

# **Uniqueness, Epistemic Modals and Dynamic Pronominal Anaphora**

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## **Abstract**

While dynamic semantics successfully captures presupposition mechanisms and some uses of anaphoric pronouns, the theory has some lacunas with regards to anaphoric pronouns that seem to refer to a unique individual as well as ones that are preceded by epistemic modals.

The general goal of this dissertation is to fill these lacunas and develop an improved dynamic model. After delivering a general introduction to dynamic semantics, we will tackle the first issue of the dynamic model. More specifically, we will address the criticism put forward by philosophers like Robert van Rooij, which deem dynamic predictions for certain uses of indefinite-linked pronominal anaphora to be unsatisfactory. To put it simply, they claim that in some cases anaphoric pronouns seem to refer to unique individuals, yet dynamic semantics does not represent them in that way. In order to solve the problem concerning uniqueness, I propose to interpret certain uses of indefinite-linked pronominal anaphora, that do not require uniqueness constraints, as being subordinated under a covert epistemic must-operator. This modification allows us to syntactically differentiate between cases that require uniqueness constraints and ones that do not. Due to this syntactic difference, I manage to accurately introduce uniqueness constraints into the semantics so that they solely target cases that require them and, therefore, solve the problem.

The second lacuna that will be addressed relates to epistemic modals. In dynamic semantics, might- and must-claims do not license pronominal anaphora. However, intuitively, a pronominal anaphora that has a must-claim or a might-claim as its antecedent utterance is completely felicitous. Hence, I attempt to solve this problematic interpretation of indefinite-linked pronominal anaphoras that are subordinated under an epistemic modal. The dynamic interpretation of must-claims and might-claims will be scrutinized and revised, in order to provide an interpretation that licenses pronominal anaphora by allowing modal claims to add discourse referents to the domain of the context.

## **Impact Statement**

This dissertation contributes to the ongoing research in philosophy of language by presenting a solution to some lacunas of dynamic semantics.

# Table of Contents

Introduction	4
<b>Chapter I: Uniqueness and Anaphoric Pronouns</b>	5
1. A Dynamic Analysis of Indefinite-linked pronominal Anaphora	5
2. A Problem concerning Uniqueness	8
3. A Conceptual Distinction	12
3.1. Taxonomy	14
3.1.1. Referential Cases	14
3.1.2. Specific Cases	15
3.1.3. Definite Cases	15
3.1.4. Evidential Cases	16
3.1.5. Statistical Cases	17
3.2. Taking Stock	18
4. Integrating the Conceptual Notion into the Formal Theory	18
4.1. The Indirectness of ‘must’	20
4.2. Indefinite-linked pronominal Anaphora and ‘must’	21
4.2.1. Referential Cases and ‘must’	22
4.2.2. Specific Cases and ‘must’	22
4.2.3. Definite Cases and ‘must’	23
4.2.4. Evidential Cases and ‘must’	23
4.2.5. Statistical Cases and ‘must’	23
4.3. Reviewing the results	24
4.4. Explaining the Exploitation Cases	24
<b>Chapter II: Epistemic Modals and Anaphora in Dynamic Semantics</b>	27
1. A Problematic Interpretation of Epistemic Modals	27
1.1. The Virtues of the Test-like Interpretation	31
1.2. The Flaws of the Test-like Interpretation	41
1.3. Informative vs. Non-informative	44
2. A Solution to the Problematic Interpretation of Epistemic Modals	49
<b>Chapter III: A Toy Dynamic Semantics for Uniqueness Ascriptions and Epistemic Modals</b>	74
1. Definitions and Notations	75
2. A Toy Dynamic Semantics	76
Conclusion	82
Bibliography	84

## Introduction

Context plays an important role in understanding what we say. Philosophers like Peter Strawson and Paul Grice famously criticized semantic theories that consider the meaning of a sentence in isolation from the context in which it is uttered.<sup>1</sup> Several decades after Grice's and Strawson's criticism, the linguist Irene Heim developed a theory of meaning that attempts to capture the relevance of context in a formal semantic framework. With this dynamic approach to semantics, the meaning of a sentence equates to its effect on the discourse, rather than its isolated truth conditions.

While dynamic semantics successfully captures presupposition mechanisms and some uses of anaphoric pronouns, the theory has some lacunas with regards to anaphoric pronouns that seem to refer to a unique individual as well as ones that are preceded by epistemic modals. The general goal of this dissertation is to fill these lacunas and develop an improved dynamic model.

In the first chapter, we will deliver a general introduction to dynamic semantics and then we will tackle the first issue of the dynamic model. More specifically, we will address the criticism put forward by philosophers like Robert van Rooij, which deem dynamic predictions for certain uses of indefinite-linked pronominal anaphora to be unsatisfactory. To put it simply, they claim that in some cases anaphoric pronouns seem to refer to unique individuals, yet dynamic semantics does not represent them in that way. In order to solve the problem concerning uniqueness, I will propose to interpret certain uses of indefinite-linked pronominal anaphora, that do not require uniqueness constraints, as being subordinated under a covert epistemic must-operator. This modification will then allow us to syntactically differentiate between cases that require uniqueness constraints and ones that do not. Due to this syntactic difference, I will manage to accurately introduce uniqueness constraints into the semantics so that they solely target cases that require them and, therefore, solve the problem.

The second lacuna that will be addressed in the second chapter relates to epistemic modals. In dynamic semantics, might- and must-claims do not license pronominal anaphora. However, intuitively, a pronominal anaphora that has a must-claim or a might-claim as its antecedent utterance is completely felicitous. Hence, I will attempt to solve this problematic interpretation of indefinite-linked pronominal anaphoras that are subordinated under an epistemic modal. The dynamic interpretation of must-claims and might-claims will be

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<sup>1</sup> Stalnaker (1998)

scrutinized and revised, in order to provide an interpretation that licenses pronominal anaphora by allowing modal claims to add discourse referents and their relative assignments to the context. To put it in other words, I will develop an interpretation of must- and might-claims that devises them as purely additive sentences insofar as they will not eliminate files from the context but rather internally structure the context by modifying the assignment functions present in the files.

In the third and final chapter of this dissertation I will develop a toy dynamic semantics that integrates the modifications presented in the previous chapters. This will tie the conclusions drawn in the previous two chapters together and show how they can be envisaged within a formal framework.

## **Uniqueness and Anaphoric Pronouns**

This chapter will focus on dynamic semantics and on how this theory interprets pronominal anaphoras that have as antecedent a sentence containing an indefinite noun. More specifically, some philosophers have argued that dynamic semantics faces some problems concerning uniqueness when confronted with pronominal anaphoras. I will attempt to solve these problems by proposing a minor modification of dynamic semantics.

The first section of this chapter will provide an introduction to dynamic semantics and its interpretation of indefinite-linked pronominal anaphora. The second section will then display the problem that I will attempt to solve in this chapter. The third section will introduce a conceptual notion that identifies the origin of the problem and distinguishes between different uses of indefinite-linked pronominal anaphora with regards to uniqueness. The fourth and final section will integrate this conceptual notion into dynamic semantics through different modifications and present a revised version of the theory that overcomes the problem outlined previously.

### **1. A Dynamic Analysis of Indefinite-linked Pronominal Anaphora**

The English expression, around which this chapter and arguably the whole dissertation revolves, is normally composed of two sentences. The first sentence contains an indefinite noun and the second one contains a pronoun, as exemplified by (1).

(1) A fighter pilot enters a bar. She orders a beer.

When a speaker utters (1) a hearer intuitively recognizes that there is an anaphorical link between the indefinite ‘a fighter pilot’ present in the first sentence and the pronoun ‘she’ of the second sentence. In other words, the hearer realizes that the pronoun is picking up the indefinite of the antecedent utterance. But what exactly is the pronoun expressing when it picks up an indefinite noun? Many different theories of meaning attempt to answer this question. One of these theories is *dynamic semantics*.<sup>2</sup> A feature that distinguishes this theory from its alternatives is the implementation of *discourse referents*. Despite their nature being relatively opaque, discourse referents can be intuitively imagined as being linguistic placeholders that speakers use in order to keep track of ‘who did what’ according to the current discourse. For example, in dynamic semantics the first sentence of (1) introduces a discourse referent by containing the indefinite noun ‘a fighter pilot’. In particular, a discourse referent  $x$  is introduced in the context such that for all the individuals  $n$  that can be assigned to  $x$  in the context,  $n$  is a fighter pilot that enters a bar. Irene Heim suggests the following metaphor<sup>3</sup> for grasping this mechanism: suppose that the context in which (1) was uttered is a file, and that introducing a new discourse referent simply amounts to putting a new file card into the file. This new card has the label  $x$  and contains all the information regarding  $x$  which, according to the first sentence in (1), is that  $x$  is a fighter pilot and that  $x$  entered a bar. Now, when the second sentence in (1) is uttered, the one that contains the pronoun ‘she’ which is anaphorically related to ‘a fighter pilot’, we simply have to take the file card with the label  $x$  out of our file and add the information that  $x$  is female and that  $x$  orders a beer.

The file-metaphor might provide a general understanding of this dynamic mechanism. Yet the picture that has been drawn until now is far from being an accurate representation of dynamic semantics. 'What is a context?' And 'what is an assignment?' Are just some of the questions that rightfully come to mind when reading this first introduction to dynamic

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<sup>2</sup> The theory that I have in mind here is mainly based on Heim (1982)

<sup>3</sup> *ibid.*

semantics. So, let us take a step back from our analysis of indefinite-linked pronominal anaphora by answering these questions about the general structure of the theory.

Despite its undoubtable importance for understanding what we say, context can be difficult to represent. Especially because of its peculiar feature of changing when an assertion is expressed in it. An attempt to represent context in a formal model can be found in Stalnaker (1978). For Stalnaker context is a set of possible worlds that contains all the worlds that are compatible with what the participants of the discourse assume to be true, viz. the common ground of the discourse. The mutability of the context with regards to assertion is captured by an eliminative process. For example, if a speaker in a context asserts that it is raining and all the other members of the context accept (tacitly or otherwise) the assertion, then the context shrinks in such a way that all the possible worlds in which it does not rain are eliminated from it. Because, if a sentence is asserted and accepted in a context then the content of said sentence becomes part of the common ground. Hence, a nondefective context will exclude worlds in which it rains given that they are not compatible with the common ground.

Dynamic semantics adopts this model for representing context but enriches it by defining it as a set of pairs of assignment functions and possible worlds. While maintaining the eliminative nature of the Stalnakerian context, the dynamic representation allows for an additive mechanism as well. By introducing partial assignment functions as part of the context, the dynamic semanticist can claim that the context has a *domain*, i.e. the domain of the assignment functions of the context. Furthermore, participants of a discourse are able to add arguments to the domain of the context by asserting certain sentences. These sentences are ones that contain indefinite nouns and the arguments that they add to the domain are discourse referents. So, when I previously said that a discourse referent  $x$  was being introduced, what I meant was that  $x$  was being added to the domain of the context. This freshly introduced discourse referent will, therefore, be an argument of the assignment function, which in turn will assign to the discourse referent all the individuals that satisfy the predication attached to it. Moreover, the values assigned to the discourse referent by the function will be dependent on the world that is paired with the function. If we take the first sentence of (1) as an example, then we can see how two different mechanisms are initiated in this dynamic representation of context. On the one hand, there is the additive mechanism initiated in virtue of the presence of the indefinite noun ‘a fighter pilot’. This process adds a discourse referent  $x$  to the domain of the context and the functions assign to  $x$  all the

individuals that satisfy the predication of the sentence, i.e. being a fighter pilot and entering a bar. On the other hand, there is the eliminative mechanism that reduces the context by eliminating all the worlds in which no individual can be assigned to  $x$ . Because those are worlds in which no fighter pilot enters a bar.

One can notice how the dynamic representation of context differs from the Stalnakerian one by giving a more fine-grained model that does not solely represent the information present in the context through possible worlds but also structures it with the help of assignment functions that are paired with those worlds. This contextual internal structure is especially apparent when we consider the second sentence of (1). For dynamic semantics, anaphoric pronouns are interpreted as placing further constraints on the set of individuals that can be assigned to the discourse referent that was introduced in the antecedent sentence. If the context is updated by the second sentence of (1), i.e. ‘She orders a beer’, not only does an individual have to satisfy the requirements of being a fighter pilot and entering a bar, in order to be assigned to the discourse referent, but it also has to be female and order a beer. Now, suppose there are two worlds in the context and that both contain five individuals that are fighter pilots and that enter a bar. Suppose further that for both worlds just one of those five individuals is also female and orders a beer. Asserting the second sentence of (1) in a Stalnakerian context would have no effect on it, given that in both worlds there is one individual that satisfies the predication and, therefore, both worlds are compatible with the common ground. On the contrary, a dynamic representation of context captures the nuance expressed by the sentence by eliminating all the assignments for  $x$  that do not satisfy the constraints introduced by the assertion. Hence, despite having the same amount of worlds, the context changes by adjusting the assignment functions and the values that they output when having a certain discourse referent as their argument.

## **2. A Problem Concerning Uniqueness**

While what we just sketched may seem a neat analysis of intersentential anaphora, philosophers like Robert Stalnaker (1998), Robert van Rooij (2001) and Paul Dekker (2004) deem its predictions to be unsatisfactory. Their criticism relies on the intuition that sometimes pronouns appear to behave as *referential expressions* that pick up a *unique* individual. Let us clarify this point with an example. Suppose Max and Tom are at a party and that they are both looking at the buffet table.

- (2) Max: Look! A man is eating all the shrimp cocktails.  
Tom: He looks hungry.

According to dynamic semantics, updating a context with (2) will (i) introduce a new discourse referent  $y$ , (ii) assign to  $y$  all individuals relative to each world in the context that satisfy the predication, and (iii) eliminate all the worlds in which there are no individuals that satisfy the predication. Now, it must be highlighted that this interpretation allows multiple individuals to be assigned to the discourse referent. For example, If there is another man on the other side of the buffet table that is also eating all the shrimp cocktails and looks hungry, then he is as a viable assignment for  $y$  as the man that Max and Tom are looking at. Because, after all, the discourse referent is simply a placeholder with no uniqueness constraints; whoever matches the description written on the file card  $y$  can be an assignment for  $y$ . However, Stalnaker et al disagree exactly on this point. They think that the pronoun ‘he’ present in (2) refers to the unique individual that Max and Tom are looking at. A case that argues in favour of their claim can be exemplified by (3).<sup>4</sup>

- (3) Max: a client called me up yesterday.  
Tom: did he call about something important?  
Max: # that depends, if he called in the morning he did, but if he called in the afternoon he did not.

According to dynamic semantics, updating a context with (3) is completely fine. The presence of the indefinite noun ‘a client’ introduces a new file card  $z$  that contains all the information given in (3). Max is not contradicting himself by uttering the third line of the dialogue, given that it is possible that multiple men called him up yesterday and that the one that called him in the morning wanted to discuss something important while another one that called in the afternoon just had trivial matters to express. However, the third line of this dialogue sounds completely infelicitous. It seems that Max is not allowed to express (3) while exploiting the reading for which multiple men call him up. van Rooij and others take the infelicity of (3) to be a counterexample for theories, like dynamic semantics, that claim that pronouns do not

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<sup>4</sup> A slightly different version of (3) can be found in van Rooij (2001)

refer to a unique individual in these cases. This leads van Rooij and others to propose theories that interpret pronouns as terms that refer to whom the speaker ‘has in mind’ or, in other words, whom the speaker *intends* to refer to when using a pronoun. Without diving into the formal details of these referential accounts for pronouns, one can easily see how such theories explain the infelicity of (3). If the pronoun refers to a unique individual, then the pronoun cannot refer to multiple men that called Max. Hence, the dialogue is infelicitous.

Nevertheless, Karen Lewis criticises these theories, which she calls *referential intentions accounts*, in her 2013 paper ‘Speaker’s Reference and Anaphoric Pronouns’. She claims that the referential intention account lacks explanatory power. After giving a taxonomy of cases in which indefinite-linked pronominal anaphora is used, she points out that in some of those cases pronominal anaphora is licensed even when the speaker does not have any unique individual ‘in mind’ when uttering those sentences. For example, “imagine a speaker at a cancer research fundraiser”<sup>5</sup> uttering (4).

