-binders (here represented with lambdas) that are distributed throughout the structure. Per default, every sentence includes the utterance world, utterance time, and utterance location as its topmost binders (in (52) represented by the lambdas with index 0, 1, 2).

(52) *Interpreting sentences and predicates in the index-pronoun approach*

a. $[\![\lambda_{w0}\ \lambda_{t1}\ \lambda_{l2}\ [\text{it's raining } w_0\ t_1\ l_2]]\!]^g$ = 1 iff it is raining in g(0) at g(1) in g(2)
b. $[\![\text{swim } w_3\ t_8\ l_4]\!]^g = \lambda x_e$. x is a swimmer in g(3) at g(8) in g(4)

In this systems, shifters manipulate the evaluation of index-sensitive expressions by binding their index-pronouns. (53) gives a simplified[28] representation for "Antoinette believes that it was raining in Vienna".

[27] I will simplify and ignore the fact that the sentence can only express a contingent claim by relating its meaning to the utterance world/time/location as well.

[28] Among other things, I will ignore the contribution of the matrix present tense. Also, I will again be sloppy and ignore the fact that the matrix predicate is index-sensitive as well and must thus also combine with a world, time, and location pronoun (which will be bound by the topmost utterance binders).

(53) *"Antoinette believes that it was raining in Vienna" in the index-pronoun approach*

a. $[\![\lambda_{w0}\ \lambda_{t1}\ \lambda_{l2}$ [Antoinette believe λ_{w9}[PAST λ_{t7}[inVienna λ_{l5}[it's raining w_9 t_7 l_5]]]]]$]\!]^g$ = 1 iff it is raining in g(9) at g(7) in g(5)

Having set up the different systems for dealing with index-sensitivity, I will now turn my attention back to the taxonomy of index-dependence we outlined in 2.2.. In the rest of this chapter, the goal will be to systematize index-constraints from the literature by relating them to the different types of index-dependencies in the taxonomy. More specifically, I will discuss intradimensional constraints (A-dependencies), which have been the main focus in the literature.

2.4. Intradimensional (in-)dependence

2.4.1. Shifter (in-)dependence

First, let us look at intradimensional shifter dependencies, which were defined as in (54).

(54) *Intradimensional Shifter Dependence* (S/A-dependence)

The value of an *A-parameter* depends on an *A-shifter*

(where "depends on an *A*-shifter" translates to: The set of possible values of the *A*-parameter is restricted by the values of type *A* that are *introduced* by the *A*-shifter)

We can consider the different ways in which the values introduced by the A-shifter can influence the A-parameter of an index-sensitive expression in its scope. There are three logical possibilities:

a. *Obligatory shifting*
The A-parameter *obligatorily* takes on (i.e. "shifts" to) the value introduced by the shifter.

b. *Optional shifting*
The A-parameter *optionally* takes on the value introduced by the shifter.

c. *Obligatory non-shifting*
The A-parameter *cannot* take on the value introduced by the shifter.

Interestingly, natural language seems to instantiate all three of these possibilities. In section 2.2. (example (41)), we have already seen evidence that the possible interpretations of a sentence are restricted by the inability of verbs to be evaluated at worlds other than those introduced by its most local shifter[29]. In the literature, this S/A-type constraint is known as Generalization X (see Percus 2000). Generalization X also holds for the verb's evaluation time. Indeed, it may seem trivial that Generalization X must hold for times as well, since in this case it effectively describes the semantic relationship between a verb and its tense morphology. Obviously, a sentence like (55) cannot situate Napoleon's running at the utterance time. The whole point of using the past tense is to situate Napoleon's running at a past time different from the time of utterance.

(55) In 1814, Napoleon ran

[29] However, see Sudo (2014) for potential counterexamples to this generalization.

However, even though this data point may seem obvious, this does not mean that it straightforwardly falls out from our system of intensionality (see Keshet 2008 on this point). Indeed, in an index-pronoun system that takes tense to be a sentential operator that introduces a binding index, nothing *per se* rules out an LF in which the time argument of the verb is bound by the utterance time binder instead of the past tense[30].

(56) *Possible LF for an impossible reading of "Napoleon ran"*

$[\![\lambda_{w0}\ \lambda_{t1}\ \lambda_{l2}\ [\text{PAST}\ \lambda_{t7}[\text{Napoleon ran}\ \ w_0\ t_1\ l_2]]]]\!]^g$
= 1 iff Napoleon runs in the actual world *at the utterance time* in the utterance location

Unsurprisingly, Generalization X was first introduced as part of a demonstration that an index-pronoun system must be accompanied by a binding theory in order to avoid overgeneration (see Percus 2000 for the original argument). Interestingly, Generalization X falls out straightforwardly if we assume the parameter theory instead of the index-pronoun approach. In the parameter system, verbs are trapped in the index-determining intensional domain of their most local world or time shifter and are therefore obligatorily shifted. Before we move on, note that Generalization X can be argued to be operative in the spatial domain as well. Indeed, even if (57) is uttered in Vienna, it is not possible to situate the running event in any location other than Paris.

(57) Marianne is running in Paris

In addition to verbal predicates, Percus (2000) further argues that adverbs (e.g. "always") are subject to obligatory world-shifting. Percus calls this constraint Generalization Y. Moreover, Keshet (2008: 123-124) shows that Generalization Y is also active when it comes to the temporal evaluation of adverbs. We can try to test whether Generalization Y holds for locations as well. (58) indicates that this is indeed the case.

(58) In Paris hat der Tourist *überall* Obdachlose gesehen (uttered in Vienna)
In Paris has the tourist everywhere homeless seen
'In Paris, the tourist saw homeless people everywhere'

Intended meaning
#A German native who is right now in Paris as a tourist saw homeless people when he is/was in Vienna at some earlier visit (He never saw a single homeless person during his Paris vacation)

Besides obligatory shiftees, there are also index-sensitive expressions that are free to choose their evaluation parameter when they are in an environment where more than one A-value has been introduced. Famously, this is the case for nominal predicates, which in an intensional domain allow

[30] The Generalization X data for tenses may be more easily accounted for if we assume that tense is the direct spell-out of the verb's time pronoun, instead of an operator that binds that pronoun. In this case, the "pastness"-requirement would come in the form of a feature on that time pronoun, which induces a presupposition of the relevant kind. If this is the implementation we choose, we would not need a binding theory to derive the temporal version of Generalization X. However, since the operator-free analysis is not available for attitude verbs and similar world-shifters, we would still need a binding theory for Generalization X in the domain of worlds.

different readings depending on the selected index-parameter. In the literature, the optional shifting of nouns is generally known under the name *de re/de dicto*- or *transparent/opaque*-ambiguity (see Keshet & Schwarz 2019 for an overview). Since the world- and time-freedom of nouns will be extensively discussed in chapters 3 and 4, I will not give an introduction here. However, since the intensional freedom is seldomly discussed in the context of locations[31], let us briefly look at (59).

(59) In Frankreich hat mir *ein Ausländer* den Weg gezeigt (uttered in Austria)
In France has me a foreigner the way shown
'In France, a foreigner showed me the way'

Possible reading 1 (foreigner from the perspective of France)

In Austria, Hans says: "In France, the natives ignored me because I couldn't speak French. Fortunately, a foreigner was nice enough to show me the way. Actually, I think that the foreigner I met was from here, Austria."

Possible reading 2 (foreigner from the perspective of Austria)

In Austria, Fritz says: "In France, a native showed me the way. I usually don't like French people, but this foreigner was nice."

The example in (59) aims to show that the evaluation location of a noun is only optionally shifted. That is, the noun "foreigner" is ambiguous between an evaluation at the shifted location (a foreigner from the perspective of France) and the utterance location (a foreigner from the perspective of Austria). Considering the well-known ambiguities observed for a noun's evaluation world and time, we can conclude that nominal predicates are *optional (intradimensional) shiftees* when it comes to all three index-dimensions. Note that this fact poses further challenges for theories of intensionality. This time, it seems that the index-pronoun theory is better equipped when it comes to dealing with optional shifting. Optional shifting is exactly what we predict if index pronouns are freely indexed. The parameter theory, on the other hand, needs a mechanism that allows the nominal to (optionally) escape the intensional domain of a shifter. Since it has been independently argued that DPs have the ability to covertly raise to higher positions at LF (via Quantifier Raising), this might not be a problem. However, it has also been claimed (most notably by Fodor 1970) that a noun can pick up a non-local index parameter even when it resides in a position within the intensional domain of a shifter. Put differently, even when a DP can be shown to take narrow scope with respect to its local shifter, it can escape the influence of that shifter (see section 3.7. for a discussion of the narrow-scope transparent reading of nominals). If this generalization is true, then the parameter theory needs a different way of accounting for optional shifting.

Next, let us briefly turn to index-sensitive expressions that are obligatorily non-shifting. The best candidates for such expressions are indexicals. Indexicals are per definition expressions that are always dependent on the utterance context. They cannot adopt the contextual information (i.e. a world, a time,

[31] But see Mitchell (1986) and Partee (1989) for literature on (implicit) location-sensitivity, including ambiguities of the relevant kind.

or location) that is introduced by a shifter. The example in (60) contains two indexicals in an index-shifted environment, the temporal adverb "now" and the locational adverb "here". Observe that "now" can only refer to the time of utterance, not the 'now' of the times introduced by any of the tenses. Similarly, "here" specifically picks out the utterance location (which is Vienna) and not any of the locations introduced by a shifter (e.g. Rome, Paris).

(60) In Rome a few years ago, Augustus believed that Leopold had prophesized at some time in Paris that Marianne would live *here now* (uttered in Vienna)

Interestingly, the classification of indexicals as *obligatory non-shiftees* is not universal. Much recent research has focused on languages in which indexicals (optionally) shift (see Deal 2020 for a discussion of *indexical shift*). It thus appears that indexicals sometimes pattern with nouns and belong to the class of optional shiftees, at least in some languages.

At this point, I want to highlight that a noun's ability to shift optionally becomes unavailable under certain conditions. For instance, Musan (1995) has famously argued that nominals lose their temporal independence when they appear in the pivot of an existential construction.

(61) #There were *many professors* in kindergarten in the '80s.
(Keshet 2010: 386)

(61) is odd because individuals that are professors are adults and therefore not in kindergarten. If "professor" were able to make use of optional shifting to get evaluated at the utterance time, (61) should be acceptable. Keshet (2008) has argued that the world evaluation of nouns is subject to the same constraint. The example in (62) illustrates this. For the sentence to make sense, "an unemployed person" would have to receive a transparent interpretation. This is not available in this case.

(62) #Mary thinks that there is *an unemployed person* on our payroll
(Percus 2020: 17)

Although further testing might be necessary, the nominal location parameter seems to be constrained in a similar way.

(63) #(?) There was *a foreigner* at the meeting (of French nationalists) in Austria (uttered in France)

Context

The French nationalist society of Vienna holds annual meetings. Usually, only French citizens attend. However, at the last meeting, Hans (an Austrian and declared Francophile) shows up.

Why do (some) DPs in some contexts behave like obligatory shiftees? Several answers have been proposed in the literature, which for the most part share the intuition that a DP must have a certain discourse-pragmatic status in order to allow optional shifting. Specifically, it has been proposed that optionally shifting DPs (or their predicates) must be *strong* (vs. *weak*, in the sense of Milsark 1974; e.g.

Musan 1995; Keshet 2008), presuppositional (Musan 1999; Schwarz 2012), or discourse-familiar (O'Leary 2022).

Combining what we know about S/A-dependencies from the literature, we get the following classification.

(64) *Classification of S/A-behavior*

S/A-type	**Expression**	**Generalization from the literature**
Obligatory Shiftees	verbal predicates	Generalization X
	adverbs	Generalization Y
	nominal predicates (in weak/non-presuppositional/discourse-novel DPs)	Musan's (1995) generalization and related work
Optional Shiftees	nominal predicates (in strong/presuppositional/discourse-familiar DPs)	Transparent/Opaque ambiguity
	indexicals (in languages/contexts with indexical shift)	Indexical Shift
Obligatory Non-Shiftees	indexicals (in languages without indexical shift)	Behavior of indexicals

Next, I will turn to (intradimensional) neighbor dependencies (N/A-dependencies).

2.4.2. Neighbor (in-)dependence

Are there dependencies between the index-values of two neighboring (but independent) expressions of the kind described in (65)?

(65) *Intradimensional Neighbor Dependence* (N/A-dependence)

The value of the *A-parameter* of an index-sensitive expression α depends on the *A-parameter* of a (neighboring) index-sensitive expression β

(where "depends on the *A-parameter* of a (neighboring) index-sensitive expression β" translates to: The set of possible values of the *A*-parameter of α is restricted by the value of the *A-parameter* of β)

One case of an N/A-dependencies is exhibited by optionally shifting indexicals that undergo indexical shift. It has been repeatedly argued that shiftable indexicals that occupy the same shifting domain must shift together (i.e. if one indexical shifts, then all indexicals in the domain must shift). See Anand &

Nevins (2004) and Anand (2006) for discussion of the *Shift Together* constraint. Here, I will focus on two other N/A-type constraints from the literature: The *Nested DP Constraint* (Romoli & Sudo 2009) and the *Intersective Predicate Generalization* (Keshet 2010).

The Nested DP Constraint was formulated by Romoli & Sudo (2009) to account for cases in which the world-value of a DP_1 is restricted by the world-value of a DP_2 that is embedded inside DP_1. (66) gives a relevant example.

(66) Mary thinks that [$_{DP1}$ the *wife* of [$_{DP2}$ the *president*]] is nice.
(Romoli & Sudo 2009: 430)

Besides the readings where the nouns of DP_1 and DP_2 are both opaque (i.e. evaluated relative to the worlds introduced by the attitude) or both transparent (i.e. evaluated relative to the utterance world), (66) has a reading in which the noun of DP_1 is opaque, but the noun of DP_2 is transparent. For instance, imagine that Mary does not know who Joe Biden is, but one time she sees him on television standing beside a nice-seeming woman. If Mary then thinks to herself that the woman must be the man's wife (even though she is not), we get the opaque-DP_1+transparent-DP_2-reading. Interestingly, the reverse reading – the transparent-DP_1+opaque-DP_2-reading – is unavailable. Let us imagine that Mary believes that Bernie Sanders is president (DP_2 is opaque). Let us further assume that Mary thinks Jane Sanders (his wife) is nice, but that she also mistakes her for his sister (DP_1 is transparent). For some reason, this scenario cannot be expressed by (66). We thus need a constraint like the one in (67).

(67) *Nested DP Constraint*
When a DP is embedded inside a DP, the embedding DP must be opaque if the embedded DP is opaque.
(Romoli & Sudo 2009: 430)

Again, this constraint on possible index-values (as any constraint on possible index-values) raises immediate problems for the index-pronoun theory. If DP_1 and DP_2 can contain their own world pronouns, then nothing rules out the transparent-DP_1+opaque-DP_2-reading. At first glance, the parameter theory may have an easier time explaining (67). Assuming that variations in indexing correlate with different scope positions for the DP, then raising DP_1 as a whole derives the transparent-DP_1+transparent-DP_2-reading, while leaving DP_1 (as whole) in situ derives the opaque-DP_1+opaque-DP_2-reading. The opaque-DP_1+transparent-DP_2-reading could be derived by moving DP_2 out of DP_1, so that DP_2 escapes the intensional domain, but DP_1 does not. Importantly, the reverse is syntactically much less plausible. Since DP_2 is dominated by DP_1, there is no straightforward way of moving DP_1 outside the intensional domain that leaves DP_2 behind[32]. Thus, if formulated in a precise way, the transparent-DP_1+opaque-DP_2-reading might be ruled out by syntax. However, note that this solution might not work once we acknowledge that transparent readings are from a position within an intensional domain (i.e. the narrow scope-

[32] DP_2 would have to leave first in a short movement step that does not cross the intensional domain. Then, DP_1 could undergo remnant movement.

transparent reading). A revised parameter system that accounts for this reading would likely lose the original advantage of appealing to syntactic plausibility. Yet, see section 3.4.2. for an idea of how a revised parameter theory might deal with the Nested DP-Constraint.

I am not aware of any literature that looked for an equivalent constraint in the temporal or spatial dimension. The temporal analogue for the transparent-DP_1+opaque-DP_2-reading would be the utterance time-DP_1+tense time-DP_2-reading. So far I have not tested this systematically. But from first impressions, the reading does seem to be worse than its alternatives.

(68) Im Jahr 1980 war [$_{DP1}$ die Frau [$_{DP2}$ des Präsidenten]] krank
in year 1980 was [$_{DP1}$ the-Nom wife [$_{DP2}$ the-Gen president]] sick
'In 1980, the wife of the president was sick'

a. *Tense Time-DP_1+Utterance Time Time-DP_2*

The current president (elected after 2015) was married to Susan from 1976 to 1981 (He married his current wife in 1991). In 1980, Susan spent several months in a hospital because of an illness.

b. *#Utterance Time-DP_1+Tense Time-DP_2*

The former president (He was in office from 1976-1984) left his first wife in 1989 and later married Beth. Today, he is still married to Beth. In 1980, Beth spent several months in a hospital because of an illness. She never fully recovered from it.

I will leave it for future work to confirm or falsify these initial intuitions. I will also leave it for future work to look for an analogue in the spatial dimension.

Keshet's (2010) *Intersective Predicate Generalization* is given in (69).

(69) *Intersective Predicate Generalization (IPG)*

Two predicates interpreted intersectively may not be evaluated at different times or worlds from one another.

(Keshet 2010: 388)

The IPG captures data such as (70) in which a noun and intersective adjective cannot be evaluated at different worlds. Since the two incompatible properties "married" and "bachelor" must hold either both in the actual world or both in Mary's belief-worlds, the sentence is odd.

(70) #Mary thinks *the married bachelor* is confused.

(Keshet 2010: 391)

See section 4.6. for discussion of the IPG in the realm of times. Moreover, (71) might show that the IPG extends to locations as well.

(71) #In Österreich hat *der ausländische Staatsbürger* Peter getroffen (uttered in France)
In Austria has *the foreign citizen* Peter met
'In Austria, the foreign citizen met Peter.'

In (71), the DP seemingly cannot refer to a French citizen (i.e. a foreigner from the adverb perspective of Austria, but a citizen from the utterance perspective of France) or an Austrian citizen (i.e. a foreigner from the utterance perspective of France, but a citizen from the adverb perspective of Austria). Interpreting both the adjective and the noun at the same location leads to the intuition that (71) is contradictory. Again, I will leave it to others to corroborate this intuition[33]. The IPG presents another challenge for the index-pronoun theory since it again asks for a more restrictive system of index-assignment. See Keshet (2010) for a proposal framed within the index-pronoun approach. For the (unmodified) parameter theory, the coordinated evaluation of intersective predicates is expected as long as we assume (quite plausibly) that the predicates do not scope independently. Overall, we have seen evidence that there are constraints that might be characterized as H/A-dependencies. Let me now briefly comment on dependencies of the Host/A-type.

2.4.3. Host (in-)dependence

The class of host dependencies aims to allow for the possibility that a single index-sensitive expression (e.g. a single DP/nominal predicate) might be dependent on multiple indices whose values influence each other. On an interdimensional level, host dependencies (i.e. H/B-dependencies) will be the main topic of chapter 3, where I will examine how the world and time parameter of a single nominal predicate interact. Host dependencies on the intradimensional level could show up if the meaning of a single index-sensitive expressions was sensitive to more than one world/time/location-parameter. It is not clear whether generalizations of this kind exist. However, chapter 4 will explore cases where a single (simple) DP-interpretation makes use of two distinct times whose relationship is subject to constraints. Thus, chapter 4 might be viewed as a case study of a H/A-dependency (Although, from a more decompositional view, the relevant constraint could also be classified as a neighbor dependency). I will leave it open for now whether intradimensional host dependencies are a relevant category.

2.5. Conclusion and outlook

What have we learned about how language cuts down on possible index-values? We have seen that there exist complex dependency relations (on an intradimensional level) between index-sensitive expressions and their shifters (S/A-dependencies), as well as dependencies between different index-sensitive expressions (S/H-dependencies). Up to this point, we can fill in the table as follows.

[33] Importantly, see O'Leary (2022) for a discussion of how notions of familiarity/novelty might interfere with the IPG in certain contexts.

(72) *Intra- and interdimensional dependencies (for a given A-parameter)*

	Dependent on		
Dimensionality	*Shifter (S)*	*Neighbor (N)*	*Host (H)*
Intradimensional (A)	**i.) Obligatory Shifting** (Generalization X, Generalization Y, Musan's Generalization) **ii.) Optional Shifting** (transparent/opaque-ambiguity, shifted indexicals) **iii.) Obligatory Non-Shifting** (indexicals)	**i.) Nested DP Constraint** **ii.) Intersective Predicate Generalization** **iii.) Shift Together**	?
Interdimensional (B)	?	?	?

Moreover, our discussion of intradimensional generalizations in 2.4. reveals a general pattern that seems to hold interdimensionally. It appears that all three index-parameter (worlds, times, and locations) are uniformly subject to the same intradimensional constraints. Even more strikingly, the three index-parameters of a single expression seem to behave in concord. That is, if an index-sensitive expression is an optional shifter for worlds, it will also be an optional shifter for times and locations. Likewise, if an expression is an obligatory shifter, then it is an obligatory shifter in all three dimensions. Especially in systems that manipulate the three index-parameters independently from each other (as is at least the case for the index-pronoun approach as it was outlined in 2.3.), this finding is far from obvious. Indeed, it is an interesting (and likely important) fact that different index-parameters seem to work in parallel (see also Keshet 2008 for an extensive study into the parallels of worlds and times; see also Schmitt 2023 for arguments that worlds do not behave in parallel to other ontological entities). We can capture this fact with the following meta-generalization[34].

(73) *Interdimensional meta-generalization about intradimensional behavior*

> If an index-parameter of an index-sensitive expression α is subject to an intradimensional constraint, then all other index-parameters of α must be subject to an intradimensional constraint of the same type.

Let us now examine how the constraints in (72) narrow down the 64 possible readings we identified for the simple tensed attitude sentence from section 2.2. (here repeated in (74)). Importantly, the Nested DP

[34] We could have also framed it as an interdimensional host dependeny. However, since this generalization does not add new index-restrictions, but only generalizes over the intradimensional generalizations that are already in place, it is probably better to formulate it as a meta generalization over our taxonomy.

Constraint and the IPG are not relevant for this simple case, but they will restrict readings once more complex DP structures are involved. Indeed, since nominal predicates are optional shifters in all dimensions, the only restriction comes from the obligatory shifting of the verbal predicate. However, this restriction alone is enough to narrow down the logically possible 64 alternatives to 8 candidates.

(74) At her house in Vienna (in 2011), Marie thought that a *student* was *swimming*

(Uttered in Paris in 2019 in the actual world)

Claim Nr.	**Evaluation of "student"**		**Evaluation of "swim"**
1	A student **in Vienna in 2011 in Marie's thought-worlds**	was	swimming **in Vienna in 2011 in Marie's thought-worlds**
2	A student *in Paris in 2019 in the actual world*		
3	A student **in Vienna** *in 2019 in the actual world*		
4	A student **in Vienna in 2011** *in the actual world*		
5	A student **in Vienna** *in 2019* **in Marie's thought-worlds**		
6	A student *in Paris* **in 2011 in Marie's thought-worlds**		
7	A student *in Paris in 2019* **in Marie's thought-worlds**		
8	A student *in Paris* **in 2011** *in the actual world*		

8 possible readings are more manageable from a communicative perspective, but still quite a lot, especially considering that we could drastically increase the number of readings by introducing additional optional shiftees. A question we could ask next is whether nouns actually allow all the possible combinations of world-, time-, and location-values in (74). This question brings us into the realm of interdimensional dependencies. In particular, we need to ask ourselves whether the world (or time, or location) parameter of an optional shiftee α is in any way predictable from the value of α's other parameters. That is, what combinations of modal/temporal/spatial readings are possible? Are there any implicational generalizations of the type: 'If the modal interpretation of a DP_{α} is x, then the temporal interpretation of DP_{α} must be/cannot be y'[35]? This question will be the topic of the next chapter. Because of the limited nature of this thesis, I will exclusively focus on the relationship between a noun's world and a noun's time. The study of interdimensional relations involving the location parameter is put aside for future work.

[35] Where x is a variable that stands for the choice of world-interpretation (e.g. utterance world-interpretation, belief world-interpretation …) and y stands for a particular time-interpretation.

3. Interdimensionality: Modal-temporal interactions inside DPs

3.1. Summary and overview of this chapter

This chapter is an investigation into the interaction of worlds and times. Specifically, it examines how the world and time parameter of a nominal predicate may depend on each other.

It is well-known that DPs have the ability to pick up essentially any piece of world or time information that is made available at higher points in the structure. For instance, in (76), the DP "a butler" can either describe a butler in the worlds introduced by "believe" (i.e. a butler in Augustus' belief-worlds w_{belief}; since Augustus might be mistaken, the butlers in his belief-worlds might not be actual butlers) or a butler in the actual world (the actual/utterance world w_{utt} is available by default in any sentence; in this case, Augustus might have a belief about a particular individual about whom he does not even know that he is a butler in the actual world).

(75) *A butler* is stealing Marianne's jewelry

(76) Augustus believed that *a butler* stole Marianne's jewelry

The same is true for the temporal interpretation of DPs: In a tensed sentence, a DP can either pick up the time introduced by tense (e.g. refer to someone who was a butler in the past at t_{tense}) or the utterance time (e.g. refer to someone who is presently a butler at t_{utt}). In this chapter, I explore what can happen to a DP when it is inside a context in which both modal *and* temporal information is manipulated/added (The sentence in (76) is such a contexts, since it includes both an attitude verb and tense). Specifically, I try to find out whether the temporal interpretation of a DP is in any way dependent on the DP's modal interpretation, or vice versa. The guiding research questions can be thus framed in the following way.

(77) *(Guiding) Research Questions*

> What combinations of modal/temporal readings are possible for a DP inside a simple (tensed) attitude context? Are there any implicational generalization of the type: 'If the modal interpretation of a DP_{α} is x, then the temporal interpretation of DP_{α} must be/cannot be y'? [36]

Concretely, for a DP such as "a butler" in (76), I try to find answers to questions such as: Can "a butler" receive its temporal interpretation from the utterance time (instead of a time introduced by one of the tenses) when its modal interpretation is determined by the belief-worlds introduced by the attitude verb? Can "a butler" receive its temporal interpretation from the time introduced by the embedded tense when its modal interpretation is determined by the utterance world? Or more generally, which of the following modal/temporal readings are possible for "a butler" in (76).

[36] Where x is a variable that stands for the choice of world-interpretation (e.g. utterance world-interpretation, belief world-interpretation …) and y stands for a particular time-interpretation.

(78) *Which of these readings are possible?*

a. 'a butler in w_{utt} at $t_{matrix\text{-}tense}$' (an actual past butler at the believing-time)
b. 'a butler in w_{utt} at $t_{embedded\text{-}tense}$'
c. 'a butler in w_{utt} at t_{utt}'
d. 'a butler in w_{belief} at $t_{matrix\text{-}tense}$'
e. 'a butler in w_{belief} at $t_{embedded\text{-}tense}$'
f. 'a butler in w_{belief} at t_{utt}'

Section 3.2. gives a general introduction into the intensional behavior of nominal predicates. It is shown in detail that nouns are ambiguous in an intensional environment, both when it comes to their evaluation world and when it comes to their evaluation time (i.e. they are optional shiftees).

Section 3.3. then shows how modal-temporal readings have implications for our theories of modality and temporality. It is demonstrated that different systems of modality/temporality (e.g. systems that relativize interpretations to world/time parameters vs. systems that rely on object language world/time variables) give us quite different expectations about the types of modal/temporal readings that should be attested. For instance, a classic conception of modality/temporality (based on the parameter view) analyzes attitude verbs and tenses as operators that shift the evaluation world/time of all expressions in their scope. In such a system, the range of possible modal/temporal DP-readings is limited by the possible scope positions of DPs relative to modal and temporal operators. (79) schematically illustrates the available scope positions for a DP inside a simple attitude sentence (e.g. (76)). According to this traditional view, the DP takes its world and time value from the most local modal and temporal operators. That is, based on the four logically possible scope positions in (79), we derive the corresponding modal/temporal readings in (80).

(79) $(DP)_1$ (TENSE$_{matrix}$ $(DP)_2$ (BELIEVE $(DP)_3$ (TENSE$_{emb}$ $(DP)_4$)))

(80) a. $(DP)_1$: 'a butler in w_{utt} at t_{utt}' (i.e. an actual butler at the utterance time)
b. $(DP)_2$: 'a butler in w_{utt} at $t_{matrix\text{-}tense}$'
c. $(DP)_3$: 'a butler in w_{belief} at $t_{matrix\text{-}tense}$'
d. $(DP)_4$: 'a butler in w_{belief} at $t_{embedded\text{-}tense}$'

The important thing is that the modal interpretation and the temporal interpretation of DPs is determined by the same factor: The DP's scope position. This inevitably leads to the prediction that the modal and temporal values of a DP must depend on each other in systematic ways. Specifically, the scope-based theory (in its unmodified form) predicts that the following two modal/temporal readings should not exists: (78f.) 'a butler in w_{belief} at t_{utt}', and (78b.) 'a butler in w_{utt} at $t_{embedded\text{-}tense}$'. The reason for this is that the world value and the time value for (78f.) and (78b.) have incompatible scope requirements. For instance, to derive (78f.), the DP would have to take narrow scope with respect to BELIEVE for its world-evaluation, but wide scope with respect to BELIEVE for its temporal evaluation (since the DP must outscope TENSE$_{matrix}$). In section 3.3., it is shown that the prediction of the parameter view is borne out only when it comes to reading (78f.) (the opaque+utterance time-reading), but not for (78b.) (the transparent+embedded tense-reading). Moreover, it is shown that the alternative theory – the index-

pronoun theory – makes exactly the reverse (but still false) predictions: It correctly derives the existing transparent+embedded tense-reading, but also the non-existing opaque+utterance time reading.
Section 3.4. examines how various amendments to the traditional theories of intensionality might solve their over- and undergeneration problems. Section 3.5. considers the full range of modal-temporal readings.

Sections 3.6.-3.7. reexamine the opaque+utterance time-reading and ask whether it might be a special subcase of a generalization on (im-)possible temporal relations. It is argued that this is the case. Specifically, the chapter arrives at the following generalization about modal-temporal readings.

(81) *Microlevel Generalization: Ban on O+(MT<ET)/Upper Limit Opaqueness*

> A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude)

Section 3.8. summarizes and gives an outlook.

3.2. The world and time sensitivity of nominal predicates

This chapter looks at how the modal and temporal dimensions interact in determining the interpretation of Determiner Phrases (DPs). The interpretation of DPs (and in particular, their nominal predicates) crucially involves information about a world and a time of evaluation. As discussed in chapter 2, nominal predicates are *optional shiftees*, i.e. their evaluation parameters can, but do not have to shift in the presence of a shifter. In constructions that introduce modal or temporal displacement (i.e. shifters), this leads to well-known ambiguities that concern the world or time parameter of the noun. For example, let us consider the DP "a butler" from (82) and (83).

(82) Augustus believes that *a butler* stole Marianne's wallet

(83) (In 2010) *A butler* stole Marianne's wallet

The extension of the noun "butler" is typically taken to be the set of individuals that are butlers. Note, however, that this set contains different individuals depending on the world under consideration. Let us say that James, Michael and John are in fact butlers in the utterance world, but Edmund and Edwin are not. Additionally, let us assume that Augustus is ignorant about the exact individuals that are butlers in his mansion, but he (for whatever reason) wrongly believes that Edmund is among them. In this case, the extension of "butler" in the utterance world is given in (84)a.[37], while the extension of "butler" for one of Augustus' belief-worlds might look like (84)b[38].

[37] For the sake of illustration, let us assume that James, Michael and John are the only butlers in the universe. The denotation given in (84)a. is thus exhaustive with respect to the butlers in the actual world.

[38] Since Augustus is mostly ignorant about the individuals that are butlers in his house, his belief-worlds will contain worlds that differ with respect to the denotation of *butler*. Since the (wrong) assumption that Edmund is a butler is the only specific belief that Augustus has about butlers, Edmund will be the only individual that must be consistently included in all of Augustus' belief worlds. Among Augustus' belief-worlds are thus worlds that assign the denotations in (i)-(iii), but no worlds that would allow the extension in (iv).

(84) a. *butlers in* w_{utt} = {x | x is a butler in w_{utt}} = {James, Michael, John}
b. *butlers in* $w_{belief1}$ = {x | x is a butler in $w_{belief1}$} = {Edmund, James, Michael}

The world-sensitivity of DPs becomes particularly relevant when sentences introduce worlds other than the utterance world (the utterance world being the ultimate evaluation world that is available in every sentence). This is the case in (82): In addition to the actual world w_{utt} (which is the evaluation world of Augustus' belief because it is an *actual* belief he holds in the world of utterance), the attitude verb "believe" introduces Augustus' belief-worlds w_{belief} as additional worlds of evaluation. For a DP like "a butler", this situation raises the following question: Which of the (now *two*) available evaluation worlds w_{utt} and w_{belief} is a possible evaluation world for the DP? The answer seems to be both. Imagine first the following context.

(85) *Transparent Reading (de re)*

> One night, Augustus sees a man hurriedly leaving Marianne's bedroom. Augustus doesn't get a good look at him, so he doesn't realize that it is in fact Michael, one of his butlers. Michael is also Marianne's secret lover. He had snuck into her room a few hours before and was just about to leave when Augustus saw him. The next day, Marianne notices that her wallet is missing. Augustus thinks of what he observed the night before and says: "I saw a man leave your room last night. It was very late and he seemed to be in a hurry. I bet he stole your wallet!" Edmund is certain that the man Augustus saw was Michael (He witnessed Michael coming from the direction of Marianne's room shortly after Augustus' made his observation). Later, he tells this to someone by uttering:
>
> "Augustus believes that *a butler* stole Marianne's wallet"

Given the context, Augustus has a belief about the particular individual that he saw coming out of Marianne's room (i.e. Michael): In all of his belief-worlds w_{belief}, this individual stole Marianne's wallet. Importantly, Augustus does not hold this belief about Michael under the description that he is a butler. In fact, Augustus does not know or think that the individual he saw was a butler. Nevertheless, (82) can be read as a true statement about Augustus' beliefs. The key to this seems to be the fact that Michael is a butler in the actual world w_{utt} and the speaker of (82) knows this. Thus, the context in (85) triggers a reading where the DP "the butler" is evaluated with respect to the utterance world w_{utt}. It is an individual from the extension of "butler" in the actual world (i.e. Michael) about whom Augustus is reported to have a belief[39]. This is the so-called *transparent reading* (or *de re reading*) of a DP inside a modal environment.