- (4)
- a. A woman dies of breast cancer every five minutes. (pause)
  - b. A woman just died.
  - c. Her life would have been saved if we had a cure.

Lewis argues that the speaker in (4) does not have a unique individual in mind, because there is no relation, causal or otherwise, between the speaker and an individual which could be the referent of the pronoun. Therefore, the pronoun ‘she’ in (4) can not pick up a unique individual, given that there is simply no referent for the pronoun. However, uttering sentences like (4) is completely felicitous. Hence, the referential intentions account is unable to explain these cases and lacks, consequently, explanatory power as a theory of meaning.

Despite my agreeing with Lewis’s criticism of the referential intentions account, dynamic semantics still faces a problem concerning uniqueness. Lewis shows with her argument that a specific way of interpreting indefinite-linked pronominal anaphora, i.e. the referential intentions account, is unsatisfactory. Yet, her argument does not solve the infelicity of the dynamic interpretation of (3). The dynamic semanticist still has to come up with an explanation for why it is infelicitous to interpret a pronoun as referring to multiple individuals in those cases, regardless of whether alternative theories that explain this infelicity fail to

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<sup>5</sup> Lewis (2013)

cover other uses of pronominal anaphora. So, how could a dynamic semanticist solve this problem? Given that the infelicitous prediction of the dynamic analysis originates from the lack of uniqueness constraints put on the discourse referent, or rather, on the assignments of the discourse referent, one could propose to simply put uniqueness constraints on the discourse referent when it is being introduced. In particular, one could add a constraint such that a discourse referent  $x$  can only have one assignment per world. If just one individual is assigned to the discourse referent, then the pronoun would pick up that unique individual and the dynamic semanticist would have an explanation for the infelicity of (3), because readings where the pronoun refers to multiple men are out of the question at that point. Furthermore, it is important to notice that it is not necessary that the individual assigned to the discourse referent be the same individual in all the worlds present in the context. The problematic aspect of the dynamic prediction with regards to (3) is that the theory allows for multiple assignments relative to one world; introducing a constraint that also guarantees inter-worldly uniqueness is superfluous in this case.

Now, why do we not simply adopt this solution and add this uniqueness constraint to dynamic semantics? Despite solving the problem related to the dialogue presented in (3), which I will call more generally ‘exploitation case’ from now on, adding this constraint would eliminate one of the greatest virtues of the dynamic model: interpreting indefinite-linked pronominal anaphora without putting uniqueness constraint neither on the indefinite nor on the pronoun. There are strong linguistic intuitions that suggest that sentences like (4) are not concerned with a unique individual, rather they seem to communicate an existential claim, as shown by (4ex).

(4ex) Some woman dies of breast cancer every five minutes.

Arguments that defend this intuition are numerous in the literature and can be dated back to Russell’s writings on indefinites. Hence, it seems that we have reached an impasse. On the one hand, if we leave dynamic semantics as it is, then we are unable to explain the infelicity of the exploitation case, but we preserve the intuitive interpretation of indefinite-linked pronominal anaphora provided by dynamic semantics. On the other hand, if we modify dynamic semantics by introducing a uniqueness constraint, then we explain the infelicity of

the exploitation case, but lose the intuitive interpretation of indefinite-linked pronominal anaphora. Is there a way to overcome this stalemate?

### **3. A Conceptual Distinction**

What transpired from the previous section is that some uses of indefinite-linked pronominal anaphora seem to require uniqueness constraint while others do not. Moreover, if we attempt to modify the semantics in order to accommodate one set of cases, then we neglect the other one, and vice versa. Can we accommodate both sets of cases? Yes, we could stipulate that exploitation cases ought to be interpreted with uniqueness constraints while the remaining cases ought to be interpreted without them. Yet, this stipulation is rather ad hoc. If we want to have it both ways, then we should start looking for a conceptual notion that comprehensively distinguishes the two sets. Because, if it can be argued that these two sets of cases are different from each other under a certain aspect, then we can probably also argue that they should be treated differently in dynamic semantics and, therefore, have a theory that appropriately interpretes both sets while avoiding the apparent contrast between the two. Which conceptual notion can comprehensively distinguish between uses of indefinite-linked pronominal anaphora that require uniqueness and ones that do not?

A possible candidate that could satisfy this role is the notion of *speaker's reference* of the referential intentions account discussed earlier. One could argue that whether uniqueness is required or not depends on whether a speaker intends to refer to a unique individual when uttering a pronoun in an indefinite-linked pronominal anaphora. If the speaker has a unique individual in mind and intends to refer to it via the assertion in question, then uniqueness constraints are appropriate. On the contrary, if the speaker does not have a unique individual in mind, then no uniqueness constraint is required. Relying on the notion of speaker's reference provides us with a neat distinction between cases while not having to go to the trouble of defining a completely new notion, given that it is already used by the referential intentions account. Moreover, Karen Lewis's argument about the lack of explanatory power has no negative effect on this distinction. The topic at hand is finding a conceptual notion that distinguishes between different uses of indefinite-linked pronominal anaphora. We are not claiming that all cases in which these expressions are used are instances in which the speaker is referring to a unique individual. On the contrary, we acknowledge Lewis's point and are, therefore, able to distinguish between the cases. Nevertheless, for how promising the notion

of speaker's reference might seem, it is still deemed to fail. In her 2013 paper Karen Lewis presents a second argument against the referential intentions account that also affects the conceptual notion of speaker's reference. Lewis argues that the referential intentions account gets the truth-conditions of indefinite-linked pronominal anaphora wrong. In particular, If we interpret these expressions by assuming that the speaker intends to refer to a unique individual that he has in mind, then whether the sentence is true or false will be dependent on the speaker's referent. Yet, our intuitions speak against this, as this passage taken from Lewis (2013) shows:<sup>6</sup>

Suppose a professor tells his class one day:

- (5)    a. An anthropologist discovered the skeleton called 'Lucy'.  
      b. He named it after a Beatles song.

Suppose further that the professor has a particular anthropologist in mind, say, Louis Leakey, and fully consciously intends to be talking about him. The next day, the professor realizes he had the wrong person in mind; it was actually Donald Johanson who made the discovery. Did the professor utter a falsehood to his class? According to the referential intentions account he did. For the individual raised to salience and thus the value of the pronoun he is Louis Leakey, and so (5b) is false. (...) But it is intuitively clear that there is nothing about what the professor said that is false.

I do, again, agree with Lewis on this point. If we rely on the notion of speaker's reference and identify the cases that do require uniqueness by claiming that they communicate something about a unique individual that the speaker has in mind, then we have to accept these counterintuitive truth-conditions. But this seems rather a big bullet to bite. Hence, we will abandon the notion of speaker's reference, with the hope of finding another notion that does not give rise to similar complications.

The conceptual notion that I will present in this chapter relates to the evidential structure of the grounds that support the speaker's utterance. I will argue that whether uniqueness constraints are required depends on whether the speaker has direct or indirect evidential

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<sup>6</sup> Lewis (2013) p. 419, number of the example changed from (25) to (4)

access to the grounds that sustain the indefinite-linked pronominal anaphora uttered by her. More specifically, if the utterance is sustained by an *indirect evidential inference* about the identity of the discussed individual, then the utterance constitutes a case in which uniqueness constraints are not required. On the contrary, if no such inference supports the utterance, then uniqueness constraints are required. In order to clearly characterize this notion and show how it distinguishes between uses of indefinite-linked pronominal anaphora, I will go through Karen Lewis's (2013) taxonomy of these expressions and provide a cases-by-case analysis of how my notion evaluates these different cases. Moreover, I will also compare the results of my notion with the ones that originate from adopting the notion of speaker's reference. If the two carve up the taxonomy in similar fashion, then an argument could be made in favour of my notion. Because after all, adopting the speaker's references seemed to be a promising way for distinguishing between cases. We only abandoned it due to its counterintuitive truth-conditions. Thus, if my notion about the evidential structure of the grounds that support pronominal anaphora turns out to do a similar job without getting us in trouble with the truth conditions, then we have found the conceptual notion that will help us solve the problem concerning uniqueness.

### **3.1. Taxonomy**

Lewis's (2013) taxonomy of indefinite-linked pronominal anaphora incorporates some cases from Ludlow's and Neale's (1991) taxonomy of indefinites as well as ones presented by other authors.

#### **3.1.1. Referential Cases**

These are instances in which a speaker points out something about the environment in which the discourse is taking place. An example that characterizes this set of cases can be found in (2), which is presented here again as (6) for the sake of clarity. Suppose Max and Tom are at a party and have the following dialogue.

(6) Max: Look! A man is eating all the shrimp cocktails.

Tom: He looks drunk.

In referential cases, both the speaker and the hearer have direct evidential access to the identity of the discussed individual. In this particular instance, both Max and Tom have direct evidential access to the man in question by *seeing* him standing at the buffet table. If they have direct evidential access to the discussed individual, then the grounds that support their dialogue lack an indirect evidential inference about the discussed individual. Hence, my notion identifies referential cases as instances in which uniqueness constraints are required. Similarly, if we evaluate this case using the notion of speaker's reference, we will also identify referential cases as requiring uniqueness constraints. Given that we can point to a causal relation between the speaker and the discussed individual which in turn allows the referential intention account to claim that the speaker has someone in mind when uttering the sentence.

### 3.1.2. Specific Cases

These are cases in which a speaker has direct evidential access to the grounds that sustain her assertion but the audience to which she is communicating it lacks that direct access. Here is an example from Ludlow and Neale (1991). “Suppose Anna knows there is a specific auditor who comes to see her every year, and last year he put her through a horrible audit for no reason; in the end she didn’t owe anything in taxes. She believes today is the day for the auditor to visit her and says:”<sup>7</sup>

- (7)    a. An auditor is coming to see me today.  
       b. He is a ghastly man.

Anna has direct evidential access to the identity of the auditor, given that she *remembers* him. Anna’s grounds for the indefinite-linked pronominal anaphora do not display an indirect evidential inference about the identity of the individual. Hence, my notion will classify particular cases as instances in which uniqueness constraints are required. The same result is achieved when adopting the notion of speaker's reference, given that the same reasoning presented in the referential cases can be applied here as well.

### 3.1.3. Definite Cases

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<sup>7</sup> Lewis (2013) but originally from Ludlow and Neale (1991)

These cases are less straightforward than the previous ones. So starting with an example is probably the best way to introduce them.

Suppose that many people in a certain wealthy village have had their jewelry stolen over the last two months. The police are convinced that the thefts were all carried out by a single individual. They issue a warning about "the local jewelry thief." One morning, one of the villagers comes back from a walk to find his house has been broken into. The ground floor of the house has been completely ransacked and his jewelry has been stolen. Later in the day he meets a friend who asks him why he is so upset. The villager replies as follows:<sup>8</sup>

- (8) a. A jewelry thief paid me a visit this morning.  
b. He took my gold watch.

The villager does not have direct evidential access to the jewelry thief visiting his house. He instead inferred from the evidence (the missing gold watch, the ransacked ground floor, etc.) that a thief visited his house. So, given that the villager's grounds for the assertion are characterized by an indirect evidential inference about the identity of the thief, this case will be one that does not require uniqueness constraints, according to my notion. However, evaluating this case while using the notion of speaker's reference will provide us with the opposite result. For the referential intentions account this is technically considered as a case in which a speaker has a unique individual in mind,<sup>9</sup> because there is a unique individual that can satisfy the description expressed by (8), i.e. the local jewelry thief.

### 3.1.4. Evidential Cases

Evidential cases are instances in which the speaker does not have direct evidential access to the individual in question, and the expressed indefinite-linked pronominal anaphora is not expressing a description that is uniquely satisfied as the definite cases from before. To give an example, picture Karen coming home after a long day at work and seeing that there is dog pee

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<sup>8</sup> Ludlow and Neale (1991)

<sup>9</sup> Lewis (2013) p.183

on a bush in her yard as well as some uprooted flowers. She immediately calls her sister Sarah and says (9).

- (9) a. A dog was in the yard while I was at work.  
b. It trampled the pansies and peed on the poor barberry bush at the corner of the lot.

Karen is inferring from the evidence that a dog was in her yard; she does not have direct evidential access. The grounds that support Karen's utterance contain an indirect evidential inference about the identity of the dog. Thus, according to my notion, this is a case in which uniqueness constraints are not required. Moreover, the same results are achieved by using the notion of speaker's reference. Karen does not have a unique dog in mind when uttering (9), because there is no relevant connection between the speaker and the dog that could straightforwardly function as a referential link.<sup>10</sup>

### 3.1.5. Statistical Cases

These cases are similar to the evidential cases. However, "the potential connection between evidence (such as dog pee) and particular individuals (the dog or dogs that peed)"<sup>11</sup> is severed. We already encountered this case in § 2. as (4); here displayed again as (10). "Imagine a speaker at a cancer research fundraiser."<sup>12</sup>

- (10) a. A woman dies of breast cancer every five minutes. (pause)  
b. A woman just died.  
c. Her life would have been saved if we had a cure.

The speaker is making an inference on the basis of the statistical information he provided in (10a). (10b) is the resulting conclusion from (10a) and the pause he took after uttering it. Also these cases, like the evidential cases, are identified as instances that do not require uniqueness according to my notion. Furthermore, the speaker has no unique individual in mind as we already pointed out previously. Hence, also a division that uses the notion of speaker's

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<sup>10</sup> Causal connections that link speaker and referent via the evidence left by the referent are disregarded here for clarity's sake.

<sup>11</sup> Lewis (2013)

<sup>12</sup> *ibid.*

reference will group statistical cases as being part of the set of instances in which uniqueness constraints are not required.

### **3.2. Taking stock**

In conclusion to this section, what can be said about distinguishing uses of pronominal anaphora while relying on the notion of the evidential structure of the grounds that sustain the expression? The taxonomy shows, on the one hand, that uniqueness constraints are required in referential cases and specific cases. On the other hand, a lack of uniqueness constraint is endorsed in definite, evidential and statistical cases.

This distinction bears some similarity with the one achieved by adopting the notion of speaker's reference. However, it must be noted that this latter notion predicts definite cases to be instances in which uniqueness constraints are required. Nevertheless, this divergence seems rather a small price to pay when confronted with the counterintuitive truth-conditions that follow with the use of the speaker's reference notion. The notion that I have presented provides a comprehensive distinction between cases and does not give rise to awkward truth-conditions. Because, the distinction relates purely to the grounds that support the utterance and not the utterance itself. This allows us to avoid interfering with the truth-conditions, given that the notion has directly nothing to do with what is being expressed. But even if we were to assume that the notion directly relates to what is being expressed, then we would still predict appropriate truth-conditions. Because this would simply amount to saying that the speaker is communicating to the audience the grounds that sustain his assertion. So, if we considered Lewis's anthropologist case again (see (5)), then, given that my notion identifies it as being a case that requires uniqueness constraints, it would follow that the professor is simply expressing to the class that he has a direct evidential access to the identity of the anthropologist he mentioned. Whether he is remembering correctly or not is completely irrelevant for a notion that relates to how his evidential grounds are structured, rather than whom he has in mind, like the speaker's reference notion.

## **4. Integrating the Conceptual Notion into the Formal Theory**

The previous section provided us with a conceptual notion that allowed us to differentiate between cases that require uniqueness constraints and ones that do not. Yet, the notion still

needs to be appropriately introduced in the dynamic formal framework, in order to solve the problem regarding uniqueness. How can this be accomplished?

I will argue that all cases of unembedded indefinite-linked pronominal anaphora, which are identified as not requiring uniqueness constraints, are instances in which the sentence is subordinated to an operator. More specifically, I will defend the claim that, in definite, evidential and statistical cases, a indefinite-linked pronominal anaphora has a covert epistemic ‘must’ in the antecedent sentence. With this modification in place, we will have a clear syntactic distinction between cases that require uniqueness and ones that do not. From there, I will stipulate that all cases of unembedded indefinite-linked pronominal anaphora (the remaining referential and specific cases) are interpreted as having uniqueness constraints. This second modification will now be harmless given that, by separating definite, evidential and statistical cases with the embedding, it will solely target cases that do require uniqueness. Thus, in the end, I will show how this revised version of dynamic semantics is able to explain the infelicity of exploitation cases.

In order to guarantee a clear understanding of the upcoming argument, it seems imperative to provide some preliminary information on how uniqueness relates to embedded indefinite-linked pronominal anaphora. According to Lewis (2013), if an indefinite-linked pronominal anaphora is subordinated under an operator, be it a conditional, modal, generic quantifier etc., then the speaker does not have a unique individual in mind, because most of the times there is not even an individual that could be the intended referent, as we can see with (11).<sup>13</sup>

- (11) a. I wish I had a pet unicorn.  
b. I would take her out at night and fly all around.

Hence, if we do end up interpreting definite, evidential and statistical cases as instances of subordination, they will be in good company with other instances that do not require uniqueness. Nevertheless, I am not claiming that these cases will be subordinated to a random operator; what I am arguing for is that they are subordinated to an epistemic must-operator. Therefore, let us focus on the modal operator ‘must’ and its ability to signal indirectness.

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<sup>13</sup> Lewis (2013) p. 412

#### 4.1. The Indirectness of ‘must’

The first distinction that is important to draw here is that I’m interested in an *epistemic* ‘must’ rather than a *deontic* or *bouletic* one.

(12) The butler must be the murderer.

(13) Max must save the ten miners.

(14) I must water my garden.

All three of these sentences are must-claims. However, they have distinct *flavours*.<sup>14</sup> (13) expresses a deontic ‘must’ and communicates a moral obligation. This sentence can be paraphrased as ‘Max has the moral duty to save the ten miners’. (14) expresses a bouletic ‘must’. This flavour does not relate to a moral duty but rather to the preferences that the speaker has, (14) can be understood as similar to ‘I will water my garden given that I want my garden to be beautiful’. Lastly, there is (12) that expresses an epistemic ‘must’. This sentence communicates something about the epistemic grounds that a speaker possesses. A way of paraphrasing (12) is through the addition of a ‘given all I know’ in antecedent position, as exemplified by (15).

(15) Given all I know, the butler is the murderer.

The literature on epistemic ‘must’, and modal operators in general, is quite extensive. For the purpose of this chapter, however, I am mainly interested in one particular feature that ‘must’ has and that was first discovered by Karttunen (1972).

Suppose Max is drinking his morning coffee while looking out the window. Suppose further that he sees that it is raining. Now, notice how it is completely fine for Max to utter (16a) but not the modalized claim (16b).

- (16) a. It’s raining.  
b. # It must be raining.

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<sup>14</sup> Kratzer (1977)

Nevertheless, if Max is not in a situation where he sees the rain and instead he is looking at some workers that just entered his flat and that are all wet, then both (16a) and (16b) are felicitous utterances. What is the explanation for this phenomenon? The view that is uncontroversially held in the literature regarding this phenomenon is that an epistemic ‘must’ “carries an *evidential* signal, in particular it signals that the speaker has reached her conclusion via an indirect inference.”<sup>15</sup>

To put it in other words, a must-claim signals that its prejacent is a proposition to which the speaker does not have direct evidential access. Furthermore, the proposition expressed is the result of inferring from some other piece(s) of evidence that is(are) accessible to the speaker. Hence, (16b) is felicitous if Max does not have direct evidential access to the state of affairs represented by the subordinated proposition. Yet, given that in the first scenario he sees the rain, he cannot felicitously utter (16b). On the contrary, in the second scenario, the one in which he just sees the wet workers, it is completely fine for him to utter (16b), given that he is making an indirect inference regarding the prejacent.

#### **4.2. Indefinite-linked Pronominal Anaphora and ‘must’**

The reasoning that links uses of indefinite-linked pronominal anaphora to must-claims is quite straightforward. The conceptual notion used previously in order to divide between cases distinguishes instances with regards to whether the grounds that support them exhibit an indirect evidential inference about the identity of the discussed individual or not (i.e. if there is an indirect inference, then the case does not require uniqueness, while if there is no indirect inference, then the case does require uniqueness). Moreover, as we have just seen, the felicity-conditions of must-claims depend on whether the epistemic grounds that support the prejacent exhibit an indirect evidential inference (i.e. a must-claim is felicitous if there is an indirect inference, but is infelicitous if there is no indirect inference). Thus, I assume that all unembedded indefinite-linked pronominal anaphoras that do not require uniqueness can be felicitously subordinated under a must-operator, while all unembedded indefinite-linked pronominal anaphoras that do require uniqueness constraints cannot be felicitously subordinated under a must-operator.

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<sup>15</sup> von Stechow & Gillies (2010)

This assumption can be tested by simply modifying the different examples that were given in the taxonomy and make them must-claims. If 'must' can be easily added to expressions that do not require uniqueness without changing their meaning, whilst addition to expressions that do require uniqueness is impossible without drastically changing its meaning, then we can show that 'must' appropriately tracks the distinction provided by the conceptual notion.

#### **4.2.1. Referential Cases and 'must'**

[Max and Tom are at a party and are looking at the buffet table]

(17) Max: # Look! A man must be eating all the shrimp cocktails.

Tom: He looks drunk.

This dialogue is clearly infelicitous. Max is using 'must' while having direct evidential access to the state of affairs represented by the subordinated sentence. (17) bears the same counterintuitiveness as scenario (16b) in which the speaker is seeing the rain. Adding 'must' in referential cases is therefore impossible if one wants to preserve felicity. Hence, referential cases fail the must-test.

#### **4.2.2. Specific Cases and 'must'**

[Anna is talking about an auditor she met a year ago, who she believes will visit her today]

(18) a. An auditor must be coming to see me today.

b. He is a ghastly man.

This sounds fine. However, specific cases still fail the must-test. The reason for the felicity of (18) relates to (18a) having contents that are the result of an indirect evidential inference. More specifically, Anna's belief that the auditor is coming to see her today is grounded on an indirect evidential inference. Yet the indirect inference does not relate to the identity of the auditor. Thus, this is a bad example for the must-test, given that the 'must' that is being added ought to relate to the identity of the discussed individual. A more apt example could be (19).

(19) a. # I must have met an auditor last year.

b. He is a ghastly man.

Similarly to the referential cases, the use of ‘must’ in (19a) makes Anna’s utterance infelicitous given that she had direct evidential access to the identity of the auditor.

#### **4.2.3. Definite Cases and ‘must’**

[a wealthy villager comes home and sees that his house has been ransacked and that jewelry is missing]

- (20) a. A jewelry thief must have paid me a visit this morning.  
b. He took my gold watch.

Adding ‘must’ is unproblematic here. It neatly fits into the claim of the villager and signals that the villager is expressing a proposition for which he has indirect evidential access, as he does. (20) communicates the same utterance as its unembedded counterpart. Definite cases pass the must-test.

#### **4.2.4. Evidential Cases and ‘must’**

[Karen comes home from work and sees that there is dog pee in the yard and her flowers are uprooted]

- (21) a. A dog must have been in the yard while I was at work.  
b. It trampled the pansies and peed on the poor barberry bush at the corner of the lot.

Evidential cases are the ones that most-strikingly resemble a must-claim. In this particular example, the evidence that allows the indirect inference is even asserted by (21b). The must-claim relates to the identity of the individual that is being discussed (in this example: a dog). The subordination is flawless and does not change the sentence. Evidential cases pass the must-test.

#### **4.2.5. Statistical Cases and ‘must’**

[a speaker at a cancer fundraiser]

- (22) a. A woman dies of breast cancer every five minutes. (pause)  
b. A woman must have just died.  
c. Her life would have been saved if we had a cure.

Finally, even statistical cases pass the must-test. The speaker is making an indirect inference on the basis of statistical evidence expressed by (22a) which is followed by (22b) as the evidential conclusion of the inference. Ordinary must-claims follow the same pattern. Therefore it is unsurprising to see that the addition of ‘must’ in these cases is so straightforward.

### 4.3. Reviewing the Results

The must-test bears the predicted results. It is impossible to felicitously add ‘must’ in referential and specific cases, yet the addition is flawless in definite, evidential and statistical cases. These results speak therefore in favor of my assumption; ‘must’ appropriately tracks the distinction given by the conceptual notion. Thus, we do not only have found an intuitive way to determine whether an indefinite-linked pronominal anaphora requires uniqueness or not, but also, and most importantly, we have found a way to clearly integrate the conceptual notion and its consequent division into the formal framework. By interpreting definite, evidential and statistical cases as subordinated cases, i.e. as being embedded under a must-operator, we can syntactically distinguish instances that require uniqueness constraints and ones that do not. Now, we can simply add uniqueness constraints to the introduction of the discourse referent in an *unembedded* pronominal anaphora, as discussed in § 2., and we have a solution to the problem concerning uniqueness, given that the uniqueness constraints will now only apply to referential and specific cases.

### 4.4. Explaining the Exploitation Cases

The only thing that is left to do, is to show how this revised version of dynamic semantics deals with uniqueness, and what better way to do this than with van Rooij’s exploitation case? Suppose Max and Tom are co-workers in a company that sells vintage watches. Suppose further that important clients always call in the morning and that unimportant clients always call in the afternoon. Now, Max is having a coffee-break with Tom and they have the following dialogue.

(23) Max: a client called me up yesterday.

Tom: did he call about something important?

Max: # that depends, if he called in the morning he did, but if he called in the afternoon he did not.

Now, as we already noticed, the infelicity of the third line of the dialogue originates from the lack of uniqueness constraints put on the discourse referent. Our intuitions are apparently telling us that (23) is similar to a specific case, an instance in which the speaker has direct evidential access to the discussed individual. Therefore, Max's answer is infelicitous because he does not abide to the uniqueness constraints that our revised semantics impose on the discourse referent. Furthermore, it is important to highlight how the counterintuitiveness of this example is similar to the one originated by uttering must-claims while having direct evidential access to the state of affairs represented by their prejacent. For example, suppose that I know that a friend of mine always is in a park at 9.00 a.m.. Suppose further that I meet this friend in the evening and ask him whether it was raining at 9.00 a.m.. If he answered: "It must have rained at 9.00 a.m.", then I would be quite confused by his answer, because I know, due to him being in a park, that he saw the rain. What I am trying to say here is that something similar is going on in the exploitation case. Tom's question seems to suggest that Max ought to have direct evidential access to the identity of the client and, therefore, Max's answer becomes infelicitous, because, as I argued, a lack of uniqueness constraints is linked to having indirect evidential access to the identity of the individual in question. This assumption can be bolstered by simply adding a 'must' in the first line of the dialogue.

(24) Max: a client must have called me up yesterday.

Tom: # did he call about something important?

Max: that depends, if he called in the morning he did, but if he called in the afternoon he did not.

We can see here how the dialogue has completely changed. Max lines are completely fine now, while Tom's question sounds slightly awkward. (24) corroborates the account I have sketched in this chapter not only with regards to the claim that uniqueness constraints for

indefinite-linked pronominal anaphora are dependent on the grounds that support the assertion, but also with regards to the usefulness of ‘must’ as a tool for gaining more insight on linguistic phenomena that involve pronouns and indefinites. Hence, the exploitation case is not just taken care of in this revised dynamic semantics, but it is also used as data that argues in favour of this revision.

What can be said as a final remark? The aim of this chapter was to address the criticism put forward by philosophers like Robert van Rooij, which deemed dynamic predictions for certain uses of indefinite-linked pronominal anaphora to be unsatisfactory, due to the inability of dynamic semantics to explain the counterintuitiveness of cases like the exploitation case. In order to defeat this criticism, I introduced, first of all, a conceptual notion that relates to the evidential structure of the epistemic grounds that the speaker has for supporting the indefinite-linked pronominal anaphora. This notion allowed us to define a comprehensive distinction between cases that do require uniqueness, like the exploitation case, and those that do not. From there I linked this conceptual notion with the use of the term ‘must’. In order to solve the problem concerning uniqueness, I proposed to interpret certain uses of indefinite-linked pronominal anaphora, that do not require uniqueness constraints, as embedded expressions. More specifically, I argued for regarding those instances as being subordinated under an epistemic must-operator. This modification allowed us to syntactically differentiate between cases that require uniqueness constraints and ones that do not. Due to this syntactic difference, I then managed to accurately introduce uniqueness constraints into the semantics so that they solely targeted cases that required them. This modified version of dynamic semantics was, therefore, able to explain the infelicity of the exploitation case thanks to these precise uniqueness constraints.

It must be noted finally that my reasoning leads to the transformation of some indefinite-linked pronominal anaphoras, which exhibit no need for uniqueness constraints, into must-claims. Some might see this as problematic, given that dynamic semantics considers epistemic modals to be unable to license pronominal anaphora. However, this is more a problem for dynamic semantics in general rather than for my specific version. Intuitively, a pronominal anaphora, that has a must-claim as its antecedent utterance, is completely felicitous. Analysing a pronominal anaphora that has a modal as antecedent sentence is a

problem that needs to be solved by dynamic semanticists. Nevertheless, my account guarantees that, by solving it, also the problem concerning uniqueness will be solved.

## **Epistemic Modals and Anaphora in Dynamic Semantics**

In the previous chapter I gave an account that solves a problem regarding dynamic semantics and anaphoric pronouns that seem to require uniqueness constraints. In my solution I suggested to interpret indefinite-linked pronominal anaphoras, that do not require uniqueness constraints, as having a covert ‘must’ in the antecedent sentence, making them modalized expressions. However, the current dynamic interpretation of sentences that are subordinated under an epistemic modal does not license anaphora. The inability to allow anaphoric links after a must- or might-claim does not take anything away from the soundness of the argumentation presented in the previous chapter. It rather exposes a more general problem of the dynamic model. Nevertheless, it seems appropriate to tackle this issue in order to provide a complete account that does not incorporate dysfunctional mechanisms.

Hence, in this chapter I will present further modifications of the dynamic model in order to correctly capture pronominal anaphoras that have a must- or might-claim as their antecedent. In the first section of this chapter I will sketch the dialectic of the problem and explain why the combination of epistemic modals and pronominal anaphora is so problematic for the dynamic model in the first place. It will become apparent that several other data and conceptual points about epistemic modals are relevant for an appropriate evaluation of the problem. Therefore, the analysis that will be presented can be seen as tackling the dynamic interpretation of epistemic modals in general. The second section will build upon the first one by offering an informal solution that takes into account the different considerations made beforehand. Broadly speaking, I will argue that interpreting epistemic modals as triggering a purely additive mechanism, rather than a traditional test-like mechanism, will preserve the virtues of the traditional interpretation while eliminating the flaws, like the inability to license pronominal anaphora, that came with it.

### **1. A Problematic Interpretation of Epistemic Modals**

To be on the same page regarding what kind of linguistic phenomenon will be tackled in this chapter, let us consider the following two sentences.

- (1) A police officer might come to the bar.
- (2) A dog must be in the yard.

These two examples characterize the modal claims that will be the focus of this chapter. Sentence (1) exemplifies a might-claim, while (2) is a must-claim. Following Veltman (1996) and Beaver (2001), the traditional dynamic interpretation of modal claims of this kind is similar to a *test*. More specifically, what is being tested when a context is updated with a modal claim is whether certain relations between the prejacent of the modal claim and the context hold. If the test succeeds and the relation between prejacent and context is accounted for, then the update leaves the context unchanged. On the contrary, if the test fails, then the update leads the context to a conversational failure viz. an empty context. But, what exactly are these relations between prejacent and context that ought to be present in order to pass the test set by a modal claim? Let us start answering this question by looking at the might-claim in (1). The sentence subordinated to the might-operator is ‘a police officer comes to the bar’. Suppose that the context in which (1) is being uttered is made out of two possible worlds and that just one of these worlds contains an individual that satisfies the predication of the prejacent in (1), i.e. there is only one world that has a police officer that comes to the bar. If we took the prejacent as a non-modalized sentence uttered in the context and updated the context accordingly, then we would get a context containing just one world. The context would shrink, but the prejacent in (1) would still be compatible with the common ground. In other words, the context can be updated with the prejacent without reaching the empty context. Yet, if we imagined a context in which there is no world with an individual satisfying the predication of the prejacent, then updating the context would eliminate all the worlds. In this second case the prejacent is incompatible with the common ground and the context cannot be updated with it while not becoming empty. The difference between these two scenarios determines whether the test introduced by a might-claim succeeds or fails. A might claim in dynamic semantics is a test concerning the compatibility of its prejacent with the context. If the context can be updated with the prejacent by leaving at least one world in it, then the context remains unchanged. However, if updating the context with the prejacent leads

to the elimination of all the worlds present in the context, then the might-claim yields the empty context.