(i) *butlers in* $w_{belief2}$ = {Edmund, James}
(ii) *butlers in* $w_{belief3}$ = {Edmund, John, Michael}
(iii) *butlers in* $w_{belief4}$ = {Edmund, James, Edwin}
(iv) **butlers in* $w_{belief'}$ = {James, Michael, John}

[39] Without further assumptions about the semantics of *de re*-attitudes, the picture presented so far leads to problems. It is well-known that a proper semantics for *de re*-readings must overcome the problem of *double vision*, which was first discussed by Quine (1956). The problem can be easily illustrated for the context in (85): Augustus believes *of the individual he saw leaving Marianne's room* that he stole Marianne's wallet. This individual happens to be Michael, although Augustus does not know this. Since Augustus is in fact acquainted with Michael from other situations (Michael is, after all, a butler at Augustus' mansion), Augustus might have beliefs about Michael

Now, consider the context in (86).

(86) *Opaque Reading (de dicto)*

> One day, Marianne reports that her wallet is missing. Augustus, who is always quick to mistrust the staff at his mansion, says: "I'm sure one of the butlers stole your wallet. I have never trusted them". Edmund later tells someone about Augustus' beliefs:
>
> "Augustus believes that *a butler* stole Marianne's wallet"

In the case of (86), there is no particular individual about whom Augustus holds a belief. Moreover, the description of the nominal predicate "butler" is an integral part of what Augustus believes: In every of Augustus' belief-worlds w_{belief}, it is a butler that stole Marianne's wallet (Even though it can be a different butler in different belief-worlds, since Augustus does not have a particular butler in mind). In this reading, then, the DP "a butler" is evaluated in Augustus belief-worlds w_{belief}. This reading is called the *opaque reading* (or *de dicto reading*).

It seems that a DP can freely choose between the evaluation worlds that are made available at earlier points in the sentence (including the utterance world)[40]. In a construction where a modal element (e.g. an attitude verb) introduces additional (non-actual) evaluation worlds, the result of this choice is the famous *de re/de dicto*-ambiguity (or *transparent/opaque*-ambiguity), which has received a considerable amount of attention in the philosophical and linguistic literature (see Keshet & Schwarz (2019) for a recent overview). For (82) (repeated here as (87)), the two readings can be informally described by making the evaluation world of each predicate explicit[41].

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that are quite different from the beliefs he would claim to hold of the individual he saw leaving Marianne's room (whom Augustus does not identify as Michael). For instance, let us assume that Augustus has the conscious belief about his butler Michael that he is an upstanding citizen who obeys the law and who has never stolen anything. Now, if Augustus' *de re*-belief in (85) is simply construed as a belief about the individual Michael, we would ascribe contradictory beliefs: On the one hand, we would ascribe Augustus the belief that a.) Michael stole Marianne's wallet. On the other hand, we would ascribe to him the belief that b.) Michael has never stolen anything. A semantics for "believe" in which a belief must be true in all of Augustus' belief-worlds would lead to a contradiction: There are no worlds for which both a.) and b.) can hold at the same time.
One way to deal with this problem is to rely on *acquaintance relations* in our semantics of *de re*-reports (e.g. Kaplan 1969; Lewis 1979). The idea is this: *de re*-attitudes are not attitudes about objects *per se*, but attitudes about objects *under a certain mode of presentation*. That is, the attitude-holder is acquainted with the object/individual in a certain way and it is relative to this acquaintance relation to the object that he holds a certain belief. For the two seemingly contradictory beliefs a.) and b.), this resolves the issue: For Augustus, the belief expressed by a.) is a belief about Michael as he presents himself to him in the situation where he catches him hurriedly leaving Marianne's bedroom. Given this restricted acquaintance relation to the individual Michael (under which he does not even recognize him as Michael), it is indeed the case that he can believe him to be a thief, without thereby contradicting his conscious opinion about Michael the butler. The latter (expressed by attitude b.)), is then simply a *de re*-belief under a different acquaintance relation (In this case, the relevant relation might be based on Augustus' experience with Michael as a butler).

[40] With worlds that are made available at "earlier points in the sentence", I mean the actual/utterance world (which is always available) and any worlds that are introduced by (structurally) higher intensional shifters.

[41] Importantly, the informal description in (87) ignores issues of DP-scope. This is no accident. It is true that the *de re*-reading in (85) crucially involves wide-scope of "a butler" ((85) provides a context in which Augustus has a *particular* individual in mind about whom he holds a belief, i.e. the existential quantifier of the indefinite takes scope over the universal quantifier of the attitude verb), while the *de dicto*-reading in (86) relies on a narrow-scope reading of the indefinite (Augustus does not have a particular butler in mind, i.e. in every of his belief-worlds there exists a butler who stole Marianne's wallet, but it might be a different butler in different belief-worlds). However, since the seminal work of Fodor (1970), it has been known that the issue of quantificational DP-scope

(87) Augustus believes that *a butler* stole Marianne's wallet

a. *Transparent Reading (also called: de re)*

w_{utt}, w_{belief}: Augustus believes-w_{utt} that [**a butler-w_{utt}**] stole-w_{belief} Marianne's wallet

b. *Opaque Reading (also called: de dicto)*

w_{utt}, w_{belief}: Augustus believes-w_{utt} that [**a butler-w_{belief}**] stole-w_{belief} Marianne's wallet

In addition to being world-sensitive, the interpretation of DPs is influenced by temporal information. Again, we can see this influence by the way the denotation of nominal predicates is determined: The predicate "butler" is true of different individuals at different times. For instance, one could imagine that Augustus employed different butlers in the past than he does now. Let us say that James, John and Michael (the current butlers) did not become butlers before the year 2018. Additionally, let us assume that Leonard, Rick and Martin worked as Augustus' butlers in the past (including the year 2010), but changed profession at some time before the year 2018. If these assumptions hold[42], then the extension of "butler" is quite different depending on the time of evaluation:

(88) a. *butler at* $t_{utterance/2022}$ = {x | x is a butler at $t_{utterance/2022}$} = {James, Michael, John}
b. *butler at* $t_{tense/2010}$ = {x | x is a butler at $t_{tense/2010}$} = {Leonard, Rick, Martin}

In a sentence that introduces times that are different from the utterance time, we find an ambiguity that is similar to the transparent/opaque-ambiguity we discussed for evaluation worlds. The past tense in (83) above (repeated in (91)) introduces a time $t_{tense/2010}$ in the past of the utterance time t_{utt}. Similar to its choice between multiple evaluation worlds, the nominal predicate "butler" is able to select freely

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must be separated from the issue of transparency/opacity (i.e. the evaluation world of the nominal predicate). The reason for this is the existence of narrow scope-transparent readings (also known as Fodor's third reading). For instance, let us assume the following scenario:

> Context:
>
> Ludwig is at a party at Marianne's mansion. At one point, Marianne cries out that someone has stolen the jewelry from her bedroom. Earlier on the same evening, Ludwig witnessed three occasions when someone came out of Marianne's room: At one point, he saw James coming out of Marianne's room. At another point, he saw John leaving her room. At a third point, Michael came out of Marianne's room. Unbeknownst to Ludwig, James, John and Michael are butlers at Marianne's house. So he doesn't know that the three men are her butlers when he points them out to Marianne and tells her: "Each of these three men has been in your room at one time. One of them must have stolen your jewelry!"
> Marianne later tells Ludwig's belief to the police. She says:
>
> (i) Ludwig believes that *a butler* stole the jewelry

In (i), Ludwig does not have a particular individual in mind as the thief of Marianne's jewelry (In some of his belief-worlds, the thief is James, in others it is Michael etc.). The indefinite "a butler" thus takes narrow scope with respect to the universal quantifier over Ludwig's belief-worlds. Importantly though, the nominal predicate is evaluated in the actual world, not Ludwig's belief-worlds, since Ludwig does not know that the individuals he suspects are butlers. Therefore, it is a transparent/*de re* reading.

In this thesis, I assume that the transparent/opaque ambiguity (or *de re/de dicto* ambiguity) is about the choice of the evaluation world of the nominal predicate. Quantificational scope (including specific/unspecific readings of indefinites) may interact with the choice of evaluation world, but is, in principle, a separate issue.

[42] Assuming, again, the simplification that Augustus' butlers exhaust the set of butlers that exist in the universe at a given time.

between the two available times. On the one hand, (83) can be used to talk about butlers at the utterance time (i.e. 2022).

(89) *Utterance Time Reading*

In 2022, James is working as a butler in Marianne's house. In 2010, when he was still a child and his father worked as a cook for Marianne, James snuck into Marianne's room and stole her wallet. In 2022, he confesses this to his employer, Augustus. Augustus later tells a friend:

"In 2010, when he was still a child, *a butler* stole Marianne's wallet"

On the other hand, (83) can be used to talk about butlers at the time picked out by the past tense.

(90) *Utterance Time Reading*

In 2010, Leonard was working as a butler at Marianne's house. One day, he snuck into Marianne's bedroom and stole her wallet. Later, the police found the wallet among Leonard's possessions. Leonard was dismissed immediately and put in jail. He never again found work as a butler. In the year 2022, Marianne's husband Augustus recounts:

"In 2010, *a butler* stole Marianne's wallet"

The ambiguity can be informally summarized as in (91).

(91) (In 2010) *A butler* stole Marianne's wallet

a. *Utterance Time Reading*

t_{utt}, $t_{tense(2010)}$: [**a butler-**t_{utt}] stole-$t_{tense(2010)}$ Marianne's wallet

b. *Tense Time Reading*

t_{utt}, $t_{tense(2010)}$: [**a butler-**$t_{tense(2010)}$] stole-$t_{tense(2010)}$ Marianne's wallet

We have now seen that the interpretation of DPs is influenced by manipulations in both the modal and the temporal dimension of a sentence. Moreover, the semantics of DPs seems to interact with these two dimensions in a way that is (at least on the surface) quite similar: The evaluation of a nominal predicate can freely choose a world *and* a time that has been made available by other expressions or by the utterance context (in the case of the utterance world/time). Next, we will consider possible ways in which the modal and temporal dimension can interact.

3.3. Systems of intensionality and modal-temporal interactions in DPs

In this section, I will look at what happens when one and the same DP is influenced by both modal and temporal information. In fact, a sentence like (82) is the prime test case I will be considering. We have already seen that the attitude verb in (82)[43] introduces additional evaluation worlds for the DP in its scope. In addition to this, however, the sentence has two tenses[44] that both have the potential of introducing new evaluation times. If we now assume that a nominal predicate can choose its evaluation

[43] Repeated again in (92) below. I changed the matrix tense to a past tense in order to make its contribution clearly distinct from the utterance time.

[44] A matrix tense and an embedded tense. For clarity, I will (for the moment) abbreviate the matrix tense time as t_{matrix} and the embedded tense time as t_{emb}.

world/time freely from all the evaluation worlds/times made available in a sentence, we get the following logical possibilities for its interpretation:

(92) Augustus believed that *a butler* stole Marianne's wallet

w_{utt}, w_{belief} t_{utt}, t_{matrix}, t_{emb},: Augustus believed-w_{utt}-t_{matrix} that [**a butler**-$w_?$-$t_?$]
stole-w_{belief}-t_{emb} Marianne's wallet

Evaluation world/time for "a butler-$w_?$-$t_?$"		
Evaluation World	**Evaluation Time**	**Reading**
w_{utt}	t_{utt}	transparent + utterance time (T+UT)
w_{utt}	t_{matrix}	transparent + matrix tense (T + MT)
w_{utt}	t_{emb}	transparent + embed. tense (T + EmbT)
w_{belief}	t_{utt}	opaque + utterance time (O + UT)
w_{belief}	t_{matrix}	opaque + matrix tense (O + MT)
w_{belief}	t_{emb}	opaque + embed. Tense (O + EmbT)

Are all of these readings attested? Or put differently: How (in-)dependent are the modal and temporal dimensions when it comes to the interpretation of a single DP? Are particular temporal readings of DPs predictable from their modal reading or vice versa?[45] These are the questions that are at the heart of the following investigation.

How are these questions relevant for linguistic theory? The short answer: Different theories of intensionality (explicitly or implicitly) assume different degrees of (in-)dependence between the modal and temporal dimension. By looking at how these two dimensions interact in determining the interpretation of DPs, we might gain deeper insights into how modality and temporality (and their interplay) contribute to a general system of intensionality. In fact, simple choices in our theory of intensionality can change the types of modal-temporal interactions we predict. For illustration, let us briefly compare two of the classic systems of intensionality that have been proposed in the literature[46]:

[45] Framed in the terminology of section 2: Can we find interdimensional host-dependencies (H/B-dependencies) when it comes to the time and world parameter of a nominal predicate?

[46] Both the parameter theory and the index-pronoun theory characterize the modal and temporal freedom of DPs in terms of the freedom to select a non-local evaluation world/time-parameter. Recently, a group of proposals has argued that the issue of transparent readings should be viewed in a different light. In particular, these approaches analyze transparent readings in terms of the *replacement* of predicates (see Schwager 2011; Sudo 2014; Percus 2020). These proposals discuss a number of fundamental challenges to the traditional *evaluation* idea of

the *parameter theory* and the *index-pronoun theory* (see section 2 for an introduction into these two frameworks). How do these two theories account for the modal and temporal evaluation of nominal predicates?

On the parameter view[47], the semantic interpretation of an expression is relativized to a world and time of evaluation[48]. This is implemented by adding a world and a time parameter to the interpretation function.

(93) $[\![\text{butler}]\!]^{w,t,g} = \lambda x_e$. x is a butler at t in w

Modal and temporal shifters (e.g. attitude verbs, tenses) have the ability to change the world or time parameter of expressions in their scope. For instance, let us assume the following semantics for "believe"[49]:

(94) $[\![\text{believe}]\!]^{w,t,g} = \lambda p_{<i,<s,t>>}. \lambda x_e. \forall w'.$ w' is a world that is compatible with what x believes in w at t: p(t)(w')=1

The proposition variable p stands for the intension of the sentential complement of "believe" (i.e. the intension of "(that) a butler stole Marianne's wallet" in our example), which is an abstraction over the world and time parameter.

(95) *Extension of "(that) a butler steals Marianne's wallet"*

$[\![\text{(that) a butler steals Marianne's wallet}]\!]^{w,t,g}$ = 1 iff ∃x. x is a butler in w at t: x steals Marianne's wallet in w at t

(96) *Intension of "(that) a butler steals Marianne's wallet"*

$\lambda t'. \lambda w'. [\![\text{(that) a butler steals Marianne's wallet}]\!]^{w',t',g}$

In the parameter theory, intensional operators/shifters are expressions that take the intension of their complement as an argument, which gives them the ability to manipulate their world and/or time parameters. The semantics given in (94) essentially requires that the embedded clause (the complement of "believe") is evaluated in the subject's belief-worlds w' instead of the matrix evaluation world w (i.e. "believe" shifts the world parameter for the embedded clause). Ignoring the contribution of tense for the moment, the compositional semantics of (92) can be derived as follows.

transparent readings. Although the replacement idea is intriguing, I will neglect these proposals in the discussion that follows.

[47] For a classic example of this type of framework see Montague (1973).

[48] Since we are only interested in the interactions of worlds and times in this section, I will omit the spatial dimensions when I discuss implementations of different systems of intensionality.

[49] This is essentially a version of the classic believe-semantics of Hintikka (1969) with the addition of time arguments.

(97) ⟦believe [that a butler steal Marianne's wallet]⟧^{w,t,g}
= ⟦believe⟧^{w,t,g}(λt''. λw''. ⟦(that) a butler steal Marianne's wallet⟧$^{w'',t'',g}$)[50]
= [λp$_{<i,<s,t>>}$.λx$_e$. ∀w'. w' is a world that is compatible with what x believes in w at t: p(t)(w')=1](λt''. λw''. ⟦(that) a butler steal Marianne's wallet⟧$^{w'',t'',g}$)
= λx$_e$. ∀w'. w' is a world that is compatible with what x believes in w at t: [λt''. λw''. ⟦(that) a butler steal Marianne's wallet⟧$^{w'',t'',g}$](t)(w')=1
= λx$_e$. ∀w'. w' is a world that is compatible with what x believes in w at t: ⟦(that) a butler steal Marianne's wallet⟧$^{w',t,g}$=1

⟦Augustus [believe [that a butler steal Marianne's wallet]]⟧^{w,t,g}
= 1 iff ∀w'. w' is a world that is compatible with what Augustus believes in w at t: ⟦(that) a butler steal Marianne's wallet⟧$^{w',t,g}$=1
= 1 iff ∀w'. w' is a world that is compatible with what Augustus believes in w at t: ∃x. x is a butler in w' at t: x steals Marianne's wallet in w' at t

Importantly, the attitude verb shifts the world parameter of the entire embedded clause. Since the DP "a butler" is inside the embedded sentence, its evaluation world must shift too. That is, when a DP occupies a position inside the complement clause at LF, this always results in an opaque reading in this system. In order to derive a transparent reading, the parameter approach requires the DP[51] to outscope the shifted intensional domain, e.g. via some sort of (covert) movement operation[52]:

(98) ⟦[a butler] [λ$_1$ [Augustus [believe [that x$_1$ steal Marianne's wallet]]]]⟧^{w,t,g}
= ⟦a butler⟧^{w,t,g}(λx. ∀w'. w' is a world that is compatible with what Augustus believes in w at t: x steals Marianne's wallet in w' at t)
= 1 iff ∃x. x is a butler in w at t: ∀w'. w' is a world that is compatible with what Augustus believes in w at t: x steals Marianne's wallet in w' at t

Therefore, the parameter theory derives the transparent/opaque-ambiguity by the DP's scope position at LF. The same is true for the temporal evaluation of a DP. Similar to modal operators, tenses are analyzed as operators that shift the time parameter of their intensional argument. For our simple sentence in (83), this might look as follows[53]:

(99) ⟦PAST⟧^{w,t,g}= λ$p_{<i,<s,t>>}$. ∃t'. t'<t & p(t')(w)=1

⟦PAST[A butler steal Mariann's wallet]⟧^{w,t,g}
= ⟦PAST⟧^{w,t,g}(λt''.λw''. ⟦(that) a butler steal Marianne's wallet⟧$^{w'',t'',g}$)
= 1 iff ∃t'. t'<t & [λt''.λw''. ⟦(that) a butler steal Marianne's wallet⟧$^{w'',t'',g}$](t')(w)=1
= 1 iff ∃t'. t'<t & ⟦(that) a butler steal Marianne's wallet⟧$^{w,t',g}$=1
= 1 iff & ∃t'. t'<t & ∃x. x is a butler in w at t': x steals Marianne's wallet in w at t'

Again, the position of "a butler" inside the scope of the past tense shifts its time of evaluation to a time in the past of the utterance time. By scoping the DP outside of the intensional complement of PAST, it may get an interpretation relative to the utterance time parameter.

[50] This step here assumes the application of *Intensional Functional Application* (IFA), which is a rule that should be known to anyone familiar with von Fintel & Heim (2021).
[51] Or more precisely: The nominal predicate inside the DP.
[52] I assume a version of the standard LF and semantics of movement from Heim & Kratzer (1998).
[53] < stands for the temporal precedence relation.

(100) $[\![[\text{a butler}]\ [\lambda_1\ [\text{PAST}[x_1\ \text{steal Marianne's wallet}]]]]\!]^{w,t,g}$
= $[\![\text{a butler}]\!]^{w,t,g}(\lambda x_e.\ \exists t'.\ t'<t\ \&\ x \text{ stole Marianne's wallet in } w \text{ at } t')$
= 1 iff $\exists x.$ x is a butler in w at t & $\exists t'.\ t'<t$ & x stole Marianne's wallet in w at t'

Since both the modal and temporal evaluation of DPs are determined by their scope position relative to fixed intensional operators along the clausal spine, the resulting *scope theory of DP-intensionality*[54] makes a clear prediction about which of the world-time readings in (92) should exist. (101) lists all the logically possible scope positions for a DP inside a simple attitude sentence, and the readings they would derive. (102) lists the two readings that are excluded if the evaluation of a DP is determined solely by scope.

(101) *Derived readings of the (parameter-based) Scope Theory of DP-intensionality*

DP-position	Corresponding Reading
TENSE$_{matrix}$(BELIEVE(TENSE$_{emb}$ **DP**))	$[\![DP]\!]^{w_{belief},t_{emb}}$ opaque + embedded tense
TENSE$_{matrix}$(BELIEVE **DP** (TENSE$_{emb}$ …))	$[\![DP]\!]^{w_{belief},t_{matrix}}$ opaque + matrix tense
TENSE$_{matrix}$(**DP** BELIEVE(TENSE$_{emb}$ …))	$[\![DP]\!]^{w_{utt},t_{matrix}}$ transparent + matrix tense
DP (TENSE$_{matrix}$(BELIEVE(TENSE$_{emb}$ …))	$[\![DP]\!]^{w_{utt},t_{utt}}$ transparent + utterance time

(102) *Non-derived readings of the (parameter-based) Scope Theory of DP-intensionality*

DP-position	Corresponding Reading
TENSE$_{matrix}$(BELIEVE(TENSE$_{emb}$ **DP**)) for temporal evaluation *AND* **DP** (TENSE$_{matrix}$(BELIEVE(TENSE$_{emb}$ …)) for modal evaluation	$[\![DP]\!]^{w_{utt},t_{emb}}$ ***transparent + embedded tense***
DP (TENSE$_{matrix}$(BELIEVE(TENSE$_{emb}$ …)) for temporal evaluation *AND* (TENSE$_{matrix}$(BELIEVE(**DP** TENSE$_{emb}$ …))[55] for modal evaluation	$[\![DP]\!]^{w_{belief},t_{utt}}$ ***opaque + utterance time***

[54] The idea that transparent/opaque-ambiguities (or ambiguities of a similar flavor) can be analyzed as an ambiguity of scope goes back (at least) to observations made by Russell (1905). Montague (1973) gives an influential implementation of this idea. A recent defense of this approach can be found in Keshet (2011). Keshet develops a system of *split intensionality* that addresses many of the shortcomings of older scope theories.

[55] For the relevant modal evaluation, the DP could scope even lower.

As (101) illustrates, deriving the transparent+embedded tense-reading (T+EmbT) and the opaque+utterance time-reading (O+UT) via scope would result in a scope paradox. The DP would be required to take both narrow *and* wide scope with respect to the relevant intensional operator.

Contrast this with the predictions made by the index-pronoun theory[56]. In this competing approach to intensionality, worlds and times are represented as (covert) syntactic variables in the object language. That is, instead of relativizing the interpretation of language to world and time parameters, language itself contains expressions that can refer to worlds and times directly. One way to implement this idea is to assume that every predicate syntactically combines with a world and a time pronoun (the world/time pronoun approach). In the semantics, the values of these pronouns (which they receive via the assignment function g) then combine compositionally with the denotation of the predicate (which is of an intensional type <i,<s,t>>). In this way, the values of the world and time pronouns determine the modal and temporal evaluation of the predicate.

(103) $[\![\text{butler } w_2\ t_4]\!]^g = \lambda x_e$. x is a butler in g(2) at g(4)

In this system, attitude verbs and tenses can influence the evaluation of nominal predicates by increasing the binding options for their world and time pronouns. Each intensional operator introduces an abstractor over worlds or times, which can be coindexed with a world or time pronoun in its scope. Additionally, it is often suggested (e.g. in Percus (2000)) that the utterance world and the utterance time are represented by dedicated binders at the top of the LF-structure. (104) gives a rough sketch of a possible LF-structure for a simple attitude sentence.

(104) $\lambda w_{utt0}\ \lambda t_{utt1}$ [TENSE$_{matrix}$ [$\lambda t_{matrix2}$ [ATTIT [$\lambda w_{belief3}$ [TENSE$_{emb}$ [λt_{emb4} [DP NPred $w_?$ $t_?$]]]]]]

With the way this system works, it is easy to see that it allows a greater degree of freedom than the parameter theory. Without imposing explicit restrictions on co-indexing, the world and time pronouns inside a DP will be able to be bound by any higher world or time binder[57]. In consequence, every modal-temporal reading in (92) can be derived by this system, including the T+EmbT-reading and the O+UT-reading. Possible LFs for all the potential readings are given in (105).

[56] Various versions of this approach can be found in Heim (1994), von Fintel & Heim (2021), Percus (2000), von Stechow (2004), Keshet (2008, 2010), Schwarz (2012), Elbourne (2013), von Stechow & Beck (2015), Kratzer (2021), and many others.

[57] However, the world/time pronoun theory still makes interesting predictions about the effect of DP-scope: Since a world/time pronoun cannot pick up an index from an abstractor that is introduced lower in the tree, higher DP-scope means reduced binding-options. Similar to the parameter theory, widest scope should only be compatible with an utterance world/time-reading. Intermediate scope should exclude binding by a lower tense/attitude verb, but it should allow binding by any higher intensional operator, including the utterance time/world. The difference between the parameter theory and the world/pronoun theory is a difference in locality assumptions: While the parameter theory *requires* a DP to consider the closest evaluation world/time (i.e. the worlds/times that are introduced by the most local intensional operator), the world/time pronoun theory allows a long-distance association with evaluation worlds/times that are introduced at higher points in the tree.

(105) *Derived readings of the world/time-pronoun theory*

LF-structure	**Corresponding Reading**
λ*wutt*0 λ*tutt*1 [TENSE*matrix* [λ*tmatrix*2 [ATTIT [λ*wbelief*3 [TENSE*emb* [λ*temb*4 [DP NPred w3 t4]]]]]]]	O+EmbT
λ*wutt*0 λ*tutt*1 [TENSE*matrix* [λ*tmatrix*2 [ATTIT [λ*wbelief*3 [TENSE*emb* [λ*temb*4 [DP NPred w3 t2]]]]]]]	O+MT
λ*wutt*0 λ*tutt*1 [TENSE*matrix* [λ*tmatrix*2 [ATTIT [λ*wbelief*3 [TENSE*emb* [λ*temb*4 [DP NPred w0 t2]]]]]]]	T+MT
λ*wutt*0 λ*tutt*1 [TENSE*matrix* [λ*tmatrix*2 [ATTIT [λ*wbelief*3 [TENSE*emb* [λ*temb*4 [DP NPred w0 t1]]]]]]]	T+UT
λ*wutt*0 λ*tutt*1 [TENSE*matrix* [λ*tmatrix*2 [ATTIT [λ*wbelief*3 [TENSE*emb* [λ*temb*4 [DP NPred w0 t4]]]]]]]	***T+ET***
λ*wutt*0 λ*tutt*1 [TENSE*matrix* [λ*tmatrix*2 [ATTIT [λ*wbelief*3 [TENSE*emb* [λ*temb*4 [DP NPred w3 t1]]]]]]]	***O+UT***

Overall, the basic mechanisms that underly different systems of intensionality give us quite different expectations about the types of modal-temporal interactions we should find. To take just one of the readings for which the two systems make different predictions, let us consider the transparent+embedded tense (T+EmbT) reading, which is derived by the world/time pronoun theory, but not by the scope/parameter theory. Does this reading exist? It seems that it does. Consider (106).

(106) Lucy believes that *a student* killed Mr. Chandler (in 1990) (T+EmbT)

> Context
> In the year 2020, Susan tells Lucy about the time her neighbor (Mr. Chandler) was murdered. It was in the year 1990 and the murderer has never been found. Her friend Lucy believes that she has the supernatural ability to determine the killer just by looking at a picture of him. Thus, when Susan shows her photos from that time, she points to a particular individual in the photos and says: "That's the murderer! I feel it". Unbeknownst to her, the person she pointed at was Michael, a former student and classmate of Susan. He was one of the nicest people in Susan's school. Susan doesn't tell her this. Instead, she humors Lucy and asks what else her abilities tell her about the person in the picture. She replies: "Quite a lot. For instance, I can sense that he must have been a teacher back then!"
> Susan later tells her experience to a friend:
>
> "Lucy believes that *a student* killed Mr. Chandler. She's crazy!"

In (106), Lucy has a belief about a particular individual that was a student *in 1990*. Therefore, the evaluation time of the predicate coincides with the time of the embedded past tense (Neither the matrix present tense nor the utterance time could provide an appropriate evaluation time). Moreover, Lucy does not know that Michael was a student (In fact, her "abilities" tell her he was a teacher in 1990). On the modal dimension, the nominal predicate is thus evaluated relative to the utterance world. Overall, we get an evaluation in the utterance world w_{utt} and at the embedded tense time t_{emb} – a T+EmbT-reading. This reading is easily available for (106).

We have now seen a type of modal-temporal interaction for which the world/time pronoun theory has the advantage: It correctly predicts the existence of the T+EmbT-reading. On the other hand, the parameter theory (in its pure version without added assumptions) undergenerates. Interestingly, the case of the T+EmbT-reading shows similarities to other readings that have proven problematic for the traditional scope/parameter approach. The most prominent among them is the narrow scope-transparent reading[58]. It is well-known that a DP may be evaluated in the utterance world even when it can be shown to take narrow (quantificational) scope relative to an attitude verb[59]. For the scope/parameter theory, the existence of this reading presents a scope paradox, since it both requires wide scope to get access to the utterance world parameter and narrow scope for the right interpretation of its quantificational force. The T+EmbT-reading presents a similar scope paradox: Again, the DP should take wide scope relative to "believe" in order to arrive at a transparent reading, but at the same time it must take narrow scope to get access to the time parameter introduced by the embedded tense. We might therefore come to the conclusion that the T+EmbT-reading is just a special subcase of the wide scope-transparent reading. However, the T+EmbT-reading has a slightly different flavor. It is not about the dissociation of a DP's quantificational force and the evaluation of the nominal predicate. Instead, it is about two competing requirements imposed by the predicate evaluation itself: The demands of the modal evaluation (wide scope) versus the demands of the temporal evaluation (narrow scope)[60] [61]. This new type of evidence, in

[58] Also called Fodor's third reading because it was first discussed in Fodor (1970).

[59] An example is given in (i).

(i) Valentin believes that *a butler* won the mayoral election

Context

Valentin doesn't know the first thing about politics. When he attends a party shortly after the mayoral election, everybody is excited because the mayor elect is rumored to attend. Valentin does not know what the mayor looks like, but he nevertheless attempts to guess who it is. Based on his observations, he comes to the belief that the mayor must be one of the following four individuals: James, Michael, John, and Bert. Unbeknownst to him, these four individuals are actually the mayor's butlers, and not the mayor himself. He later tells Augustus about his belief, who tells his wife jokingly:

"Valentin believes that a butler won the mayoral election"

The important points about (i): On the one hand, Valentin does not know that the four individuals are butlers, so the nominal predicate receives a transparent reading (an evaluation in the utterance world). On the other hand, there is no particular individual that won the mayoral election in every one of Valentin's belief-worlds. Therefore, the existential quantifier introduced by the indefinite must take narrow scope relative to the attitude verb (i.e. the universal quantifier over Valentin's belief-worlds).

[60] One might be tempted to suggest that the relevant T+EmbT-reading in (106) is not even a narrow scope-reading when it comes to the quantificational force of the indefinite, since it is about a *particular* individual. However, this conclusion would be premature: Since the wide scope reading of the existential quantifier entails the narrow scope reading (If there is an individual that killed Mr. Chandler in every belief-world, then it is also true that in every belief-world there is an individual that killed Mr. Chandler), one cannot easily identify the scope position based solely on considerations of quantificational force in this case.

[61] This has actually some consequences for potential amendments to the scope theory. Based solely on the narrow scope-transparent reading, a potential solution would be to assume that the nominal predicate (the NP) can scope independently from the quantificational force of the determiner. However, this solution still gets into trouble when it comes to the T+EmbT-reading. This is because this reading is about conflicting positional requirements of the nominal predicate alone, not the DP.

which it is the evaluation of the nominal predicate alone that requires two incompatible scope positions, adds another dimension to the old problem of determining a noun's evaluation via scope.

The upshot of both the narrow scope-transparent reading and the T+EmbT-reading seems to be that the evaluation of a nominal predicate needs access to non-local evaluation parameters[62]. This is exactly what the world/time-pronoun theory makes possible, but the scope/parameter-theory does not.

However, we need to be cautious before we generalize this conclusion to both world *and* time parameters. The narrow scope-transparent- and the T+EmbT-reading strictly speaking only require the possibility of long-distance association with non-local *worlds*. They did not show that the same must be true for times. In fact, the choice of a non-local time parameter is exactly what is at stake in the second type of modal/temporal interaction that the parameter-theory blocks: the opaque+utterance time-reading (O+UT-reading). Since the discussion so far has favored the world/time-pronoun theory, we would expect that the O+UT-reading is available as well. Surprisingly, however, this is not the case. Let us take a look at example (107).

(107) #In 2000, Augustus believed that *a prisoner* stole Marianne's wallet (#O+UT)

Context

Augustus and Marianne have 8 children. In the year 2000, Marianne's wallet gets stolen. Augustus suspects that one of the children took it. He tells his friend Charlie at that time: "I bet one of the children stole the wallet, but I'm not sure which child exactly. Some of my children have a criminal tendency, you know. I think their future is doomed. I'm pretty sure that some of them will end up in prison in the future. I am making a prediction now: In 20 years, the child that stole Marianne's wallet – whoever it is – will be in prison. I'm sure of it." In the year 2020, after non of Augustus' children ended up in prison, Charlie recounts his past belief by saying:

"#In 2000, Augustus believed that *a prisoner* stole Marianne's wallet"

The relevant evaluation time for "prisoner" cannot be provided by one of the two past tenses, since Augustus is explicitly thinking about prisoners in the future of the year 2000 (i.e. the future of the year of the stealing- and believing-time). The evaluation time must be the utterance time t_{utt}. Moreover, Charlie is not talking about actual prisoners (since Augustus' children did not actually go to prison at all), but about prisoners in Augustus' belief-worlds $w_{belief3}$. If we try to force this reading, however, the sentence comes out as odd[63].

[62] This need to access non-local evaluation parameters has been shown to be relevant not just for nominal predicates, but for other expressions as well (e.g. for indexical temporal adverbials such as "yesterday"). It is often presented as a key argument in favor of the notion of introducing explicit intensional variables in the object language (i.e. the index-pronoun theory), since it seems to demonstrate that natural language has the full expressive power of object language quantification over worlds/times/situations. See Cresswell (1990) and Kratzer (2021) for discussion.

[63] The non-existence of this reading is corroborated by similar observations made by O'Leary (2022). Since I was made aware of O'Leary's work only after the relevant elicitation work on modal/temporal readings (especially for the O+UT-reading) had already been conducted, I take the fact that O'Leary's work came to similar conclusions (i.e. no O+UT-reading, but available T+EmbT-reading) as strong confirmation of the empirical claims made in

We now have conflicting evidence, where the parameter theory makes the right predictions for one modal/temporal-reading (the O+UT-reading) and the world/time-pronoun theory makes the right predictions for another (the T+EmbT-reading). Importantly, we have seen that basic assumptions about our system of intensionality can lead to non-trivial commitments to the (non-)existence of certain modal-temporal interactions.

In the next section, I will discuss several strategies for making the parameter and the index-pronoun theory compatible with the attested modal/temporal-readings.

3.4. Modifying the index-pronoun theory and the parameter theory

3.4.1. The ontological strategy for making index pronouns more restrictive

Within the framework of the index-pronoun theory, different types of pronouns have been used: Some researchers employ syntactically distinct pronouns for worlds and times (e.g. von Stechow 2004; von Stechow & Beck 2015), while other approaches use situation pronouns (e.g. Percus 2000; Schwarz 2012; Elbourne 2013; Kratzer 2021) or world-time-pair pronouns (e.g. von Fintel & Heim 2021). Moreover, sometimes the term *situation pronoun* is used as a stand-in for what is actually a world-time-pair pronoun (e.g. Keshet 2010)[64]. For the purposes of this section, I want to draw a clear distinction between world-time-pair pronouns $<w_j,t_k>$, on the one hand, and proper situation pronouns s_j, on the other hand. While the former allow the independent indexing of their world and time components, the latter are treated as unanalyzable units when it comes to their modal and temporal parts[65]. The distinction between the three types of index-pronoun systems (as I conceptualize them here) can be drawn along the following two dimensions:

a) the co-indexing possibilities for the world and time component, and
b) the possible syntactic distribution of the world and time component

a) separates the situation pronoun s_j, on the one hand, from independent world and time pronouns (w_j and t_k) and the world-time-pair pronoun ($<w_j,t_k>$), on the other. I define a situation as a part of a world that has (or can have) a certain temporal and/or spatial extension[66]. The important point is that a situation collapses the modal, temporal and spatial dimension into one single, (unanalyzable) ontological entity and a situation pronoun refers to this entity (as whole). The consequences of this are probably best

this section. To my knowledge, O'Leary's dissertation is the only work in the literature that discusses the combination (and interaction) of modal and temporal DP-readings.

[64] In general, the (implicit) attitude that is dominant in the literature seems to be that the choice between these options doesn't matter. However, as this section is supposed to illustrate, the choice becomes important when modal-temporal interactions are considered.

[66] Note that I do not claim that my definition of situations is identical to the definition assumed in situation semantics (e.g. Kratzer 2021). Here, I use the term *situation pronoun* simply as a term for a type of intensional pronoun that refers to an entity with modal and temporal properties (i.e. it is situated in a particular world and it has a (coherent) spatiotemporal extension), and that only allows single indexing (i.e. no separate indexing for its modal and temporal parts, as in the $<w_j,t_k>$-pronoun).

understood by looking at what this means for potential anaphoric dependencies. Let us assume the following two situations.

(108) *Situation 1 (S1)*

$World_0$: utterance worlds
$Time_3$: 21st December 1991
Location: Vienna
Description: "It is snowing"

(109) *Situation 2 (S2)*

$World_2$: Augustus' belief-worlds
$Time_4$: 8th November 2005
Place: Vienna
Description: "It is raining"

The distinction between the situation pronoun and other types of index-pronouns comes out in the granularity of information they can pick up via an anaphoric dependency. A situation pronoun (as an expression that refers to a situation as an atomic entity) can only be referentially related to complete situations. Let us assume that Situation 1 (S1: the actual snowing-situation in Vienna on December 21st 1991) and Situation 2 (S2: the non-actual raining-situation in Vienna on November 8th 2005 as it is represented in Augustus' beliefs) are the only situations previously referenced in the discourse (i.e. by some type of index pronoun). A new situation pronoun can be anaphorically related to each of these situations as a whole and nothing else. Crucially, this means that it cannot single out the modal and temporal properties of these situations – the situation pronoun either picks up the whole situation as a referent or looks for a different referent altogether.

This contrasts with what a world-time-pair pronoun $<w_j,t_k>$ (or two independent world and time pronouns) can do. In a $<w_j,t_k>$-pronoun, the modal and temporal pieces can be coindexed independently from each other. This means that a $<w_j,t_k>$-pronoun does not actually refer to a situation as a whole. Instead, it independently refers to i.) a modal property of a situation and ii.) a temporal property of a situation, and then relates these two pieces of information to a complex entity that could be conceptualized as a situation. Importantly, the modal and temporal information need not necessarily come from the same antecedent situation. For instance, if we co-index our world-time pronoun as $<w_0, t_4>$, we combine the modal information from S1 (the utterance world) with the temporal information from S2 (8th November, 2005). Adding spatial information, $<w_0, t_4>$ effectively constructs a new situation S3 by rearranging the individual modal and temporal pieces from S1 and S2. Importantly, S3 can have quite different properties from both S1 and S2. For instance, if the weather was actually nice and sunny on November 8th, S3 would then be an actual situation in Vienna on November 8th that stands in stark contrast to the non-actual raining-situation S2 from which it inherited its temporal information. Therefore, a theory based on $<w_j,t_k>$-pronouns is able to construct *new* intensional entities (i.e. situations) by isolating and combining the modal and temporal information of other (distinct) situations. A system with independent world and time pronouns has essentially the same co-indexing possibilities.

Independent time- and world-indexing makes the <w_j,t_k>-theory (and the theory based on separate w_j and t_k) considerably more powerful than a world-time-collapsing situation pronoun theory. (110) gives the different co-indexing options for the three pronoun-systems, including the readings they would derive based on the situations in (108) and (109).

(110) *Co-indexing possibilities with respect to S1 (w_0, t_3) and S2 (w_2, t_4)*

a. *Situation Pronoun s_j:* s_1, s_2

$[\![s_1]\!]^g$ = snowing-situation in Vienna on December 21st, 1991 in w_{utt}
$[\![s_2]\!]^g$ = raining-situation in Vienna on November 8th, 2005 in $w_{belief,A}$

b. *World-time-pair pronoun <w_j,t_k>:* <w_0, t_1>, <w_2, t_3>, <w_0, t_3>, <w_2, t_1>

$[\![< w_0, t_3 >]\!]^g$ = snowing-situation (in Vienna) on December 21st, 1991 in w_{utt}
(or rather: The time [December 21st, 1991] in the world w_{utt}[67])
$[\![< w_2, t_4 >]\!]^g$ = raining-situation (in Vienna) on November 8th, 2005 in $w_{belief,A}$
(or rather: The time [November 8th, 2005] in $w_{belief,A}$)
$[\![< w_0, t_4 >]\!]^g$ = sunshine-situation (in Vienna) on November 8th, 2005 in w_{utt}
(or rather: The time [November 8th, 2005] in w_{utt})
$[\![< w_2, t_3 >]\!]^g$ = raining-situation (in Vienna) on December 21st, 1991 in $w_{belief,A}$
(or rather: The time [December 21st, 1991] in w_{utt})

c. *Independent world and time pronouns w_j, t_k:* w_0, t_3; w_2, t_4; w_0, t_4; w_2, t_3

$[\![w_0]\!]^g = w_{utt}$, $[\![t_3]\!]^g$ = December 21st, 1991
$[\![w_2]\!]^g = w_{belief,A}$, $[\![t_4]\!]^g$ = November 8th, 2005
$[\![w_0]\!]^g = w_{utt}$, $[\![t_4]\!]^g$ = November 8th, 2005
$[\![w_2]\!]^g = w_{belief,A}$, $[\![t_3]\!]^g$ = December 21st, 1991

Importantly, this means that the choice of our index pronoun-system will affect the degree of (in-) dependence we expect for the modal and temporal dimension of nominal predicates. In particular, if the evaluation of a nominal predicate is determined by a single situation pronoun (as it is explicitly or implicitly assumed in some of the relevant literature cited above), then the types of modal-temporal readings we predict are severely limited.

[67] It would probably be better to replace the world-time-pair pronoun with a triple pronoun that includes a variable for spatial information. If *r* is a pronoun that refers to a location in space, then we would get the triple pronoun <w,t,r>. The denotation of this pronoun would then more closely resemble a situation, but would of course also increase the power of the system.

(111) gives the possible LFs for such a system[68] [69].

(111) *Possible LFs for systems with single DP-internal situation pronouns*

LF-structure	**Corresponding Reading**
λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP NPred s_3]]]]]]]	O+EmbT
λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP NPred s_2]]]]]]]	O+MT
λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP NPred s_1]]]]]]]	T+MT
λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP NPred s_0]]]]]]]	T+UT
No LF available	****T+ET***
No LF available	****O+UT***

The result is surprising: When it uses situation pronouns to derive world/time-dependence, the index-pronoun theory becomes effectively equivalent to the (unrevised) scope/parameter theory, at least when it comes to its prediction for possible modal-temporal interactions. The reason for this is the collapse of the modal and temporal dimension that is characteristic for the situation pronoun: Both the T+EmbT-reading and the O+UT-reading require that one dimension is determined *locally*, while the other dimension is determined *non-locally*. This requires a level of dissociation between the modal and temporal dimension that is blocked by the situation pronoun theory (since this theory requires both dimensions to be determined together either locally or non-locally) and the scope/parameter theory

[68] An important consequence of this system is that modal and temporal operators now manipulate the same type of entities: situations. In order to interpret these LFs, we would have to revise our semantics in several crucial ways (see Elbourne 2013 for an example of a semantic system based on situations). Most importantly, we would have to reconsider our semantics for "believe". If "believe" would quantify over situations that are as large as whole possible worlds (including all times contained within those worlds), nominal predicates whose situation pronoun is bound by $\lambda s_{belief2}$ would lose their temporal contingency (More precisely: The property denoted by the predicate would be predicted to be true of the DP-individual *throughout all times* within w_{belief}). This condition is likely too strong. Even if we could still derive temporally constrained opaque readings by scoping a DP below the embedded tense, this is probably not what we want, since the temporal contingency for opaque nominals would be restricted to only EmbT-readings. A possible change we could consider is to make "believe" quantify not over whole belief-worlds, but over (temporally-limited) situations that are part of a subjects belief-worlds. That is, we might assume that "believe" quantifiers over all possible situations *s'*, where *s'* is a situation in which the attitude holder's locates himself given everything that he believes.

[69] See O'Leary (2022) for arguments against the situation pronoun approach that are based on similar considerations about its inability to derive the T+EmbT-reading.

(since here, only local determination is possible) alike. We have already discussed in the last section that these predictions lead to an undergeneration problem at least when it comes to the T+EmbT-reading.

Since the $<w_j,t_k>$--approach allows the same indexing options as the independent world- and time-pronoun theory, it is not surprising that it allows a greater degree of freedom when it comes to modal-temporal interactions. Concretely, the $<w_j,t_k>$--approach allows all readings (including long-distance binding of worlds and times) and thus overgenerates when it comes to the O+UT-reading. Again, we face the problem of deciding between a system that undergenerates (the s_j-pronoun theory) and a system that overgenerates (the $<w_j,t_k>$--pronoun- or the independent w_j/t_k-theory). The decision seems to boil down to the following question: Which of the problems is more severe for the index pronoun approach, the undergeneration or the overgeneration problem? At least at first glance, the undergeneration problem of the situation pronoun theory seems hard to overcome. In order to derive the T+EmbT-reading, the situation pronoun must match its world component to the non-local utterance situation and its time component to the situation introduced by the embedded tense. Since it is an intrinsic property of the (world-time collapsing) s_j-theory that it cannot split its world and time component in order to connect them to two different antecedents, it is hard to see a way out if the LFs in (111) are all that is available to us. Note, however, that the possible values for s_j were crucially restricted by the accessible situation binders that we stipulated in (111). In particular, the situations in (111) were all linked to world or time shifters. In order to get access to the embedded tense time, the situation pronoun had to take on the index of the situation binder introduced below the embedded tense. By doing so, the pronoun also had to take on the modal value that came with this embedded tense situation. Since the embedded tense situation is introduced within the attitude complement, it seems that it must describe a situation that is part of the attitude worlds, thereby forcing an opaque reading for the situation pronoun. This derives the O+EmbT-reading, but not the T+EmbT-reading. However, since it is not directly introduced by a world-shifting element, one might wonder whether the embedded tense situation must necessarily be part of the attitude worlds. Indeed, in the literature on tense, it is often assumed that embedded tenses allow transparent readings (so-called *temporal de re*, see Heim 1994; Ogihara 1996; Abusch 1997; Ogihara & Sharvit 2012). If this is the case, then temporal de re should allow a variant of the embedded tense situation that is part of the actual/utterance world. If the relevant mechanism would further allow a DP's situation pronoun to take this *res*-situation as its antecedent, the result would indeed be a T+EmbT-reading[70]. Note that this makes an interesting prediction about the noun's evaluation time in T+EmbT-readings. In cases where the attitude holder is mistaken about the time of the event that is described by the embedded verb, the evaluation time of the noun should have to overlap with the actual event time ($EmbT_{Res}$), but not the time as it appears to the attitude holder ($EmbT_{belief}$). Specifically, according to the s_j-pronoun theory, only the T+$EmbT_{Res}$-reading should be grammatical, but not the T+$EmbT_{belief}$-reading. In most cases, potential deviations between $EmbT_{Res}$ and $EmbT_{belief}$ are too marginal to make a detectable

[70] Importantly, the same option would not open up for the O+UT-reading, since there is no obvious way to get an opaque/de dicto-reading for the utterance situation.

difference for the evaluation time. However, we can try to modify our T+EmbT-example to bring out the difference more clearly[71].

(112) Lucy glaubt, dass *ein Kellner* mein Armband gestohlen hat (T+EmbT$_{Res}$)
Lucy believe, that *a waiter* my bracelet stolen has
'Lucy believes that a waiter stole my bracelet'

Context

In 1970, Marianne's golden bracelet was stolen at a party that she hosted at her house. She knows for a fact that the thief must have been Charlie, a guest who was a collector of rare and expensive jewelry. Marianne's friend Lucy claims to possess the supernatural ability to see into a person's past as soon as she holds a picture of that person in her hand. To test this claim, Marianne gives Lucy three photos from the party, each depicting a different person: One shows Charlie (the culprit), another shows Brian (who was hired as a waiter for the night; he was actually a car salesman who just took on the gig as a waiter for the duration of the party), and the third shows Leon (another guest). Lucy is asked to point out the person that stole her bracelet. Lucy responds: "That's easy. It is the person on the second picture." She points at Brian. "I can tell you more: It was the year 1990 when the picture was taken, which is when your party must have taken place. Also: The person in the picture was a millionaire and obviously a guest at your party". Marianne does not correct her, but later tells someone:

"Lucy believes that *a waiter* stole my wristband. She is a fraud!"

(113) Lucy glaubt, dass *ein Kellner* mein Armband gestohlen hat (T+EmbT$_{belief}$)
Lucy believe, that *a waiter* my wristband stolen has
'Lucy believes that a waiter stole my wristband'

Context

In 1970, Marianne's golden bracelet was stolen at her birthday party. She knows for a fact that the thief must have been Charlie, a guest who was a collector of rare and expensive jewelry. Marianne's friend Lucy claims to possess the supernatural ability to see into a person's past as soon as she holds a picture of that person in her hand. To test this claim, Marianne gives Lucy three photos from the party, each depicting a different person: One shows Charlie (the culprit), another shows Leon (another guest), and the third shows Jerome. In 1970 (when the photo was taken), Jerome was a millionaire who was a guest at Marianne's birthday party. In the 1980s, Jerome lost all his money. Since Marianne hated Jerome and since she was an overall cruel person who liked to humiliate people, Marianne later hired (the now poor) Jerome as a waiter for her birthday party in 1990. Lucy is asked to point out the person that stole her wristband. Lucy responds: "That's easy. It is the person on the third picture." She points at Jerome. "I can tell you more: The photo was taken at your birthday party in 1990. Also: The person in the picture was a doctor and obviously a guest at your party". Marianne does not correct her, but later tells someone:

"Lucy believes that *a waiter* stole my wristband. She is a fraud!"

In (112), Brian is a waiter at the actual party time in 1970 (EmbT$_{Res}$), but not at the party time as it is according to Lucy (EmbT$_{belief}$=1990). Moreover, since in Lucy's mind, Brian is not a waiter at all (at any time), the only possible reading for (112) is the T+EmbT$_{Res}$-reading. Based on the judgements I have elicited, the T+EmbT$_{Res}$-reading in (112) is indeed a possible reading. Judgments are less clear when it comes to the T+EmbT$_{belief}$-reading. In (113), the relevant individual Jerome was a waiter at a time that

[71] These readings have (so far) only been tested for German.

complies with $EmbT_{belief}$ (the party/stealing time according to Lucy), but he was crucially not a waiter at the actual party/stealing time in 1970 (He was still a millionaire back then). When it comes to accepting the T+$EmbT_{belief}$-reading in (113), informants show hesitation, especially when compared to their judgements on the T+$EmbT_{Res}$-reading. Still, the availability of T+$EmbT_{belief}$-readings in (113) is not consistently ruled out either.

There are several factors that might be responsible for this result. The most obvious factor is that the considerable complexity of the contextual information makes it difficult to get consistent and stable judgements for (113). Some hesitation is almost inevitable. Indeed, it is imaginable that we can improve on many of the choices made in constructing the example (e.g. the choice of the nominal predicate, the way the $EmbT_{Res}$-$EmbT_{belief}$-divide is stipulated etc.) to get a context that more concisely and directly brings out the T+$EmbT_{belief}$-reading. I will leave it for future research to work out better examples. Importantly, note that despite its comparable complexity, the judgements for (112) were much more stable and consistent. Thus, there are likely additional factors that interfere with the T+$EmbT_{belief}$-judgments. One possibility is that (113) did not adequately control for the behavior of the nominal evaluation time. Later in this chapter, I will highlight the (so far neglected) fact that the evaluation time can be assigned contextually. If the evaluation time in (113) is contextually assigned to overlap with the year 1990, then the perceived compliance with the $EmbT_{belief}$-time would be merely accidental. The fact that informants do not outright reject (113) could then indicate that they compute a truth-conditionally equivalent reading in which the evaluation time receives a contextual value (the T+Context $Time_{1990}$-reading). However, this then begs the question of how we would ever disentangle a "true" T+EmbT-reading from a (truth-conditionally equivalent) T+Context Time-reading. In the end, we cannot even rule out the possibility that the existence of T+EmbT-readings is only apparent, and that all instances where we encountered T+EmbT-compatible judgments were in fact instantiations of the T+Context Time-reading. I will leave this issue aside for now, but see later sections for the discussion of contextual evaluation times. Overall, the situation pronoun approach shows potential. Combined with the assumptions that embedded tense situations might have de re-readings, it might be possible to overcome its undergeneration problems (Provided that these undergeneration problems even remain an issue once contextual situation values are permitted). Since it would require a discussion of the various complex issues that come up in the literature on temporal de re as well as situation semantics, I will not pursue this approach any further. Future work will hopefully fill in the details for what a temporal de re-analysis for embedded tense situations might look like.

We can now turn to the alternative implementations of index-pronouns, which both face an overgeneration problem: The $<w_j,t_k>$- or the independent w_j/t_k-theory. These two theories are hard to set apart. Given standard assumptions about the positions of evaluation worlds/times (i.e. both worlds and times combine locally with the nominal predicate they evaluate), the two approaches are indeed indistinguishable. Still, these two approaches could eventually make different predictions about the syntactic distribution of worlds and times (this is what b) above alluded to). According to the $<w_j,t_k>$-

theory, the world and time components form a lexical unit (i.e. a single, doubly indexed pronominal expression). This is not the case for the independent w_j/t_k-theory, where the world and time are introduced by separate (silent) lexical items (i.e. two pronouns with a single index). For the $<w_j,t_k>$-theory, then, every syntactic restriction on the evaluation world of a predicate must simultaneously affect syntactic properties of the evaluation time, and vice versa. Again, this is something that would be different in an independent w_j/t_k-theory, where, in principle, nothing prohibits the evaluation world-pronoun to have different syntactic properties than the evaluation time-pronoun. Although this is certainly a point we should keep in mind, it remains to be seen whether these different syntactic possibilities can be related to empirical differences in a revealing way. For now, let us consider ways to solve the problem that both of these systems have in common: They overgenerate when it comes to the O+UT-reading. The next subsection shows how these systems might block O+UT-readings by assuming a Binding Theory for world- and time-indices.

3.4.2. The constraint strategy for making index-pronouns more restrictive

The O+UT-reading is not the only overgeneration issue that comes up once we allow the presence of index-pronouns in the object language. In fact, it has been generally assumed that the index-pronoun approach must be accompanied by a binding theory that blocks the generation of non-existing readings (see Percus 2000). We can adopt this strategy to overcome the overgeneration problem of the $<w_j,t_k>$- and w_j/t_k-theory. For instance, we could devise the following two binding conditions.

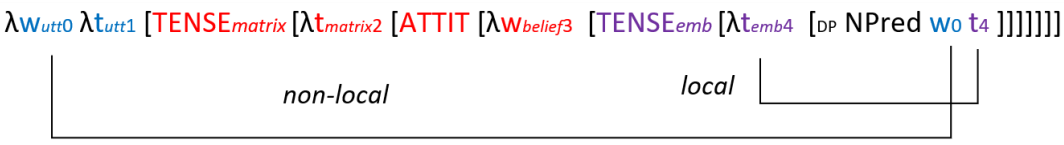
(114) *(Hypothetical) Binding Conditions for World and Time Pronouns*

I. Binding of World Pronouns
World pronouns must be locally or non-locally bound

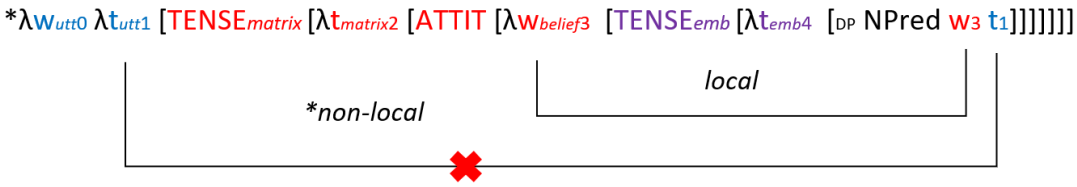
II. Binding of Time Pronouns
Time pronouns must be locally bound

These two binding conditions would make the right predictions for the T+EmbT- and the O+UT-reading. Importantly, we still derive the T+EmbT-reading: The DP takes narrow scope, its time pronoun is locally bound by the embedded tense (conforming to binding condition II.) and its world pronoun is non-locally bound by the utterance world-binder (conforming to condition I.). The O+UT-reading, on the other hand, is blocked by binding condition II.: The opaque reading requires world-binding by the attitude verb. This is only possible from a scope position below the matrix tense. Since time binding is restricted to local binding, the evaluation time can only be the embedded tense time or the matrix tense time, but not the utterance time.

(115) *LF for T+EmbT-reading*



(116) *LFs for O+UT-reading*



At this point, it would be premature to take these binding conditions seriously[72]. We will first need a better sense of what the full range of modal-temporal readings looks like. But before we explore modal-temporal readings in more detail, let us first consider potential ways to deal with the undergeneration issue of the parameter theory.

3.4.3. The memory strategy for making the parameter theory less restrictive

In order to derive the T+EmbT-reading, the parameter theory has to (locally[73]) allow certain predicates to get evaluated relative to non-local evaluation worlds. Since similar issues have come up in the literature before, there are already strategies in place to make the parameter theory less restrictive. A possible strategy that has been successfully used in the literature makes modifications along the following lines (see Kamp 1971; Vlach 1973; Cresswell 1990; Percus 2020).

a.) World/time parameters that are introduced at higher points in the sentence (including the utterance world/time) remain accessible to expressions in embedded contexts even after the evaluation world/time has been shifted. This is achieved by allowing multiple world/time parameters (including all earlier evaluation parameters) to be present on the interpretation function.

b.) Covert operators can locally combine with predicates and shift the evaluation world/time of the predicate back to an earlier (non-local) evaluation world/time.

[72] Especially, it remains to be seen whether the impossibility of the O+UT-reading is actually the reflection of a fundamental property of intensionality (e.g. a local binding-requirement for time pronouns) or the result of an independent factor.

[73] "locally" because we want to selectively shift the evaluation world/time of an expression in an intensional domain, without thereby changing the evaluation parameters for other expression in the same domain.

Concretely, in order to make previous world and time parameters accessible, we can assume that the interpretation function is relativized to a memory store that consists of sequences of worlds and times that have been introduced at an earlier point (see Percus 2020). In such a system, world and time shifters do not only shift the evaluation world/time of their argument, they also add their own evaluation world/time to the memory store. As a consequence, expressions that are interpreted relative to shifted evaluation worlds/times have access to a memory store that contains all previous evaluation parameters. The definitions in (117) and (118) illustrate the meaning contribution of tenses and attitude verbs in this system.

(117) $[\![\text{Peter believe } \phi]\!]^{<>_{W-stor.},<>_{T-stor.},w_1,t_1,g} = [\![\phi]\!]^{<w_1>_{W-stor.},<>_{T-stor.},w_{belief2},t_1,g}$

(118) $[\![\text{TENSE } \phi]\!]^{<>_{W-stor.},<>_{T-stor.},w_1,t_1,g} = [\![\phi]\!]^{<>_{W-stor.},<t_1>_{T-stor.},w_1,t_2,g}$

With the memory store in place, we could define two indexed[74] syntactic operators – TShift and WShift – that combine with a predicate[75] and shift its evaluation world/time to an earlier evaluation parameter from the memory store[76].

(119) $[\![\text{WShift}_i\ \phi]\!]^{<w_i>_{W-stor.},<>_{T-stor.},w_h,t_h,g} = [\![\phi]\!]^{<w_i,w_h>_{W-stor.},<>_{T-stor.},w_i,t_h,g}$

(120) $[\![\text{TShift}_i\ \phi]\!]^{<>_{W-stor.},<t_i>_{T-stor.},w_h,t_h,g} = [\![\phi]\!]^{<>_{W-stor.},<t_i,t_h>_{T-stor.},w_h,t_i,,g}$

It is not hard to see that these changes make the parameter theory essentially equivalent to the (unrestricted) world/time pronoun theory. The only difference is that the work done by (silent) syntactic world/time variables is carried out by (silent) syntactic shifters[77]. Most importantly, the parameter theory can now derive the T+EmbT-reading. The relevant LF would involve a nominal predicate that takes narrow scope in a position below the embedded tense (so that the evaluation time is shifted to the

[74] They need to be indexed since they need the ability to shift the evaluation parameter to an arbitrary parameter on the interpretation function. Dedicated operators that shift the evaluation parameter to the utterance world/time (such as Kamp's NOW-operator) will not be enough, since the evaluation of a nominal predicate can also pick up worlds and times introduced by any higher attitude verb/tense. This is illustrated in (i) (a special case of Fodor's third reading), where the DP "a coat like Bill's" takes narrow scope with respect to "want", but takes its evaluation world from the belief-worlds introduced by the higher attitude verb "believe" (i.e. neither from the desire-worlds introduced by "want" nor from the utterance world).

(i) Peter believes that John wants to buy *a coat like Bill's*

Context

Peter heard that, whatever coat John is going to buy, he wants it to be made out of cashmere. Moreover, Peter believes that Bill has a coat made out of cashmere. John does not know this (In fact, John does not know Bill at all). I know for a fact that Bill actually does not have a coat made out of cashmere (His coat is made of cotton). Importantly, the description *coat like Bill's* can now only be part of Peter's belief-worlds, since John does not even know Bill and Bill's coat in the actual world is not made of cashmere (only in Peter's belief worlds it is). With (i), I tell someone about Peter's false belief that John wants whatever coat he is going to buy to have the property that Peter (wrongly) ascribes to Bill's coat.

[75] Semantically, they combine with the intension of the predicate. Again, some notion of Intensional Functional Application is needed (see von Fintel & Heim 2021).

[76] w_i and t_i stand for arbitrary higher evaluation parameters.

[77] For this reason, many researchers have argued that one might very well simply opt for the world/time pronoun approach (e.g. Kratzer 2021).

embedded tense time), but locally combines with a WShift-operator that shifts the evaluation world back to the utterance world.

(121) $[\![\text{WShift}_0 \text{ student}]\!]^{<w_{utt/0}>w-stor.,<t_{utt/0},t_{matr./1}>T-stor.,w_{att/1},t_{emb./2},g}$
$= [\![\text{student}]\!]^{<w_{utt/0},w_{att/1}>w-stor.,<t_{utt/0},t_{matr./1}>T-stor.,w_{utt/0},t_{emb./2},g}$

Note that, similar to the different implementations of the index-pronoun approach we discussed earlier (e.g. the choice of s_j vs. $<w_j,t_k>$ vs. w_j/t_k), seemingly innocent choices we make in our implementation of the storage approach may have non-trivial effects on its empirical predictions. For instance, according to (119)-(120), WShift and TShift affect the meaning of ϕ in two distinct ways: 1.) They shift ϕ's evaluation world/time back to a world/time from the memory store, and 2.) they update/shift ϕ's memory store to include the local evaluation world/time of WShift/TShift. Importantly, only 1.) had to be part of the definition of WShift in order to derive the T+EmbT-reading. Although memory update (i.e. 2.)) was a required consequence of shifters like attitude verbs, it is in principle not necessary to make all world/time-shifters into memory shifters as well[78]. In fact, the choice of making WShift/TShift into memory shifters has direct empirical ramifications: If WShift/TShift do not update the memory store of ϕ, then the local evaluation world/time of WShift/TShift (i.e. w_{local}/t_{local}) becomes inaccessible for all expressions within ϕ. Thus, a predicate γ that is embedded within (the predicate) ϕ could never shift its evaluation world/time back to w_{local}/t_{local}, even if γ combines with WShift/TShift-operators.

(122) $[\![\text{WShift}_i\ \phi]\!]^{<w_i>w-stor.,<>T-stor.,w_h,t_h,g} = [\![\phi]\!]^{<w_i>w-stor.,<>T-stor.,w_i,t_h,g}$

(version without memory update)

(123) $[\![\text{TShift}_i\ \phi]\!]^{<>w-stor.,<t_i>T-stor.,w_h,t_h,g} = [\![\phi]\!]^{<>w-stor.,<t_i,>T-stor.,w_h,t_i,,g}$

(version without memory update)

A case where this difference is relevant is given in (124).

(124) Augustus thinks that [$_{DP1}$ the *butler* of [$_{DP2}$ the *senator*]] is pretty

Focusing on the world evaluation of the two predicates *butler* and *senator*, we can now see how the decision to make WShift a memory shifter changes the combinations of transparent and opaque readings we can derive. The interesting cases are readings were *butler* and *senator* have different evaluation worlds, i.e. where one is transparent and the other is opaque. Both versions of WShift in (119) and (122) allow a reading in which the embedding DP_1 (with head noun "butler") is opaque, but the embedded DP_2 (head noun "senator") is transparent. This reading is derived by combining WShift with the embedded noun ("senator").

[78] Another option would be a system in which worlds/times are added to the memory store by the shifters that introduce them (and not by the shifters that shift away from them).

(125) *Opaque embedding DP+Transparent embedded DP with memory updating WShift*

LF: [the [butler [of [the [WShift$_0$ senator]]]]]

$[\![\text{WShift}_0\ \text{senator}]\!]^{<w_{utt/0}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{att/1},t_{emb./2},g}$
$= [\![\text{senator}]\!]^{<w_{utt/0},w_{att/1}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{utt/0},t_{emb./2},g}$

(126) *Opaque embedding DP+Transparent embedded DP with non-updating WShift*

LF: [the [butler [of [the [WShift$_0$ senator]]]]]

$[\![\text{WShift}_0\ \text{senator}]\!]^{<w_{utt/0}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{att/1},t_{emb./2},g}$
$= [\![\text{senator}]\!]^{<w_{utt/0}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{utt/0},t_{emb./2},g}$

In contrast, a reading in which the embedding DP$_1$ is transparent and the embedded DP$_2$ is opaque is only possible in a theory that assumes that WShift makes the attitude worlds accessible for expressions in its scope. The reason is that this reading is derived by combining the noun of DP$_1$ with a WShift-operator that shifts the evaluation world away from the attitude worlds to the utterance world. If the WShift operator does not update the memory store to include the attitude worlds, the attitude world parameter will be lost for the evaluation of DPs in the operator's scope. If the memory store is updated, however, a second WShift-operator can be inserted inside DP$_2$ to give "senator" an opaque reading.

(127) *Transparent embedding DP+Opaque embedded DP with memory updating WShift*

LF: [the [WShift$_0$ [butler [of [the [WShift$_1$ senator]]]]]]

$[\![\text{WShift}_1\ \text{senator}]\!]^{<w_{utt/0},w_{att/1}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{utt/0},t_{emb./2},g}$
$= [\![\text{senator}]\!]^{<w_{utt/0},w_{att/1}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{utt/1},t_{emb./2},g}$

(128) **Transparent embedding DP+Opaque embedded DP with non-updating WShift*

LF: [the [WShift$_0$ [butler [of [the [WShift$_1$ senator]]]]]]

$[\![\text{WShift}_1\ \text{senator}]\!]^{<w_{utt/0}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{utt/0},t_{emb./2},g}$
$=$ *undefined*

Interestingly, it has been argued that the empirical behavior of nested DPs is exactly as predicted by a storage system with non-updating WShift. Specifically, Romoli & Sudo (2009) argue that modal evaluation of nested DPs is captured by following constraint.

(129) *Nested DP Constraint*
When a DP is embedded inside a DP, the embedding DP must be opaque if the embedded DP is opaque

(Romoli & Sudo 2009: 430)

The Nested DP Constraint is formulated to capture the fact that in sentences like (124), the noun "butler" cannot be transparent if the deeper embedded noun "senator" is opaque (while the reverse – opaque "butler", transparent "senator" – is possible). Even though a closer look at its exact predictions is still

necessary[79] [80], it speaks in favor of the parameter storage solution that it (or at least a plausible version of it) naturally derives an independent constraint for which it was not designed.

However, there are still several open issues that the storage approach needs to address before it becomes a viable candidate. One of the questions that remains unanswered is how to incorporate the effect of memory store update into a theory that is fully compositional. So far, I have only given syncategorematic definitions for WShift/TShift as well as for the memory update of attitude verbs and tenses. A compositional implementation would likely require a more complicated notion of intension. Since attitude verbs and tenses do not only manipulate the evaluation worlds/times of their prejacent, but also their memory store, intensions must give them access to memory store parameters as well. I will leave it for others to work out the details. Here, I will focus on an a more serious issue that is directly related to modal/temporal interactions. Remember that the introduction of WShift and TShift give the parameter theory essentially the expressive power of an unrestricted world/time pronoun theory. Even though this solves the undergeneration issue (the T+EmbT-reading is derived), it also makes the parameter theory susceptible to the same overgeneration challenges[81] that plague the world/time pronoun theory. That is, the revised parameter system unfortunately loses its predictive edge when it comes to the (non-existent) O+UT-reading. By combining narrow DP-scope with a TShift-operator[82] that locally shifts the nominal evaluation time back to the utterance time, the system is now able to derive this (impossible) reading as well.

(130) $[\![\text{TShift}_0\ \text{student}]\!]^{<w_{utt/0}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{att/1},t_{emb./2},g}$
$= [\![\text{student}]\!]^{<w_{utt/0}>_{W-stor.},<t_{utt/0},t_{matr./1}>_{T-stor.},w_{att/1},t_{utt/0},g}$

[79] In particular, we would have to check whether the predictions of this theory are still correct in cases where the nested DPs are embedded under two (or more) attitude verbs. In contexts where DP_1 is transparent, non-updating WShift only prevents DP_2 from getting an opaque reading with respect to the most local attitude verb. However, since the evaluation worlds from higher attitude verbs are already in the memory store once WShift applies, nothing rules out that DP_2 receives an opaque reading with respect to higher attitude verbs (as long as it is transparent with respect to the lowest attitude). This is an interesting prediction that is certainly worth looking into in future work.