Must-claims are construed as the dual of might-claims. Hence, rather than testing whether at least one world survives the prejacent's update, a must-claim tests whether all the worlds of the context remain after the update. If we take (2) for example and imagine a context in which all the worlds possess an individual that is a dog and that is in the yard, then uttering (2) leaves the context unchanged. On the other hand, if the context includes some worlds in which there is no dog in the yard, then the test fails and uttering (2) leads to a conversational failure. So, where might-claims check the compatibility of their subordinated sentences with the context, must-claims tests whether the prejacent is supported by the context, i.e. they make sure that their prejacent conveys information that is already present in the context.

It is important to highlight here that these atomic modal claims are non-informative. A context in which a modal claim is uttered either stays the same or becomes a conversational failure. Updates involving the prejacent of the modal are carried out solely for the purpose of determining whether the context fails or passes the test, and do not introduce persistent changes of the context like non-modalized assertions do. So, if there is at least one world that survives the update with the prejacent of (1), then all the worlds in the context survive the update with (1). Moreover, while a discourse referent is introduced and assigned to individuals that satisfy the predication of the prejacent in (1) in order to determine the outcome of the test, that discourse referent does not persist as a member of the domain of the context unlike referents that are introduced by non-modalized assertions. Hence, generally speaking, if someone utters a bare modal claim in a context, she either leads the conversation to a failure or it is as if she did not say anything. It is exactly for this reason that updating a context with a modal claim can be regarded as non-informative. If we understand the information carried by a sentence as the impact it has on the dynamic context, e.g. the sentence 'it's raining' is informative to the extent that it eliminates all the worlds from the context in which it is not raining, then successful tests introduced by modal claims have to be understood as being non-informative. Because they do not change the context in any shape or form, be it via an additive mechanism or an eliminative mechanism.

Someone could, however, argue that, while *successful* tests do appear to be non-informative, modal claims in general, as tests that can be successful or unsuccessful, can be considered informative. More specifically, a modal sentence might be regarded as having

an informative character given that they can potentially lead to the empty context if certain conditions are satisfied, and leading a context to a conversational failure is undoubtedly a modification of the context. While this remark is reasonably justified, it presupposes a rather broad understanding of the term ‘informative’. It is true that we just defined an informative sentence as simply one that has any impact on the context. Yet, this seems to be a too coarse grained definition for our current purposes. On the one hand, the information carried by a unembedded sentence like ‘it’s raining’ is the elimination of all the context-worlds in which it is not raining. On the other hand, if we accept the remark above, a modal claim is informative insofar as it potentially can eliminate all the worlds from the context if its prejacent lacks certain relations with the context. To put it differently, the information carried by ‘it’s raining’ answers the question of whether or not it is raining while the information carried by a modal sentence answers the question of whether or not a certain relation holds between its prejacent and the context. In the latter case the information is about the relation that the prejacent has with the context rather than being about the prejacent itself. So, while it can be argued that modal claims are informative in a general sense, they do exhibit a non-informative character with regards to the contents of their prejacent, i.e. whatever update the subordinated sentence would trigger without its modal embedding is cancelled by the modal operator. Regardless of whether the test is successful or not.

This interpretation of modals, however, leads to complications with regards to pronominal anaphora.

(1p) A police officer might come to the bar. She would ask some questions.

(2p) A dog must be in the yard. He left some footprints on the floor.

As explained in the previous chapter, anaphoric pronouns pick up the discourse referent introduced by the indefinite noun of the antecedent sentence. For example, the pronoun ‘she’ in (1p) picks up the discourse referent introduced by the indefinite noun ‘a police officer’. Yet, given the just discussed interpretation of modal claims which defines them as non-informative, the indefinite noun does not introduce a persistent discourse referent. Consequently, if no persistent discourse referent is introduced by ‘a police officer’, then the pronoun ‘she’ cannot develop an anaphoric link with the indefinite noun by picking up the discourse referent, simply because there is no discourse referent to begin with. This leaves the

pronoun referentless and the whole sentence undefined which in turn leads the context to a conversational failure. Thus, a dynamic model that incorporates a test-like interpretation of modal claims predicts that pronominal anaphoras preceded by a modal claim are infelicitous. Nevertheless, this prediction seems quite unintuitive. Uttering (1p) or (2p) seems completely fine. So, why would Veltman and others suggest an interpretation of modal claims that predicts such unintuitive results with regards to licensing pronominal anaphora?

### **1.1. The Virtues of a Test-like Interpretation**

There are mainly two reasons in favour of a traditional, test-like, interpretation; the first one being conceptually driven while the second one being data driven. To understand the former, one has to recall what epistemic modals are in the first place. As I said in chapter one, epistemic modals express sentences that are about the knowledge that the participants of a conversation have. After all, a must-claim can be paraphrased by replacing ‘must’ with the expression ‘given everything I know’.

(2’) Given everything I know, a dog is in the yard.

More specifically, in a static viz. non-dynamic model a must-claim is generally interpreted as asserting the necessity of its prejacent given what the speaker knows, while a might-claim is understood as expressing that its prejacent is possible in view of the speaker’s knowledge.<sup>16</sup> Now, in dynamic semantics context is defined as being what the participants of a conversation know or presuppose in that discourse. So, if epistemic modals make claims about the knowledge of speakers, then they are also making claims about the context. With this connection between epistemic modals and context one can see how the test-like interpretation of modals is quite intuitive within the dynamic model. By being concerned with the context itself, modal claims are different from non-modalized assertions that deliver new information to the context and are better understood as meta-claims about what is already contained in the context. The epistemic necessity of the subordinated sentence expressed by a must-claim is then cashed out as contextual support, while the epistemic possibility of a might-claim is represented as the compatibility of the prejacent with the context. To put it differently, in a static model, the epistemic necessity of a proposition amounts to it being true in all the

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<sup>16</sup> Kratzer (1977)

possible worlds that are epistemically available to a speaker, so, in a dynamic model, given that the epistemically available worlds are the context, a must-claim tests whether the prejacent is contained in all the worlds present in the context. Similarly, for a static interpretation of might-claims, epistemic possibility is defined as there being at least one epistemically viable world in which the prejacent is contained. Therefore, in a dynamic model, a might-claim checks whether its prejacent is present in at least one world of the context. The test-like interpretation can boast to embody a fitting integration of what is generally said about epistemic modals in static systems. Moreover, once someone realizes that the modal base of epistemic modals in static systems is equivalent to the context of a dynamic model, then the test-like interpretation starts looking like quite an intuitive approach for representing epistemic modals in dynamic semantics.

Nevertheless, this conceptual reason is not the only one that supports the test-like interpretation. The second one relates to how this interpretation is able to deliver good predictions when confronted with a certain version of Moore's paradox. Broadly speaking, when I talk about a Moore's paradox I have sentences in mind that follow this general formula:  $(a \wedge O(\neg a))$ . To put it into words, Moore's paradox is a conjunction in which the first conjunct is a simple unembedded claim while the second conjunct subordinates the negation of the simple claim under an operator; as shown by (3) and (4).

(3) It's raining and I don't know it's raining.

(4) A man is in the closet and I don't believe there is a man in the closet.

When confronted with (3) or (4) we tend to intuitively judge them as unassertable and consider them contradictions.<sup>17</sup> Yet, logically speaking, (3) and (4) are not contradictions, given that it might well be the case that it is raining and that I don't know that it is, because, for example, I am in a room with no windows. This tension is exactly what makes Moore's paradox a paradox in the first place. Nevertheless, the test-like interpretation of epistemic modals seems to be able to solve this tension when it comes to a version of Moore's paradox which is construed with 'might' as the operator.

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<sup>17</sup> Yalcin (2007)

(5) It is raining and it might not be raining.

As we just said, the intuitive response to Moore's paradox is to consider it unassertable. So, given that a good semantic model should align with our linguistic intuitions, the desired prediction for this paradox should deem it infelicitous. Does the test-like interpretation meet the desired prediction? If we apply what we learned about dynamic semantics so far and assume that a conjunction simply signals that the second conjunct updates the context after the first conjunct has updated it, then we will see how, first of all, the sentence 'it is raining' will eliminate all the worlds in which it is not raining from the context. Furthermore, when we reach the second conjunct, the might claim 'it might not be raining' will introduce a test that checks whether there is at least one world left in the context in which it is not raining. Yet, given the previous update, there is obviously no world in the context in which it is not raining. Hence, the test fails and the might-claim leads us to conversational failure. Nevertheless, a conversational failure was the desired prediction, given that intuitively Moore's paradox is an inappropriate linguistic construction. Moreover, the test-like interpretation is also able to capture a certain asymmetry between (5) and (6).

(6) It might not be raining and it is raining.

The sentence expressed by (6) is the result of switching the two conjuncts of (5) around and, while (6) is admittedly rather bad English, it does not sound as infelicitous as (5). Probably, in order to better express this intuition, we can modify (6) without changing its meaning as follows:

(6') It might not be raining. (pause) It is raining.

The addition of a pause and dividing the conjunction into two separate sentences does indeed help to make the point that (6') is felicitous while (5) is not. Moreover, as we said before, the test-like interpretation is able to capture this difference. If we start our analysis with a blank context, i.e. one that includes all possible worlds, then an update with the might-claim in the first sentence of (6') will be unproblematic. Because the test will succeed due to there being some worlds in which it is not raining. Therefore, the blank context will remain unchanged.

Now, when reaching the second sentence, the update with ‘it is raining’ will eliminate all the worlds from the blank context in which it is not raining. Nevertheless, (6’) is not predicted to lead to the empty context as (5). This asymmetry between two logically equivalent sentences with regards to their assertability is captured by the test-like interpretation. And while there are philosophers that do not consider this asymmetry to be supported by clear intuitions,<sup>18</sup> the fact that the test-like interpretation covers said asymmetry cannot be completely ignored.

Some might argue that the ability of the test-like interpretation to deliver a semantic explanation for the infelicity of Moore’s paradox is hardly a virtue of the model. After all, there are several philosophers who explain the unassertability of the paradox on the basis of pragmatic grounds. One can, therefore, maintain a static model and still explain the infelicity of the paradox through pragmatics. But what kind of pragmatic explanation can clarify the infelicity of (5)? The details vary depending on the philosopher but the general explanation rests on the claim that, while Moore-paradoxical sentences do not represent a semantic or logical contradiction, they do ensnare the speaker within a pragmatic conflict and are, therefore, unassertable.<sup>19</sup> What licenses this pragmatic conflict is the assumption that assertion is, at least on a pragmatic level, linked to knowledge on the basis that a speaker normally asserts what he knows. To give an example of what this pragmatic connection between assertion and knowledge is supposed to signify and to see how this link leads to a conflict, let us take a look at (3) again.

(3) It’s raining but I don’t know it’s raining.

Now, if we accept the claim that normally we assume that a speaker asserts what she knows, then the assertion in the first conjunct of (3) will have a covert know-operator. So, even if semantically the sentence is completely non-contradictory, when somebody utters this sentence we will hear something along the lines of (3p) due to our pragmatic understanding of it.

(3p) I know It’s raining but I don’t know it’s raining.

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<sup>18</sup> Yalcin (2011)

<sup>19</sup> Yalcin (2007)

This last sentence is a clear contradiction. Therefore we perceive Moore's paradox to be unassertable given that we recognize the speaker as having incoherent epistemic attitudes. This pragmatic approach for explaining the unassertability of Moore's paradox can be also used for the modalized versions of the paradox that we discussed so far. The only step that needs to be added to the argument is the assumption that there is some synonymy between (5) and (3) so that a similar pragmatic conflict can be generated.

Even if this explanation might be convincing for some, Seth Yalcin shows in his paper 'Epistemic Modals' how there is a clear distinction between the classic version of Moore's paradox and the modalized version characterized by (5). Yalcin introduces his argument by embedding (5) under the propositional attitude 'suppose' and therefore generating (7).<sup>20</sup>

(7) Suppose it's raining but it might not be raining.

It is clear that even this sentence is unassertable, putting us therefore in a position of having to find an explanation that not just covers the unembedded (5) but also one that justifies the infelicity of the embedded (7). As we just said, for the unembedded version we can rely on the pragmatic approach and assume that (5) behaves similarly to (3) and therefore justify the infelicity on the basis of a pragmatic conflict. However we also need an explanation for why (7) is bad. It is important to notice here, as Yalcin highlights, that attempting to recycle the same reasoning that is used to explain the unassertability of (5) is ruinous when it comes to the embedded case.<sup>21</sup> The basic premise used to justify (5) via the pragmatic approach is that (5)'s infelicity originates for the same reason that makes classic versions of Moore's paradox, like (3), unassertable. If this premise stands, then we can reach a pragmatic conflict by assuming that, in a pragmatic sense, assertion is linked to knowledge. Yet, while (5) is bad when embedded under the propositional attitude 'suppose', classic versions of Moore's paradox are completely fine when embedded under the same propositional attitude.

(8) Suppose it's raining but I don't know it's raining.

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<sup>20</sup> Yalcin (2007)

<sup>21</sup> *ibid.*

This difference in assertability between (7) and (8) is testament to how the premise supporting the pragmatic explanation is false with regards to embedded modalized cases. Hence we are forced to abandon the pragmatic approach, if we want to explain the unassertability of (7).

Moreover, when recognizing this divergence between (7) and (8) we can also reach a more general realization. The fact that non-modalized Moore-paradoxical sentences can be embedded under a propositional attitude like ‘suppose’ is evidence in favour of the pragmatic explanation for Moore’s paradox. By transforming the assertion expressed by the unembedded version of the paradox into a supposition via the embedding, we are eliminating the pragmatic link between assertion and knowledge given that the speaker that utters (8) is supposing something rather than asserting it. If the infelicity of the paradox disappears as soon as the link between assertion and knowledge cannot be established, then embedded sentences like (8) seem to show that the unassertability of Moore’s paradox truly originates from a pragmatic conflict rather than a semantic one. Given that, as soon as we introduce the supposition, we realize that the embedded sentence is representing non-contradictory conjuncts. Indeed, as Yalcin mentions, sentences like (8) are already used in the literature as evidence in favour of the pragmatic explanation for the unassertability of Moore’s paradox.<sup>22</sup> Yet, if the difference in assertability between embedded and unembedded Moore-paradoxical sentences lets us assume that the infelicity of the paradox is given by a pragmatic contradiction rather than a semantic one, then what should we make out of the fact that both the embedded and unembedded modalized versions of the paradox are unassertable? The evidence here seems to suggest that sentences like (5) and (7) are infelicitous due to them characterizing, not just pragmatic contradictions, but also semantic contradictions. Given that we came to realize that there is a clear difference between classic versions of Moore’s paradox and sentences like (5), it seems appropriate to call them something different than ‘modalized versions of Moore’s paradox’ in order to avoid confusion. Therefore, let us refer to these sentences with the term ‘epistemic contradictions’ from now on.<sup>23</sup>

Epistemic contradictions raise a completely new challenge for someone that aims to maintain a static semantic system while relying on the pragmatic explanation of Moore’s paradox. While the infelicity of Moore’s paradox can be explained away by pointing to a pragmatic conflict, epistemic contradictions present a semantic conflict that cannot be solved

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<sup>22</sup> Yalcin (2007)

<sup>23</sup> using the same term as Yalcin (2007)

on a pragmatic level. However, it is still unclear why these sentences are so problematic for a static semantic system. If epistemic contradictions are sentences that cannot even be supposed to true, as shown by the infelicity of (7), and are contradictions that simply originate from the meaning of the sentence, then why not conclude that the two conjuncts in (5) are incompatible and, therefore, contradicting each other on a semantic level? As Yalcin remarks, concluding that the two conjuncts of an epistemic contradiction are incompatible is rather problematic for a static semantic model.<sup>24</sup> Take the schematic representation of (5):  $(r \wedge \diamond \neg r)$ , where ‘ $r$ ’ stands for ‘it is raining’ and ‘ $\diamond$ ’ for the epistemic might-operator. Now, by employing a basic understanding of logic, let us suppose that the conjuncts are incompatible with each other. We quickly realize, as Yalcin notes, that if  $r$  and  $\diamond \neg r$  are contradictory, “then the truth of one entails the negation of the other”.<sup>25</sup> It becomes apparent that this entailment leads to severe theoretical complications. Because, in order to entail the negation of  $r$ ,  $\diamond \neg r$  ought to entail  $\neg r$ . But this an entailment that we cannot light-heartedly accept. Given that this would make ‘might’ a factual operator, which it is clearly not.