[80] Another open question is whether there is an equivalent constraint when it comes to the evaluation times of nested DPs. I am not aware of any work on this topic.

[81] One of these overgeneration issues is the non-existence of transparent readings for verbs (Generalization X (Percus 2000)). The classic scope/parameter theory predicts a difference between nouns and verbs when it comes to the possibility of transparent/opaque-readings: Under the (plausible) syntactic assumption that DPs have the ability to take scope via movement/Quantifier Raising, a nominal predicate will be able to escape an intensional domain and display transparent/opaque ambiguities. This is not necessarily true for verbs, for which long-distance scoping/movement-operations are usually not assumed (i.e. they are trapped inside the intensional domain). However, if silent WShift-operators allow long- distance association with worlds, the revised system would provide all the means to derive a transparent reading *in situ*. This could be applied to both nominal and verbal predicates. To explain why a transparent reading does not exist for verbs, we would potentially need to resort to syntactic restrictions for WShift/TShift-operators. That is, the syntactic distribution of these covert operators should be predictive of all the world/time readings that are possible. The greater world/time-flexibility of DPs might be covered by the assumption that Shift-operators are (syntactically) restricted to a sister-position of NP and cannot syntactically combine with verbs. Solutions along these lines have been proposed by proponents of the index-pronoun theory, with the only difference being that it is the syntactic distribution of world/time/situation pronouns that is constrained (e.g. Schwarz 2012; Elbourne 2013).

[82] In the example, I now use the non-updating version from (123).

There are two obvious ways we can address this issue:

a.) We could propose that there is a memory storage for worlds (W-store), but not for times (T-store).
b.) We could propose that syntax only provides covert operators that shift evaluation worlds (WShift), but not covert operators that shift evaluation times (TShift).

Because the existence of TShift-operators depends on the existence of a memory store, a.) is the more extreme assumption, since it effectively entails b.). We have good reasons to assume that a.) cannot be right. Indeed, systems that allow access to multiple time parameters on the interpretation function have been introduced to account for phenomena that are entirely unconnected to the issue of nominal evaluation times. For instance, Kamp (1971) introduced his influential *double-indexed* temporal semantics to deal with embedded tenses that shift the evaluation time relative to the utterance time (i.e. absolute tenses), not the local time introduced by the matrix tense. Similarly, Dowty (1982) argues for the need of two (or more) time parameters to model the behavior of indexical temporal adverbials. Since the meaning of some tenses and adverbials seems to require access to previous evaluation times, loosing the T-store is not an option. What about proposal b.)? It must be said that some of the multiple time-index proposals just mentioned make use of covert temporal shifters very similar to TShift (Most notably, Kamp (1971) uses a NOW-operator to shift the evaluation time back to the utterance time). However, even more important is the fact that we have independent reasons to rely on TShift for the derivation of nominal evaluation times. The crucial case is based on Enç's (1981, 1986) famous observation that the evaluation time of a noun can be entirely contextual. Based on examples like (131), it can be shown that the evaluation time can be temporally disjoint from both the utterance time and any time introduced by a sentence-internal expression. Indeed, the only coherent reading for (131) is one where we are talking about individuals that were fugitives at a contextually salient time in the past of the utterance/tense time.

(131) Every fugitive is now in jail.

It has been argued (most notably by Enç herself) that the existence of contextual readings shows that nominal evaluation times must be modeled with a system based on referential times (i.e. time pronouns). Although it is correct that contextual readings are not immediately expected under the parameter theory, the parameter storage approach at least opens up a potential strategy for analyzing these readings. Acknowledging the reality of discourse, we can plausibly assume that the memory store is not emptied at the start of each utterance. That is, at the beginning of an utterance β, the T-store may already contain a sequence of contextually relevant (e.g. previously introduced) times that remain accessible as anaphoric anchors for expressions within β. Contextual evaluation times are thus derived by a covert TShift-operator that is co-indexed with a contextually relevant time in the memory store. Indeed, I do not see an alternative way of accounting for contextual readings under the parameter approach. Crucially, since this account of contextual readings relies on the existence of TShift-operators, denying

the existence of TShift to block O+UT-readings is not an option either. At this point, we are left with no satisfying solution for the parameter theory.

3.4.4. A note on other strategies: Semantic reconstruction and split intensionality

There are still a few approaches to the problems of overgeneration/undergeneration that I have not discussed so far. Probably the two most important are a.) semantic reconstruction-approaches (von Fintel & Heim 2021; O'Leary 2022) and b.) Keshet's theory of split intensionality (Keshet 2011). Since the space of this thesis is limited, I will refrain from discussing these approaches in detail. Nevertheless, since, when we compare them to the theories discussed up to this point, at least the semantic reconstruction-approach has a comparable success at (not) deriving the T+EmbT/*O+UT-readings, a brief comment is in order. For a more detailed discussion of these approaches, the reader is referred to O'Leary (2022) (for semantic reconstruction) and Keshet (2011) (for split intensionality).

Semantic reconstruction-approaches use higher-type traces to allow certain parts of a moved DP to be interpreted in its landing site, while other parts are interpreted in its trace-position. Von Fintel & Heim (2021) show how semantic reconstruction can be added to the parameter theory to derive wide scope-transparent readings. O'Leary (2022), which is the only discussion of modal/temporal DP-readings I am aware of, derives the different locality-options for worlds and times (essentially, the binding-options given in 114)) from differences in their ability to semantically reconstruct with the moved DP. Specifically, according to O'Leary, times can semantically reconstruct, but worlds cannot. Coupled with the assumptions that worlds and times take their value from the most local world or time source, we derive the desired result: If the DP takes wide scope (which forces a transparent reading, since worlds cannot reconstruct and the DP must adopt the local evaluation world) and semantically reconstructs for times, we derive the T+EmbT-reading. Moreover, the O+UT-reading is blocked: Since the evaluation time is determined locally (according to O'Leary's assumptions), an utterance time-reading requires the DP to take wide scope. Since worlds do not semantically reconstruct, wide DP-scope is incompatible with an opaque reading, i.e. the O+UT-reading cannot be derived.

In Keshet's (2011) theory of split intensionality, the intensionality of an attitude complement is contributed by an operator ^ that is syntactically independent from the attitude verb. Essentially, this operator is a type-shifter that shifts an extension of an expression into its intension. Intensionality of the attitude-complement is therefore not forced via a rule of Intensional Functional Application (e.g. von Fintel & Heim 2021), but via a distinguished operator that makes the complement clause into a possible argument for an attitude verb. Since this operator ^ is distinct from the attitude verb, the quantificational force of an attitude verb and the trigger of intensionality are (syntactically) separated. This makes it possible that a DP can move into a position between the attitude verb and the intensionality-inducing operator ^. When a DP does this, it effectively escapes the intensional domain (i.e. it is interpreted transparently), but it nevertheless remains in the scope of the attitude verb's quantificational force (i.e.

it receives narrow scope). This opens up a way to derive the wide scope-transparent reading within a scope/parameter theory.

(132) *Schematic LF for wide scope-transparent reading based on split intensionality*

LF: … attitude verb/quantifier over worlds … [$_{\text{narrow scope wrt attitude}}$ DP_1 … [^ **[**$_{\text{opaque domain}}$ t_1 **]**]]

Notice, however, that split intensionality is not a good solution for the type of scope paradox that the T+EmbT-reading presents. In the case of this reading, the quantificational force of the attitude verb does not matter. What matters is solely the nominal predicate's intensionality. Framed within the assumptions of split intensionality, the T+EmbT-reading is a scope paradox about a DP's relative position to the intensionality-inducing operator ^ that is introduced below the attitude verb: The DP must be both within the scope of ^ (to receive an EmbT-reading) and outside the scope of ^ (to receive a transparent-reading). For this reason, split intensionality by itself does not offer a way to derive the T+EmbT/*O+UT-pattern.

(133) *Incompatible LF-requirement for T+EmbT-reading:* [DP_1 … ^] vs. [^ … DP_1]

a.) LF for transparent reading: DP_1 … ^

[… attitude verb … [DP_1 … [^ **[**$_{\textit{opaque domain}}$ … embedded tense **[**$_{\textit{embedded tense domain}}$ … t_1 **]]**]]

or

[… DP_1… attitude verb … [… [^ **[**$_{\textit{opaque domain}}$ … embedded tense … t_1 **]**]]

b.) LF for embedded tense time-reading: ^ … DP_1

[… attitude verb … [… [^ **[**$_{\textit{opaque domain}}$ … *embedded tense* **[**$_{\textit{embedded tense domain}}$ … DP_1 **]]**]]

Overall, no theory among the ones discussed so far offers a straightforward explanation for the T+EmbT/*O+UT-readings. Importantly, we saw that different ways of constructing theories of intensionality were directly reflected in their success of (not) deriving T+EmbT- and O+UT-readings. Interestingly, none of the choices we have examined so far seem to influence the predictions for other modal/temporal reading-types (i.e. the T+UT-reading, the T+matrix tense time/MT-reading, the O+MT-reading, and the O+EmbT-reading). Indeed, it seems like the existence of the other modal/temporal readings is universally expected under all intensional systems that we have considered. This is a prediction that still needs confirmation. For this reason, the next section will discuss examples for the remaining four reading types.

3.5. Other modal/temporal readings

So far, we have only examined the existence of two modal/temporal readings: The T+EmbT-reading and the O+UT-reading. These readings were singled out because they appeared to be of particular theoretical relevance: Different theories of intensionality make different predictions about their existence. Other modal/temporal readings are interesting for a different reason. None of the intensional systems we have considered so far rules them out. Is this prediction borne out? It seems the answer is yes. For the sake of completeness, this section will give examples for the four reading-types that were neglected so far: The transparent+utterance time-reading (T+UT), the transparent+matrix tense time-

reading (T+MT), the opaque+matrix tense time-reading (O+MT), and the opaque+embedded tense time-reading (O+EmbT).

Let us begin with the T+UT-reading. Since the T+UT-reading means that a DP is wholly evaluated relative to the utterance context, it is essentially a textbook *de re*-reading. Unsurprisingly, this reading is possible.

(134) Vor 20 Jahren hat Onkel Fabian gedacht, dass *ein Professor* ein Auto gestohlen hatte
before 20 years has uncle Fabian thought, that *a professor* a car stolen had
'20 years ago, uncle Fabian thought that a professor had stolen a car'
(T+UT)

Context

When Magnus was still a student, he once arrived at a party in a Porsche. Since Magnus had no money, Fabian suspected that Magnus must have stolen the car. In fact, however, Magnus had borrowed the Porsche from his uncle. 20 years later, Magnus is a university professor. Fabian's niece Angela is a student at the same university. At one time, she and her friends debate whether their boring and stiff professors had ever done anything exciting, rebellious or illegal. Angela recounts what her uncle told her in the past:

"My uncle Fabian knew most of the university staff when they were still students, and they were already boring back then. At a party 20 years ago, uncle Fabian thought that a professor had stolen car. It later turned out that he had only borrowed it."

(135) Karl believed that *the mayor* was a spy (T+UT)

Context

Karl met Michael Ludwig in a bar, long before he became mayor of Vienna. Karl is generally a very paranoid guy who suspects a conspiracy against him at every corner. When Michael Ludwig tells him something about his recent trip to Moscow, the first thing that Karl suspected was that Michael Ludwig was a Russian spy who was out to get him. I report Karl belief about Michael Ludwig (the person) by uttering:

"In a bar a few years back, Karl believed that the mayor was a spy"

In (134), Magnus becomes a professor decades after Fabian's belief. The same is true for the noun-property in (135). When Karl had a belief about Michael Ludwig, he was years away from becoming a mayor. From the utterance perspective, it is nevertheless possible to pick out the relevant individuals by the properties they have at the utterance time, as long as the property holds in the actual world (and not only in the attitude holder's belief-worlds).

The flipside of the T+UT-reading is the O+EmbT-reading. Under most assumptions about intensionality, the O+EmbT-reading should be the most straightforward case of an opaque nominal. Indeed, the reading is available.

(136) Daniel glaubt (noch immer), dass (vor 20 Jahren) *ein Jusstudent* ein Auto gestohlen hat
Daniel believes (still always), that (before 20 years) *a law-student* a car stolen has
'Daniel (still) believes that (20 years ago) a law student stole a car'

(O+EmbT)

Context

At a college party 20 years ago, Daniel saw someone arriving in a Porsche. He initially thought that the driver was a medical student, but 10 years later, a former classmate convinced him that it must have been a law student. Moreover, since Daniel cannot believe that a student can afford such an expensive car, he thinks that the Porsche must have been stolen. In reality, however, the driver of the Porsche was a linguistics professor who decided to buy the Porsche while going through a midlife crisis. 20 years after the party, Daniel tells his friend Markus about his belief. Markus later recounts Daniel's belief:

"Daniel still believes that a law student stole a car"

(137) Karl glaubt, dass *der Bürgermeister* von Aliens gefressen wurde
Karl believes, that *the mayor* by aliens eaten was
'Karl believes that *the mayor* was eaten by aliens'

(O+EmbT)

Context

Karl is ignorant about the fact that his grandfather Thomas was the mayor of his hometown from 1980 to 1990. One day, Karl reads a Facebook post that vaguely claims that in the 1980s, the then mayor of his hometown was eaten by aliens. Since Karl (of course) believes everything he reads online, he comes to the belief that the mayor at that time (whoever he was) had been eaten by aliens. Of course, he does not belief that his grandfather was eaten by aliens. Today, I tell someone about Karl's belief by saying:

"Karl believes that the mayor was eaten by aliens"

Let us briefly consider the example in (137). Karl's belief is not about the current mayor. It is about the mayor in the 1980s. Since MT is a present tense, only the EmbT is thus a possible time source for the noun's evaluation time. Moreover, since Karl's belief is not about his grandfather (the actual mayor in the 1980s), the noun "mayor" must be opaque.

Next, let us look at the T+MT-reading[83].

[83] We could construct a similar example for an indefinite DP by replacing "the mayor" with "a senator". If Paul had a belief about the past of a particular senator at the party, we get the same result.

(138) Paul hat geglaubt, dass *die Bürgermeisterin* in ihren 20ern eine Sängerin gewesen war
Paul has believed, that *the mayor* in her 20s a singer been was
'Paul believed that (in her 20s) *the mayor* had been a singer'

(T+MT)

Context

Paul does not know the first thing about politics. Thus, when he meets Larissa (a woman in her 70s) at a party in the year 1990, he is not aware that she is the mayor of his hometown. Nevertheless, Paul has the feeling that he met Larissa before. Specifically, he believes that Larissa was a singer that he met in the 1940s. He is mistaken. In actuality, Larissa has never been a singer. In the 1940s, she was working at a grocery store. Paul tells his belief to Charlie who knows better and corrects him. In 2020, after Larissa and Paul have been dead for a while, Charlie recounts this incident:

"At the party, Paul believed that (in her 20s) the mayor had been a singer"

In (138), Paul does not know that Susan is the mayor of his town. Moreover, Larissa is a mayor at the belief-time (MT), but not at EmbT (She worked at a grocery store in the 1940s) or the utterance time (She was dead by then). Also, since Paul does not know that Larissa is mayor, the noun must be transparent. (138) is acceptable under this reading.

Finally, let us look at the O+MT-reading.

(139) Augustus hat geglaubt, dass *ein Senator* (als Kind) in seine Schule gegangen war
Augustus has believed, that *a senator* (as child) in his school went was
'Augustus believed that a senator had attended his school'

(O+MT)

Context

In the 1960s, Augustus attended an elite private school that was known to produce very successful alumni. At a reunion in 1990, most of his former classmates showed up bragging about their careers as corporate lawyers, bankers, and doctors. Augustus also heard the rumor that there was a senator among them, but he could not find out who it was exactly (Even though he suspected three former students to be the most likely candidates). In actuality, there was no senator that attended Augustus' school in the past. The rumor was started by his former classmate Eberhard, who, surrounded by overachievers, was embarrassed to reveal his true profession as a school teacher and instead pretended to be a senator. A few weeks later, Augustus is talking to Eberhard's close friend Herbert: "I heard that there is a senator among my school's alumni. Unfortunately, I do not know who it is exactly." Herbert knows about Eberhard's farce and corrects Augustus. 20 years later, the incident comes up and Herbert remarks:

"One time at dinner 20 years ago, Augustus believed that a senator had attended his school"

Augustus belief is about someone who is supposed to be a senator at the time of the reunion in 1990 (= 1990), and not at the utterance time (since Augustus does not express a belief about what is the case 20 years later) or the embedded tense time (since at this time, the supposed senator ought to be a child in school). Moreover, there is no actual senator that fits Augustus' belief (Augustus would not mistake any of the actual senators to be a former student of his school), i.e. the reading of "senator" must be opaque. As expected, this reading is also available.

Until now, we have focused on broad types of modal-temporal DP-readings and showed what their existence would mean for different systems of intensionality. Next, we will look at more fine-grained ways to examine modal-temporal readings.

3.6. Macrolevel readings, microlevel readings, and Upper Limit Effects

So far, we have only considered general types of modal-temporal readings. For instance, we have asked whether a reading-type exists where a nominal predicate receives its evaluation world from the utterance world (instead of a local attitude verb), but its evaluation time from an embedded tense (We called this type of reading the T+EmbT-reading). However, it is also possible that we could find interesting generalizations that refer to different subreadings of these more general reading-types. That is, each of the general reading-types (which I from now on will call macrolevel readings) has various different subtypes depending on the particular temporal relations involved. For example, instead of looking at any T+EmbT-reading, we might compare distinct T+EmbT-subreadings that are distinguished by the choice of particular tenses, i.e. T+EmbT:PAST (for an embedded past tense), T+EmbT:PRESENT, and T+EmbT:FUTURE. It might very well be the case that a transparent nominal is able to pick up the evaluation time from an embedded past tense, but not from an embedded future tense. We would miss these types of *microlevel* generalizations about particular subreadings if we only concern ourselves with the existence of readings on the macrolevel. The various subreadings (which I will call *microlevel readings*) of a given macrolevel reading can be construed in several ways. One possibility is to select and compare different tense-values as the antecedent of a nominal's evaluation time in order to see whether the choice of tense is limited in any interesting way (The T+EmbT:PAST/PRESENT/FUTURE subreadings would be an example of this perspective on microlevel readings). Another way to look at the microlevel would be to examine possible temporal relations for the nominal's evaluation time. This perspective is slightly more complicated, since it considers relations between multiple pieces of temporal information, while simultaneously controlling for the nominal's evaluation world. For the T+EmbT-macrolevel reading, we would choose a particular value for the evaluation time (i.e. a particular tense for EmbT) and look at the possible temporal relations it can have relative to another time in the sentence (e.g. the matrix tense time or the utterance time). From this perspective, the relevant microlevel readings would be the following.

(140) *Microlevel readings of the macrolevel-type T+EmbT (relational perspective)*

a. Evaluation Time (ET) < Matrix Tense Time (MT)
b. ET > MT
c. ET o MT[84]
d. ET < Utterance Time (UT)
e. ET > UT
f. ET o UT
g. …

[84] o is used as the symbol for temporal overlap. < means "temporally precedes", > means "temporally follows"

Of course, we could push this perspective to the extreme: Since the evaluation time ET always stands in a relation to multiple times at once[85], and these other times also stand in specific temporal relations to each other, we could look at all possible temporal combinations from a global perspective. For the T+Embt-reading, we would then compare all logically possible relations among the three times ET/EmbT, UT and MT (these micro(micro)level readings would then amount to readings such as: ET > UT > MT; UT > MT > UT; ET o UT > MT; … etc.). Examining all these micro(micro)level readings would be an enormous undertaking. For now, it should be enough to look from a more superficial perspective at how the modal dimension influences the possible temporal relations between an evaluation time and some particular other time (i.e. the microlevel perspective outlined in (140)). Of course, this does not exclude the possibility that interesting patterns can be found at the micro(micro)level.

The investigation of microlevel readings adds another dimension to the investigation of modal-temporal interactions. We have seen that general theories of intensionality make certain commitments to the (non-)existence of readings on the macrolevel. This is generally not the case for readings on the microlevel. The basic mechanisms of our system of intensionality (e.g. the choice between the parameter approach and the index pronoun approach) will probably have little to say about a specific temporal relation between ET and UT, for example. As such, these generalization might reveal deeper puzzles about modal-temporal interactions that are independent of the general framework of intensionality we adopt. Nevertheless, the investigation of microlevel readings can inform the conclusions we draw from a macroperspective. In particular, for each potential constraint on macrolevel readings we find, we have to ask whether it actually reflects a macrolevel generalization, or whether it can be accounted for by independent constraints on the microlevel. This is crucial, because, as we have seen, macrolevel generalizations can have major ramifications for our systems of intensionality. For instance, much of our discussion in the previous sections have contrasted the way different intensional systems can ban the O+UT-macrolevel reading. This discussion was based on the implicit assumption that data such as (141)-(143) reflect the macrolevel generalization[86] in (144).

[85] The evaluation time always stands in a relation to at least two other times. In (52): MT and UT.

[86] The examples (53)-(55) aim to show that the generalization extends to different types of determiner phrases. (53) repeats the effect for an indefinite, (54) attempts to show the same effect for DPs headed by universal quantifiers, and (55) involves a definite DP with a possessive determiner.

(141) #(In 2010) Karl believed that *a millionaire* won the election (#O+UT-reading)

Context

Shortly after the mayoral election of 2010, Augustus met up with his friend Karl. Karl does not follow politics closely so he was not aware (nor did he care) who won the election. He told Augustus then: "Believe me, every politician is a crook. I'm telling you, the only reason anyone would run for mayor is to take briberies and become rich. And indeed, the mayor will be rich. I don't know or care who won the election, but one thing I know: Whoever won the election is someone who will be a millionaire in 10 years." In 2020, Augustus tells someone about what his friend Karl told him back then:

"#After the mayoral election in 2010, Karl believed that *a millionaire* won the election"

(142) #Bei einer Prüfung im Jahr 2000 hat Ludwig geglaubt, dass *jeder Professor* geschummelt hat
at an exam in year 2000 has Ludwig believed, that *every professor* cheated has
'At an exam in the year 2000, Ludwig believed that every professor cheated'

(#O+UT-reading)

Context

In the year 2000, Ludwig and Susan take a physics exam that is notorious for its difficulty. The smug professor that is teaching the class likes to tell his students that they need to ace the exam if they ever want to become a physics professor in the future. After more than half of the students fail the exam, Ludwig remarks: "There is no way that anyone can ace this exam without cheating. If you really have to ace this exam in order to become a physics professor, then I guess the following must be true: In the year 2020, everyone from our class that will be a physics professor by then, must have cheated on the exam." In the year 2020, Susan retells this story at a class reunion:

"#At an exam in the year 2000, Ludwig believed that *every professor* cheated"

(143) #Bei einem Tanzwettbewerb im Jahr 2000 hat Magnus geglaubt, dass *seine Ehefrau* getanzt hat
at a dancing-context in year 2000 has Magnus believed, that *his wife* danced has
'At a dancing contest in the year 2000, Magnus believed that his wife was dancing'

(#O+UT-reading)

Context

In the year 2000, Magnus goes to a fortuneteller who tells him that his future wife (who Magnus has not met) will participate in a dancing competition on the following Monday. She further tells him that he would marry the dancer by the year 2020. On Monday, Magnus goes to the dancing contest. He is enamored by all the female dancers there. Pointing to the dancers, he tells his friend that he is completely convinced that he would marry one of these women. Specifically, he tells him that he would be married to one of the dancers by the year 2020. Magnus' prediction does not come true. In the year 2018, Magnus marries Susan, who did not participate in the dance competition (However, she was present as a spectator on that day). In the year 2020, Magnus' friend reports on Magnus' past belief:

"#At a dancing contest in the year 2000, Magnus believed that *his wife* was dancing"

(144) *(Hypothetical) Macrolevel Generalization: Ban on O+UT-Readings*
A nominal predicate cannot receive a temporal evaluation relative to the utterance time when its modal evaluation is opaque (i.e. relative to the attitude-worlds introduced by an attitude verb)

Based on (141)-(143), it seems to be impossible to interpret a nominal predicate at the utterance time when its modal evaluation is relative to an attitude holder's belief-worlds. But is the macrolevel generalization in (144) really the best characterization of this data? We might point out, for instance, that the examples given in (141)-(143) adhere to a particular pattern at the microlevel: In all cases, the evaluation time denotes a time that is into the relative future of the matrix tense time (i.e. the belief-time). What then, speaks against accounting for the data by a microlevel generalization such as (145)?

(145) *(Hypothetical) Microlevel Generalization: Ban on O+(MT<ET)*
A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is later than the matrix tense time (e.g. the perspective time of the attitude)

What type of evidence could tell us which of the two generalizations is correct? For a start, a microlevel generalization like the *Ban on O+(MT<ET)* should not exclusively constrain O+UT-readings, but must affect other macrolevel readings as well. Unfortunately, it is hard to find other macrolevel readings that can instantiate the O+(MT<ET)-pattern. First, we have to restrict ourselves to opaque macroreadings. Second, we have to exclude O+MT-readings, since they require temporal overlap between ET and MT. This leaves the O+EmbT-macroreading. To test the O+(MT<ET)-pattern with respect to this reading-type, we can look at a Future-under-Past sentence such as (146). And indeed, the O+(MT<ET)-reading is possible in this case.

(146) (In 2010), Karl believed that *a millionaire* will win the election (in 2099)

Context

In the year 2010, Karl tells his friend Augustus: "Elections are rigged. Only money decides who will win an election. In order to be elected into office, you have to be rich in the first place. I fear this will never change. I'm sure that even in the year 2099 the election will be won by a millionaire". In the year 2020, Augustus tells someone about Karl's predictions about the future:

"In 2010, Karl believed that *a millionaire* will win the election in 2099"

A conclusion we could draw from the data in (146) is that the macrolevel generalization in (144) is right and the microlevel generalization in (145) is wrong. However, this conclusion would be premature. The problem is that the embedded future in (146) adds a complication that might obscure the facts: The future auxiliary "will" is often assumed to include a modal component as part of its semantics (e.g. Condoravdi 2002; Copley 2002, among many others[87]). If this is true, then we cannot be sure that the nominal predicate "millionaire" receives its evaluation world from "believe". In fact, it probably does not: "will" as a modal would add additional evaluation worlds[88]. In the reading where the nominal predicate picks up the evaluation time from "will", it is likely to receive its evaluation world from "will"

[87] However, see Kissine (2008) for arguments that "will" is in fact a purely temporal expression.

[88] Either by introducing a new world binder (world/time pronoun theory) or by adding a new world-parameter to the interpretation function (and in this process shifting the evaluation world away from the belief-worlds).

as well. This would mean that (146) diverges in crucial ways from the type of example we are looking for. Since we cannot be sure what the exact consequences of adding an additional modal element in the scope of "believe" would be, I will ignore examples where the future tense plays an important role. The problem now is to find alternative instances of the O+(MT<ET)-reading. The only viable candidate that is left[89] would be a Past-under-Past sentence in which the embedded tense time is into the past of the utterance time, but also into the relative future of the past time introduced by the matrix tense (So that we get the temporal relation MT<EmbToET<UT as an instance of an O+EmbT-macroreading). However, this context will not help us either. It is well-known that an embedded past tense cannot denote a time that is forward-shifted relative to the matrix tense[90]. In the literature, this generalization is best known in the form of Abusch's (1997) Upper Limit Constraint, which makes the local evaluation time an upper limit for the denotation of an embedded tense. (147) illustrates the upper limit phenomenon for a Past-under-Past sentence[91].

(147) #At Marianne's 20th birthday party (in 1980), Augustus believed that Marianne was in Vienna on her 40th birthday (in 2000)

(148) *Upper Limit Constraint for Embedded Tenses (ULC)/Ban on MT<Embt*

An embedded tense (EmbT) cannot denote a time that is later than the matrix tense time[92]

For this reason, Past-under-Past variants of the O+EmbT-reading will not give us the opportunity to test for the O+(MT<ET)-pattern, since this would require a reading that is impossible because of an ULC-violation. Notice, however, the peculiar similarity between the ULC and the microlevel *Ban on O+(MT<ET)* we have been considering in (145). Both of these generalization state that a certain time (the EmbT-time, on the one hand, and the evaluation time of the nominal, on the other) cannot be later than the time of the embedding (matrix) verb. The only difference is that the *Ban on O+(MT<ET)* additionally connects this temporal restriction to an opaque reading on the modal dimension. That the opaqueness-requirement is necessary, becomes clear once we consider the possibility of T+(MT<ET)-readings. As (149) shows, readings of this type are easily available.

[89] Present-under-Past readings, which could potentially provide the right context, will also be ignored here, since it is well-known that these readings can have odd properties that might interfere with our findings. Most notably, Present-under-Past constructions can display so-called *double access*-readings (see Ogihara 1996, Abusch 1997, among many others). That is, the embedded tense receives a reading for which both the matrix tense time *and* the utterance time are relevant. This is not an ideal situation for the test cases we want to construct here, since the ET of a nominal predicate would be based on an EmbT-time that is not properly independent form the MT-time (i.e. it might not be a proper O+(MT<ET)-context). However, given that the Upper Limit Constraint has been evoked in the analysis of double access-readings (see Abusch 1997), it might be interesting to see whether the evaluation time of opaque nominals is also subject to a double access-requirement in Present-under-Past contexts.

[90] A past tense embedded under a matrix past tense can only receive a *simultaneous* and a *backwards-shifted reading* (see Abusch 1997, Heim 1994, Ogihara 1996, Ogihara & Sharvit 2012, among many others).

[91] The example is a slight adaptation from examples discussed in Heim (1994).

[92] Or rather: Its most local evaluation time (which is the matrix tense time in the simple attitude-sentences we are considering)

(149) (In 1998) Karl believed that *a millionaire* won the election (T+(MT<ET))

Context

In 1998, three people ran for city council president in a local election: Lisa, Chris and Leonard. Back then, Leonard was a poor waiter without any savings at all. Since then, however, he has won the lottery (He won the lottery in 2015 and is now a millionaire). At the election in 1998, Leonard lost to Chris. Shortly after the election, Karl told Augustus that he had heard that Leonard had won the election. In 2022, Augustus (knowing that Leonard has since become a millionaire) tells someone about Karl's mistaken belief:

"In 1998, Karl believed that *a millionaire* won the election"

At first glance, the microlevel ban on O+(MT<ET)-readings sets itself apart from the otherwise parallel ULC by imposing an additional opacity-requirement. On a closer look, however, it is not so obvious that this is actually the case. Remember that the ULC applies to embedded tenses and is therefore a constraint about the temporal interpretation of verbal predicates inside an intensional domain. In the literature on transparent/opaque-readings, the general consensus has been that embedded verbal predicates (unlike DP-internal nominal predicates) cannot receive a transparent reading (i.e. *Generalization X*, after Percus 2000). If this observation is true, then it is also true that all cases that are affected by the ULC are cases where the relevant (verbal) predicate[93] is opaque. This would mean that it is a real possibility that the ULC is a constraint that is directly linked to the opacity of verbal predicates. The link to opaqueness would simply be obscured by the fact that embedded verbs are always opaque.

(150) *(Hypothetical) Upper Limit Constraint for the evaluation of verbal predicates/Ban on O+(MT<EmbT)*

A verbal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time[94] that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude)

Considering this possibility, the ULC now looks even more similar to the (potential) O+(MT<ET)-constraint on the evaluation of nominal predicates. We might even be tempted to combine both constraints (*Ban on O+(MT<ET)* and *Ban on O+(MT<EmbT)*) into a general condition on the temporal evaluation of predicates.

(151) *Generalized Upper Limit Constraint/Generalized Ban on O+(MT<ET)*

A predicate (of any kind) that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude)

If it is indeed possible to relate the microlevel generalization over O+(MT<ET)-readings in the nominal domain to similar constraints for verbal predicates, the microlevel perspective might become a viable alternative to the macrolevel ban on T+UT-readings.

[93] Meaning the verbal predicate whose temporal evaluation is determined by the ULC-restricted embedded.
[94] The evaluation time of a verbal predicate being supplied by its tense, in this case: the embedded tense.

Still, so far we have not seen any direct evidence that a microlevel O+(MT<ET)-ban is active for nominals beyond their O+UT-macrolevel readings. In order to make the microlevel-view convincing, it is necessary to make it empirically distinguishable from a ban on O+UT-readings. Since the macroreadings we have considered until now do not provide us with the relevant test-cases, we need to construct other readings where the O+(MT<ET)-pattern could emerge. In fact, there are still macrolevel readings that have been missing from our discussion.

The temporal readings we have considered so far have inherited the nominal evaluation time from either the utterance time or a sentence-internal tense. In section 3.4.3, I have already alluded to the fact that a nominal predicate can also receive its temporal evaluation contextually, as has been famously shown by Enç's (1981) for examples like (152).

(152) *Every fugitive* is now in jail.

In (152), the nominal predicate "fugitive" is not evaluated at the MT-time or the utterance time (Indeed, the MT-time and the utterance time are the same in this case). Instead, the most likely reading of (152) is the reading where we are talking about people who have *formerly* been fugitives at some contextually salient past time. Additionally, contextual readings include the possibility of anaphoric readings for a nominal's evaluation time.

(153) In the year 1980, Charlotte taught Math in a local high school. She was very cruel towards her students. In 2010, *some students* visited her grave and smiled.

It seems clear that the noun "students" denotes students from Charlotte's class in 1980, and not students from 2010 or the utterance time. The evaluation time of the noun is thus anaphorically related to a time introduced by an earlier sentence[95]. I will call a temporal reading that is determined by contextual/anaphoric information, and not by the utterance time[96] or by a sentence-internal tense, a

[95] See Tonhauser (2021) for discussion of deictic, anaphoric and bound readings for nominal evaluation times. The discussion of deictic, anaphoric and bound readings for times goes back to seminal work by Partee (1973). The existence of these three readings is often taken to show that tenses (as well as temporal information inside DPs) are pronominal in nature. Thus, they have been argued to support the time pronoun theory.

[96] Although it might be argued that the UT-reading is only a special (default) case of a CT-reading (i.e. UT would be the deictic CT-reading where the contextually salient time is the time of the utterance situation). Indeed, since all of our test cases involved elaborate contextual clues (including context information about times), most of the readings that appeared at first glance to relate the ET to a sentence-internal tense could be rethought in terms of contextual evaluation times. For example, we might want to question whether the T+EmbT-reading actually involved an evaluation time that is based on the embedded tense, and not merely a contextually determined time that overlaps with the embedded tense time on accident.

Context Time-reading (CT)[97]. We can now add two additional macrolevel modal/temporal-readings to our list[98].

(154) *New macrolevel readings*

(i) Transparent+Context Time (T+CT)
(ii) Opaque+Context Time (O+CT)

Before we ask whether the O+CT-reading can realize the O+(MT<ET)-pattern, we should first determine whether the readings in (i) and (ii) are possible at all. Let us consider first the T+CT-reading.

(155) David believes that *a fugitive* is beating up the warden (T+(CT<MT))

Context

David is in prison. One day, he sees someone beating up the warden. He runs away because he wants to avoid getting into trouble. He did not get a good look at the prisoner that is beating up the warden, but (based on what he saw) he believes it must be Greg. Unbeknownst to David, Greg is among a group of prisoners that recently escaped from prison. Unfortunately for them, they got caught and were put back in prison a week before David witnesses the beating. As David runs away from the location of the beating, he is stopped by a guard who forces him to report on what he saw. The guard (who knows about Greg's recent prison escape), turns to a second guard:

"Prisoner David believes that a fugitive is beating up the warden"

(156) Karl believed that *the mayor* was senile (T+(CT<MT))

Context

Karl did not know the first thing about politics. When he attends an event were the former mayor (now an old woman in retirement) was present, he does not know who she was. As he is talking to her, she seems confused that Karl does not recognize her. Karl interprets this confusion as senility on her part. Karl's friend Herbert later tells this story and concludes:

"Karl believed that the mayor was senile"

(155)-(156) clearly demonstrate the possibility of a T+CT-reading. Again, "fugitive" is evaluated at a contextually-salient time that is located in the past of the time denoted by the tenses and the utterance time (which is the present in each case). Also, since David is ignorant about the past prison escape, "fugitive" must be read transparently. Similar things are true for (156): The mayor is already retired when Karl mistakes her for a random, senile woman. (155)-(156) avoid the MT<ET-relation. Before we

[97] A different question is whether worlds also have contextual/anaphoric readings. I will not pursue this question here. However, Keshet (2008: 33-34) argues that the following is an example for a contextual world-reading.

(i) ?Elwood's wife wants Elwood to stop talking to *the six-foot rabbit*

The nominal predicate "six-foot rabbit" does not describe individuals in the real world, nor does it describe individuals in the desire-worlds of Elwood's wife. Instead, the six-foot rabbit exists in the worlds according to Elwood's imagination. These worlds are not associated with any expression in the sentence and are thus (presumably) contextually provided.

[98] Of course, these two reading-types immediately raise the questions what predictions the parameter theory and the world/time pronoun theory make with respect to their existence. For the world/time pronoun theory, the answer is easy: The existence of anaphoric time-readings is exactly what we would predict if the evaluation time is introduced by a temporal pronoun. Moreover, both T+CT and O+CT should be derivable. For the parameter theory, contextual readings are a greater challenge, but see section 3.4.3. for discussion.

concern ourselves with the O+CT-reading, let us look at a different T+CT-reading in which the CT-time is forward-shifted relative to the MT-time.

(157) Steve believed that *a fugitive* was beating up the warden (T+(MT<CT))

Context

In the year 1980, Steve was working as a prison guard. One day, he saw that a prisoner was beating up the warden. He quickly ran to fetch the other guards for back up. When Bernd asked him who was beating up the warden, he told him that he believed it was Thomas (He was mistaken: It actually was Maurice). Five years later (in the year 1985), Thomas was part of a group of individuals that managed to escape from prison. In the year 1992, all three of them got caught and were put back in prison.
In the year 2000, Bernd, who was aware of the prison escape of 1985 as well as the fact that the fugitives were caught in 1992, speaks with a former colleague about the night the warden was beaten up. He is speaking about the moment when Steve came running to tell him about what was going on:

"Steve believed that a fugitive was beating up the warden"

It seems that the MT<ET-relation is no problem for the T+CT-reading. In (157), the relevant individual is neither a fugitive at the utterance time (He is back in prison by then), nor at the belief- or beating-time (At which he is in prison as well). Instead, the individual is a fugitive in the relative future to the MT- and EmbT-times. This reading seems to be fine when "fugitive" is transparent.

Now, let us examine the O+CT-reading. Consider (158)-(160).

(158) Theodor hat gedacht, dass *jeder Arzt* eingeschlafen ist
Theodor has thought, that *every doctor* asleep is
'Theodor thought that every doctor fell asleep'
(O+(CT<MT))

Context

In the year 2005, Theodor worked as a lab assistant. At one time, his lab conducted an experiment that involved two experimental groups: A group of former lawyers and a group of former doctors (The experiment specifically looked at individuals that were lawyers and doctors in the 1990s, but that were fired for professional misconduct before the year 2000). During the experimental run, every lawyer fell asleep while finishing the experimental task. The former doctors stayed awake. Because of his sloppy notes, Theodor mixes up the two experimental groups. He therefore thought that the individuals that he observed falling asleep were former doctors. He goes to his supervisor to report his findings. The supervisor notices his mistake and even years later, he tells people about his sloppy lab assistant:

"Theodor thought that every doctor fell asleep"

(159) John believed that *a fugitive* was in jail (O+(CT<MT))

Context

John heard a false rumor that someone had escaped from prison a few weeks ago and that this person has since been captured and put back in prison. John tells this belief to Peter who knew that it was false and corrects him. Peter later tells Mary about John's belief:

"John believed that a fugitive was in jail"

(160) Charlotte believed that *a senator* was in love with her (O+(CT<MT))

Context

In 2000, Charlotte was living in a nursing home. Matteo, who was also living at the facility, went around claiming that he had been a senator in the past. This was not true. In actuality, he had been a school teacher his whole life. At one point, Matteo declared his love for Charlotte. Charlotte, who believed Matteo's claim that he had been a senator in the past, was thrilled and told her nephew Augustus: "There is a former senator living here who is in love with me." Augustus knows that Matteo is crazy, but does not correct his aunt. 20 years later, he tells someone about his aunts time at the nursing home:

"At one point, Charlotte believed that a senator was in love with her"

Admittedly, the judgements for (158)-(160) are a little bit less clear compared to the T+CT-contexts. But overall, the consensus among my informants was that the O+(CT<MT)-reading is possible. We can now finally turn to our primary test case: The O+(MT<CT)-reading. Relevant examples are given in (161)-(163).

(161) #Napoleon believed that *a spy* gave a speech (#O+(CT<MT))

Context

In 1805, Napoleon attended an event where three people gave a speech: Louis, Pierre and Jean. The night before, he had a vision that told him that one of these three individuals would become a Prussian spy in the future. At the event, he turned to one of his aides to tell him: "I don't know who exactly, but one of the people giving a speech today will be recruited as a spy by the Prussians at some time in the future, so keep an eye on them. Because I'm telling you: By the year 1810, one of them will work as a Prussian spy." Historians assume that Napoleon was wrong and that Louis, Pierre and Jean remained French loyalist for the rest of their lives. In 2022, a historian gives a lecture on Napoleon's life in 1805. He cites Napoleon's quote above and concludes:

"#Napoleon believed that *a spy* gave a speech"

(162) #Als Bach vorgespielt wurde hat Hubertus geglaubt, dass *jeder Arzt* geweint hat
as Bach played was has Hubertus believed, that *every doctor* cried has
'As Bach was playing, Hubertus believed that every doctor was crying'
(#O+(CT<MT))

Context

In the year 1890, Hubertus was the head of a rich, aristocratic family. He was also very superstitious. At one point, he brought all his nephews and grandchildren (all in all 23 young children) to a fortuneteller to predict their future careers. Among other things, the fortuneteller claimed that he could predict the future of children by analyzing their response to particular pieces of music. For instance, he claimed that each child that would respond to Bach's music by crying would later in life become a doctor. Hubertus believed this. However, in reality, non of the children that cried after hearing Bach later became doctors. In 2010, a family member speaks of his superstitious ancestor:

"#As Bach was playing, Hubertus believed that every doctor was crying"

(163) #At his house in 1980, Karl believed that *the mayor* was playing check (#O+(MT<CT))

Context

In 1980, Karl had three children: Ludmilla, Louis and George. He had specific plans for the future careers of his children: One would become a doctor, another a lawyer and yet another a politician. He did not yet decide which child should take which of the three career paths he had in mind. At a party at his house in 1980, he points to his three children (who are playing check at the moment) and tells his friend Hugo: "I have great plans for these children. One of them will be mayor by the year 2000. By the year 2003, the same child will be governor and by the year 2008, the child will be president. I will make sure of it. So be aware that one of the children playing check right now will become a successful politician in the future." None of Karl's children actually became a politician in the end. In the year 2020, Hugo is talking with a friend about past mayors. When the 2000 mayoral election comes up, Hugo reports what Karl told him at his house in 1980:

"#At his house in 1980, Karl believed that the mayor was playing check"

Let us first confirm that the examples establish the right kind of context. Assuming that we (and Napoleon) acknowledge that Louis, Pierre and Jean are mere mortals (and assuming further that a person cannot be a spy and dead at the same time), then the nominal evaluation time for "spy" will not overlap with the utterance time. The ET will also be into the future of both MT and EmbT, since, at the time of the event, Napoleon did not think that the relevant individuals had already been recruited as spies. Also, "spy" requires an opaque-reading since Louis, Pierre and Jean never become spies in the actual world. Similar things can be said about (162) and (163). Importantly, the readings under discussion are not available.

These data suggest the following: Even when the ET is not the utterance time, an MT<ET-relation is blocked when the noun is interpreted opaque. Considering that the microlevel ban on O+MT<ET-readings shows obvious similarities to the verbal Upper Limit Constraint (which suggests that a unified account for verbal and nominal MT<ET-restrictions might be within reach), and now first empirical evidence that the O+MT<ET-ban extends beyond the O+UT-macroreading, the microlevel generalization from (145) looks more and more like a serious alternative to a macrolevel O+UT-restriction. Indeed, if we opt for a macrolevel O+UT-ban, we would now be forced to impose a similar ban on O+CT-readings in order to account for (161)-(163). Notice that such a constraint would not necessarily mean an added stipulation. The reason for this is that we could plausibly argue that the O+UT- and the O+CT-readings are not actually distinct macrolevel readings at all. In fact, the utterance time itself is a (special type of) contextually-salient time. This means that every UT-reading can be seen as a particular instance of a CT-reading (essentially: the deictic CT-subreading). Instead of a macrolevel ban on O+UT-readings, we could thus postulate a (generalized) macroban on O+CT-readings that includes O+UT as a subtype.

(164) *(Hypothetical) Generalized Macrolevel Generalization: Ban on O+CT-Readings*

A nominal predicate cannot receive a temporal evaluation relative to a context time (including the utterance time) when its modal evaluation is opaque (i.e. relative to the attitude-worlds introduced by an attitude verb)

However, this generalization is actually falsified by the data in (158)-(160). An O+CT-reading *is* possible in cases where the context time is into the past of to the matrix tense time (the O+(CT<MT)-reading). We can conclude: A macrolevel generalization will not do. The more promising strategy is to look at (im-)possible patterns at the microlevel. At this point, the best candidate we have is some sort of Upper Limit Generalization (ULG). Ignoring for the moment the (promising) possibility of finding a unified ULG that accounts for the behavior of both nominal and verbal predicates, I will assume that the *Ban on O+(MT<ET)* is the right way to characterize the missing modal-temporal readings we have encountered so far.

(165) *Microlevel Generalization: Ban on O+(MT<ET)/Upper Limit Opaqueness*

> A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb) cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude)

The generalization in (165) is equivalent to an implicational statement of the following kind.

(166) $O \rightarrow$ **MT<ET*

> *If a nominal predicate is opaque*, then its temporal evaluation cannot be at a time that is exclusively later than the matrix tense time

A potential way to attack this generalization is to deny the antecedent condition of the implication in (166). Is opacity of the predicate the right characterization of the *MT<ET-triggering environment? The following sections briefly address some potential challenges to this idea. In particular, we will consider the possibility that scope, instead of opacity, is the relevant factor for the MT<ET-ban.

3.7. Opacity or scope? A look at *MT<ET in narrow scope-T readings

The modal dimension interacts with the quantificational force of a DP in interesting ways: When the quantificational force of a DP takes wide scope (e.g. in the *specific* reading of an indefinite), the nominal predicate can only be interpreted transparently[99] (That is, there is no *wide scope+opaque* reading, see e.g. von Fintel & Heim 2021, Keshet 2008). However, when the quantificational force of a DP takes narrow scope (e.g. the *non-specific* reading), the nominal predicate can be either transparent or opaque.

Beginning with the seminal work by Fodor (1970)[100] the existence of the *narrow scope+transparent* reading (also known as *Fodor's third-reading*) has received particular attention in the literature[101], since it has been perceived as a serious challenge for the classic parameter theory (and as potential evidence

[99] A generalization that is correctly predicted by both the parameter theory and the index-pronoun theory.

[100] See also Bäuerle (1983) for the discussion of a narrow scope+transparent reading that is of a slightly different flavor than the examples discussed by Fodor (1970) as it is tested for universally quantifying DPs that must scope below an indefinite with narrow scope (relative to an attitude verb).

[101] E.g. Fodor (1970), Bäuerle (1983), von Fintel & Heim (3021), Keshet (2008, 2010, 2011), among many others.

in favor of object-language world variables, see von Fintel & Heim (2021) for discussion). (167) gives a slightly modified version of Fodor's classic example.

(167) Augustus wants *a coat like Bill's* (narrow scope+T-reading)

Context

Augustus does not have any particular coat in mind, but he has the desire that whatever coat he is going to buy must be made out of cashmere. Augustus does not know this, but Bill actually owns a coat made of cashmere.

If the context is as described in (167), then the existential quantifier of the indefinite takes narrow scope with respect to "want" (since there is not a single *specific* coat, but various different coats that are compatible with what Augustus wants – any coat made of cashmere will do), but the nominal predicate ("coat like Bill's") must be interpreted relative to the utterance world (since Augustus would not agree that it is his desire to buy a coat like Bill's – he does not even know of Bill's coat). Therefore, a DP might be simultaneously interpreted with narrow scope and as transparent with respect to the modal evaluation of its noun. For us, this reading is of particular interest for the following reason: In the last section, we have argued extensively that the MT<ET-ban is tied to the opaqueness of predicates. That is, we have argued for the implication in (168).

(168) $O \rightarrow *MT<ET$

If a nominal predicate is opaque, then its temporal evaluation cannot be at a time that is exclusively later than the matrix tense time.

As mentioned at the beginning of this section, however, opaqueness of a predicate is involved in another implicational relation: When a nominal predicate is opaque, it must take narrow scope/NS (There is no wide scope+opaque reading).

(169) $O \rightarrow NS$

If a nominal predicate is opaque, then it must take narrow scope with respect to its local modal operator.

The implication in (169) allows for the possibility that the ban on MT<ET is not actually tied to opacity per se, but to an independent factor that is implicationally linked to opacity: narrow scope/NS. We might therefore ask whether the missing O+(MT<ET)-reading might be better captured by the following generalization.

(170) *(Hypothetical) Ban on NS+(MT<ET)*

A nominal predicate that takes narrow scope with respect to an attitude verb[102] cannot be evaluated at a time that is (exclusively) later than the time of the tense on the attitude verb (i.e. the matrix tense time in simple attitude sentences)

(171) *(Hypothetical) NS → *MT<ET*

If a nominal predicate takes narrow scope with respect an attitude verb, then it cannot be evaluated at a time that is (exclusively) later than the time of the tense on the attitude verb

In order to test the alternative hypothesis outlined in (170) and (171), we need to look at cases in which a nominal predicate takes narrow scope, but does not receive an opaque reading. The wide scope+transparent-reading describes exactly the reading we are looking for. Does the wide scope+T-reading allow a temporal evaluation that is into the future of the MT-time? Put differently, does a (NS+T)+(MT<ET)-reading exist? First, let us consider the reverse temporal ordering, which should not be a problem if our assumptions so far are correct.

(172) David believes that *a fugitive* is beating up the warden ((NS+T)+(ET<MT))

Context

David is in prison. One day, he sees someone beating up the warden. He runs away because he wants to avoid getting into trouble. He did not get a good look at the prisoner that is beating up the warden, but (based on what he saw) he believes it must be either Greg, Thomas or Maurice, who are all members of the same prison gang. Unbeknownst to David, Greg, Thomas and Maurice recently escaped from prison. Unfortunately for them, they got caught and were put back in prison a week before David witnesses the beating. As David runs away from the location of the beating, he is stopped by a guard who forces him to report what he saw. The guard (who knows about the recent prison escape), turns to a second guard:

"David believes that a fugitive is beating up the warden"

In (172), Peter's belief-worlds vary with respect to the prisoner that is beating up the warden. In some of his belief-worlds, the relevant prisoner is Greg. In others, it is Thomas. And in others, it is Maurice. There is not a particular individual that is beating up the warden in all of David's belief-worlds, i.e. the quantificational force of the indefinite must take narrow scope with respect to "believe". Additionally, the predicate "fugitive" must be transparent since David does not know of any recent prison-escapes that occurred. And finally, the ET of "fugitive" is backwards-shifted with respect to MT since the relevant individuals are no longer fugitives at MT. (172) seems to be fine under this reading.

Next, let us examine the (NS+T)+(MT<ET)-case.

[102] Or more generally: Narrow scope relative to any tense/time-introducing expression, regardless of whether this tense is tied to a modal operator or not. O'Leary (2022), who parallels a lot of the discussion in this thesis, argues for exactly this solution: According to her, the missing O+UT-reading (This is the only *MT<ET-reading she discusses) is caused by the fact that an opaque nominal must take narrow scope with respect to the attitude verb and the fact that an evaluation time (or rather: An evaluation time-determining *input time*) must be locally bound by the nearest temporal operator (which cannot be UT in a narrow scope-position).

(173) Steve believed that *a fugitive* was beating up the warden ((NS+T)+(MT<ET))

Context

In the year 2000, Steve is working as a prison guard. One day, he sees someone beating up the warden. He quickly runs to fetch the other guards for back up. When they ask him which prisoner is beating up the warden, he cannot give an exact answer because he did not get a good look at him. However, based on what he saw, he believes it must be either Greg, Thomas or Maurice (In fact, it later turns out to be neither one of them). He reports this to Bernd, his supervisor. Ten years later (in 2010), Greg, Thomas and Maurice are among a group of individuals that manage to escape from prison. They have been fugitives on the run ever since.

In the year 2020, Bernd, who was aware of the prison escape of 2010, speaks with a former colleague about the night the warden was beaten up. He is talking about the moment when Steve came running to tell him about what was going on:

"Steve believed that a fugitive was beating up the warden"

(173) is narrow scope and transparent for the same reasons that (172) is. This time, however, the evaluation time is forward-shifted relative to MT. It is not easy to reach a definite conclusion about the existence of this reading[103], but the majority of judgements I gathered seem to indicate that it is possible[104]. If this is true, then we have good reasons to assume that narrow scope cannot be the determining factor for the MT<ET-ban. We are left with the conclusion that an opaque-reading, but not narrow scope, necessarily triggers an upper limit effect of the MT<ET-type. Thus, the *Ban on O+(MT<ET)/Upper Limit Opaqueness-Constraint* remains our best characterization of the missing modal-temporal readings.

[103] O'Leary (2022) also attempts to test for this reading, but does not reach a final verdict about its existence.

[104] A similar test case could be provided by *Bäuerle sentences* (after Bäuerle 1983). In these constructions, a NS+T-reading is forced for a universally quantifying DP ("every member of his band" in (i)) because it must take narrow quantificational scope relative to an existential indefinite ("a women from Vienna" in (i))) which itself receives a narrow scope interpretation relative to "believe". We get the following order for quantificational scope: BELIEVE > ∃ > ∀. In such environments, the nominal predicate of the universally quantifying DP can be shown to allow transparent readings (i.e. it receives a NS+T-reading). For us, the interesting question would be whether the ET of the ∀-DP can be forward-shifted relative to the MT-time of "believe". The context in (i) tries to force such a reading.

(i) John believed that a woman from Vienna hated *every member of his band*

Context

Two years ago (in 2018), John started a successful band with his three closest friends Franz and Bobby. Before they became famous, John, Franz and Bobby had a bad reputation with women. In 2005, years before they started the band, John told Billy: "Franz, Bobby and I have a difficult history with women. There must be hundreds of women in Vienna that we have upset at some point. There is probably even some woman in Vienna that has a passionate hatred for all three of us: Franz, Bobby and me." In the year 2020, when Billy talks with someone about John's famous band, Billy speaks of his past encounter with John. Billy says:

"Back in 2005, John believed that a women from Vienna hated every member of his band"

Again, these types of examples are very difficult to judge. However, on a first glance, (i) seems to be possible.

3.8. Preliminary conclusion and outlook

After our discussion so far, a microlevel Ban on O+(MT<ET)-readings seems to be the best candidate for a generalization about modal-temporal interactions. It can be stated as follows.

Microlevel Generalization: Ban on O+(MT<ET)/Upper Limit Opaqueness

A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude)

Moreover, this constraint has the potential to eventually get subsumed under a more general constraint on O+(MT<ET)-readings that can extend beyond the nominal domain to upper limit effects observed for other predicate types (e.g. ULC-effects for embedded verbs and their tenses). An important consequence of the *Ban on O+(MT<ET)* is that it makes a macrolevel ban on O+UT-readings redundant. The unavailability of the (observable) O+UT-readings falls out from the *Ban on O+(MT<ET)* alone. We therefore do not need to incorporate a ban on O+UT-readings into our system of intensionality. If this is the right way to go, then this has significant implications for our earlier discussion of different systems of intensionality and their (in-)ability to derive various modal-temporal readings. Remember that it was considered to be an advantage of the parameter theory that a macrolevel ban on O+UT-readings was derived directly by the most fundamental assumptions of the approach. Even more importantly, the missing O+UT-reading was considered to be a major overgeneration issue for the index-pronoun theory, which did not offer any inherent reasons to exclude this reading. Now that the unavailability of the (observable) O+UT-readings seems to be the consequence of an independent (microlevel) generalization, the situation is different: If the *Ban on O+(MT<ET)*-generalization is correct, we would need an independent account for this, regardless of whether we adopt the parameter- or the index-pronoun approach. A microlevel generalization like the *Ban on O+(MT<ET)* is neither predicted nor excluded by the elementary choices of our system of intensionality. This also means: If the unavailability of the O+UT-reading does not need to be accounted for by the basic workings of our system of intensionality (since its absence is explained by independent factors), then it is probably better that our system *does not* account for it, since this would otherwise make our theory redundant. Considering this, the index-pronoun theory does not look bad after all when it comes to the various modal-temporal readings. The index-pronoun theory (in its unrestricted form) is essentially a theory that predicts that there should not be any restrictions on macrolevel readings (As with the parameter theory, it has little to say about microlevel restrictions). Since our only potential candidate for a macrolevel restriction (the ban on O+UT-readings) can be abandoned in favor of an independent microlevel restriction, the prediction of the index-pronoun theory seem to be plausible after all. That is, we could conjecture that there are not any macrolevel restrictions at all. This conjecture can be stated as follows.

No restriction on macrolevel readings (Conjecture)

There is no restriction on *macrolevel* modal-temporal readings. In principle, any of the following reading-types should be derived by our system of intensionality:
T+UT, T+MT, T+EmbT, T+CT, O+UT, O+MT, O+EmbT, O+CT

As promising as these generalizations/conjectures look at first glance, we will see that this picture might be too simplistic. Most importantly, we have neglected a crucial aspect of the temporal properties of DPs: DPs do not involve just one temporal component (such as the nominal evaluation time ET), but (at least) two. Consider (174)[105].

(174) (At the class reunion in 2010) *The students* were (all) drunk

Context

In 2010, former members of the graduation class of 1990 come together for a reunion. Not all former class members make it to the reunion, but everyone who shows up drinks at least two bottles of wine each.

(175) The individuals that were students [1 *in/before 1990*] and [2 that were present at the reunion *in 2010*] were drunk (at the reunion in 2010)

Two (disjoint) times are involved in determining the referent for the DP *the students* in (174). Since we are not talking about (groups of) individuals that were students in 2010, the ET of the nominal predicate is a time in the past of the reunion. The noun picks out (groups of) students that graduated in 1990. However, (174) is also not a claim about (all) students from the graduation class of 1990, but only those (former) students from that class that were also *present at the reunion in 2010*. This additional information is contributed by the implicit domain restriction of the DP. The temporal component of this implicit restriction is what I call the *resource time* (RT).

What this demonstrates is that the temporal dimension of DPs is much more complicated than originally assumed. If we want to make serious claims about the interaction of modal and temporal DP-components, we cannot ignore this complication. Most importantly, our conclusions about modal/temporal readings must be viewed as merely tentative. Without carefully considering the role of the *resource time* (RT), generalizations such as the *Ban on O+(MT<ET)* might overlook relevant properties of modal/temporal readings. For instance, a question we might ask is whether the generalization bans the right temporal relation. It is clear that the generalization must have something to do with a forward-shifted DP-time. But is it actually the ET that is the issue? Or was this conclusion premature and the right ban is actually about forward-shifted RT (i.e. MT<RT)? Alternatively: Is there maybe an Upper Limit Opaqueness-constraint that generalizes to both ET *and* RT? Moreover, another possibility is that the generalization is indeed about ET, but we identified the wrong time relative to which a future-shift is blocked. Maybe the relevant generalization is about DP-internal temporality (i.e.

[105] An example along these lines was first pointed out to me by Daniel Büring (p.c.).

RT<ET) and not about a relation to a DP-external tense (MT<ET). In this case, it could also be hypothesized that opacity is only accidentally linked to the *RT<ET-constraint, for instance, by (hypothetically) requiring binding of RT to the matrix tense so that any MT<ET-relation automatically becomes an RT<ET-relation[106]. To summarize, the following (hypothetical) generalizations could be serious alternatives to the *Ban on O+(MT<ET)* and need to tested systematically before any conclusion can be reached.

(176) *Hypothetical alternatives*

a. *O+(MT<RT)
b. *O+(MT<ET) & O+(MT<RT)
c. *O+(RT<ET)
d. *RT<ET

Before we can probe into these potential alternatives, we need to get a better understanding of DP-internal temporality. The next section thus turns to the intradimensional relations we find among the individual time components of DPs.

[106] We would then need to see evidence for a RT<ET-ban outside of opaque-contexts. Also, transparent-readings should show the same unacceptability as O+(MT<ET)-contexts when a RT<ET-relation is forced.

4. Intradimensionality: Temporal relations inside DPs and their restriction

4.1. Introduction and main claims of this section

The present chapter is an investigation into the temporal relations we find inside simple DPs. Specifically, I explore the relationship between two DP-internal times: The evaluation time (ET) of the noun and the resource time (RT), which is the time that contributes to the implicit domain restriction. At the center of the investigation is the observation that ET and RT can be temporally disjoint. ET-RT disjointness can be captured by assuming two independent time pronouns for ET and RT (see section 4.3.). However, such a system overgenerates when it comes to (im-)possible temporal relations between ET and RT. In section 4.4., it is shown that ET and RT show a degree of independence when it comes to their behavior as bound (or free) variables. However, it is argued that this independence is limited. Specifically, I argue for the following generalization.

(177) *No Free RT+Bound ET-Reading*

The evaluation time (ET) of a noun cannot receive a bound variable reading if the resource time (i.e. the time of the implicit domain restriction of the same DP) receives a free reading (or equivalently: RT cannot be free if ET is bound).

(178) (*Partial) independence of ET and RT w.r.t. bound variable behavior (Bound RT+Free ET)*

The resource time (RT) of a DP's implicit domain restriction can have a bound variable reading when the evaluation time (ET) of the DP's noun is free.

Moreover, section 4.5. aims to show that the DP-internal temporality is restricted to disallow RT<ET-relations.

(179) **RT<ET* or *No RT<ET-disjointness*

The ET of a DP's noun cannot be a time that is both disjoint and into the future (i.e. posterior) to the DP's RT

Finally, in sections 4.6.-4.8., further complications are discussed, and potential analyses are considered that rely on only one DP-internal time (or situation) pronoun.

4.2. Two DP-internal times: ET and RT

This section is about the temporal information that is relevant to the meaning of simple DPs of the form *determiner + noun*, e.g. "the president", "a student", "every fugitive", "most doctors"[107]. Past research on the temporal semantics of DPs has focused on the *evaluation time* (ET) of nominal predicates (for an overview, see Tonhauser 2021)[108]. Nouns describe properties that are true for different individuals at

[107] Parts of this chapter have been presented at ConSOLE31, and a slightly revised and updated version has been submitted to the associated conference proceedings.

[108] Specifically, the main questions that have been pursuit in previous research are the following.

(i) *Are there any constraints on the nominal ET?*

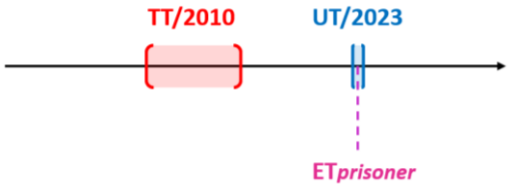
different (evaluation) times. Because of this, (180) expresses different thoughts depending on the ET of the noun "prisoner".

(180) In 2010, *a prisoner* won the Nobel Prize

a.) *ET=UT-Reading*

= A prisoner at the utterance time (UT=2023) won the Nobel Prize (in 2010)

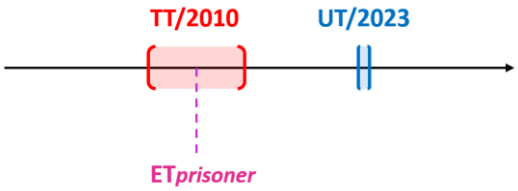
In 2010, Marcus was an esteemed scientist who won the Nobel Prize for groundbreaking work in particle physics that shed new light on some of the greatest mysteries in the universe. A few years later, he went crazy and killed his lab assistants. In 2023, while Marcus is in prison for murder, the warden at his prison brags about all the famous people he meets at work: "Besides some Oscar winners and former senators, there are also some accomplished scientists in our prison. To give just one example: *In 2010, a prisoner won the Nobel Prize*".



b.) *ET=TT-Reading*

= A prisoner at the tense time (TT=2010) won the Nobel Prize (in 2010)

As the result of his vocal protests against a corrupt, tyrannical regime, Julien became a political prisoner in 2009. While being in prison, Julien received the Nobel Peace Prize in honor of his unwavering devotion to the spread of democracy. A year later, Julien struck a deal with the authoritarian government that saw him freed from prison in exchange of becoming a public advocate for fascism. In 2023, Tom, after having listened to a critical podcast on the Nobel Prize and totally missing the point, excitedly turns to a friend and tells him: "Did you know: *In 2010, a prisoner won the Nobel Prize*. How cool is that?"



The modest aim of this section is to point out that there is more to the temporality of DPs than the nominal ET. Specifically, the temporal dimension of a simple DP involves (at least) a second time that

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(ii) *What are the syntactic/semantic/pragmatic mechanisms that determine the value of the nominal ET?*

For the most part, both of these questions have been investigated by examining the relationship between the nominal ET and the main clause tense. That is, since we know that the evaluation time of verbal predicates is determined and constrained by tense, the question of whether there are any constraints on nominal ETs has been framed as the question of whether nominal ETs are likewise constrained by tense. When it comes to this question, the literature is roughly divided into two camps:

a.) *No*, the nominal ET is independent of tense (e.g. Enç 1981, 1986; Tonhauser 2021)
b.) *Yes*, the nominal ET is dependent on tense, but only the ET of a subclass of DPs, defined by their pragmatic status and/or determiner type and/or syntactic position (e.g. Musan 1995, 1999; O'Leary 2022)

can be temporally disjoint from ET. I will call this additional time, which is the time that contributes to a DP's implicit domain restriction, the *resource time* (RT). Consider the example in (181).

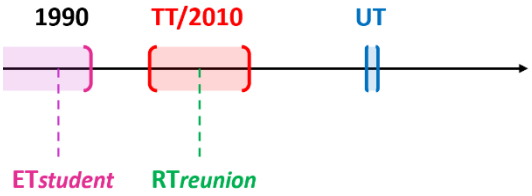
(181) (At the class reunion in 2010) *The students* were (all) drunk

Context

In 2010, former members of the graduation class of 1990 come together for a reunion. Not all former class members make it to the reunion, but everyone who shows up drinks at least two bottles of wine each.

In the given context, the content of (181) can be roughly paraphrased as in (182).

(182) The individuals that were students [1 *in/before 1990*] and [2 that were present at the reunion *in 2010*] were drunk (at the reunion in 2010)



As indicated by the square brackets in (182), the content of (181) contains information that is not expressed by overt constituents. Specifically, the context supplies implicit content that narrows down the potential referents for the subject DP ("the students") to individuals[109] that are 1.) students *in/before 1990* and 2.) attending the reunion *in 2010*. Crucially, as part of this implicit content, the meaning of "the students" relies on two distinct (i.e. temporally disjoint) times: (181) is neither about individuals that were students in 2010 (the reunion time), nor about students at the utterance time[110]. Instead, (181) is about individuals that were students in (and before) the year 1990. Since this first piece of temporal information fixes the set picked out by the noun "students", it must be the nominal evaluation time (ET). Importantly, the ET is not the only temporal information that is relevant to the interpretation of "the students": (181) does not assert that all former students from the graduation class were drunk in 2010, since not all students from before 1990 attended the reunion. Rather, (181) is a claim specifically about former students that were present *at the reunion in 2010*. This second piece of temporal information – the resource time (RT) – seems to be part of the implicit domain restriction that typically appears with the interpretation of quantifiers and determiners[111] [112]. In research on the temporal interpretation of DPs (e.g. Enç 1981, 1986; Musan 1995, 1999; Tonhauser 2002, 2006, 2021; Kusumoto 2005), the observation that the domain restriction of a DP can make reference to a time that is temporally disjoint

[109] More precisely: to pluralities/groups of individuals.

[110] The truth of (181) (under the intended reading) is not impacted by the potential presence of 2010-students, even if these students stayed sober while attending the reunion event.

[111] In (182), the implicit domain restriction, which contains more than just temporal information, is made explicit inside the square brackets labeled *2*.

[112] For a discussion of implicit domain restrictions, see von Fintel (1994) and Elbourne (2020).

from the nominal ET is rarely discussed (or even mentioned)[113]. Importantly, the fact that ET and RT can be disjoint generalizes beyond plural definites to other types of determiners and quantifiers. (183)-(186) illustrate this for universal quantifiers, singular definites, DPs headed by *most*, and indefinites.

(183) *Every student* was drunk

≈ Every individual that was a student [1 *in/before 1990*] and [2 that was present at the reunion *in 2010*] was drunk (at the reunion in 2010)

Context

Same context as in (181)

(184) *The class president* was drunk

≈ The (unique) individual that was a class president [1 *in/before 1990*] and [2 that was present at the reunion *in 2010*] was drunk (at the reunion in 2010)

Context

Same context as in (181), with the following addition: Brad is one of the former class presidents of the graduation class of 1990 (The class had the rule back then to always have two co-presidents at the same time – one male, one female). Brad is attending the reunion. There, he drinks three shots of tequila, two shots of vodka, three cans of beer and two bottles of wine (i.e. Brad is drunk). No other former class president attends.