Apart from our general intuitions which unequivocally suggest that the epistemic might-operator is not a factual one, there are several examples to support this suggestion.

(9) It might be raining and it might not be raining.

If we read a sentence like (9), we can easily say that there is nothing wrong with it and that it is a felicitous sentence. However, if we accept that the epistemic might-operator is a factual operator which entails its prejacent, then we are left with following contradiction as an entailment:

(10) It is raining and it’s not raining.

Nevertheless, (9) cannot possibly entail (10) given that it would be unassertable if it was the case. Hence, a static semantic model is unable to correctly capture the meaning of the epistemic contradictions here presented as (5) and (7) or at least it is unable to cover our intuitions regarding them. Because, on the one hand, if we assume that the conjuncts in (5) are

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<sup>24</sup> Yalcin (2007)

<sup>25</sup> *ibid.*

*incompatible* in order to align our semantic interpretation with our intuitions, then we have to accept ‘might’ as a factual operator; which is rather a big bullet to bite. On the other hand, if we assume that the conjuncts are *compatible* in order to hold onto the thought that ‘might’ is not a factual operator, then we cannot explain the unassertability of neither (5) nor (7) and are, therefore, left with a model that leads to unintuitive results.<sup>26</sup> Is dynamic semantics and the test-like interpretation able to deliver an explanation for the infelicity of (5) and (7) and overcome the challenge posed by these epistemic contradictions?

When I introduced the topic concerning Moore’s paradox in this subsection, I listed the dynamic treatment of sentences like (5) as one of the virtues of the test-like interpretation and showed how dynamic semantics is able to account for the infelicity of unembedded epistemic contradictions by exposing them as semantic contradictions. Thus, we already have an explanation for unembedded epistemic contradictions that does not rely on pragmatics. However, we are still lacking a comprehensive justification for the infelicity of embedded cases like (7). Can the dynamic test-like interpretation of ‘might’ capture the infelicity of epistemic contradictions that are subordinated under the propositional attitude ‘suppose’?

While we have already discussed how an epistemic might-operator and a conjunction impacts the dynamic context, it is still unclear how the propositional attitude ‘suppose’ ought to behave in the model. So, in order to grasp whether dynamic semantics is able to cover our intuitions regarding (7), we have to, first of all, define how ‘suppose’ interacts with the context. Fortunately, the interpretation of propositional attitudes has already been tackled within the literature concerned with dynamic semantics. More specifically, Daniel Rothschild and Matthew Mandelkern have developed a comprehensive dynamic treatment for the propositional attitude ‘suppose’.<sup>27</sup> Therefore, we are able to rely on their work without having to develop an interpretation from scratch. Rothschild and Mandelkern start by looking at the philosophical tradition about propositional attitudes and employ the general claim that propositional attitudes like ‘suppose’ relate to individuals and worlds to the extent that, if something is being supposed, then there is an individual at a specific world that is doing the supposing. From here we can develop a function that takes individuals and worlds and

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<sup>26</sup> The reader might be wondering what kind of static semantic model I have in mind when expressing this criticism. While I normally use the term ‘static semantic system’ very loosely throughout this dissertation to indicate systems that are not dynamic, it seems appropriate to specify here that I am referring to the relational semantics presented in Yalcin (2007). Given that I am aware that there are some static models that are able to overcome the challenge posed by epistemic contradictions of this sort.

<sup>27</sup> Rothschild & Mandelkern (unpublished)

delivers *suppositions states*. A supposition state is a set of worlds that represents what an individual at a world supposes, i.e. they are all the possible worlds that are compatible with the individual's suppositions. Yet, given that a dynamic context is composed of pairs of assignment functions and worlds and not just simply worlds, we cannot just adopt supposition states within our dynamic framework without further modification. Hence, in order to integrate supposition states within the dynamic system, we will introduce a second function that maps supposition states onto sets of assignment-function-world-pairs, which have no discourse referents and share the same worlds of their corresponding supposition states.

Now that we can freely use supposition states within the dynamic model, Rothschild and Mandelkern move on to define the dynamic interpretation of 'x supposes  $\varphi$ ', where x is an individual and  $\varphi$  a sentence. Their definition can be summed up as saying that if 'x supposes  $\varphi$ ' is uttered, accepted and not undefined in a context, then the assignment-function-world-pairs that characterize the supposition state of x support/accept  $\varphi$ , i.e. update with 'x supposes  $\varphi$ ' transforms the contextual supposition state so that all its worlds are  $\varphi$ -worlds. To fully grasp what this semantic entry for the propositional attitude 'suppose' is doing within a context, let us look at an example and imagine that the following sentence is uttered in a context:

(11) John supposes it's raining.

If (11) is uttered and accepted in a context its contextual update will transform the context so that all the worlds that make out John's supposition state are ones in which it is raining. In a way, the propositional attitude 'suppose' is similar to the epistemic must-operator to the extent that both make sure that all the worlds in a certain contextual set contain their prejacent. Yet, when it comes to the must-operator, its scope covers all the assignment-function-world-pairs present in the context, while 'suppose' only targets the ones that are compatible with what the individual mentioned in the utterance supposes, i.e. the supposition state of the individual. Furthermore, while must-claims make sure that their prejacent is contained in all the contextual worlds by returning the empty set if it is not the case, the attitude 'suppose' guarantees that its prejacent is contained in the supposition state by actively transforming the context so that it is the case.

Now that we have all the tools to interpret the embedded epistemic contradictions, let us take a look at (7) again.

(7) Suppose it's raining but it might not be raining.

If we assume that (7) is an imperative sentence towards an addressee which is, however, not explicitly stated in the sentence, we can give the following schematic representation of (7):  $x$  Supposes( $r \wedge \diamond \neg r$ ). As we just said, the propositional attitude in question changes the context so that its prejacent is contained in all the worlds present in the supposition state of  $x$ . Or to put it in other words, updating a context with (7) makes sure that all the assignment-function-world-pairs that are compatible with what  $x$  supposes are ones that can be updated with ( $r \wedge \diamond \neg r$ ) without triggering any eliminative processes. Moreover, given that the proposition that ought to update the supposition state of  $x$  contains a conjunction, we can say that the supposition state of  $x$ , after an update with (7), has to remain unchanged when confronted with two updates: one with  $r$  and one with  $\diamond \neg r$ .

However, it quickly becomes apparent that this is more complicated than what it seems. On the one hand, if the supposition state of  $x$  has to remain unchanged after an update with 'it is raining', then all the worlds in the supposition state of  $x$  are already worlds in which it is raining. Therefore, the subsequent update with  $\diamond \neg r$  will lead to the empty context given that an update with 'it might not be raining' will deliver an unsuccessful might-test due to the absence of worlds in which it is not raining. Differently, if we assume that there is at least one world in the supposition set of  $x$  in which it is not raining, so that the might-test can be successful, then the conditions imposed by the propositional attitude 'suppose' will be violated given that an update with 'it is raining' will eliminate all the worlds in which it is not raining and, therefore, change the supposition state of  $x$ . Thus, updating a context with (7) will always lead to either  $x$ 's supposition state being trivially empty or it being incoherent. Nevertheless, this is the desired result. It was exactly our aim to find a semantic interpretation that considers sentences like (7) to be ruinous because our intuitions judge (7) to be unassertable. Therefore, contrary to a static semantic model, dynamic semantics with its test-like interpretation of epistemic modals is able to align with our intuitions and deliver the desired results for the discussed epistemic contradictions.

To conclude this subsection about the virtues of the test-like interpretation, we can say that a supporter of the test-like interpretation can boast two reasons that speak in favour of his dynamic understanding of modal claims. First of all, he can argue that his interpretation is justified on a conceptual level. Because conceiving modals as introducing a non-informative test, that checks whether compatibility or support is guaranteed for the prejacent of the modal claim, is an intuitive dynamic translation of what is assumed about epistemic modals in static systems. Furthermore, he can justify his interpretation on an empirical, or data driven, level by mentioning how his approach is able to predict the unassertability of certain epistemic contradictions. Each reason makes a strong case for accepting the test-like interpretation. Yet, as I have briefly shown at the beginning of this chapter, this interpretation does not come without its fair share of lacunas.

## **1.2. The Flaws of a Test-like Interpretation**

Similarly to the ones in favour of a test-like interpretation, the reasons that speak against this approach are mainly two; the first one theoretical and the second one empirical.

While interpreting epistemic modals as these non-informative tests might look appealing if we accept the assumption that these modals quantify over epistemically viable worlds, i.e. the context of a dynamic model, we also have to accept the notion that modal claims are non-informative. If we welcome the test-like interpretation and its feature of making modals non-informative, then we have to ask ourselves why we utter modal claims in the first place. On a purely informational level, updating a context with a modal claim, if successful, equates to updating a context with a sentence that is already being presupposed. So, for example, if (12) does not lead to conversational failure, then it adds the same information to the context as (13b) preceded by an update with (13a).

(12) There must be a cat in the house.

(13) a. There is a cat in the house.

b. There is a cat in the house.

Now, repetitions like (13b) give rise to a certain awkwardness in a dialogue. This inappropriateness can be justified by appealing to Gricean conversational maxims and seeing how (13b) violates the maxim of Quantity.

MAXIM OF QUANTITY: “Make your contribution as informative as it is required.”<sup>28</sup>

While the use of the term ‘required’ makes the maxim rather vague and open to interpretation, we can pinpoint the violation in (13b) by recasting, similarly to Grice,<sup>29</sup> the linguistic exchange as a non-linguistic one. Suppose that Max is fixing his car and that Tom is aiding him. Suppose further that Max picks up a 9mm screwdriver from the tool box and that, as soon as he starts using it, Tom hands him another identical 9mm screwdriver. Now, Tom does not seem to be really helping here, rather it looks like he is either mocking Max or he did not see Max pick up the screwdriver. A similar situation arises when someone repeats something that has already been said. either he is not taking the conversation seriously or he is not properly following the conversation. In either case, he is not delivering an informative contribution as it is required by the linguistic exchange. Therefore, (13b) and repetitions in general violate Grice’s conversational maxim. Yet, uttering modal claims does not intuitively strike us as being awkward as uttering a repetition like (13b), even if, according to the test-like interpretation, both are completely non-informative. This discrepancy suggests that modal claims differ from simple repetitions on an informational level by actually delivering new information to the context. Indeed, it seems quite intuitive to think that we are saying something informative when uttering a modal claim. Hence, if one desires to stick to the test-like interpretation of modals, one ought to provide an explanation for this discrepancy and for why we utter epistemic modals without violating conversational maxims, even when the non-informative character of modal claims equates them to repetitions of already presupposed sentences.

While I have simply assumed that our intuitions confirm that modal claims carry information, it seems appropriate to take a closer look at how epistemic modals are used and when they seem to show an informative character. Let us therefore consider the following dialogue.

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<sup>28</sup> Grice (1991) I assume here that (8b) violates the maxim of Quantity but one could also make an argument claiming that repetitions are a violation of the maxims of Manner.

<sup>29</sup> Grice (1991)

(14) Tom: John is at the bar.

Max: John might be in the alley next to it.

Max's line about the whereabouts of John feels informative, i.e. it seems that Max is affecting the context to some degree. If analyzed within a dynamic model that applies a test-like interpretation, the analysis will predict that Tom's contribution eliminates all the worlds in which it is not the case that John is at the bar and, therefore, Max might-claim will lead the conversation to a failure given that the test imposed by his utterance will fail due to 'John is in the alley next to the bar' expressing, among other things, the negation of Tom's line. So, in a way, Max's line is affecting the context, albeit by emptying it. Yet, this does not seem to properly capture the linguistic exchange. To put it in a rather informal way, Max's contribution is informative insofar as he is bringing up a viable epistemic possibility regarding John's whereabouts. It is a possibility that challenges Tom's utterance. The dynamic context that supports this informal assumption is one that would contain some worlds in which John is in the alley. Hence, we are tempted to conclude that the semantics of 'might' should lead to this context. However, I want to argue that this would be a mistake. The reason for why 'might' feels informative in (14) is because it is used as a pragmatic tool for correction. Max is disagreeing with Tom by uttering the might-claim. He is refusing to update the context with 'John is at the bar'. Thus, the context does not undergo an update at all. Tom's line is rejected by Max and, therefore, does not change the context given that it is not accepted by all the participants of the conversation. Our intuitions are right in suggesting that the context resulting from this exchange should include worlds in which John is in the alley, because the correction expressed by Max has exactly this goal: maintaining a context in which Tom's line is not accepted. However, this pragmatic mechanism is not just triggered by might-claims. Corrections with the aim of challenging a certain assertion can be expressed by many different claims which ultimately achieve the same goal. For example, Max could utter 'I disagree' instead of his might-claim and we would have a viable alternative that does as good as a job at triggering the pragmatic mechanism in question as the might-claim. Thus, even if Max's line seems to be informative in character by suggesting certain changes to the context, this does not directly have anything to do with the semantics of 'might', but rather is a consequence of a pragmatic mechanism portrayed by the dialogue. Nevertheless, aside from

these particular cases of correction, there are instances in which modals do feel genuinely informative. All the felicitous examples containing ‘must’ of the previous chapter, for instance, strike me as informative. As we have learned, must-claims express the result of an indirect evidential inference. By seeing dog pee and uprooted flowers Karen concludes that a dog must have been in her yard. Expressing this conclusion or omitting it does seem to have an effect on the information carried by a conversation, especially if the participants do not have the same evidence. So, let us accept the notion that in some cases modal claims do strike us as intuitively informative making, therefore, the conceptual argument against the test-like interpretation even stronger.

The second reason for rejecting the test-like interpretation is data-driven and is already familiar to us. The test-like interpretation does not license anaphoric constructions. While I have already presented the problem at the beginning of this chapter, it is important to realize how big of a lacuna this is. Pronominal anaphoras preceded by a modal-claim are completely grammatical and felicitous. Yet, by interpreting ‘must’ and ‘might’ as non-informative tests which either leave the context unchanged or lead it to failure, the test-like interpretation predicts pronominal anaphoras to be infelicitous and undefined in the dynamic model. More specifically, given that the discourse referents introduced by the modal claim do not persist as members of the domain of the context, pronouns in consequent sentences cannot refer to them making sentences containing them undefined.

To sum up, the test-like interpretation has two flaws. The former being justified on a theoretical level and the latter on an empirical level. The conceptual flaw relates to Grice’s maxims and to how, given their non-informative character, modal claims should violate these maxims similarly to repetitions but seemingly do not, even if both do not carry any information. The second flaw originates from the inability of the test-like interpretation to license pronominal anaphora, even if it is clearly a grammatical phenomenon of the English language.

### **1.3. Informative vs. Non-informative**

What transpired from the previous two subsections can be represented as a dialectic between two opposing ways of understanding modals in dynamic semantics. On the one hand, we have the supporter of the test-like interpretation that understands modals as non-informative due to the reasons presented in § 1.1.. On the other hand, we have the opposer of the test-like

interpretation that understands modals as informative given that the flaws of the criticised interpretation ultimately have the non-informative nature of modals as their cause. Can one side overcome the other? More specifically, can the supporter of the test-like interpretation defuse the critiques of his adversary, or can the opposer develop an alternative interpretation which conceives modals as informative while cashing out the virtues of the test-like interpretation?

Let us start by the supporter of the test-like interpretation and call him the traditionalist and his opponent the radicalist. Now, the traditionalist must succeed in completing two tasks in order to defend himself from the radicalist. He has to, first of all, give an explanation for why we utter modal-claims, if they are non-informative and violate the Gricean maxims. Furthermore, he has to justify the unintuitive predictions of his interpretation when it comes to pronominal anaphora by either explaining why our intuitions are wrong or by finding a way to license pronominal anaphora while keeping the same non-informative character for modals.

One viable argumentative strategy for the traditionalist involves appealing strongly to pragmatics. I am using the term ‘pragmatics’ here in quite a specific sense, one that is defined by Beaver as follows:

“Rules of interpretation are termed *pragmatic* if they do not include reference to syntactic features, or act over and above the compositionally defined part of the grammar.”<sup>30</sup>

The main strategy for the traditionalist is to keep the semantics of modals as they are and address the flaws of his interpretation by arguing that they are the result of pragmatic rules. With regards to the conceptual flaw of his interpretation, he can answer the question of why modal-claims are uttered, by saying that speakers do so in order to bring something to the attention of their audience. On this view, modal-claims remain as informative as repetitions. However, no Gricean maxim is violated given that they contribute by pointing out something that was already there but was potentially forgotten by the participants of the conversation. Modal-claims are, therefore, non-informative, if the term ‘non-informative’ is understood as leaving the dynamic context as it is, but are informative in the sense that they contribute to the linguistic exchange on a pragmatic level by highlighting obsolete information. The pragmatic

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<sup>30</sup> Beaver (2001) p. 81

level that I have in mind here is one that includes things like the attention of the audience and other psychological assumptions. To go back to the non-linguistic analogy presented previously, repetitions as well as modal claims, on this view, are not to be understood as giving the same tool to a person that already has it, but rather as pointing to the tool that the person forgot to have. Thus, the traditionalist is able to give an explanation for the apparent conceptual flaw of his interpretation.

A similar pragmatic approach can be adopted for addressing the data driven flaw of the test-like interpretation. The traditionalist can argue that, while the interpretation of modal claims does not allow anaphoric links, pronouns uttered after a modal claim do find a referent on the basis of a pragmatic rule. Similarly to demonstratives that find a referent because certain objects exist in the environment in which the discourse is taking place, pronouns preceded by a modal-claim find a referent due to the modal claim making an object salient. Discourse referents are, therefore, not added to the domain of the context by the semantics of modal claims, but rather are added by a pragmatic mechanism that is triggered by speakers being now aware of the object mentioned in the modal claim. Hence, the traditionalist is able to keep his test-like interpretation and also account for anaphoric constrictions that come after a might- or must-claim.

Adopting this pragmatic approach in order to account for the issues of the test-like interpretation is successful to some degree. Yet, it must be noted that I do feel that this strategy is more an attempt to avoid the problems rather than solving them. If we are satisfied with explaining pronominal anaphoras via pragmatic mechanisms, then why not simply stick to a static system that does not integrate any semantic mechanism for representing anaphora? One of the great virtues of dynamic models is to be able to represent anaphoric constructions via semantic rules. If we concede that anaphoric constructions preceded by modal claims are governed by pragmatic rules, then we are putting one of the great virtues of dynamic semantics at risk just to preserve the test-like interpretation. Moreover, it is still unclear how these pragmatic rules ought to behave when it comes to anaphoric pronouns. It seems *prima facie* plausible to assume that anaphoric pronouns find their referent because the antecedent modal claim makes an object or individual salient. Yet, after more careful consideration, we can realize how vague the relation of salience is. While it might be easier to invoke pragmatics when it comes to certain demonstratives due to the actual presence of the referred object within the environment of the dialogue, it is a lot more difficult to do so for anaphoric

pronouns, especially if there is no object speakers can point to. Are the objects made salient unique objects? Does the salience relation only relate to a speaker and an object or does it also depend on the audience? What are the conditions for making an object salient? These are just some of the questions that would need to be answered in order to dissipate the vagueness surrounding the salience relation. Hence, as I said before, relying on pragmatics in order to maintain the test-like interpretation seems to be more like an attempt to sweep the problem under a pragmatic carpet rather than solving it.

Let us see now if the opposing view, the one supported by the radicalist, fares any better than the traditional one. While the traditionalist already has a fleshed-out interpretation of modals, the radicalist has a lot of work in front of her. She does not have a developed interpretation but rather is simply convinced that the test-like interpretation is completely wrong due to modal claims being genuinely informative. So, the radicalist thinks that modal claims change the dynamic context. Yet, modal claims cannot possibly affect the conversation as non-modalized assertions do, given that there is an obvious difference between uttering ‘it is raining’ and ‘it might be raining’. What should the radicalist do? One idea is to introduce a second context, a modal one, alongside the standard dynamic context and make modal claims affect this new context. At the beginning of a conversation the modal context would be identical with the standard blank context and then diverge from the standard context depending on what kind of modal claims are uttered while the conversation progresses. If no modal claims are uttered in the conversation, then the modal context would not diverge from the standard dynamic context and be an identical copy of the latter.

With this strategy the radicalist can deal with pronominal anaphoras that have a modalized claim as their antecedent through semantic rules, i.e. she can assume that the modal context has its own domain of discourse referents that are then picked up by the anaphoric pronouns. For example, a must-claim could be interpreted as eliminating all the worlds that contain the negation of its prejacent from this modal context and, if the prejacent contains an indefinite noun, introduce a discourse referent as a member of the domain of the modal context as well as guaranteeing the relative assignment to the individuals present in the modal context. Moreover, this two-context interpretation could probably be able to predict the intuitive results for the epistemic contradictions discussed previously by stipulating certain asymmetric relations between the standard context and the modal context. For example, the radicalist could state that all the worlds eliminated in the standard context must also be eliminated in the

modal context, but that the modal context does not influence the standard context in any way. This would, in theory, allow the radicalist to capture the infelicity of sentences like ‘it is raining and it might not be raining’ by claiming that the first conjunct eliminates all the worlds in which it is not raining in both contexts. Hence, the radicalist seems to be able to produce a theory that accounts for two flaws as well as one virtue of the test-like interpretation. The two-context interpretation answers the question of why we utter modal claims by showing that they change the modal context by eliminating worlds and adding discourse referents. Moreover, it delivers a semantic approach for capturing pronominal anaphoras preceded by modals. Lastly, it can predict the infelicity of the epistemic contradictions by introducing asymmetric relations between contexts.

Nevertheless, for how promising this interpretation might seem to some, it is not just an inelegant theory, but it also comes with several serious issues. First of all, while interpreting must-claims as eliminating all the worlds containing the negation of their prejacent in the modal context might seem intuitive, might-claims are a completely different story. Given that a conjunction made out of two might-claims with subordinated sentences that contradict each other, does not necessarily lead to a contradiction, it seems rather difficult to spell out the eliminative mechanism they trigger with regards to the modal context. Furthermore, while the radicalist might account for the unembedded epistemic contradiction ‘it is raining and it might not be raining’ by introducing asymmetric relations between the standard context and the modal context, it seems that he will not have the same luck with the embedded version. Given that the embedded epistemic contradiction discussed here exhibits a might-operator being subordinated under the propositional attitude ‘suppose’, it is difficult to imagine how the might-operator can reach the modal context without violating the scopal restrictions of the propositional attitude. In order to respect those scopal restrictions, should we start assuming that not just the standard dynamic context has a modal counterpart but also that a supposition state has something like a modal supposition state? It appears that accepting this assumption would yield quite the complicated theory, especially if one considers all the relations between different contexts that would need to be defined in order to interpret a conversation. Moreover, even if we just focus on must-claims and their ability to license pronominal anaphora, we quickly realize that the semantic approach of the two-context interpretation is rather unintuitive. If discourse referents are introduced as members of the domain of the modal context and *not* of the standard context, pronominal anaphoras referring to them will

consequently be about them, i.e. the anaphoric sentence will convey information regarding the modal context and not the standard one. Yet, It seems that the second sentence of (2p), here presented again, should influence the standard context.

(2p) A dog must be in the yard. He left some footprints on the floor.

The anaphoric sentence in (2p) does not seem to be concerned with the modal context but rather is inviting a modification of the standard context (we will discuss this point further in § 2.). Hence, even if the radicalist is able to present a semantic approach for capturing pronominal anaphoras, it does not appear to be a good one. Lastly, not only is the introduction of a second context quite an inelegant and cumbersome addition to the dynamic theory, but it is also extremely difficult to justify it on a conceptual basis. As we can recall, the first virtue of the test-like interpretation is that understanding modals as testing the dynamic context is fitting for what is generally assumed about epistemic modals. They quantify over the set of epistemically viable worlds which corresponds to the dynamic context. Thus, making them act upon a context that is different from the standard dynamic one is a stipulation that not just lacks justification, but rather goes against our general understanding of epistemic modals.

It seems that we have reached an impasse. If we side with the traditionalist, then we subscribe to a theory that avoids its flaws via pragmatic mechanisms and betrays the spirit of dynamic semantics by breaking the promise of delivering semantic rules for anaphoric constructions. On the contrary, if we side with the radicalist, then we accept an inelegant theory that exposes us to several criticisms. Is there not a third path that we could take, one that dissolves the tension between the two camps and offers an interpretation that satisfies all the points made so far?

## **2. A Solution to the Problematic Interpretation of Epistemic Modals**

This section will provide a dynamic interpretation of epistemic modals that solves the problems presented in the previous section. I will, therefore, construe a theory that overcomes the impasse between traditionalist and radicalist, and develop an interpretation that satisfies the following desiderata:

- i. Preserving the comprehensive translation of epistemic modals from static systems to dynamic systems by supporting the assumption that epistemic modals relate to

dynamic contexts similarly to how they quantify over epistemically viable worlds in static models.

ii. Answering the question of why we utter modal claims without violating Gricean maxims.

iii. Predicting intuitive results with regards to epistemic contradictions.

iv. Licensing pronominal anaphora.

To introduce my account let us recall how utterances influence a dynamic context in general. In chapter 1. I explained how dynamic semantics enriches a purely eliminative Salnakerian conception of context by introducing an additive mechanism. So, sentences like ‘it is raining’ will keep their purely eliminative nature, i.e. they will change the context by just eliminating worlds that contain their negation. But utterances that contain an indefinite noun, e.g. ‘a cat is in the living room’ will not just eliminate worlds containing their negation but also introduce a discourse referent for the indefinite noun and assign to it its relative predication. Now, imagine defining a spectrum that aims to differentiate sentences with regards to how they influence a dynamic context in a qualitative way. Given that there are two mechanisms in dynamic semantics, an additive and an eliminative one, it seems reasonable to set ‘purely eliminative’ and ‘purely additive’ as extreme points of the spectrum. Thus, sentences which just eliminate worlds like ‘it is raining’ will be located on the ‘purely eliminative’ end of the spectrum. In the middle of the spectrum we find hybrid sentences containing, for example, an indefinite noun like ‘a cat is in the living room’ which are both eliminative and additive. Finally we reach the other end of the spectrum; the one marked as ‘purely additive’. Yet we quickly realize that there are no sentences that trigger a purely additive mechanism. In other words, there are no utterances that just introduce a discourse referent with its relative assignment.

I want to argue that modalized claims containing an indefinite noun are this kind of purely additive sentences. Furthermore, I will show how such an interpretation is able to satisfy all four desiderata set at the beginning of this section. This new interpretation of modal claims that I have in mind is quite straightforward. We keep the test-like interpretation as well as its success/failure conditions, i.e. must-claims, and might-claims, still check whether their prejacent is supported by, or compatible with, the context. Moreover, we also maintain the notion that, if its test is unsuccessful, the modal claim will lead the conversation to the empty

context. The only mechanism that will be modified is the one governing the contextual output in cases of success. In the traditional test-like interpretation, if the test introduced by a modal claim is successful, then the modal claim will output an unchanged context. In my interpretation, if the test is successful, the modal claim will output a context that retains the discourse referents and their relative assignments introduced by its prejacent but ignores any eliminative process. To put it in other words, modal claims filter out any elimination of worlds that follows from an update with their prejacent but allow discourse referents to persist in the context.

Now, let us look at some examples in order to get a clear picture of this interpretation and let us suppose that all the tests introduced by the upcoming modal claims are successful. As we just said before, simple unembedded sentences like ‘a cat is in the living room’ can be seen as hybrid sentences. If uttered in a context, they trigger an eliminative and an additive mechanism. According to my interpretation, if a hybrid sentence is subordinated under a modal operator, then the modal will allow the additive process, but block the eliminative process, making the hybrid sentence a purely additive one. So, a sentence like ‘a cat must be in the living room’ will update a context by introducing a discourse referent and assign to it all the individuals that satisfy the predication, which in this case is being a cat and being in the living room, yet it will not eliminate any worlds containing the negation of the prejacent. Although for must-claims this last specification is redundant given that there cannot be any worlds containing the negation of the prejacent for the test to succeed. Thus, a must-claim triggers a total introduction of the discourse referent, i.e. the discourse referent has an assignment in every world of the context. To put it differently, if we start from a context that supports the prejacent of ‘a cat must be in the living room’, then updating the context with ‘a cat is in the living room’ or ‘a cat must be in the living room’ yields identical results according to my interpretation.

Might-claims, however, are a completely different story. These modal claims suggest a test that checks for whether the prejacent is compatible with the context. In order for this test to succeed, just some worlds need to contain the prejacent. Hence, might-claims trigger a partial introduction of a discourse referent, i.e. the discourse referent has an assignment in some worlds of the context. For example, a sentence like ‘a cat might be in the living room’ introduces a discourse referent for the indefinite noun ‘a cat’ which is then assigned to all the individuals that satisfy the predication. However, given that not all worlds might contain

individuals satisfying the predication, the discourse referent has assignments just in those worlds that would survive an update with the unembedded prejacent, i.e. worlds that do have individuals that are cats and are in the living room.

Let us see now how this account is supposed to satisfy the four desiderata set at the beginning of this section. First of all, we have one of the virtues of the test-like interpretation: the comprehensive dynamic translation of our understanding of modals in static systems. Due to my account maintaining the majority of the notions of the test-like interpretation, it does also possess this virtue. In static models, sentences subordinated under epistemic modals are possibility or necessity claims that quantify over epistemically viable worlds. Given that the set of epistemically viable worlds corresponds to the conception of a dynamic context, in dynamic semantics epistemic modals are understood as checking whether the context is compatible or supports the prejacent of the modal claim.

Since my account still understands modals as suggesting this kind of test, it also can offer this comprehensive translation from static to dynamic. To put it differently, modifying the interpretation of epistemic modals so that discourse referents and their relative assignments are preserved does not interfere with the test-like nature of the original interpretation. After all, the persistent introduction of discourse referents is only triggered if the test established by might-, or must-claims is successful. Moreover, even if the persistent introduction of discourse referents is triggered, epistemic modals can still be understood as just testing the context given that they return the same context when it comes to the quantity and quality of the possible worlds contained in it. In this new interpretation of modals, the only change that occurs when a modal claim containing an indefinite noun is uttered is within the domain of the context and the assignment functions. Yet, the domain of the context and the assignment functions are formal machinery that only pertains to the dynamic semantic model; there is no formal counterpart in static models. The static conception of epistemic modals neither considers a domain of the context nor assignment functions, but just focuses on epistemically viable worlds.

Furthermore, when it comes to accurately translating the static conception into dynamic semantics, the intuitive assumption that the epistemically viable worlds, over which epistemic modals quantify, are the same worlds contained in the dynamic context, must be preserved. Nevertheless, given that the static conception is limited to just possible worlds, changes in the domain of the context or within assignment functions are irrelevant for an appropriate

translation. It is sufficient to guarantee that modal claims do not eliminate worlds from the dynamic context, in order to correctly integrate the static notion. Hence, this new dynamic interpretation of epistemic modals that I am presenting here fully satisfies the first of our four desiderata set at the beginning of this section.

The second conceptual point in our list of desiderata relates to Grice and his conversational maxims, and demands a satisfying answer for the question of why we utter modal claims. The crucial point here is to show how modal claims can be informative contributions to a conversation. Moreover, if we do not want to end up like the traditionalist above, we have to deliver an answer that does not solely rely on pragmatic rules. Now, the interpretation defended here maintains part of the test-like interpretation as well as the idea that modal claims do not eliminate any worlds from the context when uttered. So, if we understand the term ‘informative’ as relating to whether or not a sentence eliminates worlds or not, then my interpretation also sees modals as non-informative.

Yet, if we look at the fact that the interpretation in question allows discourse referents to persist in the context, then we can argue that modal claims do change the context in some way. Hence, if we comprehend the term ‘informative’ in a more general sense, one that is not just restricted to eliminative processes but also considers sentences with a purely additive nature as informative contributions, then modal claims are informative insofar as they structure the context internally through discourse referents and their relative assignments. To put it in other words, my theory of modals answers the question of the second of our four desiderata by claiming that we utter sentences containing epistemic modals not to change the amount of possible worlds under consideration in a given conversation but to structure said worlds in an appropriate way. Therefore, modal claims expressing anaphoric constructions can be informative contributions that do not violate any conversational maxim, even though they are non-eliminative in nature, because they assign referents.