(185) *Most English teachers* were sober

≈ Most individuals that were English teachers [1 *in/before 1990*] and [2 that were present at the reunion *in 2010*] were sober (at the reunion in 2010)

Context

Same context as in (184), but in addition to the former students, several former teachers attend the reunion. Among them are six former English teachers (all of them are retired by the time of the reunion in 2010). Of the six former teachers, five do not drink a single drop of alcohol. One of them, however, is convinced by Brad to drink three shots of tequila, two shots of vodka, three cans of beer and two bottles of wine (i.e. he is drunk).

(186) *An English teacher* was drunk

≈ There was an individual that was an English teacher [1 *in/before 1990*] and [2 that was present at the reunion *in 2010*] and that individual was drunk (at the reunion in 2010)

Context

Same context as in (185)

It appears that ET and RT can be disjoint regardless of the DP-type in question. Let us call this property of DPs *ET-RT disjointness*.

(187) *ET-RT disjointness*

The evaluation time (ET) of a DP's main noun does not have to overlap with the resource time (RT) that is introduced as part of the DP's implicit domain restriction.

[113] The only mention of this that I am aware of appears in Musan (1995). However, Musan does not investigate the resource time in any detail and mostly focuses on the interpretation of the evaluation time.

The following sections explore the consequences of ET-RT disjointness. Section 4.3. makes a first attempt at deriving ET-RT disjointness by laying out a system with two DP-internal time pronouns. In Sections 4.4. and 4.5., the predictions of this system are tested. It is argued that the relation between ET and RT is restricted in ways that are not predicted by the two variable system. Section 4.6. explores the consequences of ET-RT disjointness for various conclusions drawn in the literature. Section 4.7. sketches out alternative ways to account for DP-internal temporality. Most importantly, it is shown that we need only one time pronoun to account for the relevant data. Section 4.8. discusses open questions and offers ideas for future research.

4.3. Two time variables?

It seems that the contribution of ET and RT is similar across various DP-types (i.e. the bracketed content remains constant across (181)-(186)). Specifically, ET and RT contribute to the determiner's restrictor argument, which is the argument that determines the set of individuals in the determiner's domain. Let us call the restrictor argument of a determiner NP*rest*. For the subject DPs in (181)-(186), the denotation of NP*rest* picks out the following set[114].

(188) *Denotation of NP*$_{rest}$ *in examples (2)-(7)*

$[\![\text{NP}_{rest}]\!]^{g,c}$ = { x | x is a *nom* in/before 1990 & x is present at the reunion in 2010}

(where *nom*="student(s)" in (181) and (183), *nom*="class president" in (184), *nom*="English teacher" in (185)-(186))

Essentially, the denotation of NP*rest* is a conjunction of two predicates, both of which are related to a distinct time: The nominal predicate (*Nom*), which is related to ET, and the implicit domain restriction predicate (*Dom*), which is related to RT. We can take a predicate to denote a function of the (intensional) type <i, <e,t>>, i.e. a function that takes a time argument of type i and returns a set of individuals (or more precisely: the characteristic function of that set). Importantly, while Nom activates a property described in the lexical entry of a particular noun, the domain predicate Dom denotes a salient property assigned by the context. Dom is thus a silent pronominal expression that denotes a function variable of type <i, <e,t>>. Dom gets its value from the assignment function g[115].

(189) $[\![\text{Nom}]\!]^{g,c}$ = λt_i. λx_e. x is a *nom* at t

(where *nom* stands for a property described by a particular noun)

(190) $[\![\text{Dom}_h]\!]^{g,c}$ = g(*h*) = λt_i. λx_e. x is a *dom* at t

(where *dom* stands for a contextually salient property)

[114] As a function: $[\![\text{NP}_{rest}]\!]^{g}$ = λx_e. x is a noun in/before 1990 & x is present at the reunion in 2010

[115] Alternatively, one could imagine that *Dom* is not a covert domain pronoun, but actually an elided constituent that has the content of a noun (or relative clause) at LF. See Collins (2018) for arguments that at least some cases of domain restriction should be analyzed as syntactic ellipsis. For approaches that employ covert domain variables, see von Fintel (1994), Stanley & Szabó (2000), Stanley (2002), among others.

To derive ET-RT disjointness, the temporal arguments of Nom and Dom must be saturated *before* we combine their meanings compositionally to construct $[\![\text{NP}_{rest}]\!]^{g,c}$. This can be achieved by adopting a system in which each predicate locally combines with a time pronoun (i.e. a silent variable of type i). A DP must then contain at least two time pronouns: A *proET*, whose value determines the evaluation time of Nom, and *proRT*, which fixes the RT of Dom.

(191) $[\![\text{proET}_i]\!]^{g,c}$ = g(*i*) = **ET***
(192) $[\![\text{proRT}_j]\!]^{g,c}$ = g(*j*) = **RT***
(193) $[\![\text{NomP}]\!]^{g,c} = [\![[\text{Nom proET}_i]]\!]^{g,c} = [\![\text{Nom}]\!]^{g,c}([\![\text{proET}_i]\!]^{g,c}) = \lambda x_e$. x is a *nom* at **ET***
(194) $[\![\text{DomP}]\!]^{g,c} = [\![[\text{Dom}_h \text{ proRT}_j]]\!]^{g,c} = [\![\text{Dom}_h]\!]^{g,c}([\![\text{proRT}_j]\!]^{g,c}) = \lambda x_e$. x is a *dom* at **RT***

After combining Nom and Dom with time pronouns, we arrive at two constituents (labeled NomP and DomP, respectively) that each denote functions of type <e,t>. By applying the composition rule of *Predicate Modification* (familiar from Heim & Kratzer 1998 and similar works) to derive the meaning of the node dominating NomP and DomP (i.e. NP*rest*.), we get the desired end result.

(195) *LF for the restrictor argument of determine ers (NPrest.)*

[NP*rest.* [NomP Nom proET*i*] [DomP Dom*h* proRT*j*]]

(196) $[\![\text{NP}_{rest.}]\!]^{g,c} = [\![[[\text{Nom proET}_i][\text{Dom}_h \text{ proRT}_j]]]\!]^{g,c}$
= λx_e. x is a *nom* at **ET*** & x is a *dom* at **RT***

(198) illustrates how this system derives $[\![\text{NP}_{rest}]\!]^{g,c}$ for the example (183).

(197) *LF for the restrictor argument (NPrest.)in (183)*

[NP*rest.* [NomP student proET2] [DomP Dom8 proRT4]]

(198) *Compositional semantics for (183)*

a. $[\![\text{student}]\!]^{g,c} = \lambda t_i. \lambda x_e$. x is a student at t
b. $[\![\text{Dom}_8]\!]^{g,c}$ = g(8) = $\lambda t_i. \lambda x_e$. x is present at the reunion at t
c. $[\![\text{proET}_2]\!]^{g,c}$ = g(2) = **ET*** = in/before 1990
d. $[\![\text{proRT}_4]\!]^{g,c}$ = g(4) = **RT*** = 2010
e. $[\![[\text{student proET}_2]]\!]^{g,c} = [\![\text{student}]\!]^{g,c}([\![\text{proET}_2]\!]^{g,c}) = \lambda x_e$. x is a student in/before 1990
f. $[\![[\text{Dom}_8 \text{ proRT}_4]]\!]^{g,c} = [\![\text{Dom}_8]\!]^{g,c}([\![\text{proRT}_4]\!]^{g,c})$
= λx_e. x is present at the reunion in 2010
g. $[\![\text{NP}_{rest.}]\!]^{g,c} = [\![[[\text{student proET}_2][\text{Dom}_8 \text{ proRT}_4]]]\!]^{g,c}$
= λx_e. x is a student in/before 1990 & x is present at the reunion in 2010
(via Predicate Modification)

The system above derives ET-RT disjointness by introducing two independent DP-internal time pronouns: proET and proRT. I will henceforth call this approach the *two variable solution*. Introducing two silent time variables into the object language seems like a costly way of dealing with ET-RT disjointness. In order to make up for its conceptual baggage, the two variable solution must thus proof its empirical usefulness. There are two important implications that directly follow from a system with independent ET- and RT-pronouns: 1.) Since pronouns can have bound variable readings, we expect to find DP-readings where ET and RT are selectively bound/free. 2.) Since ET and RT are determined by

the value of independently indexed pronouns, the value of ET should not depend on the value of RT, and vice versa. The next two sections explore these predictions.

4.4. The (partial) independence of ET and RT: Bound and free readings

A distinctive property of variables is that they have free (i.e. referential or discourse anaphoric) and bound uses. It has been argued in the past that the ET of a nominal predicate displays all the readings that are characteristic of a variable (see Tonhauser 2021). Examples (181)-(186) already demonstrated ET's ability to be free/unbound, since it refers to a contextually established past time that is not referenced by any expression in the sentences. ET can also receive a bound variable reading, e.g. (199).

(199) Whenever the crew served rotten salmon (on a flight), *a passenger* issued a complaint to the airline a few days later

Relevant Reading (informal description):
∀**t**. where **t** is a time the crew served rotten salmon on a flight: ∃x. where x is a passenger at **t** & x issued a complaint to the airline at a time t' a few days after **t**

Given the existence of free and bound ET-readings, it makes sense to assume at least one DP-internal time pronoun that is involved in the interpretation of ET. Since the two-variable solution relies on a second time pronoun for RT, it makes the prediction that RT should likewise allow free and bound variable uses. More specifically, the two variable approach predicts that we should observe the following four combinations of ET- and RT-readings.

(200) *ET+RT-readings predicted by the two-variable solution*

a.) Bound RT + Free ET
b.) Bound RT + Bound ET
c.) Free RT + Free ET
d.) Free RT + Bound ET

Let us first look for evidence that RT can receive a bound variable reading. Consider (201)[116].

[116] The examples have been tested for German. English translations are always given right below the German examples. For English, the judgements have not yet been systematically elicited. However, first trials indicate that the English counterparts behave similar to the German examples. If this is the case for all examples remains to be seen and any empirical claim made here should (for now) be viewed as a claim about German. Still, the reader can consider the English translation in parallel to the German examples, since preliminary evidence lets me suspect they will allow similar judgements.

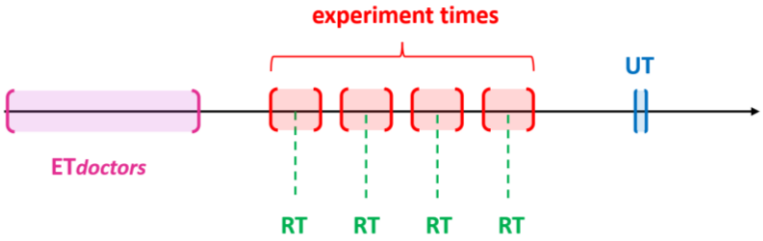
(201) Immer wenn Prof. K ein Experiment durchgeführt hat, ist *jeder Arzt* bewusstlos geworden
always when Prof. K an experiment conducted has, is *every doctor* unconscious became
'Whenever Prof. K conducted an experiment, *every doctor* fainted.'

Bound RT + Free ET (informal description)

∀**t**. where **t** is a time when Prof. K conducted an experiment: ∀x. where x was a doctor in **1990** & x was a participant at **t**: x fainted at **t**

Context

Between 2000 and 2005, Prof. K conducted several experiments. For each experiment, he randomly selected his participants from a pool of former doctors and lawyers (Prof. K was only interested in individuals that had been doctors or lawyers in 1990, but who were fired for professional misconduct before the year 1992). At each experiment, all participants that were former doctors fainted (The former lawyers did not for some reason).



Given the context, RT covaries with the time of the experiment. The experiment in 2000 used a different (randomly selected) set of participants than the experiment in 2003, which used yet a different set of participants than the experiment in 2005 etc. The implicit domain restriction (or specifically, RT) seems to be bound by the universal quantifier over times that is introduced by the antecedent whenever-clause[117]. Importantly, the ET of the nominal predicate is provided contextually (i.e. it is free): The set

[117] In some theories of implicit domain restrictions, it is assumed that a covert domain variable takes an individual variable as an argument in order to allow for cases of bound readings (e.g. von Fintel 1994: 31, who attributes the example in (i) to Irene Heim).

(i) Only one class was so bad that *no student* passed the exam.
Roughly: 'Only one class x was so bad that *no student in class x* passed the exam'

A time variable is usually not assumed in these theories. One might thus wonder whether the bound reading of the implicit domain restriction in (201) might be a case of a bound individual variable. Presumably, this would mean that the variable must be bound by the indefinite "ein Experiment" ("an experiment"). Since the indefinite takes scope inside the whenever-clause (and therefore does not c-command the variable inside "jeder Arzt" ("every doctor")), this would mean that the reading is not a straightforward case of binding, but a donkey anaphoric reading. I see no reason to adopt this option over the (possibly simpler) assumption that (201) involves non-donkey anaphoric binding of time (or situation) variables. Moreover, examples like (ii) might be difficult to account for on the basis of individual variables alone, since the sentence contains no obvious antecedent that could bind an individual variable.

of doctors is determined at the contextually salient past interval [1990] and does not covary with the time of the experiment. We thus end up with the reading: For all times t at which Prof K conducted an experiment, the individuals that were both *doctors in [1990]* and *participants at t*, fainted at t. Crucially, this indicates that RT has an independent life from ET, since it can be selectively bound without necessarily affecting the value of ET.

Example (23) illustrates the Bound RT+Free ET-Reading for singular definites[118].

(202) Immer wenn das Parlament eine Gedenkfeier für die Kriegsgefallenen veranstaltet hat, hat *der Soldat* eine kritische Rede gehalten
always when the parliament a commemoration for the fallen hosted has, has *the soldier* a critical speech held
'Whenever the parliament hosted an event commemorating the casualties of war, *the soldier* gave a critical speech.'

Bound RT + Free ET (informal description)

∀**t**. where **t** is a time when the parliament hosted an event commemorating the war: the unique individual that was a soldier **in 1950** & that was invited to the commemoration event at **t** gave a critical speech at **t**

Context

In 1950, the nation B. was involved in a short but devastating war. In the years 2000, 2010, and 2020, the parliament of B. organized an event commemorating the casualties of the war. At each of the three commemoration events, they invited a former soldier from the time of the war to give a speech. Each time they invited a different veteran, and each time the veteran gave a speech criticizing B.'s government.

Next, consider (203).

(ii) Immer wenn Prof K gesungen hat, ist *jeder Arzt* bewusstlos geworden.
always when Prof K sang has, is every doctor unconscious became
'Whenever Prof K sang, *every doctor* fainted.'

Context
The same context as in (23), but assume that each of Prof K's experiments involved him singing at some point. The goal of the experiment was to observe the participant's reaction to Prof K's singing. It so happens that every individual that was a former doctor and participated fainted as a consequence of hearing Prof K sing.

[118] Parallel examples could be constructed for other determiners.

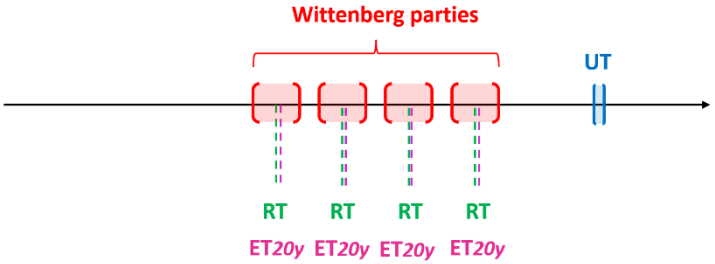
(203) Immer wenn Familie Wittenberg ein Fest gefeiert hat, hat *jeder 20-Jährige* eine Gans erschossen
always when family Wittenberg a fest celebrated has, has *every 20-year-old* a goose shot
'Whenever the Wittenberg family hosted a party, *every 20-year old* shot a goose'

Bound RT+Bound ET-Reading (informal description)

∀**t**. where **t** is a time when the Wittenberg family hosted a party: ∀x. where x was a 20-year old at **t** & x was a guest at **t**: x shot a goose at **t**

Context

Over the last 150 years, the Wittenberg family (a rich, aristocratic family) hosted annual parties, where it was custom for every 20-year old guest (i.e. guests who were 20-years old at the time of the party) to shoot a goose.



In example (203), the set of 20-year old's varies with each year of the festivities, creating a bound-ET reading. Notice that in the relevant reading, it is also the case that RT is bound. RT presumably helps to pick out the set of guests that are present at each party[119], which, for the first and the last gathering (which are 150 years apart), will be a completely different set of individuals[120]. The result is a reading where both RT and ET are bound (the *Bound RT+Bound ET-Reading*).

[119] That is, we are not talking about 20-year old servants at t. Indeed, (24) is perfectly fine in a context where the serving staff at each party included 20-year old butlers who (since they are not guests) were excluded from the individuals that were supposed to shoot a goose at t. This highlights the independent contribution of the implicit domain restriction even in cases where RT and ET denote the same time.

[120] Instead of a Bound RT+Bound ET-reading, one could consider an alternative where RT is free and picks out the salient interval of the past 150-years, e.g. [1870-2020]. When ET is bound (i.e. the set of 20-year old's covaries with the time of the party), the Bound RT+Bound ET-reading would intersect the 20-year old's at each party time t with the set of party guests from that time t and claim of every individual in the resulting set that they shot a goose at t. The Free RT+Bound ET-reading, on the other hand, would intersect the set of 20-year olds at t with the set of all individuals that, at some time between [1870-2020], were party guests of the Wittenberg's and claim that every individual in the resulting set shot a goose at t. Are these two readings equivalent? Not quite. Imagine an individual (call him Gustav) that was 20 in 1930, but that was first invited to a Wittenberg-party in 1935 (i.e. when he was 25). Given the Wittenberg traditions, Gustav was never required to shoot a goose since he was never a 20-year old guest when he was at one of their parties. However, this is only captured by the Bound RT+Bound ET-reading. The Free RT+Bound ET-reading would have to include Gustav among the people that shot a goose in 1930 since he fulfills the necessary requirements: He was 20-years old in 1930 and he was a Wittenberg party guest at some point between [1870-2020]. There is an important caveat to the arguments presented here: It is not clear whether the same distinction between the Bound RT+Bound ET-reading and the Free RT+Bound ET-reading can be drawn once we replace time variables with situation variables. For the bound ET-reading, this would presumably mean that the nominal predicate only picks out those 20-year old's that are present in the party-situation s (and not all 20-year old's of a given time, regardless of their involvement in a particular party-situation). For Gustav, this would mean that the Free RT+Bound ET-reading could suddenly make the right prediction: Even if he is 20-year old in 1930, he is not among the 20-year old's in the party-situation of 1930. Thus, he is no longer asserted to shoot a goose in 1930.

We also find readings where both ET and RT appear to be free.

(204) Immer wenn Valentin in den Jahren 2005-2010 ein Fest gefeiert hat, waren *die Minister* (alle) betrunken
always when Valentin in the years 2005-2010 a party celebrated has, were *the ministers* (all) drunk
'Whenever Valentin hosted a party in the years 2005-2010, *the ministers* were (all) drunk.'

Free RT+Free ET-Reading (informal description)

∀**t**. where **t** is a time when Valentin hosted a party in the years 2005-2010: ∀x. where x was a passenger on the plane **in 2019** & x was a minister **in 2019**: x was drunk at **t**

Context

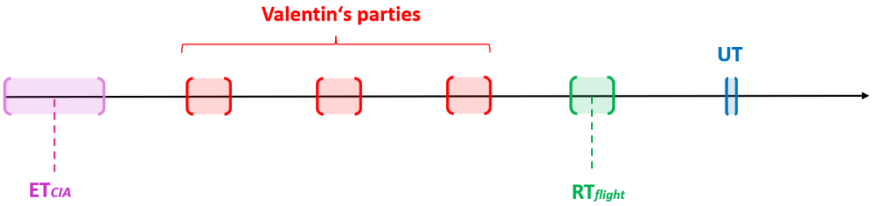
Between the years 2005 and 2010, Valentin hosted several parties for the rich and powerful, which included mayors, ministers, CEOs, among others. Archibald, Karl, Magnus, and Julius were present at each of Valentin's parties. Back then, the four of them were still young members of parliament. In 2018, they each became a minister in the newly formed government. In 2019, while on a plane to Paris, a passenger records a conversation between the four ministers and two ambassadors in which they make racist comments about the prime minister. When the recording is leaked and the four politicians have to resign, Augustus is not shocked, since he knows their behavior from meeting them at Valentin's parties. He says: "I would have never thought that the ambassadors would be racist. However, I'm not shocked by the others on that plane. Whenever Valentin hosted a party I attended, *the ministers* were (all) drunk. And they are always like this when they are drunk."

In (204), neither ET nor RT covaries with the time of Valentin's parties. Instead, (204) is about individuals that were ministers on some (contextually referenced) flight a few years after Victor's last party took place. In this example, ET and RT overlap. One might wonder whether the Free RT+Free ET-Reading also allows ET and RT to be temporally disjoint. The answer seems to be yes. Consider (205).

(205) Immer wenn bei Valentins Party jemand vergiftet wurde, war *jeder CIA-Agent* unter den Gästen
always when at Valentin's party someone poisoned was, was *every CIA-agent* among the guests
'Whenever someone was poisoned at one of Valentin's parties, *every CIA-agent* was among the guests.'

Free RT+Free ET-Reading (informal description)

∀**t**. where **t** is a time when someone was poisoned at one of Valentin's parties: ∀x. where x was a passenger **in 2013** & x was a CIA-agent **in the 1990s:** x was among the guests at **t**



Context

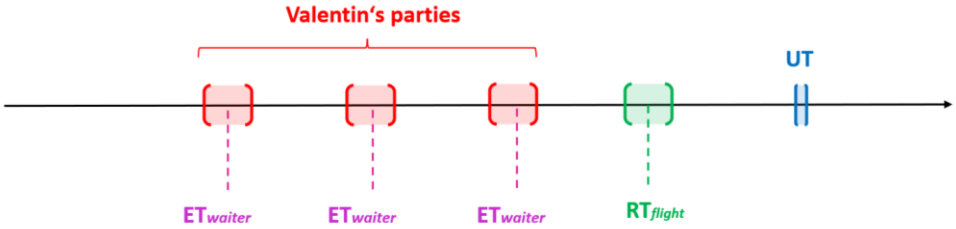
Between the years 2005 and 2010, Valentin hosted several parties for the rich and powerful. At three of these parties, a guest was poisoned. Larissa and Hannah are investigating the incidents. In 2015, the evidence suggests that, in 2013, the culprits must have been on a flight on Valentin's private jet. Incidentally, several passengers on that flight attended one of Valentin's parties in the past. However, three passengers stand out: Brad, Bill, and Tom were CIA-agents in the 1990s who had left the CIA by the early 2000s under suspicious circumstances. While it was not uncommon to find several former and active CIA agents at Valentin's parties (In fact, there were a dozen of former CIA-agents present at each party), Brad, Bill and Tom were in attendance at all parties where someone was poisoned. Larissa asks Hannah which passengers she finds most suspicious. She answers: "Not every passenger on the flight was at a party where someone was poisoned. However, what seems to be the case is this: *Whenever someone was poisoned at one of Valentin's parties, every CIA-agent was there.*"

Finally, let us consider the Free RT+Bound ET-Reading in (206).

(206) #Immer wenn Valentin in den Jahren 2008-2010 eine Party gefeiert hat, hat *jeder Kellner* ein Getränk vergiftet
always when Valentin in the years 2008-2010 a party celebrated has, has *every waiter* a drink poisoned
'Whenever Valentin hosted a party in the years 2008-2010, *every waiter* poisoned a drink.'

Free RT+Bound ET-Reading (informal description)

∀**t**. where **t** is a time when Valentin hosted a party in the years 2008-2010: ∀x. where x was a passenger **in 2013** & x was a waiter at **t**: x poisoned a drink at **t**



Context

Between the years 2008 and 2010, Valentin hosted three parties. At these parties, guests were poisoned. Larissa and Hannah investigate the incidents. In 2015, they get an anonymous tip that the culprits have been passengers on a flight in 2013. On that flight, several people are associated with Valentin's parties, either as a guest or as a member of the catering staff. Among them are Joe, Will, Jonathan, and Henry. Joe was a waiter at party 1 and 2, Will was a waiter at party 1, 2 and 3, Jonathan was a waiter at party 1 and 3, and Henry was a cook at party 3. From a different source, Larissa gets the following information:

- **Joe** poisoned a drink at Party 1 and 2
- **Will** poisoned a drink at Party 1, 2 and 3
- **Jonathan** poisoned a drink at Party 3

The list of waiters at each party:
- Waiters at Party 1: **Joe, Will, Jonathan,** Chris, Leonard
- Waiters at Party 2: **Joe, Will**, Chris, Bill
- Waiters at Party 3: **Will, Jonathan**, Bill, Thomas

Larissa shows this information to Hannah and concludes: "This information narrows down the list of passengers from that flight to the most likely suspects, since we now know: #Whenever Valentin hosted a party, *every waiter* poisoned a drink"

As (206) illustrates, judgements on the Free RT+Bound ET-Reading rely on a lot of contextual information, which makes it hard to test. Indeed, the judgements elicited for this reading have been less consistent than for other RT+ET-readings. Even though it is possible that later testing might call the result into question, the tests so far have indicated that the Free RT+Bound ET-Reading is not available (at least for native speakers of German). To further demonstrate this, let us look at another (similar) example involving a singular definite.

(207) #Immer wenn Valentin in den Jahren 2008-2010 eine Party gefeiert hat, hat *der Kellner* ein Getränk vergiftet
always when Valentin in the years 2008-2010 a party celebrated has, has *the waiter* a drink poisoned
'Whenever Valentin hosted a party in the years 2008-2010, *the waiter* poisoned a drink.'

Free RT+Bound ET-Reading (informal description)

∀**t**. where **t** is a time when Valentin hosted a party in the years 2008-2010: the unique x where x was a passenger **in 2013** & x was a waiter at **t:** x poisoned a drink at **t**

Context

Same context as in (206), but Larissa gets the slightly different information below:

- **Joe** poisoned a drink at Party 1
- **Will** poisoned a drink at Party 2
- **Jonathan** poisoned a drink at Party 3

The list of waiters at each party:
- Waiters at Party 1: **Joe,** Chris, Leonard
- Waiters at Party 2: **Will**, Chris, Bill
- Waiters at Party 3: **Jonathan**, Bill, Thomas

Larissa shows this information to Hannah and concludes: "This piece of information narrows down the list of passengers from that flight to the most likely suspects, since we now know: #Whenever Valentin hosted a party, *the waiter* poisoned a drink."

Assuming a standard semantics for definites that is based on a uniqueness condition, (207) should be able to express the Free RT+Bound ET-Reading: Since Joe, Will, and Jonathan were waiters at different parties, it is the case that there is a unique individual at each party time t that was a waiter at t *and* a passenger on the flight in 2013. Based on the judgements that I have elicited, this reading is not acceptable for the sentence in (207). With the caveat that this conclusion might turn out to be premature, I therefore assume the generalizations in (208) and (209).

(208) *No Free RT+Bound ET-Reading*

The evaluation time (ET) of a noun cannot receive a bound variable reading if the resource time (i.e. the time of the implicit domain restriction of the same DP) receives a free reading (or equivalently: RT cannot be free if ET is bound).

(209) (*Partial) independence of ET and RT w.r.t. bound variable behavior (Bound RT+Free ET)*

The resource time (RT) of a DP's implicit domain restriction can have a bound variable reading when the evaluation time (ET) of the DP's noun is free.

The absence of the Free RT+Bound ET-Reading is unexpected under the two variable solution. Since the predicted independence of ET and RT is only partial when it comes to binding, we need to ask if we can find other cases where the independence of ET and RT breaks down. Specifically, since time is a inherently relational concept, we may ask if there are any restrictions when it comes to possible temporal relations between ET and RT. This issue is explored in the next section.

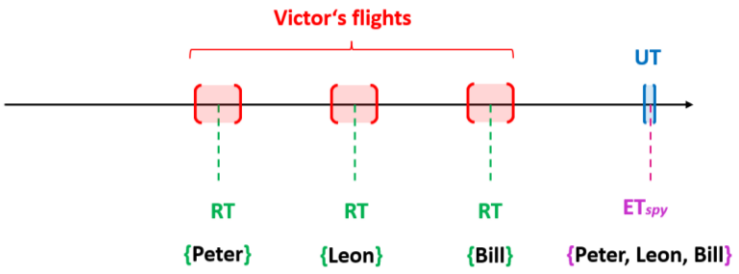
4.5. The (partial) dependence of ET and RT: DP-internal temporal relations

Times are inherently ordered in relation to other times. There are three possible relations a given time interval T1 can have in relation to another time interval T2: *Anteriority* (T1<T2), *overlap*[121] (T1oT2), and *posteriority* (T1>T2). If the two variable solution is correct, the ordering between ET and RT should be unrestricted since each time is derived by the independent indexing of a time pronoun. Considered from the perspective of ET, we have already seen instantiations of two temporal relations: Anteriority (ET<RT, e.g. (181)-(186), (201), (202), (205)) and overlap (ETоRT, e.g. (203), (204)). So far, we have not seen an example for the relation ET>RT (or equivalently: RT<ET). One way to clearly bring out the ET<RT-relation is to bind RT to a time in the past of ET. We can thus use the Bound RT+Free ET-Reading as a testing ground.

(210) #Immer wenn Victor mit seinem Privatflugzeug geflogen ist, hat *der Spion* den Kommunismus verteufelt
always when Victor with his private-jet flew is, has *the spy* the communism demonized
'Whenever Victor flew on his private jet, *the spy* condemned communism.'

Bound RT + Free ET (informal description), where RT<ET

∀**t**. where **t** is a time when Victor flew on his private jet: the unique x where x is a spy **in 1988** & x was a passenger on Victor's plane at **t**: x condemned communism at **t**



Context

In 1988, a CIA agent reports on his recruitment of spies: "Between 1975 and 1978, we had bugs installed on the private jet of a wealthy man named Victor. The individuals that Victor invited on his plane were influential and well-connected, so the CIA was interested in recruiting them as spies in the future. A curious thing about Victor was that he never invited the same guest twice, so there were always different people on his plane. When listening to the recordings, I was looking for someone who would be ideologically aligned with me. Indeed, at each of the flights I listened in, there was one individual that stood out to me because he condemned communism. After about ten years of slow persuasion, each individual that condemned communism had indeed become a spy for the CIA. In fact, every one of them is now a very capable spy for our agency. So, you are wondering how I decided which person to recruit? Well, the essence is this: #Whenever Victor flew on his private jet, *the spy* condemned communism."

[121] Including identity (i.e. T1=T2)

(211) #Immer wenn Prof K ein Experiment durchgeführt hat, ist *jeder Arzt* eingeschlafen.
always when Prof K an experiment conducted has, is *every doctor* fell-asleep
'Whenever Prof K conducted an experiment, every doctor fell asleep.'

Bound RT + Free ET (informal description), where RT<ET

∀**t**. where **t** is a time when Prof K. conducted an experiment: ∀x. where x is a doctor **in/after 2010** & x was a participant at **t**: x fell asleep at **t**

Context

Between the years 1990-1993, Prof. K conducted several experiments with children (age 5-8). Every child that would later (i.e. after the year 2010) become a doctor, fell asleep while it was a participant at one of the experiments. Specifically, the following is the case.

- Children in 1990-1993 that became doctors as adults: **Mike, Tom, Bill, Chris, George, Herbert, Bernd**
- Participants at Experiment 1 (in 1990): **Mike, Bill**, Steve, Leon, Greg, … .
- Fell asleep at E1: **Mike, Bill**, Steve
- Participants at E2 (in 1991): **Tom, Chris, George**, Ludwig, Karl, … .
- Fell asleep at E2: **Tom, Chris, George**
- Participants at E3 (in 1992): **Herbert**, **Mike**, **Bernd**, Michael, … .
- Fell asleep at E3: **Herbert**, **Mike**, **Bernd**
- Participants at E4: (in 1993): **Bill, Herbert,** Ludwig, Stefan, … .
- Fell asleep at E4: **Bill, Herbert,** Ludwig, Stefan

In 2023, a student of Prof K conducts a follow-up study, in which she tries to find out about long-term effects on the participant's future. Finding out about the occupation of the participants, she notes to herself: "#Whenever Prof. K conducted an experiment, *every doctor* fell asleep"

The context in (211) aims to bring out a reading in which a.) RT is bound to the past times of Victor's flights (i.e. the unique individual that condemned communism covaries with the time of the flights) and b.) ET is free and into the future of RT (i.e. each individual condemning communism at RT becomes a spy only later on). Since at each flight, there is always a unique individual that condemned communism and became a spy in the future, this reading should be possible. However, although the judgements are difficult and should not be taken at face value, (211) seems considerably worse to most informants when compared to similar cases in which the temporal relation is reversed (i.e. ET<RT, as in (201)-(202)). (212) tries to force the same reading for a universal quantifier. Consider now simpler cases where RT is bound to the tense time. Let us compare the two contexts, where one tries to bring about the ET<RT-reading and the other the RT<ET-reading.

(212) Bei einem Flug im Jahr 2005 wurde *jeder CIA-Agent* verwundet
on a flight in year 2005 was *every CIA-agent* injured
'On a flight in the year 2005, *every CIA-agent* was injured'

ET<RT-context

10 years after their retirement, a few former CIA-agents and a few former FBI-agents fly to Washington where they plan to take part in a ceremony that is organized in honor of their years of service. As a consequence of severe turbulences on their flight to Washington, all former CIA-agents suffer minor injuries. The former FBI-agents remain unharmed.

#RT<ET-context

In the year 2005, a plane gets hijacked. Several passengers were injured, but in the end, the hijackers were fought down. Four young passengers (who each suffered minor injuries on the flight) were inspired by the incident to pursue a career in the CIA. By 2020, all four of them work as agents for the CIA.

The implicit content associated with RT is hard to control without the covarying reading that we get from binding with a whenever-clause. Therefore, one needs to be careful to not accidentally shift RT to the utterance time or some other time that is different from the time of the flight-situation in 2005. Indeed, the #RT<ET-context is likely compatible with other implicit domain restrictions that pick out the relevant CIA-agents without relying on a RT<ET-relation (e.g. "every individual x where x is a CIA-agent at the utterance time and x *is talked about at the utterance time*"). It is hard to see how to overcome this issue without relying on some mechanisms that gives the target RT-reading an intuitively distinct character from context-compatible alternatives (e.g. by giving RT a covarying reading via binding). However, I believe once the competing readings are neglected and the focus is given to the target reading (i.e. "every individual x where x is a CIA-agent at the utterance time and x *was a passenger on the plane in 2005*"), it can be seen that the RT<ET-relation is unavailable for (212) as well. Unfortunately, the nature of the examples makes it difficult to demonstrate this conclusively. Next, we can change the sentence slightly to bring about ET<RT/RT<ET-readings in which both RT and ET are distinct from the main clause tense time (i.e. we get a Free RT+Free ET-reading).

(213) Bei der Zeremonie am 8.July trug *jeder CIA-Agent* einen Gips
at the ceremony on 8th.July wear *every CIA-agent* a cast
'At the ceremony on July 8th, *every CIA-agent* wore a cast.'