Moreover, not only does this interpretation answer the question of why we utter modal claims containing indefinite nouns, but also relies on semantic rules to do so. We can easily show how a modal claim is informative on a semantic level by pointing out the introduction of a discourse referent or the change of the assignment functions. There is no need to rely on pragmatics to overcome the challenge set by the Gricean maxim of Quantity when a might-, or must-claim trigger an additive mechanism.

However, it must be said that not all sentences containing an epistemic ‘must’ or ‘might’ can be represented as informative contributions via the semantic rules introduced by this new interpretation of modals. Certain sentences that introduce a purely eliminative mechanism when uttered in a context, e.g. ‘it is raining’, do not trigger an additive mechanism if they are subordinated under an epistemic modal like ‘might’ or ‘must’. This is obviously caused by the fact that, even as unembedded sentences, they do not introduce a discourse referent or change the assignment of one, but rather just eliminate worlds that contain their negation. So, when sentences like ‘it is raining’ are embedded under a might-, or must-operator, they will be interpreted in a traditional test-like fashion and, if their test is successful, leave the dynamic context unchanged, i.e. the quantity and quality of the worlds contained in the context will be the same as well as the number of discourse referents and their relative assignments will be unaffected. Hence, we are unable to represent these sentences as informative contributions by relying on semantic rules alone, if we consider an informative contribution to be a sentence that changes the dynamic context by either eliminating worlds or adding discourse referents and assignments. Thus, we might be forced to rely on pragmatics to explain the informative nature of this specific set of cases in the end. Nevertheless, it must be noted that, especially if we consider the purpose of this dissertation, it is a set of cases that has nothing to do with the phenomenon of pronominal anaphora.

Let us now focus on the third point on our list of desiderata and let us look at how this new dynamic interpretation of epistemic modals fares when confronted with the epistemic contradictions that we discussed in the previous section.

(15) It is raining and it might not be raining.

(16) Suppose it is raining and it might not be raining.

In order to satisfy our third requirement, my account ought to give an explanation for the infelicity of these two sentences. Yet, if we recall correctly, this prerequisite represents one of the virtues of the test-like interpretation, given that the test-like interpretation was able to account for the unassertability of (15) and (16) on semantic grounds differently from certain static models. As already mentioned, the new interpretation of modals that I am proposing shares a lot of similarities with the traditional test-like interpretation. The only substantial

difference that emerges relates to the introduction of discourse referents and their relative assignments in the dynamic context. However, epistemic contradictions like (15) and (16) do not exhibit any indefinite nouns or anaphoric pronouns in their construction. Hence, given that there are no terms that trigger an introduction of a discourse referent in (15) and (16), the difference between my new interpretation and the traditional test-like interpretation does not manifest and is irrelevant for determining whether the third of our four desiderata is satisfied or not.

Nevertheless, exactly because the divergence between these two theories does not emerge when interpreting (15) and (16), my new interpretation will behave as the traditional test-like interpretation and there will be no interference from the new formal machinery. Thus, if the traditional interpretation is able to deliver good results when confronted with (15) and (16), and manages to give a comprehensive explanation for the unassertability of epistemic contradictions by relying on semantics, then also my new interpretation of epistemic modals is able to do so.

To further highlight how this account is able to successfully satisfy the third point on our list of desiderata, let us recall the two-context interpretation proposed by the radicalist and his strategy to account for the infelicity of (15) and (16). In order to explain epistemic contradictions but also maintaining the assumption that epistemic modals had to be informative by changing the context, the radicalist resorted to the introduction of a second dynamic context, a modal one, which relates to the standard dynamic context in an asymmetric fashion. While the infelicity of unembedded sentences like (15) could be explained away by appealing to these asymmetric relations, embedded versions like (16) forced the radicalist to develop baroque formal machinery in order to justify their unassertability. It was painfully clear that the test-like interpretation possessed the more elegant solution when compared to the radicalist's approach, if the approach of the radicalist could even be called a solution to begin with. Yet, the radicalist could not adopt the same test-like approach because it contradicted his fundamental assumption that epistemic modals are informative insofar as they change the dynamic context.

Nevertheless, when we now consider the new interpretation that has been put forward, we realize two things. On the one hand, this new account is able to adopt the elegant explanation for the infelicity of epistemic contradictions like (15) and (16) that originates from the traditional view. On the other hand, the theory is also capable of maintaining the fundamental

assumption of the radicalist that modals are informative. The crucial difference between the new account and the interpretation of the radicalist, that ultimately ends up putting the former theory in a better position than the latter, relates to how the two theories interpret the informative nature of epistemic modals.

For the radicalist the assumption that epistemic modals are informative is cashed out by introducing a new context and making it be affected by epistemic modals. More specifically, the radicalist expresses the informative nature of modal claims by making them trigger the same changes that non-modalized claims manifest in a modal context rather than in a standard dynamic context. Consequently, due to the introduction of this new modal context, modal claims can be categorized as purely eliminative sentences or eliminative and additive sentences depending on whether their prejacent contains an indefinite noun or not. So, if we compare modal claims and non-modal claims with regards to their ability to change their respective context, then we come to realize that the former can affect the modal context as much as the latter can affect the standard context. Hence, modal claims are as informative as non-modalized claims in their respective context. This interpretation is probably one of the strongest expressions of the informative nature of epistemic modals that still lets us distinguish between modal and non-modal claims, given that it allows them to eliminate worlds, introduce discourse referents etc.. However, as we have seen, this approach leads to several complications.

On the contrary, the new interpretation discussed in this section cannot boast as strong as a representation of the informative nature of modal claims as the radicalist approach. Given that no modal context is introduced in the model, it seems difficult to allow modal claims to trigger the same mechanisms that non-modalized claims do, if we want to maintain a distinction between the two types of sentences. Nevertheless, we are still able to say that modal claims are informative in virtue of them being able to change the context through an additive mechanism. It is true that, if the prejacent of an epistemic modal does not contain an element that triggers an additive mechanism, then no change in the context will occur. Yet, by accepting this less strict conception of the informative nature of epistemic modals, one that considers the ability of modal claims to trigger additive mechanisms as a sufficient expression of their informativity, we are able to avoid the lacunas of the radicalist's approach. Moreover, we are also able to integrate the virtues of the test-like interpretation while maintaining the assumption that epistemic modals are informative. Hence, while the radicalist approach

overextends in order to boast the strongest representation of the informative nature of epistemic modals, the new interpretation that I am presenting here, finds a convenient middle ground. It allows us to take the best of traditionalist and radicalist theories by incorporating a more moderate understanding of the informative nature of modals and elegantly explaining epistemic contradictions like (15) and (16).

Let us now move on to the final, and probably most pressing, point on our list of desiderata and take a look at whether the new interpretation is able to license anaphoric constructions that originate from a modal claim. In order to give a satisfying treatment of these linguistic constructions, my account ought to deliver an interpretation of must-claims as well as might-claims that contain an indefinite noun and that are then followed by sentences exhibiting an anaphoric pronoun. So, for example, the account has to capture the meaning of sentences like (17) and (18) without trivially manifesting a conversational failure.

(17) A dog must be in the yard. He left some footprints on the floor.

(18) A police officer might come to the bar. She would ask some questions.

Let us start with the epistemic modal ‘must’ and, therefore, example (17). As I have already explained, the dynamic interpretation of modal claims that I have in mind is one that maintains the general features of the test-like interpretation. Hence, we will keep the same success/failure conditions of the tests introduced by the modal claims as well as the notion that, if the test is unsuccessful, then the modal claim will lead the conversation to the empty context. Now, suppose for argument’s sake that our dynamic context contains three assignment-function-world-pairs:  $\{ \langle f, w_1 \rangle, \langle f, w_2 \rangle, \langle f, w_3 \rangle \}$ . Suppose further that all three worlds in the context contain dogs that are in the yard. More specifically,  $w_1$  contains two individuals (individual  $a$  and  $b$ ) while world  $w_2$  and  $w_3$  have one individual (individual  $c$  and  $d$  respectively) that satisfy the predication of being dogs and being in the yard. If we now utter the first sentence of (17) in this dynamic context, what will be the resulting contextual update? First of all, the sentence ‘a dog must be in the yard’ will test the context. Given that it is a must-claim, the test will check whether the context supports the prejacent of the must-claim or not. To put it in other words, whether the test is successful or not depends on whether all the worlds in the context are ones in which there is a dog which is in the yard. If

the conditions are met then the test is successful. But if there is a world that does not contain a dog that is in the yard, then the context fails and the update will lead to the empty context. Fortunately for us, we have defined the context in such a way that the prejacent of the first sentence of (17) is contained in all worlds of the context. Hence, the test is successful.

For now the interpretation of (17) is the same as the one given by the traditional test-like interpretation. However, at this moment the two theories diverge. On the one hand, the test-like interpretation would deem the test successful and make the update with ‘a dog must be in the yard’ deliver the context that preceded the update with the first sentence of (17), i.e. the update would not change the context in any shape or form. On the other hand, my interpretation of must-claims does not leave the context unchanged. Instead, if the test is successful, an additive mechanism will be triggered. In the case of the first sentence of (17) specifically, a discourse referent  $x$  will be introduced due to the presence of an indefinite noun, and it will be assigned to all the individuals in the context that satisfy the predication expressed by the prejacent of the modal claim in question. Therefore in  $w_1$ ,  $x$  will be assigned to individuals  $a$  and  $b$ , in  $w_2$  it will be assigned to  $c$  and in  $w_3$  it will be assigned to  $d$ , making this schematic representation of the context possible:

$$c = \{ \langle (x \rightarrow a, x \rightarrow b), w_1 \rangle , \langle (x \rightarrow c), w_2 \rangle , \langle (x \rightarrow d), w_3 \rangle \}$$

As we can obviously see, the difference between this interpretation and the traditional test-like interpretation is that, in this case, we have introduced a discourse referent that is assigned to the individuals that possess the predication expressed by the prejacent of the modal claim, while previously none of this would happen.

The importance of this difference becomes apparent when we reach the second sentence of (17), the one containing an anaphoric pronoun. The pronoun ‘he’ expressed in the sentence ‘he left some footprints on the floor’ clearly has an anaphoric link with the indefinite noun ‘a dog’ present in the preceding sentence. Yet, if we apply the test-like interpretation, the pronoun appears to lack a referent. Why is this the case? Given that a modal claim does not affect the context and is non-informative, the indefinite noun ‘a dog’ never triggered the introduction of a persistent discourse referent with its relative assignments. Therefore, the anaphoric pronoun ‘he’ in the second sentence cannot pick up an appropriate discourse referent simply because there is none. So in the end, due to the lack of a discourse referent,

the pronoun ends up being undefined and an appropriate update with the second sentence of (17) impossible.

On the contrary, if we adopt the new approach, the anaphoric pronoun of (17) is able to pick up the right discourse referent. In this new interpretation of modal claims, we modified the test-like interpretation so that a must-claim allows a persistent introduction of a discourse referent in the context when an indefinite noun is present in the prejacent. Consequently, the indefinite noun ‘a dog’ in (17) leads to the introduction of a discourse referent with assignments in every world of the dynamic context. The individuals that are picked out by these assignments are ones that satisfy the predication attached to the indefinite noun contained in the prejacent, i.e. individuals that are dogs and that are in the yard. Thus, the anaphoric pronoun ‘he’, which is clearly uttered in order to refer to these individuals, can refer to them by picking up the discourse referent introduced by the must-claim. So, differently from the traditional test-like interpretation, the anaphoric construction in (17) does not lead to a conversational failure and is instead interpretable.

However, now that the anaphoric pronoun in (17) has a discourse referent, the pronominal sentence will be defined and, therefore, update the context according to its context change potential. The second sentence of (17) updates the context through an eliminative mechanism. More specifically, it eliminates all the assignments of the discourse referent that pick up individuals that cannot satisfy the new predication expressed in the pronominal sentence. Furthermore, if a world lacks individuals that satisfy said predication, then the update with the pronominal sentence will eliminate that world completely.

So, if we go back to the context that we updated with the must-claim previously, we can see that there are four individuals that are dogs which are in the yard, i.e. there are four individuals that have the predication mentioned in the must-claim. Now, suppose that individual  $a$  and  $c$  are not just dogs that are in the yard but also ones that have left some footprints on the floor, while individuals  $b$  and  $d$  have not. An update with ‘he left some footprints on the floor’ will consequently eliminate the assignments relating to individuals  $b$  and  $d$  given that they do not exhibit the predication expressed by the pronominal sentence. Furthermore, because world  $w_3$  only has individual  $d$  as a value for the discourse referent  $x$ ,  $w_3$  will be eliminated from the context due to a lack of individuals that satisfy the predication expressed by the second sentence of (17). So in the end, the resulting representation of our context updated with both sentences of (17) is the following:

$$c = \{ \langle (x \rightarrow a), w_1 \rangle, \langle (x \rightarrow c), w_2 \rangle \}$$

Let us reflect for a moment on this result achieved by the new interpretation of epistemic modals by comparing it with the traditional test-like interpretation and the two-context theory of the radicalist. When it comes to the traditional interpretation, there is not a lot that we can add to what we already said previously. The traditionalist is just unable to give a viable interpretation of sentences like (17). By making must-claims unable to change the context in a persistent way, the traditionalist approach cannot provide a discourse referent for the anaphoric pronoun subsequent to the must-claim. Hence, anaphoric constructions that start with a must-claim will always lead to a conversational failure.

The two-context theory of the radicalist, on the other hand, has the ability to account for anaphoric constructions like (17). As we explained previously, the radicalist defines a second context in which must-claims are as informative as non-modalized claims in the standard context. He can therefore claim that anaphoric pronouns, like the one in (17), can pick up discourse referents with the appropriate assignments. Of course, this claim rests on the assumption that he also defines a domain of the modal context in which discourse referents can be introduced. It is important to highlight here that the approach of the radicalist confines an update with (17) within the realm of the modal context. In other words, updating the dynamic context with (17) will only lead to a modification of the modal context rather than the standard one. This means that in the standard context, the one that is supposed to represent our common ground in a conversation, worlds which contain the negation of (17) will still be present. However, as I have pointed out in the previous section, anaphoric sentences like the second sentence of (17) seem to invite us to update our standard dynamic context so that all the worlds that contain the negation of (17) are eliminated. Thus, while the radicalist is at least able to interpret anaphoric constructions that start from a must-claim, his strategy seems to be in contrast with our intuitive understanding of anaphora in dynamic semantics. On the contrary, the theory that was developed in this section aligns with our intuitions by allowing pronominal sentences to eliminate worlds from the standard dynamic context even if they have a must-claim as an antecedent.

On another note, if we look carefully at how the new interpretation represents an update with (17), we can realize how its results support the reasoning presented in the first chapter of

this dissertation. Take for example the non-modalized version of (17), here represented as (19):

(19) A dog is in the yard. He left some footprints on the floor.

Now compare the update triggered by (19) with the one triggered by (17) while starting from the same context that we defined above. The resulting contexts will be the same; both updates will deliver the following contextual set:

$$c = \{ \langle (x \rightarrow a), w_1 \rangle, \langle (x \rightarrow c), w_2 \rangle \}$$

Thus, if updating a context with (17) or (19) bears the same result, then we can suppose that it is unproblematic to assume that non-modalized sentences like (19) have a covert ‘must’. Consequently, given that the reasoning presented in the previous chapter assumes that certain non-modalized sentences have a covert ‘must’, we can say that said assumption does not raise any issues as far as the dynamic interpretation of epistemic must-claims is concerned.

Of course one of the reasons for why (17) and (19) output the same context is given by the fact that we defined a starting context that meets the conditions set by the test introduced by the must-claim. If we were to define a context that contains worlds without dogs, then an update with (17) would output the empty context, while an update with (19) would be the same as before. To put it in other words, non-modalized sentences can eliminate worlds that contain their negation, while must-claims just lead a conversion to the empty set if they are uttered in a context that contains the negation of their prejacent. Nevertheless, it does not seem too far-fetched to suppose that, if a must-claim is asserted and accepted in a context, then a context that supports said must-claim will already be presupposed by the participants of the conversation, i.e. worlds that contain the negation of the prejacent of the must-claim will be eliminated through *accommodation*.<sup>31</sup>

Furthermore, besides the interesting discoveries that relate to dynamic semantics specifically, recognizing this similarity between modalized and non-modalized anaphoric constructions can lead to a more general realisation with regards to the understanding of the epistemic modal ‘must’. In the literature concerned with epistemology and philosophy of

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<sup>31</sup> Beaver (2001)

language there is a well-known debate regarding the strength of the epistemic modal ‘must’.<sup>32</sup> More specifically, the disagreement rests on whether must-claims are stronger, weaker or as strong as their non-modalized counterparts. However, in order to understand this debate, we have to be familiar with a particular concept of *strength*.