ET<RT-context

10 years after their retirement, a few former CIA-agents and a few former FBI-agents fly to Washington (date of the flight: July 3rd, 2005) where they plan to take part in a ceremony (date of the ceremony: July 8th, 2005) that is organized in honor of their years of service. As a consequence of severe turbulences on their flight to Washington, all former CIA-agents on the plane suffer injuries. They each have to attend the ceremony wearing a cast. Other former CIA-agents that are present at the ceremony arrived by train and did not get injured.

Intended reading: Free RT + Free ET, where ET<RT (available)

∀x. where x is a CIA-agent in/before 1995 & x was on the plane to Washington on July 3rd, 2005: wore a cast at the ceremony on July 8th, 2005

#RT<ET-context

In the year 2005, a plane gets hijacked (date of the flight: July 1st, 2005). Several passengers were injured, but in the end, the hijackers were fought down. Four young passengers (who each suffered injuries that had them wear casts for the next six weeks) were inspired by the incident to pursue a career in the CIA. By 2020, all four of them work as agents for the CIA. A week after the incident in 2005, the four young passengers attend a ceremony that is held in honor of the people that got killed during the attack (Also in attendance: several CIA-agents).

Intended reading: Free RT + Free ET, where RT<ET (not available)

∀x. where x is a CIA-agent in/after 2020 & x was on the plane to Washington on July 1st, 2005: x wore a cast at the ceremony on July 8th, 2005

In (213), the judgements for the (attempted) Free RT+Free ET-readings are compromised by the same issues that plagued (212). Taken together, the examples (210)-(213) nevertheless give the overall indication that the relationship between ET and RT is subject to a restriction that prohibits RT<ET-relations. Without examples that show the contrary, I will thus assume the restriction in (214).

(214) **RT<ET* or *No RT<ET-disjointness*

The ET of a DP's noun cannot be a time that is both disjoint and into the future (i.e. posterior) to the DP's RT

Since the restrictions we have seen in this and the last section do not follow from the two variable solution, we will need to rethink our analysis of DP-internal temporality. However, first we need to deal with some theoretical issues that are raised by ET-RT disjointness.

4.6. Further considerations

To summarize the results up to this point, the two variable solution to ET-RT disjointness is too powerful, since it predicts that the values of a DP's ET and RT should not depend on each other. The previous sections have tried to demonstrate that there are limits to the independence of ET and RT: First, a bound variable reading of ET seems to be conditioned on RT-binding (*No Free RT+Bound ET-Reading*). Second, ET-RT-disjointness is limited to ET<RT-relations (**RT<ET* or *No RT<ET-*

disjointness). Considering these challenges, we have arrived at a point where we need an approach that introduces a closer connection between ET and RT. But before we look at potential alternatives to the two-variable solution, there are some additional consequences of ET-RT disjointness that are worth discussion.

First, it is worth pointing out that ET-RT disjointness may pose a challenge for theories of situation pronouns (e.g. Schwarz 2012; Elbourne 2013; Kratzer 2021). It is widely assumed in these approaches that DP's contain a single situation pronoun. A major appeal of situation theories is that a single DP-internal situation pronoun is used to account for a range of seemingly disparate phenomena. In particular, the situation pronoun is supposed to take care of both the DP's implicit domain restriction and the (world and time) evaluation of the noun. The idea is that a DP such as "every student" roughly translates to 'Every individual that is a student in *s*', where the situation *s* is contributed by the situation pronoun and no further device of domain restriction is needed. Without further assumptions, this predicts that the implicit domain restriction and the noun's modal/temporal-evaluation should always rely on identical temporal and modal values (After all, their time and world information is based on information provided by the same situation pronoun). It is apparent that this prediction clashes with ET-RT disjointness: The situational information that goes into determining the implicit domain restriction (i.e. the resource situation) can be temporally disjoint from the situational information that determines a noun's evaluation (i.e. the evaluation situation). Since spatiotemporal contiguity is presumably a prerequisite for assigning a situation status to parts of a world[122], ET-RT disjointness cannot be derived by a single situation pronoun[123]. Of course, nothing prevents us from adopting a two variable-version of a situation pronoun theory. However, by employing two independent situation pronouns and thereby giving up on any connection between nominal evaluations and domain restrictions, the situation pronoun theory would lose much of the conceptual advantage that made it an attractive theory in the first place.

There is another result from the literature that might be challenged by ET-RT disjointness. Namely, ET-RT disjointness contradicts a well-established generalization on the evaluation of intersecting predicates: the *Intersective Predicate Generalization* (see Keshet 2008, 2010).

(215) *Intersective Predicate Generalization (IPG)*

> Two predicates interpreted intersectively may not be evaluated at different times or worlds from one another.
>
> (Keshet 2010: 388)

The IPG was formulated based on the observation that sentences such as (216) cannot have the meaning in (217).

[122] See von Fintel (1997) for ideas on how to count situations.

[123] At least as long as we assume that the evaluation of a predicate is *directly* established by the situation pronoun and not via additional situational information that is related to the situation pronoun. See the next section for discussion.

(216) #In 1984, *the professor in kindergarten* learned how to fingerpaint.

(Keshet 2010: 390)

(217) The unique individual x so that x is a *professor at the utterance time (2023)* & x was in kindergarten in 1984 learned how to fingerpaint in 1984

Ignoring worlds, the IPG claims that the evaluation times of two intersecting predicates (i.e. predicates that are composed via Predicate Modification) *cannot* be temporally disjoint. Since we assumed that the implicit domain restriction is essentially a predicate that is intersected with the noun, ET-RT disjointness is a generalization that stands in polar opposition to the IPG: It claims that two intersecting predicates *can* be evaluated at two disjoint times. How do we resolve this conflict? A potential solution would be to propose a different analysis for implicit domain restrictions in which they do not intersect with the noun. One could implement this by assuming that a determiner takes the implicit restriction and the nominal predicate as two separate restrictor arguments. For instance, a quantificational determiner such as "every" would then denote a function of type <<e,t>,<<e,t>,<<e,t>,t>>>, where the first two <e,t>-type arguments are saturated by the noun and the implicit domain restriction, respectively. This would mean that the domain restriction and the noun never intersect (at least not in a direct, compositional way via the application of Predicate Modification), and IPG would not be violated[124]. I have nothing to say against an approach where a noun and the implicit domain restriction are independently selected by the determiner[125]. However, I will propose instead that the conflict can be remedied by clarifying the meaning of the phrase "evaluated at different times" as it is used in the formulation of the IPG in (215). For this, I will use the slightly modified formulation in (218)[126].

(218) *(Revised) Intersective Predicate Generalization*

Two predicates which are combined via Predicate Modification must share their time (and world) argument.

In essence, (218) forces Predicate Modification to apply to two predicates of type <i,<e,t>> in contrast to the standard (extensional) version, which applies to <e,t>-type functions.

[124] Note, however, that the two predicates still intersect in a looser sense. Whatever the determiner meaning specifies for its two restrictor arguments will likely involve the intersection of the two predicate sets, because it is the intersection that derives the final domain of the determiner. This solution is thus only a solution as long as the IPG is specifically about the composition principle Predicate Modification. Keshet (2008, 2010) seems to assume that this is the case.

[125] In the literature on domain restriction variables, there has been a lively debate on whether the domain restriction comes in with the determiner (e.g. von Fintel 1994, Schwarz 2012, Feinmann 2022) or with the noun (e.g. Stanley & Szabó 2000, Stanley 2002). Here, I will not commit to one position or the other. In order to keep the discussion of determiner meanings general, I will stick to the familiar approach that builds a determiner's restrictor by first intersecting the implicit domain restriction predicate directly with the noun. However, I believe that the analysis outlined in the next section (the one-variable solution) can be straightforwardly translated into a system that separately combines nouns and implicit domain restrictions with determiners.

[126] O'Leary (2022) develops a proposal that is very similar to the one presented in this and the next section. O'Leary calls this revised version of the IPG the *Input-Based Intersective Predicate Generalization* (IBIPG, see O'Leary 2022: 101). The IBIPG essentially forces two intersecting predicates to share their semantic time argument, just like (218). Interestingly, O'Leary's approach is partly motivated by the observation that a noun and an intersecting noun-modifier can (under certain circumstances) show temporal disjointness.

(219) *Predicate Modification* (PM, intensional version)

If α is a branching node and {β, γ} is the set of α's daughters, and $[\![\beta]\!]^{g,c}$ and $[\![\gamma]\!]^{g,c}$ are both of type <i,<e,t>>, then $[\![\alpha]\!]^{g,c} = \lambda t_i.\ \lambda x_e.\ [\![\beta]\!]^{g,c}(t)(x)\ \&\ [\![\gamma]\!]^{g,c}(t)(x)$

Applying this to our example analysis from earlier (which analyzed example (183)), the nominal predicate and the domain predicate would have to compose via Predicate Modification before their time arguments are saturated by a time pronoun. Only a single time pronoun (I will call it proResT, where ResT stands for *restrictor time*) could then apply to saturate the shared time argument.

(220) *Compositional semantics for (183)*

a. $[\![\text{student}]\!]^{g,c} = \lambda t_i.\ \lambda x_e.$ x is a student at t
b. $[\![\text{Dom}_8]\!]^{g,c} = g(8) = \lambda t_i.\ \lambda x_e.$ x is present at the reunion at t
c. $[\![[\text{student Dom}_8]]\!]^{g,c} = \lambda t_i.\ \lambda x_e.$ x is a student at t & x is present at the reunion at t (via PM)
d. $[\![\text{proResT}_5]\!]^{g,c} = g(5) =$ **ResT***
e. $[\![\text{NP}_{rest.}]\!]^{g,c} = [\![[[\text{student Dom}_8]\ \text{proResT}_5]]\!]^{g,c} = [\![[\text{student Dom}_8]]\!]^{g,c}([\![\text{proResT}_5]\!]^{g,c})$ $= \lambda x_e.$ x is a student at **ResT*** & x is present at the reunion at **ResT***

By adhering to (218), we are effectively forced to adopt a theory that is akin to the situation pronoun theory in that one pronoun takes care of the temporal (or situational) dimension of both the noun and the implicit domain restriction. Of course, we are still stuck with our original conflict: Although this system derives the IPG, it does not derive ET-RT disjointness. Still, I argue that the one variable approach is superior to an approach with two variables. The goal of the next section will be to show that, with certain modifications, the one variable approach can derive ET-RT disjointness. That is, instead of deriving ET-RT disjointness by blocking time argument-sharing between the two predicates, I will adopt a strategy that achieves ET-RT disjointness by increasing the temporal complexity of predicate denotations. In addition to preserving a closer connection between implicit domain restrictions and the evaluation of nominal predicates (and thereby upholding the IPG), the resulting *one variable solution* will also derive the restrictions on possible ET-RT-relations that are not covered by the two variable solution.

4.7. A one variable solution?

Kusumoto (2005) first observed that the evaluation time of a noun cannot be (exclusively) determined by a time pronoun. The idea that the ET of a noun is the value of a time pronoun goes back to Enç (1981, 1986) who famously showed that the only coherent reading of (221) is one where the ET of *fugitive* is a contextually salient time in the past of the tense time.

(221) *Every fugitive* is now in jail

Coherent Reading

∀x. where x is a fugitive at a contextually salient time before the utterance time: x is in jail at the utterance time

For Enç, the fact that ET could be established contextually (as well as anaphorically) meant that ET is contributed by a referential time (pronoun). However, Kusumoto noticed that (221) can be used to talk about five individuals that were fugitives at different times in the past (and who are now in jail). Kusumoto concluded that ET could not be the contextually assigned value of a time pronoun, since the value of a pronoun would not vary with each individual[127]. To make sure that the individuals in the domain of *every* can be fugitives at different times, she proposed (like Musan 1995) that ET is existentially quantified. Then again, if we simply assumed that ET is existentially quantified, we would have trouble accounting for the fact that ET can receive bound variable readings. Accordingly, recent proposals (e.g. Schwarz 2012; Tonhauser 2021; O'Leary 2022) have assumed that the temporal evaluation of a noun is determined by the interaction of two times, one being introduced by an existential quantifier, the other being the value of a time pronoun that is restricting the domain of the existential quantifier. Adopting this strategy, I assume the following lexical entry for a nominal predicate.

(222) $[\![\text{Nom}]\!]^{g,c} = \lambda t_i.\ \lambda x_e.\ \exists t'\ [t'\ o\ t\ \&\ x \text{ is a } \textit{nom} \text{ at } t']$

(where *nom* stands for a property described by a particular noun and o expresses the relation of temporal overlap)

This now raises the question of whether the implicit domain restriction likewise introduces existential quantification over RT. Since the properties described by implicit domain predicates are hard to pin down exactly, this question is not easy to answer. However, at least for the implicit domain restriction that we assumed in the examples (181)-(186) (i.e. "x was present at the reunion in RT"), a similar treatment seems necessary. We probably do not want to restrict the domain of the determiners to individuals that were present *throughout* the whole duration of the reunion (RT), since the individuals at the reunion might arrive and leave at different times. For this reason, I will assume an existential quantifier over times as part of the denotation of domain predicates as well.

(223) $[\![\text{Dom}_h]\!]^{g,c} = g(h) = \lambda t_i.\ \lambda x_e.\ \exists t'\ [t'\ o\ t\ \&\ x \text{ is a } \textit{dom} \text{ at } t']$

(where *dom* stands for a contextually salient property)

Following the IPG, the next step in building the restrictor NP*rest* involves combining Nom and Dom*h* via Predicate Modification, which results in time argument sharing between Nom and Dom*h*.

(224) $[\![[\text{Nom Dom}_h]]\!]^{g,c} =$
$= \lambda t_i.\ \lambda x_e.\ [\exists t'\ [t'\ o\ t\ \&\ x \text{ is a } \textit{nom} \text{ at } t']]\ \&\ [\exists t''\ [t''\ o\ t\ \&\ x \text{ is a } \textit{dom} \text{ at } t'']]$

In order to arrive at the right type for the restrictor argument (<e,t>), the time argument of (224) must be saturated by combining it with a time pronoun proResT.

[127] Note that this argument presupposes that for an individual x to be a fugitive at t means that x is a fugitive *throughout* t. However, if to be a fugitive at t would mean that x must merely be a fugitive at some subinterval of t, then (provided that the time interval it denotes is sufficiently large) a time pronoun alone could supply the value of ET even when face a situation where the relevant individuals have the noun property at different times. See Schwarz (2012) for a comment on this issue.

(225) $[\![\text{NP}_{rest.}]\!]^{g,c} = [\![[\text{Nom Dom}_8]\ \text{proResT}_5]]\!]^{g,c} = [\![[\text{Nom Dom}_8]]\!]^{g,c}([\![\text{proResT}_5]\!]^{g,c}) =$
$= \lambda x_e.$ [∃t' [t' o **ResT*** & x is a *nom* at t']] & [∃t'' [t'' o **ResT*** & x is a *dom* at t'']]

So far, we arrive at a result that upholds (some version of) the IPG. Moreover, (225) derives the fact that both ET and RT can receive bound variable readings. Specifically, (225) derives the Bound RT+Bound ET-Reading. Once proRestT is bound by a quantifier over times, both RT (now the existentially quantified time of the domain predicate) and ET (the existentially quantified time of the noun) must covary by virtue of being indirectly "bound" through the overlap relation to RestT. For example, the Bound RT+Bound ET-Reading from (203) could now be paraphrased as in (226).

(226) Immer wenn Familie Wittenberg ein Fest gefeiert hat, hat *jeder 20-Jährige* eine Gans erschossen
always when family Wittenberg a fest celebrated has, has *every 20-year-old* a goose shot
'Whenever the Wittenberg family hosted a party, *every 20-year old* shot a goose.'

Bound RT+Bound ET-Reading (revised informal description)

∀**t**. where **t** is a time when the Wittenberg family hosted a party: ∀x such that *there is a time that overlaps with* **t** at which x was a 20-year old & *there is a time that overlaps with* **t** at which x was a guest at **t**: x shot a goose at **t**

Additionally, when proRestT is free, (225) derives Free RT+Free ET-Readings where RT and ET are overlapping (or in close temporal proximity, both overlapping ResT). What (225) does not derive so far are Bound RT+Free ET-Readings, as well as clear cases of ET-RT disjointness. The latter is covered once we allow the possibility that the temporal relation between ET and ResT might be one of *temporal anteriority* instead of overlap. Thus, besides the overlap-version in (222), the lexical entry of a nominal predicate must also have a anteriority-version[128], which yields (228) once it combines with the implicit domain predicate.

(227) $[\![\text{Nom}]\!]^{g,c} = \lambda t_i.\ \lambda x_e.$ ∃t' [t' < t & x is a *nom* at t']

(228) $[\![\text{NP}_{rest.}]\!]^{g,c} =$
$= \lambda x_e.$ [∃t' [t' < **ResT*** & x is a *nom* at t']] & [∃t'' [t'' o **ResT*** & x is a *dom* at t'']]

Since ET is now differently related to ResT than RT, (228) allows readings in which ET and RT are temporally disjoint. To take our original context as an example, (228) allows us to construct a domain that includes individuals that were students *at some time in the past of 2010* (ResT=2010) and that were present at some time overlapping the reunion *in 2010*. Moreover, (228) gives us the means to derive the truth conditions of the Bound RT+Free ET-Reading. Importantly, ET would not be truly free under this analysis of the Bound RT+Free ET-Reading. Since a Bound RT-Reading is parasitic on ResT-binding, ET's anteriority is in relation to a covarying ResT. We thus expect the pastness requirement for ET to

[128] The proposal that the lexical entry of a nominal predicate should include an anteriority relation < in addition to a relation of temporal overlap, is made by O'Leary (2022). Other approaches that assume an existential quantifier over times *and* a time/situation pronoun have only assumed an overlap relation (e.g. Schwarz 2012; Tonhauser 2021). Importantly, the temporal anteriority relation is not available for all nouns, as O'Leary (2022) shows in her dissertation. I will leave aside this issue here.

covary. This is indeed the right result. In (229), the participants at experiment E2 (in 2000) and E3 (in 2010) can be doctors after E1 (1990) took place. It is even possible that they only first became doctors after 1990. Only for the participants at E1 is it necessary that they were all doctors before 1990.

(229) Immer wenn Prof. K ein Experiment durchgeführt hat, ist *jeder Arzt* bewusstlos geworden
always when Prof. K an experiment conducted has, is *every doctor* unconscious became
.. 'Whenever Prof. K conducted an experiment, *every doctor* fainted.'

Bound RT + "Free" ET (revised informal description)

∀**t**. where **t** is a time when Prof. K conducted an experiment: ∀x. such that *there is a time in the past of* **t** at which x was a doctor & x was a participant at **t**: x fainted at **t**

Context

Prof. K conducted three experiments in which his participants were randomly selected among individuals that were former doctors and lawyers at the time of the experiment. The first experiment (E1) was conducted in 1990, the second experiment (E2) in 2000, and the third (E3) in 2010. At each experiment, all participants that were former doctors at the time of the experiment fainted (The former lawyers did not for some reason).

Note that by only allowing a single time pronoun, the one variable solution rules out a true Bound RT+Free ET-Reading *in principle*. It only allows the imposters of these readings that we find in (229). The same is true for the Free RT+Bound ET-case. According to the one variable solution, this reading is impossible. This is exactly what I have found to be the case in previous sections. Importantly, the judgements on this readings also indicated that there is no imposter version of the Free RT+Bound ET-Reading either. If (225) and (228) are the only denotations that are possible for the restrictor $NP_{rest.}$, then imposters of the type Free RT+Bound ET are indeed ruled out, since these readings would require a relation between RT and ResT that is different from temporal overlap.

Moreover, from (225) and (228) alone, a restrictor can never take on a reading in which ET is into the future of RT. Based on the temporal relations in (225) and (228), ET can only overlap or precede RT, but never follow it. We thus derive both the generalizations *No Free RT+Bound ET-Reading* and *No RT<ET disjointness*, respectively. If we assume the lexical entries in (222) and (227) for nominal predicates (or a single entry that is compatible with both denotations) and the lexical entry in (223) for implicit domain predicates, then we get the empirical coverage we need.

(230) *Success of the one variable solution*
- It derives ET-RT disjointness
- It derives the Bound RT+Bound ET-Reading, Free RT+Free ET-Reading
- It derives the Bound RT+"Free" ET-Reading
- It derives the absence of Free RT+Bound ET-Readings (*No Free RT+Bound ET*)
- It derives the absence of RT<ET-relations (*No RT<ET disjointness*)
- It derives variation of ET between individuals in the domain (i.e. Kusumoto's (2005) observation)
- It is compatible with the IPG

A word of modesty is in order. Although the one variable solution achieves a decent empirical coverage, it does so by relying on a number of stipulations that are left unexplained. For example, deriving *No Free RT+Bound ET* means accepting the stipulation that the lexical entry of implicit domain predicates may involve temporal overlap between RT and ResT, but no other temporal relation. Similarly, *RT<ET, although derived, remains as mysterious as before. Why would nominal predicates allow o and <, but not the posteriority relation >? These questions are related to O'Leary's (2022) observation that not all nouns allow the same temporal relations: So-called *flexible nouns* (e.g. "student") allow both o and <, while so-called *inflexible nouns* (e.g. "bachelor") allow only o. According to this, implicit domain predicates fall into the later category. However, this does not explain *why* implicit domain predicates must be inflexible. Nor does it explain why there is no third category of nouns that allows >-relations. I will leave it for future work to uncover the deeper principles behind the stipulations in (231) and (232) (if there are any).

(231) *Stipulation A of the one variable solution (to be explained)*
RT must overlap with ResT

(232) *Stipulation B of the one variable solution (to be explained)*
No ET<ResT

4.8. A few open questions and an alternative from situation semantics

The discussion above opens up more questions than have been answered. Besides the explanatory problem posed by the missing DP-internal temporal relations, another open question is the behavior of ET and RT in (temporally) more complex DPs (i.e. DPs containing relative clauses, adjectives, temporal modifiers, etc.). I will leave this issue open for now. However, even for simple DPs, the nature of its internal temporality leaves many questions unanswered.

For one thing, we have yet to see how our constraints on ET-RT-relations relate to potential restrictions on the relation between DP-internal times and verbal tense, which have been a frequent topic of discussion in the literature (e.g. Musan 1995; O'Leary 2022). Since DP-internal temporality shows considerable complexity in its own right, it might turn out that at least some of the supposedly tense-related restrictions actually reflect DP-internal time restrictions that become clear once the role of ET, RT, ResT (and other DP-times) is taken into account. Related to this is the question of how much temporal complexity is actually needed for the representation of simple DPs. The one variable solution seemed to rely on three times to capture the temporal behavior of DPs, two existentially quantified times (ET, RT) and one time contributed by a time pronoun (ResT). However, under closer examination, this turns out to be only partly true. The introduction of the existential quantifier crucially relied on the use of the overlap-relation o to establish a dependence on the time pronoun. Importantly, the overlap relation o itself implicitly relied on an additional existential quantifier in its definition.

(233) *The temporal overlap relation o*

A time interval t and a time interval t' stand in a temporal overlap relation o iff *there is a time interval t''* such that t'' is a subinterval of t and t'' is a subinterval of t'

Thus, the denotation of $NP_{rest.}$ could have been written out as in (234).

(234) $[\![NP_{rest.}]\!]^{g,c}$ =
= λx_e. [∃t' [∃t'' [t'' is a subinterval of t' & t'' is a subinterval of **ResT***]] & x is a *nom* at t'] & [∃t''' [∃t'''' [t'''' is a subinterval of t''' & t'''' is a subinterval of **ResT***]] & x is a *dom* at t''']

It seems that even the one variable solution cannot avoid to attribute a considerable amount of temporal complexity to the denotation of simple DPs. A goal for further research could be to find ways to achieve the same empirical results as the one variable approach, while at the same time reducing the temporal information that is stipulated as part of DP-meanings. For this, one could look at the same problem from the perspective of a different framework.

Adopting a situation semantic framework, for instance, we could attempt to order individuals directly to situations, instead of introducing an additional time as an intermediary. This is possible if individuals and situations are both of the same entity type *s*. I assume that an individual x is equivalent to the situation that contains exactly (and exclusively) itself throughout its whole temporal extendedness – i.e. from the moment it begins existing to the moment it seizes to exist[129]. We could thus define situational overlap o_s as a relation that can hold between an individual (/situation) x and a situation *s* if x and *s* share some sub-situation *s'* (which effectively amounts to a temporal part of x being in *s*). This approach could simplify the contribution of the implicit domain restriction, as it would now be enough to say that the individuals in the domain of a determiner must overlap the situation denoted by the situation pronoun (For our original reunion-example, this means that the individuals in the domain must be in some part of the reunion-situation).

This approach might have the added benefit that it would effectively unify all implicit domain restrictions to the denotation of the *overlapping function* in (237), and would thereby eliminate the need to supply domain restrictions with predicate-content through the assignment function g[130] (In other words: An implicit domain restriction would essentially be a predicate without content). Additionally, it puts us one step closer to explaining why RT only allows temporal overlap with the time of the pronoun (i.e. Stipulation A from the one variable solution): If a domain restriction is without content beyond the

[129] I.e. there is something like a *John-situation* or *Mary-situation* that pick out exactly the individuals John and Mary throughout their whole life-span.

[130] Having the denotation of an abstract functional relation without lexical content, it becomes also less surprising that implicit domain restrictions are *implicit* (i.e. silent). Furthermore, it would now potentially be a sensible strategy to follow Schwarz (2012) by a.) reanalyzing the implicit domain restriction (in the form of the overlapping function) as a part of a determiner's meaning, and b.) reanalyzing situation pronouns as arguments selected by determiners.

content associated with the situation pronoun, then there is no property that could be situated in the past or future of the pronoun-time. Shifting RT relative to the pronoun time would be pointless.

(235) *The situational overlap relation o_s*
A situation *s* and situation *s'* stand in a situational overlap relation o_s iff *there is a situation s''* such that *s''* is a part of *s* (*s''*$\leq$*s*) and *s''* is a part of *s'* (*s''*$\leq$*s'*)

(236) $[\![\text{Nom}_{overl.}]\!]^{g,c}$ = $\lambda s_s.\ \lambda x_s.\ \exists s'\ [s'\ o_s\ s\ \&\ x \text{ is a } \textit{nom} \text{ throughout } s']$
. = $\lambda s_s.\ \lambda x_s.\ \exists s'\ [[\exists s''\ [s'' \leq s'\ \&\ s'' \leq s]]\ \&\ x \text{ is a } \textit{nom} \text{ throughout } s']$

(237) $[\![\text{Dom}]\!]^{g,c}$ = $\lambda s_s.\ \lambda x_s.\ s\ o_s\ x = \lambda s_s.\ \lambda x_s.\ \exists s'\ [s' \leq s\ \&\ s' \leq x]$

(238) $[\![\text{proResS}_i]\!]^{g,c}$ = g(*i*) = $\mathbf{s_{rest.}}$*****

(239) $[\![[[\text{Nom Dom}]\ \text{proResS}_5]]\!]^{g,c}$
= $\lambda s_s.\ \lambda x_s.\ [\exists s'\ [[\exists s''\ [s'' \leq s'\ \&\ s'' \leq \mathbf{s_{rest.}}\textbf{*}]]\ \&\ x \text{ is a } \textit{nom} \text{ throughout } s']]\ \&$
$[\exists s'''\ [s''' \leq \mathbf{s_{rest.}}\textbf{*}\ \&\ s''' \leq x]]$

As of yet, it is unclear whether there are any empirical benefits to choosing (239) over (234). Importantly, note that if we strip the implicit domain restriction of its descriptive content (i.e. if we assume it is just a bare overlapping function), then our semantics for the whole restrictor argument (in (239) contains a peculiar redundancy. If the denotation of Nom is defined as in (236) – with ET overlapping $s_{rest.}$* – then the meaning of the nominal predicate *entails* the meaning of the implicit domain restriction Dom. That is, if an individual x has the property Nom *throughout* a situation that shares a subsituation s' with $s_{rest.}$*, then it follows that x shares a substitution with $s_{rest.}$* (namely s'), making the overlapping function that is contributed by Dom unnecessary. Specifically, the denotation of the restrictor predicate $NP_{rest.}$ *without* Dom (see (240)) is truth-conditionally equivalent to (239) (the denotation *with* Dom).

(240) $[\![[\text{Nom proResS}_5]]\!]^{g,c}$
= $\lambda s_s.\ \lambda x_s.\ [\exists s'\ [[\exists s''\ [s'' \leq s'\ \&\ s'' \leq \mathbf{s_{rest.}}\textbf{*}]]\ \&\ x \text{ is a } \textit{nom} \text{ throughout } s']]$

Does that mean that we can get rid of Dom entirely? Not quite. The redundancy of Dom followed from the fact that Nom was specified for temporal overlap. However, since we need to derive cases of ET-RT disjointness, we also need an anteriority-version of Nom, in which case we again need Dom to guarantee that RT still overlaps with $s_{rest.}$* (In other words: We need to guarantee that the individuals in the domain actually have to be *in* $s_{rest.}$* at some point and not just in some situation in the past of $s_{rest.}$*). Since we thus need the overlapping function contributed by Dom, we may ask the reverse: Do we need to put the overlapping relation into the meaning of Nom? We may get rid of it if we adopt a more decompositional perspective on temporal relations. Specifically, let us assume that temporal relations are never part of the lexical entries of (nominal) predicates, but are instead always introduced by independent operators. The lexical entry for Nom would then strip down to (241).

(241) $[\![\text{Nom}]\!]^{g,c}$ = $\lambda s_s.\ \lambda x_s.$ x is a *nom* throughout s

Dom would be an operator that takes a predicate of type <i,<e,t>> as an argument and introduces the overlap relation[131] . Combining Dom with Nom would then give us all cases in which ET and RT are non-disjoint.

(242) $[\![\mathrm{Dom/Op}_{overlap}]\!]^{g,c}$ = $\lambda P_{<s,<e,t>>}. \lambda s_s. \lambda x_s. \exists s' [[s' \leq s \ \& \ s' \leq x] \ \& \ P(s')(x)]$

(243) $[\![[[\mathrm{Dom/Op}_{overlap}\ \mathrm{Nom}]\ \mathrm{proResS}_5]]\!]^{g,c}$
= $\lambda x_s. \exists s' [[s' \leq \mathbf{s_{rest.}}^{*} \ \& \ s' \leq x] \ \& \ x$ is a *nom* throughout s']

In order to derive temporal disjointness, we would need to define a second operator that introduces temporal/situational anteriority[132].

(244) $[\![\mathrm{Op}_{Past}]\!]^{g,c}$ = $\lambda P_{<s,<e,t>>}. \lambda s_s. \lambda x_s. \exists s' [s' <_s s \ \& \ P(s')(x)]$

(245) $[\![[\mathrm{Op}_{Past}\ \mathrm{Nom}]]\!]^{g,c}$ = $\lambda s_s. \lambda x_s. \exists s' [s' <_s s \ \&\ x$ is a *nom* throughout s']

(246) $[\![[[[\mathrm{Dom/Op}_{overlap}\ [\mathrm{Op}_{Past}\ \mathrm{Nom}]]\ \mathrm{proResS}_5]]\!]^{g,c}$
= $\lambda x_s. \exists s' [[s' \leq \mathbf{s_{rest.}}^{*} \ \& \ s' \leq x] \ \& \ \exists s'' [s'' <_s s' \ \&\ x$ is a *nom* throughout s'']]

The decompositional situation-semantics approach seems to allow a comparably simple representation of DP-internal temporality. Moreover, it comes with the added benefit of giving a simple and uniform semantics of nominal predicates that does not require the stipulation of a lexical ambiguity. Of course, many unresolved issues remain. For instance, nothing in the lexical entry of $\mathrm{Op}_{overlap}$ and Op_{Past} prohibits them from applying in the reverse order. Applying Op_{Past} after $\mathrm{Op}_{overlap}$ again would end in a reading in which the individuals in the domain would not have to be in $s_{rest.}$*, only some situation in the past of $s_{rest.}$*. To avoid this, we could assume that at least $\mathrm{Dom/Op}_{overlap}$ is not an independent syntactic operator after all and that its meaning is instead part of the meaning of determiners. A determiner would then take a bare (or Op_{Past}-manipulated) NP of type <s,<e,t>>, as well as a situation pronoun proResS as its arguments, and would in its meaning relate the situation argument of the NP and the situation of proResS via the overlap-relation (thereby achieving the effect of an implicit domain restriction). Op_{Past} would in this case only ever apply directly to the nominal predicate, and the Op_{Past}-over-$\mathrm{Op}_{overlap}$-issue would not arise. This approach would look very similar to the analysis in Schwarz (2012), in which both ET's existential quantification and its relation to the pronoun situation $s_{rest.}$* are put into the lexical entry of the determiner. Alternatively, of course, we could block the Op_{Past}-over-$\mathrm{Op}_{overlap}$-ordering by some syntactic stipulation.

[131] In effect, one could think of Dom as a nominal version of the present tense.

[132] Note that it is not trivial to define temporal anteriority between situations. We might need to impose a temporal ordering on situations that we did not need for the definition of situational overlap (for which the mereological parthood-relation was sufficient). Situational disjointness could be defined by the negation of situational overlap. But it is still not entirely obvious how to get from situational disjointness to situational anteriority. Here, I will simply assume (maybe to a fault) that there is a way to define $<_s$ (maybe inspired by insights from interval semantics, e.g. Bennett & Partee 1972) that does not lead to additional complications.

Similarly, in the decompositional approach, nothing prevents us from combining proResS directly with the noun. Again, we could prevent this with a syntactic stipulation that restricts the position of proResS. Perhaps more elegantly, this issue would be resolved if, continuing the reasoning from the previous paragraph, the determiner had to combine with an NP of type <s, <e,t>>. If a situation pronoun combines directly with the nominal predicate, its situation argument would be saturated before it could combine with the determiner. Since the determiner cannot take an argument of type <e,t>, we would end up with a type mismatch.

Another open question is the explanatory problem posed by Stipulation B (*No ET<ResT*), which is now reframed as the question of why language has covert operators for temporal anteriority, but no covert operators for temporal posteriority. It remains to be seen whether the new formulation of this problem is more likely to lead to answers than the original version that presupposed a lexical ambiguity.

After looking at DP-times and their relation from an intradimensional perspective, we might wonder how our updated (and much more complex) picture of DP-temporality impacts the conclusions from section 3, where we examined the (interdimensional) interaction between a DP's world and time. Importantly, the discussion in section 3 presupposed that the temporal evaluation of a DP was simple, i.e. essentially established by a single piece of temporal information that could be manipulated by shifters. Since this simplified view on DP-temporality is now obsolete, section 5 will briefly examine potential ways the findings from section 3 and 4 connect to each other.

5. Putting things together and a brief outlook

5.1. Inter- and intradimensional dependencies: an update

In chapter 3, I argued for the following generalization.

(247) *Ban on O+(MT<ET)/Upper Limit Opaqueness*

A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude).

In chapter 4, I argued for the two generalizations in (248) and (249).

(248) *No Free RT+Bound ET-Reading*

The evaluation time (ET) of a noun cannot receive a bound variable reading if the resource time (i.e. the time of the implicit domain restriction of the same DP) receives a free reading (or equivalently: RT cannot be free if ET is bound).

(249) **RT<ET* or *No RT<ET-disjointness*

The ET of a DP's noun cannot be a time that is both disjoint and into the future (i.e. posterior) to the DP's RT.

I believe that the empirical case for the *Ban on O+(MT<ET)* is convincing. The evidence in favor of the generalizations in (247)-(249) is less stable and needs further (independent and most likely experimental) testing for confirmation (or falsification). For now, I will take the results from chapter 4 at face value and assume that *No Free RT+Bound ET* and *No RT<ET-disjointness* are the right description for DP-internal temporality. With this caveat in mind, we can update our taxonomy of index-reducing dependencies from chapter 2 by the *Ban on O+(MT<ET)* (an interdimensional restriction of type H/B), and the two intradimensional dependencies in (248) and (249)[133].

[133] Note that a dependency between ET and RT could be classified either as a neighbor- or as a host-dependency, depending on the analysis of ET and RT. For no particular reason, I will put them in the category of host-dependencies. Moreover, note that these intradimensional constraints – since they exclusively relate to times – have (so far) no obvious correlate in the modal or spatial dimension, and might thus not fall under the metageneralization that all dimensions follow parallel constraints on the intradimensional level. However, this conclusion might change once we consider the possibility that the meaning of a simple DP could be related to more than one piece of world or location information (i.e. maybe we need to distinguish between a resource world/location and an evaluation world/location, respectively).

(250) *Intra- and interdimensional dependencies (for a given A-parameter)* (update)

	Dependent on		
Dimensionality	*Shifter (S)*	*Neighbor (N)*	*Host (H)*
Intradimensional (A)	**i.) Obligatory Shifting** (Generalization X, Generalization Y, Musan's Generalization) **ii.) Optional Shifting** (transparent/opaque-ambiguity, shifted indexicals) **iii.) Obligatory Non-Shifting** (indexicals)	**i.) Nested DP Constraint** **ii.) Intersective Predicate Generalization** **iii.) Shift Together**	**i.) Constraints on ET-RT relations** (No Free RT+Bound ET, No RT<ET disjointness)
Interdimensional (B)	?	?	**i.) Ban on O+(MT<ET)**

At this point, it is important to note that the *Ban on O+(MT<ET)* and *No RT<ET-disjointness* show a curious similarity. They both describe the impossibility of the nominal evaluation time (ET) being into the future of another time, the matrix tense time (MT) in the first case and the resource time (RT) in the second case. That a forward-shifted ET is implicated in both generalizations is unlikely accidental. There is probably a deeper connection between these two generalizations that we are missing so far. Given the inter- and intradimensional nature of the generalizations, uncovering this connection might give us an idea for how closely our representation of different intensional dimensions should be coordinated. A simple way in which two generalizations about impossible temporal relations could be connected would be that they are about the *same* type of temporal relation. Is there a way we could unify the MT<ET-and the RT<ET-context under the umbrella of a single temporal relation? Since the Ban on O+(MT<ET) was formulated before we considered the possibility that DP-internal temporality could be more complex (and involve RT in addition to ET), it is tempting to ask whether the Ban on O+(MT<ET) can be reduced to a special subcase of the RT<ET-ban. Effectively, this would be the case if an opaque reading would somehow force RT to be bound to the MT-time (or a time in the past of MT). That is, maybe we can replace the Ban on O+(MT<ET) by the constraint in 251, which would entail the Ban on O+(MT<ET) by virtue of *RT<ET being active.

(251) O → [(RToMT) ∨ (RT<MT)]
(or in short: *MT<RT)

(252) *RT<ET

(253) O → *MT<ET
(follows from (251) and (252))

For this to work, our analysis of the modal dimension should be designed in such a way that the mechanism that makes a DP opaque also restricts the possible values for the DP's RT. In the rest of this thesis, I will briefly consider how well some of the systems we have examined so far accomplish this task.

5.2. Reducing the Ban on O+(MT<ET) to *RT<ET

5.2.1. The one-situation pronoun theory

In a situation pronoun framework, the world and time dimension are collapsed into a single entity (the situation) that is the referent of a situation pronoun inside the DP. The situation pronoun receives its value either contextually, from the utterance situation, or by being bound by a situation binder introduced by a higher tense or attitude verb. In section 3.4.1., we came to the conclusion that the situation pronoun approach did not adequately capture the range of modal-temporal readings of DPs. However, this discussion was based on simplistic assumptions about a DP's internal temporality. For the analysis of ET-RT-relations, section 4.8. considered a more complex version of the situation pronoun approach that was able derive the *RT<ET-generalization (as well as the other facts about DP-internal temporality discussed in chapter 4). The approach assumed the following lexical entries[134].

(254) $[\![\text{Nom}]\!]^{g,c}$ = $\lambda s_s.\ \lambda x_s.$ x is a *nom* throughout s
(255) $[\![\text{Dom/Op}_{overlap}]\!]^{g,c}$ = $\lambda P_{<s,<e,t>>}.\ \lambda s_s.\ \lambda x_s.\ \exists s'\ [[s' \leq s\ \&\ s' \leq x]\ \&\ P(s')(x)]$
(256) $[\![\text{Op}_{Past}]\!]^{g,c}$ = $\lambda P_{<s,<e,t>>}.\ \lambda s_s.\ \lambda x_s.\ \exists s'\ [s' <_s s\ \&\ P(s')(x)]$
(257) $[\![\text{proResS}_i]\!]^{g,c}$ = g(i) = $\mathbf{s_{rest}}$*

In this version, the evaluation of the nominal predicate is only indirectly determined by the situation pronoun. Operators that introduce existential quantification over situations mediate between the value of the situation pronoun and the evaluation (situation) argument of the noun. Assuming the conservative placement of situation binders we used in 3.4.1., this approach allows the following LF-structures (Note that $\text{Op}_{overlap}$ is obligatory, Op_{Past} is optional and $\text{Op}_{overlap}$ must always be higher than Op_{Past}. These stipulations might be resolved if we put the meaning of $\text{Op}_{overlap}$ into the meaning of determiners. See section 4.8. for discussion).

[134] Note that the approach makes a commitment about the ontology of individuals that essentially treats them as situations. This move does not affect the predictions of the situation pronoun approach when it comes to deriving the Ban on O+(MT<ET) and *RT<ET. Indeed, we could build the situation pronoun approach without this ontological commitment (which would lead to a slightly more complicated treatment of domain restriction), but get the same results.

(258) *LFs derived by the (extended) one-situation pronoun theory*

Nr.	LF-structure	Corresponding Reading
1	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_3 [Op$_{overlap}$ Nom]]]]]]]]	O+EmbT
2	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_2 [Op$_{overlap}$ Nom]]]]]]]]	O+MT
3	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_1 [Op$_{overlap}$ Nom]]]]]]]]	T+MT
4	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_0 [Op$_{overlap}$ Nom]]]]]]]]	T+UT
5	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_7 [Op$_{overlap}$ Nom]]]]]]]]	T+CT
6	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_3 [Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]]]]]	O+(ET<EmbT)
7	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_2 [Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]]]]]	O+(ET<MT)
8	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_1 [Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]]]]]	T+(ET<MT)
9	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_0 [Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]]]]]	T+(ET<UT)
10	λs_{utt0} [TENSE$_{matrix}$ [$\lambda s_{matrix1}$ [ATTIT [$\lambda s_{belief2}$ [TENSE$_{emb}$ [λs_{emb3} [DP [proResS_7 [Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]]]]]	T+(ET<CT)

From this system – which was originally devised to capture facts about DP-internal temporality such as the *RT<ET-constraint – all the relevant facts about modal-temporal interactions fall out automatically. First, there is no LF that allows an O+(MT<ET)-reading. In order to derive an opaque reading, the situation pronoun proResS must be either bound by the attitude verb or by the embedded tense (They are the only operators that introduce situations that are not part of the actual world)[135]. Importantly, there is no LF in which proResS is bound in this way and that also allows the evaluation time of the noun to be a time into the future of the matrix tense (i.e. there is no LF that is compatible with a O+(MT<ET)-reading). In LFs with no backward-shifting Op$_{Past}$ (LFs 1 and 2 in the table), the situation denoted by proResS (the restrictor situation ResS) has to overlap with either the matrix tense situation or the embedded tense situation. Since the evaluation situation of the noun has to overlap ResS in these cases,

[135] The evaluation situation of the noun becomes opaque by virtue of being related to an opaque proResS via Op$_{overlap}$ and Op$_{Past}$. Note that it is obvious for the situational overlap relation that two situations that overlap must be part of the same world. Before we have not defined temporal ordering for situations, we cannot in principle rule out that situations from different worlds can be related by $<_s$. Here, I will merely assume that a temporal ordering for situations only makes sense for situations within the same world and that $<_s$ can thus only relate situations from the same world.

we can derive opaque readings where the evaluation time (ET) overlaps the matrix tense time (O+MT) or the embedded tense time (O+EmbT). The first is obviously not compatible with an MT<ET-relation. The O+EmbT-reading, in principle, would be compatible with an MT<ET-context if the embedded tense could pick out a time that is into the relative future of the matrix tense time. However, this possibility is independently ruled out by the Upper Limit Constraint for embedded tenses, which makes MT an upper limit for EmbT (e.g. Heim 1994, Abusch 1997).

In cases where we insert Op_{Past}, we can only derive readings in which the evaluation situation (and hence ET) is into the past of ResS. Since ResS is temporally bound to either MT or EmbT, we only derive O+(ET<MT) and O+(ET<EmbT)-readings, but no O+(MT<ET)-readings. Indeed, this is exactly what we want. Remember from section 3.6. that opaque readings do not require that the evaluation time obligatorily overlaps with MT or EmbT. In fact, they also allow readings in which the evaluation time is some contextually given time that is into the past of both MT and EmbT. In section 3.6., we called these cases O+(CT<MT)-readings. In the situation pronoun system, they are derived by the LFs 6 and 7 from the table. The LFs 1, 2, 6 and 7 exhaust our options to derive opaque readings in this system. There is thus no way to generate a reading in which the noun is opaque but it has an evaluation time that is into the future of the matrix tense time. The Ban on O+(MT<ET)-readings thus falls out automatically from the mechanisms that were put in place to deal with the No RT<ET disjointness generalization.

In our discussion about modal/temporal-readings, our systems were judged not solely on their ability to block O+(MT<ET)-cases, but also on their ability to allow a reading in which the noun is transparent, but its evaluation time is the embedded tense time (the T+EmbT-reading). The situation pronoun system offers several (indirect) ways of deriving a reading of this flavor. For one thing, we could assign a contextual value to proResS (i.e. LF 5) that is temporally identical to the embedded tense situation. Additionally, since EmbT can be into the past of the utterance time and the matrix tense time (and EmbT is usually into their past in the relevant test cases), the T+(ET<MT)- and T+(ET<UT)-reading (which are the result of LFs 8 and 9, respectively) are also compatible with the truth conditions of a T+EmbT-reading.

Overall, the one-situation pronoun analysis is empirically successful, both when it comes accounting for the complex patterns of DP-internal temporality (see chapter 4), and when it comes to deriving the consequences of modal-temporal interactions. Let us briefly compare this to a slightly different variant of the index-pronoun approach that is based on independent variables for worlds and times.

5.2.2. The one-time (and one-world) pronoun theory

The success of the one-situation pronoun theory was crucially linked to the assumptions that the world evaluation and the time evaluation of a noun were both (at least indirectly) determined by the same variable (proResS). It was this property of the system that created a causal chain between an opaque reading (which required binding of proResS for the world evaluation) and restrictions on the noun's

evaluation time (which are based on possible relations to the value of proResS). Crucially, this causal link is cut once we assume independent variables for worlds and times. For illustration, let us assume the following version of a single-time variable theory (It is a slightly revised modalized and decompositional version of the system in section 4.7.). Again, I assume that only Op_{Past} is optional and that it can only be inserted below Dom (i.e. the temporal overlap function).

(259) *Lexical entries for the single time-pronoun theory*

a. $[\![\text{Nom}]\!]^{g,c} = \lambda w_s.\ \lambda t_i.\ \lambda x_e.$ x is a *nom* in w at t
b. $[\![\text{Dom}_h]\!]^{g,c} = g(h) =$
$= \lambda P_{<s,<i,<e,t>>>}.\ \lambda w_s.\ \lambda t_i.\ \lambda x_e.\ \exists t'\ [[t' \circ t$ & x is a *dom* in w at t'] & P(w)(t')(x)]
c. $[\![\text{Op}_{Past}]\!]^{g,c} = \lambda P_{<s,<i,<e,t>>>}.\ \lambda w_s.\ \lambda t_i.\ \lambda x_e.\ \exists t'\ [t' < t$ & P(w)(t')(x)]
d. $[\![\text{proW}_i]\!]^{g,c} = g(i) =$ **w***
e. $[\![\text{proT}_h]\!]^{g,c} = g(h) =$ **t***

(260) *Denotations for LF without insertion of Op_{Past}*

a. $[\![[\text{Dom}_3\ \text{Nom}]]\!]^{g,c} =$
$= \lambda w_s.\ \lambda t_i.\ \lambda x_e.\ \exists t'\ [[t' \circ t$ & x is a *dom* in w at t'] & [x is a *nom* in w at t']]
b. $[\![[\text{proW}_5[\text{Dom}_3\ \text{Nom}]]]\!]^{g,c}$
$= \lambda t_i.\ \lambda x_e.\ \exists t'\ [[t' \circ t$ & x is a *dom* in **w*** at t'] & [x is a *nom* in **w*** at t']]
c. $[\![[\text{proT}_7[\text{proW}_5[\text{Dom}_3\ \text{Nom}]]]]\!]^{g,c}$
$= \lambda x_e.\ \exists t'\ [[t' \circ$ **t*** & x is a *dom* in **w*** at t'] & [x is a *nom* in **w*** at t']]

(261) *Denotations for LF with insertion of Op_{Past}*

a. $[\![[\text{Op}_{Past}\ \text{Nom}]]\!]^{g,c} = \lambda w_s.\ \lambda t_i.\ \lambda x_e.\ \exists t'\ [t' < t$ & x is a nom in w at t']
b. $[\![[\text{Dom}_3\ [\text{Op}_{Past}\ \text{Nom}]]]\!]^{g,c}$
$= \lambda w_s.\ \lambda t_i.\ \lambda x_e.\ \exists t'\ [[t' \circ t$ & x is a *dom* in w at t'] & [$\exists t''\ [t'' < t'$ & x is a *nom* in w at t'']]]
c. $[\![[\text{proT}_7\ [\text{proW}_5\ [\text{Dom}_3\ [\text{Op}_{Past}\ \text{Nom}]]]]]\!]^{g,c}$
$= \lambda x_e.\ \exists t'\ [[t' \circ$ **t*** & x is a *dom* in **w*** at t'] & [$\exists t''\ [t'' < t'$ & x is a *nom* in **w*** at t'']]]

This system can derive all kinds of modal/temporal-readings, including the unattested O+(MT<ET)-reading. To see this, consider the LFs in (262).

(262) *Examples for LFs that are incompatible with the Ban on O+(MT<ET)-readings*

a. λw_{utt0} $\boldsymbol{\lambda t_{utt1}}$ [TENSE_{matrix} [$\lambda t_{matrix2}$ [ATTIT [$\boldsymbol{\lambda w_{belief3}}$ [TENSE_{emb} [λt_{emb4}
[$_{DP}$ [**proT$_1$** [**proW$_3$** [Dom_9 Nom]]]]]]]]]]

b. λw_{utt0} λt_{utt1} [TENSE_{matrix} [$\lambda t_{matrix2}$ [ATTIT [$\boldsymbol{\lambda w_{belief3}}$ [TENSE_{emb} [λt_{emb4}
[$_{DP}$ [**proT$_{12}$** [**proW$_3$** [Dom_9 Nom]]]]]]]]]]

(262)a. derives the opaque+utterance time reading that (when the matrix tense is past) is a special subcase of the O+(MT<ET)-reading. (262)b. gives the LF for a contextually assigned proT-value. Nothing in b. prevent proT from denoting a context time that is into the future of MT. Importantly, the problem is a result of the independent indexing of the world- and time-pronoun. Because the index of proT is determined independently of proW, binding proW by the attitude verb cannot have an influence on the possible index-values of proT. From this, we can conclude that our system of intensionality needs to make the connection between worlds and times close enough so that the value of the world parameter may restrict the possible values for the time parameter. The world-time collapsing situation pronoun

theory offers a system of this kind. The independent world-time pronoun theory does not. Next, I will briefly consider the potential of a system that does not rely on index pronouns at all.

5.2.3. The memory-based situation parameter theory

The discussion in chapter 4 presupposed that we need a time (or situation) pronoun. We assumed this (among other things) because we wanted to account for the fact that DP-internal times show bound variable readings when they are under the influence of a temporal quantifier (e.g. a whenever-clause). However, we never considered whether we could derive the same readings with the pronoun-free system of intensionality that we discussed in the chapters before: the parameter theory. We could ask what predictions this system makes once we update it based on the insights on DP-internal temporality from chapter 4. Moreover, we will this time also use a world-time collapsing situation as the sole evaluation parameter on the interpretation function. For the most part, this means that we can translate our lexical entries form the situation pronoun approach into our parameter framework. Additionally, we will add a memory store for situations, as well as an SShift-operator (modeled after the memory-based parameter framework from 3.4.3.).

(263) *Lexical entries in the (memory-based) situation parameter theory*

a. $[\![\text{Nom}]\!]^{<>_{s-stor.},s,g} = \lambda x_s.$ x is a *nom* throughout s
b. $[\![\text{Dom/Op}_{overlap}\ \phi]\!]^{<>_{s-stor.},s,g} = \lambda x_s.\ \exists s'\ [[s' \leq s\ \&\ s' \leq x]\ \&\ [\![\phi]\!]^{<>_{s-stor.},s',g}(x)]$
c. $[\![\text{Op}_{Past}\ \phi]\!]^{<>_{s-stor.},s,g} = \lambda x_s.\ \exists s'\ [s' <_s s\ \&\ [\![\phi]\!]^{<>_{s-stor.},s',g}(x)]$
d. $[\![\text{SShift}_i\ \phi]\!]^{<s_i>_{s-stor.},s_h,g} = [\![\phi]\!]^{<s_i>_{s-stor.},s_i,g}$
e. $[\![\text{whenever}\ \alpha\ \beta]\!]^{<>_{s-stor.},s_1,g} = \forall s'\ [[\![\alpha]\!]^{<s_1>_{s-stor.},s',g} \rightarrow [\![\beta]\!]^{<s_1>_{s-stor.},s',g}]$

Let us first consider how this approach derives bound variable readings for DP-internal times (ET/RT). Essentially, temporal quantifiers (e.g. "whenever") are treated as situations shifters. They quantify over situations and bind (i.e. shift) the world parameter of expressions in their scope. This has the effect that all situation-sensitive expressions in their scope will covary, i.e. receive a bound variable reading. If the relevant DP (and thereby its Nom) is in the scope of "whenever", it will inevitably receive a bound variable reading (in the terminology of chapter 4, a Bound-RT+Bound-ET-reading), even without containing an object language situation variable. The more difficult readings are actually those where either RT or ET is free. However, the lexicon entries in (263) make their derivation possible. Concretely, the following LFs derive all the relevant readings.

(264) *LFs for possible ET-RT-relations*

a. Bound RT+Bound ET-Reading
   [[whenever α] [$_{\beta}$ … [$_{DP}$ … [Dom/Op$_{overlap}$ Nom]]]]
b. Bound RT+Free ET-Reading (ET<RT)
   [[whenever α] [$_{\beta}$ … [$_{DP}$ … [Dom/Op$_{overlap}$ [Op$_{Past}$ Nom]]]]
c. Free RT+Free ET-Reading (EToRT)
   [[whenever α] [$_{\beta}$ … [$_{DP}$ … [SShift$_i$ [Dom/Op$_{overlap}$ Nom]]]]
d. Free RT+Free ET-Reading (ET<RT)
   [[whenever α] [$_{\beta}$ … [$_{DP}$ … [SShift$_i$ [Dom/Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]

Note that I stipulated the ordering between the silent operators to always be SShift-over-Op$_{overlap}$-over-Op$_{Past}$, which rules out LF-structures such as (265).

(265) *[[whenever α] [$_{\beta}$ … [$_{DP}$ … [Dom/Op$_{overlap}$ [SShift Nom]]]]]

The reason for this stipulation is that LFs such as (265), in which SShift shifts the situation argument of the nominal predicate directly, give ET too much temporal flexibility. Since (265) makes ET independent of RT (SShift effectively gives the noun the instruction to ignore the RT-determining parameter that was introduced by Dom/Op$_{overlap}$), the LF circumvents constraints on RT-ET-relations. For instance, if SShift changes the evaluation parameter of Nom to the utterance situation, this would be compatible with an RT<ET-reading (This reading was argued to be impossible by the *RT<ET-generalization). Of course, it might later turn out that this reading is not impossible after all. In this case, the situation parameter approach would have a straightforward strategy for deriving the RT<ET-reading. Since for now, I do not see any reasons to doubt this generalization, I view LFs such as (265) as a problem to be eliminated. So far nothing in the semantics of the silent operators rules out the illicit combination in (265). For lack of a better alternative, I will simply stipulate that the syntactic order must conform with the hierarchy SShift-over-Op$_{overlap}$-over-Op$_{Past}$.

Indeed, if the operators adhere to this order, then the parameter theory makes the right predictions. First, no LF can derive a Free RT+Bound ET-reading. For RT to get a "free" reading, SShift has to apply above Op$_{overlap}$ to shift the situation parameter away from the situations quantified over by the "whenever"-clause. Applying SShift, however, has the consequence that all expressions in its scope lose access to the "whenever"-situations (in particular if SShift is not a memory updater). This means that a free RT-reading can only be derived in a way that makes ET free as well, i.e. there is no way to derive a Free RT+Bound ET-reading. Moreover, since (by the ordering stipulation) Op$_{Past}$ and/or Op$_{overlap}$ always intervene between the noun and SShift, there is no way to escape a reading in which ET either overlaps or is into the past of RT (i.e. there is no RT<ET-reading).

Finally, let us examine how this system deals with modal-temporal readings. Importantly, to get an opaque reading for the nominal predicate, no SShift-operator can apply, since the noun needs access to

the local parameter introduced by the world shifter (e.g. “believe”). This leaves the following LFs as possible candidates for an opaque reading.

(266) *LFs for opaque readings*

a. O+MT- or O+EmbT
   [situation shifter$_{\alpha}$ … [$_{\text{shifted domain } \alpha}$ … [$_{DP}$ … [Dom/Op$_{overlap}$ Nom]]]]

b. O+(ET<MT) or O+(ET<EmbT)
   [situation shifter$_{\alpha}$ … [$_{\text{shifted domain } \alpha}$ … [$_{DP}$ … [Dom/Op$_{overlap}$ [Op$_{Past}$ Nom]]]]]

The result conforms exactly to the predictions made by the situation pronoun theory. Depending on the scope position within the shifted domain, the local evaluation parameter will be either the situation introduced by the attitude verb or the situation introduced by the embedded tense. The available operators Op$_{overlap}$ and Op$_{Past}$ allow for the possibility that the evaluation situation either overlaps or precedes MT/EmbT. This derives exactly the four opaque modal/temporal readings that are attested (i.e. O+MT, O+EmbT, O+(ET<MT), O+(ET<EmbT)). Importantly, it rules out readings in which the evaluation situation is into the future of MT/EmbT (The Ban on O+(MT<ET) is derived).

Lastly, the T+EmbT-reading, which was the biggest problem for the classic parameter theory, might be derived in two ways: On the one hand, we could make the evaluation relative to a contextual parameter (i.e. a contextual situation that overlaps with the embedded tense situation) via the application of SShift. However, this option requires that we work out in detail how the memory store interacts with the context. What kind of constraints are put on extra-sentential situations that are carried over into the memory store at the beginning of an utterance? What contextual situations are included/excluded? I will leave these and similar questions for future work. Importantly, the T+EmbT-reading might be derivable by a different strategy as well: If the DP takes wide scope to get locally evaluated at the utterance situation parameter, then Op$_{Past}$ could apply to Nom to shift ET to a time that is in the past of UT, but that overlaps EmbT.

To conclude, we have seen that it might be fruitful to see the Ban on O+(MT<ET)-readings as a special subcase of the No RT<ET-disjointness generalization. By assuming this, we are led to adopt a system of intensionality that assumes a single intensional entity (the situation), instead of two separate entities for worlds and times. Although the situation pronoun theory seemed to be the obvious choice to implement this idea, we have now seen that an alternative that rejects the use of object-language situation pronouns achieves a comparable empirical coverage. It remains to be seen whether there are any empirical differences that help us decide between these two theories.

6. Conclusion

This thesis offered a status report on a larger project that tries to identify, categorize and eventually explain different ways to constrain the index-values of index-sensitive expressions. Chapter 2 gave a general introduction into the topic of intensionality and outlined the types of dependencies that can hold between world, time, and location parameters. Based on generalizations known from the literature, I provided an overview of how the three index-dimensions (world, time, and space) are constrained on an intradimensional level (i.e. how does the world parameter depend on world-information, how does the time parameter depend on time information? etc.). The overall picture that emerged was that the three dimensions of an expression were always subject to parallel intradimensional constraints. For instance, if the world parameter of an expression was subject to obligatory shifting, then the time and location parameter of that expression were subject to obligatory shifting as well. The coordinated behavior of the three index-dimensions was put in form of the following meta-generalization.

(267) *Interdimensional meta-generalization about intradimensional behavior*

> If an index-parameter of an index-sensitive expression α is subject to an intradimensional constraint, then all other index-parameters of α must be subject to an intradimensional constraint of the same type.

Chapter 3 was concerned with the interaction of the world and time dimension. Specifically, the focus was given to the world and time evaluation of (optionally-shifting) nominal predicates. It was asked whether the value for the time parameter of a noun was dependent on the world parameter of the same noun (and vice versa). It was then shown how different theories of intensionality make (unintended) commitments to the existence of different modal-temporal readings. Furthermore, neither the (classic) parameter framework nor the index-pronoun framework offered a straightforward way to account for the (non-)existing modal-temporal readings. The chapter gave a detailed discussion of how the different frameworks might overcome the over- and undergeneration of modal-temporal readings. A particular focus was given to the availability of Transparent+Embedded Tense-readings (T+EmbT-readings) and the unavailability of Opaque+Utterance Time-readings (O+UT-readings), since accounting for both poses a challenge for all frameworks of intensionality (often for very different reasons). Later in the chapter, it was argued that the unavailability of O+UT-readings should be reanalyzed as a special subcase of a constraint on a more fine-grained level. The constraint was formulated as in (268).

(268) *Ban on O+(MT<ET)/Upper Limit Opaqueness*

> A nominal predicate that is opaque when it comes to its modal evaluation (e.g. its evaluation is relative to the attitude-worlds introduced by an attitude verb), cannot be evaluated at a time that is (exclusively) later than the matrix tense time (e.g. the perspective time of the attitude).

In chapter 4, the discussion turned to DP-internal temporality. Specifically, it was argued that the semantics of simple DPs made reference to (at least) two DP-internal times that can be temporally disjoint: The evaluation time (ET) of the nominal predicate and the resource time (RT) that is part of the

DP's implicit domain restriction. It was demonstrated how ET-RT disjointness posed non-trivial questions for the representation of times within DP's. Representing ET and RT by two independent time pronouns seemed to overgenerate. The relation of ET and RT was shown to be restricted in several ways, which led to the formulation of the two following constraints.

(269) *No Free RT+Bound ET-Reading*

> The evaluation time (ET) of a noun cannot receive a bound variable reading if the resource time (i.e. the time of the implicit domain restriction of the same DP) receives a free reading (or equivalently: RT cannot be free if ET is bound).

(270) **RT<ET* or *No RT<ET-disjointness*

> The ET of a DP's noun cannot be a time that is both disjoint and into the future (i.e. posterior) to the DP's RT.

The data in favor of these generalizations is intricate and further testing will be necessary to corroborate them. Nevertheless, chapter 4 considered the consequences of these constraint on the representation of DP-internal temporality. In particular, I argued that a representation that used a single time (or situation) pronoun led to promising results that not only captured ET-RT-restrictions, but were also compatible with independent generalizations from the literature (e.g. the Intersective Predicate Generalization).

Chapter 5 tried to build a bridge between chapters 2, 3, and 4. In particular, I argued that the analysis of DP-internal temporality from chapter 4 straightforwardly captures the relevant facts about world-time interactions from chapter 3. This led to the conclusion that the Ban on O+(MT<ET) should be considered as a special subcase of the *RT<ET-generalization. Finally, it was shown that this unification was dependent on using a system that collapsed worlds and times into a single intensional entity (the situation). When it comes to adequately capturing both modal-temporal interactions and DP-internal temporality, a situation semantics framework (both in form of a pronoun- and in form of a parameter-approach) yields the best results. This conclusion fits well with the result from chapter 2 that the different index-dimensions are closely coordinated. If the different index-dimensions collapse into a single situational dimension, it directly follows that they must behave the same when it comes to intradimensional dependencies.

Still, much work has yet to be done.

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Abstract

This thesis is an investigation into the modal and temporal dimension of (nominal) predicates. A predicate such as "priest" does not lexically specify whether it denotes actual priests or priests in some other, not actual world (i.e. it is underspecified for its modal evaluation). Moreover, the noun on its own leaves open whether we are talking about present priests or priests from some time in the past (i.e. it is underspecified for its temporal evaluation). When the predicate appears in a sentence that contains multiple pieces of world- and time-information (e.g. (i), which contains a world-introducing attitude verb and time-introducing tenses), the question arises which world and time the noun selects for its evaluation. Specifically, this thesis explores in what way the world/time-selection is constrained by the world/time-information of a predicate's environment.

(i) Bernd believed that *a priest* wrecked his car

The thesis examines this issue from an intradimensional and an interdimensional perspective. From an intradimensional perspective, I examine questions such as "How is the evaluation world of a predicate restricted by the *world* information in its environment?". From the interdimensional perspective, a relevant question would be "How is the evaluation world of a predicate restricted by the *time* information in its environment?". Chapter 2 looks at intradimensional constraints. Based on restrictions known from the literature, I conclude that the different dimensions (i.e. for worlds, times, and also locations) always behave in parallel when it comes to intradimensional restrictions. In chapter 3, I examine how the modal and temporal dimension interact when it comes to the evaluation of nominal predicates. I show that different systems of intensionality (e.g. the parameter theory and the index-pronoun theory) make different commitments to the existence of certain types of modal-temporal readings (Importantly, none of the classical systems make the right predictions). I then argue that the interaction of the world and time of a noun is subject to a constraint that prohibits the evaluation time to be into the future of the matrix tense time when the noun has an opaque world interpretation (the *Ban on O+(MT<ET)*). Chapter 4 takes a detailed look at the representation of temporality inside DPs. I argue that even simple DPs are temporally complex and involve (at least) two times (the evaluation time ET and the resource time RT) that can be temporally disjoint. Although at least partially independent, I show that there are certain restrictions on possible ET-RT-relations (e.g. RT<RT is prohibited). Finally, chapter 5 tries to connect the insights from chapters 2-4. It is shown that the data on modal/temporal interactions from chapter 3 directly follow from a situation-based analysis that was introduced in chapter 4 for independent reasons to account for DP-internal temporality.

Deutsche Zusammenfassung

Diese Arbeit ist eine Untersuchung der modalen und temporalen Dimension von (nominalen) Prädikaten. Ein Prädikat wie „Priester“ ist lexikalisch nicht dafür spezifiziert, ob es Priester aus der tatsächlichen Welt denotiert oder Priester aus einer anderen, nicht-tatsächlichen Welt (d.h. es ist hinsichtlich seiner modalen Evaluation unterspezifiziert). Des Weiteren lässt die Bedeutung des Prädikats offen, ob wir über gegenwärtige Priester oder über Priester einer vergangenen Zeit reden (d.h. das Prädikat ist hinsichtlich seiner temporalen Evaluation unterspezifiziert). Wenn das Prädikat in einem Satz vorkommt, der mehr als eine Welt- und Zeitinformation enthält (z.B. enthält (i) ein welteneinführendes Einstellungsverb und zeiteneinführende Tempora), stellt sich die Frage, welche der Welten und Zeiten für die Evaluation des Nomens ausgewählt wird. Diese Arbeit untersucht, wie die vorhandene Welt/Zeit-Information die Auswahl der Welt und Zeit eines Prädikats beschränkt.

(i) Bernd hat geglaubt, dass *ein Priester* sein Auto zerstört hat

Die Arbeit untersucht diese Problematik von einer intradimensionalen und einer interdimensionalen Perspektive. Von einer intradimensionalen Perspektive untersuche ich Fragen wie „Wie wird die Evaluationswelt eines Prädikates von der *Welteninformation* in seiner Umgebung beschränkt?“. Von einer interdimensionalen Perspektive wäre die Frage „Wie wird die Evaluationswelt eines Prädikats von der *Zeiteninformation* in seiner Umgebung beschränkt?“ relevant. Kapitel 2 untersucht intradimensionale Beschränkungen. Basierend auf Beschränkungen, die aus der Literatur bekannt sind, komme ich zur Schlussfolgerung, dass sich verschiedene Dimensionen (d.h. für Welten, Zeiten, und auch Orte) hinsichtlich intradimensionaler Beschränkungen parallel verhalten. In Kapitel 3 untersuche ich, wie die modale und temporale Dimension bei der Evaluation nominaler Prädikate interagieren. Ich zeige, dass sich verschiedene intensionale Systeme (z.B. die Parameter-Theorie und die Indexpronomen-Theorie) in ihren Vorhersagen zur Existenz modal-temporaler Lesarten unterscheiden (Allerdings macht keine der klassischen Systeme die richtigen Vorhersagen). Danach argumentiere ich, dass die Interaktion der Welt und Zeit eines Nomens einer Beschränkung unterliegt, die für Nomen mit einer opaquen Weltlesart eine Evaluationszeit ausschließt, die in der relativen Zukunft der Zeit des Matrixtempus verortet ist. Kapitel 4 untersucht die Repräsentation von Temporalität innerhalb von DPn. Ich argumentiere, dass sogar einfache DPn temporal komplex sind und (zumindest) zwei Zeiten involvieren (die Evaluationszeit ET und die Ressourcenzeit RT). Auch wenn diese Zeiten teilweise unabhängig sind, so gibt es auch Beschränkungen für mögliche ET-RT-Relationen (z.B. ist RT<ET verboten). Zum Abschluss wird in Kapitel 5 der Versuch unternommen, die Erkenntnisse von Kapitel 2-4 zu verbinden. Es wird gezeigt, dass die Daten zu modal/temporalen Interaktionen von Kapitel 3 direkt aus einer situationsbasierten Analyse folgen, die in Kapitel 4 aus unabhängigen Gründen für die Analyse DP-interner Temporalität entwickelt wurde.