Without getting too deep into the discussion, we can intuitively grasp this concept through a basic understanding of epistemic commitment. Simply put, when a speaker engages in a discussion and makes a certain assertion the audience will normally assume that he is saying the truth and hold him accountable for his assertion. For example, if a speaker utters: “It is raining” and then it turns out that it is not raining, the other participants of the conversation may legitimately challenge his assertion. The fact that the audience can legitimately challenge the speaker in such cases is based upon the fact that speakers typically make commitments when they make assertions. Moreover, if the audience feels that this commitment is broken when the negation of the uttered assertion turns out to be true, then the commitment that the speaker incurs relates to the truthfulness of his assertion.

Now, different claims will lead to different commitments, even if the content of the claims is similar. For example, compare the two following dialogues.

(20) Max: John is at the bar.

Tom: no, you are wrong, I’ve seen John in the alley next to the bar.

(21) Max: John might be at the bar.

Tom: no, you are wrong, I’ve seen John in the alley next to the bar.

One can clearly see that Tom’s response in (20) is unproblematic while in (21) it seems that Tom is overreacting. It does not seem to be difficult to imagine Max answering with something like: “Calm down, I just said he *might* be there”. The fact that we perceive Tom’s answer differently depending on the dialogue, even if both conversations are about John being at the bar, indicates that Max is incurring in two different commitments. Furthermore, given that Tom is correcting Max with regards to the factual whereabouts of John and his correction is successful only in (20), it becomes apparent that Max’s epistemic commitment in (20) is stronger than the one in (21). Thus, *might*-claims induce a weaker commitment than their

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<sup>32</sup> von Fintel & Gilles (2010)

non-modalized counterparts and, therefore, unembedded assertions are stronger than might-claims. What about must-claims then? As I mentioned, There is some disagreement within the philosophical community when it comes to comparing the strength of must-claims with their non-modalized counterparts. Nevertheless, our analysis of anaphoric construction and our interpretation of the epistemic modal ‘must’ allows us to make two remarks with regards to this discussion.

First of all, even without appealing to dynamic semantics, we can point to the fact that a pronominal anaphora is unaffected by whether its preceding sentence is a must-claim or a non-modalized claim. Or in other words, when transforming an unembedded pronominal anaphora like (19) in an anaphoric construction that has a ‘must’ in its first sentence like (17), there is no need to modify the sentence containing the anaphoric pronoun. On the contrary, transforming an unembedded pronominal anaphora into one that is embedded under a might-operator, leads to a modification of the pronominal sentence. More specifically, pronominal sentences that follow after a might-claim normally require a *non-factual mood*, i.e. the use of terms like ‘would’ or ‘could’. Anaphoric pronominal sentences have a strong link with the sentence that precedes them. The fact that there is no alternation of the pronominal sentence when the preceding unembedded sentence becomes a must-claim, can be regarded as evidence for assuming that must-claims are at least as strong as unembedded assertions. Especially if we consider that anaphoric constructions seem to show a sensitivity to the strength of the preceding sentence, as suggested by the transformation with ‘might’, which weakens the sentence.

The second point that can be made with regards to the debate relates to the interpretation of epistemic modals that I am developing in this dissertation. More specifically, we can attempt to determine the position of our version of dynamic semantics within the debate. As we have seen above, the interpretation of modal claims presented here considers an update with a must-claim containing an indefinite noun as informative as one triggered by its modalized counterpart. So, *prima facie*, it seems correct to conclude that our dynamic model interprets must-claims as being as strong as its non-modalized counterparts. Because, if they have the same impact on the context, then they will have the same strength in the context.

Yet, if we consider our discussion in chapter 1., we realize that we determined a divergence between certain unembedded claims and must-claims, which relates to uniqueness. This difference led us to conclude that unembedded claims supported by direct evidential

access ought to be interpreted as having uniqueness constraints on the introduction of a discourse referent. These uniqueness constraints, however, should not be kept for must-claims. So, in the end, there is a difference in interpretation between unembedded claims and must-claims when it comes to reference.

Moreover, even without having to discuss our findings of chapter 1., must-claims that embed sentences which do not affect assignment functions are interpreted as just introducing a test, while their non-modalized counterparts actively eliminate worlds from the context. It is true that, if the test is successful, an update with a must-claim will output the same context as its non-modalized counterpart. Nevertheless, it seems difficult to compare the test-like must-claim with its counterpart that actively eliminates worlds. Is an utterance that tests the context stronger than one that actively changes the context? There does not seem to be a clear answer to this question. It even seems to be an inappropriate question to ask given the circumstances. This is exactly what I would like to argue for: the dynamic model cannot be recasted within this debate about the strength of the epistemic modal ‘must’.

Aside from the points that were just presented, it is important to highlight that the debate regarding the strength of ‘must’ mainly revolves around a certain conception of actuality and epistemic availability. For example, theories that claim that must-claims are stronger than their non-modalized counterparts argue that uttering a must-claim commits a speaker to the truth of the prejacent in all epistemically available worlds, while uttering the non-modalized counterpart incurs a commitment with regards to the truth of the claim in the actual world.<sup>33</sup> So, even when the prejacent of a must-claim turns out to be true in the actual world, a speaker can still violate his commitment if there are some epistemically viable worlds that falsify the prejacent. Therefore, a must-claims is stronger than its non-modalized counterpart given that the latter only requires the truth of the claim in the actual world.

Yet, dynamic semantics does not exhibit the same understanding of the meaning of a sentence as these theories. By representing their meaning as their context change potential, sentences are directly linked to the context, i.e. the possible worlds that are epistemically available in the given conversation, and can only indirectly be connected to their truth in the actual world. Arguments proposed within the debate regarding the strength of ‘must’ can hardly be applied within the dynamic model and, therefore, positioning the dynamic system within the landscape of this debate seems to be out of place. Because the concept of a claim

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<sup>33</sup> von Fintel & Gilles (2010)

being stronger or weaker compared to others as it is used in the debate only makes sense within a static framework that considers the meaning of a sentence to be directly linked to its truth conditions.

Let us now move on to the interpretation of the epistemic modal ‘might’ and, therefore, to the anaphoric construction presented by (18). As before, suppose that our dynamic context contains three assignment-function-world-pairs:  $\{ \langle f, w_1 \rangle, \langle f, w_2 \rangle, \langle f, w_3 \rangle \}$ . Suppose further that just two worlds ( $w_1$  and  $w_2$ ) contain individuals that are police officers that come to the bar. More specifically,  $w_1$  contains two individuals (individual  $a$  and  $b$ ) that satisfy the predication of being police officers that come to the bar, world  $w_2$  has one individual (individual  $c$ ) that satisfies the same predication while  $w_3$  has no individual that satisfies the predication. Again, also our interpretation of might-claims maintains the general features of the test-like interpretation. So, when uttering the sentence ‘a police officer might come to the bar’, the context will, first of all, undergo a test. When it comes to might-claims, the test that is being introduced relates to the compatibility of the prejacent of the might-claim with the dynamic context. In other words, if there is at least one world in the context that contains the prejacent of the might-claim, then the test is successful and an update with a might-claim does not lead to the empty context. In our case, the dynamic context that we have defined contains two worlds in which the prejacent of the first sentence of (18) is true. Hence the test is successful.

While the traditional test-like interpretation would now return the same context as before, our interpretation will trigger an additive mechanism. However, the additive mechanism triggered by a might-claim has to be different than the one introduced by a must-claim. After all, the test related to the epistemic modal ‘might’ is about compatibility. The test can be successful even if the context contains worlds in which the negation of the prejacent of the might-claim is true. Hence, a complete introduction of a discourse referent would be inappropriate. If there are some worlds that do not contain individuals that satisfy the predication expressed by the prejacent, then those worlds do not have individuals to which the discourse referent can be assigned.

What kind of additive mechanism is triggered then, when a might-claim, like the one in (18), updates the context? Give that a total introduction is impossible, only a partial introduction will occur. In other words, a might-claim containing an indefinite noun will introduce a discourse referent which has assignments in just those worlds that contain its

prejacent. This means that only assignment functions paired with these worlds will be enriched by having said discourse referent as part of their domain. On the contrary, assignment functions paired with worlds that do not contain the prejacent of the might-claim will remain unaffected by the update. In the case of the first sentence of (18) specifically, a discourse referent  $y$  will be introduced and assigned to just the individuals in the context that satisfy the predication expressed by the prejacent of the might-claim in question. Therefore, in  $w_1$   $y$  will be assigned to individuals  $a$  and  $b$ , in  $w_2$  it will be assigned to  $c$  and in  $w_3$  there will be no assignment, as we can see in this schematic representation of the context:

$$c = \{ \langle (y \rightarrow a, y \rightarrow b), w_1 \rangle, \langle (y \rightarrow c), w_2 \rangle, \langle f, w_3 \rangle \}$$

Again, such a result would be impossible if we kept the traditional test-like interpretation. Similarly to must-claims, might-claims would not introduce a persistent discourse referent if we employed the traditional theory. Therefore, the anaphoric pronoun ‘she’ contained in the second sentence of (18), i.e. ‘she would ask some questions’, would not have a discourse referent to pick up and (18) would end up being undefined. Instead in our new account, the pronoun in (18) does have a suitable referent.

Nevertheless, there is a substantial difference between the assignment of the discourse referent introduced by a might-claim and the one introduced by a must-claim. The discourse referent introduced by the former claim does not necessarily have assignments in all the worlds of the context, but rather just in those worlds that satisfy the prejacent of the might-claim. Consequently, this difference will have an impact on how we interpret the pronominal sentence that follows the might-claim. If we were to adopt the usual dynamic interpretation for pronominal sentences, e.g. the one used when interpreting the second sentence of (17), we would face some complications. The usual interpretation of pronominal sentences represents them as purely eliminative. The mechanism triggered by those claims eliminates assignments as well as worlds that lack individuals with which an assignment with the relative discourse can be established. Therefore, maintaining this interpretation of pronominal claims for sentences like the ones present in (18), leads to the elimination of all the contextual worlds that do not have a police officer that comes to the bar and asks some questions. To put it in other words, by adopting the usual interpretation of pronominal sentences an update with (18) has the same result as its non-modalized counterpart. However,

this is definitely a wrong prediction. As we said, there is a clear difference between might-claims like ‘it might be raining’ and their non-modalized counterpart like ‘it is raining’, regardless of there being an anaphoric construction or not. Thus, a different interpretation for pronominal sentences preceded by a might-claim must be developed in order to correctly capture their meaning.

However, changing the dynamic interpretation of pronominal sentences is not something that can be done light-heartedly. If we change the interpretation as a whole in order to accommodate cases like (18), then we end up sacrificing the previous dynamic interpretation that worked perfectly for indefinite-linked pronominal anaphoras that start with an unembedded claim or a must-claim. One could attempt to maintain the normal interpretation while introducing a new one for sentences like (18) by stating some kind of rule that differentiates between cases. If we find a linguistic element that clearly differentiates pronominal sentences that require a new interpretation from cases that need the usual one, then we can use it as a condition for triggering the appropriate interpretation for the relative pronominal sentence. For example, the most obvious element that comes to mind for fulfilling this purpose is the property of having a might-claim as an antecedent. If we stipulated a rule for when to use which interpretation and used the property of having a might-claim as an antecedent as the condition for applying the rule, then we could differentiate between cases and the model would apply the correct interpretation depending on the case. The rule could then be stated roughly in the following way: if a pronominal sentence  $\Phi$  has a might-claim as an antecedent, then use interpretation  $y$ , use interpretation  $x$  otherwise.

However, this looks like quite the bland strategy. The rule just stated seems to be too specific, especially if we desire a dynamic model that can be expanded to cover other epistemic modals that behave similarly to ‘might’. So, while we might have been on the right track when we looked for a linguistic element that could differentiate between cases, the resulting rule leaves much to be desired. More specifically, the property of having a might-claim as an antecedent seems to be a suboptimal candidate for characterizing the linguistic element that we desire. It is a property about the specific positioning of the pronominal sentence in a conversation and, therefore, a burdensome element that cannot be clearly identified by looking at the propositional sentence alone.

Is there a linguistic element that can overcome these shortcomings and justify two different interpretations of pronominal anaphora on rational grounds? If we look closely and compare

pronominal sentences that are preceded by a might-claim with their counterparts that are not preceded by might-claims, like (22) below, we realize that there is an explicit linguistic element within the former set of sentences that differentiates them from the latter one.

(18) A police officer might come to the bar. She would ask some questions.

(22) A police officer comes to the bar. She asks some questions.

The linguistic element that I have in mind is the *non-factual mood* present in the second sentence of (18).<sup>34</sup> Conceptually, we can intuitively grasp a non-factual mood as something that accompanies a sentence that a speaker utters in order to describe a possible world that is not necessarily the actual one. Linguistically, non-factual mood is signalled by different terms like, for example, ‘would’. The fact that the pronominal sentence in (18) expresses a non-factual mood with the term ‘would’ while the pronominal sentence (22) does not, is the comprehensive difference that will allow us to give different interpretations of pronominal sentences. It is also relatively safe to assume that this difference can be generalised, given that, as we said multiple times, epistemic ‘might’ is not a factual operator. So, if an anaphoric pronoun is picking up discourse referent which was introduced in a sentence embedded under a non-factual operator, it is not surprising that the sentence containing said anaphoric pronoun, one that further elaborates the information left by the might-claim, will have a non-factual mood.

Moreover, a non-factual mood is expressed through terms that are *within* the pronominal sentence. Hence, establishing a different dynamic interpretation for pronominal sentences that are preceded by a might-claim does not require the introduction of any rules that differentiate between interpretations. We can simply treat pronominal sentences with a non-factual mood and ones with a factual mood as completely different sentences by relying on the presence of terms like ‘would’. Consequently, we can develop a new interpretation for pronominal sentences that have a might-claim as their antecedent without endangering the already present interpretation of pronominal sentences. But what is this new interpretation of pronominal sentences that relies on terms that signal a non-factual mood?

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<sup>34</sup> Roberts (1989)

As we just mentioned, a pronominal anaphora that follows after a might-claim intuitively elaborates the information left by the might-claim that precedes it. So, if the might-claim affects only those worlds in which its prejacent is contained via its additive mechanism, it seems reasonable to assume that the pronominal sentence will only affect those worlds. Therefore, an anaphoric pronominal sentence with a non-factual mood triggers its eliminative mechanism only in assignment-function-world-pairs that contain an assignment introduced by the might-claim that precedes them. It must be noted that this modification only affects the scope of the eliminative mechanism not the behavior of the mechanism itself. Hence, the pronominal sentence eliminates all the assignments of the discourse referent introduced by the might-claim that pick up individuals that cannot satisfy the new predication expressed in the pronominal sentence. Furthermore, if a world within the scope of the non-factual pronominal sentence lacks individuals that satisfy its predication, then the update with the pronominal sentence will eliminate that world.

So that we are on the same page with regards to this interpretation, let us recall the context that we updated with the first sentence of (18). The context that we gave before the update with the might-claim in (18) had three worlds and three individuals that satisfied the predication. More specifically,  $w_1$  contained two individuals (individual  $a$  and  $b$ ) that satisfied the predication of being police officers that come to the bar, world  $w_2$  had one individual (individual  $c$ ) that satisfied the same predication while  $w_3$  had no individual that satisfied the predication. After the update with the might-claim in (18) and the successful test outcome that came with it, we were left with a context in which a discourse referent  $y$  was introduced and no worlds were eliminated. Moreover,  $y$  was assigned to individuals  $a$ ,  $b$  and  $c$  while  $w_3$  did not have any assignment.

Now, suppose that only individual  $a$  is a police officer that comes to the bar and asks some questions. If we update the current context with the pronominal sentence of (18), i.e. ‘she would ask some questions’, we will have the following result. First of all, the anaphoric pronoun ‘she’ picks up the discourse referent  $y$  introduced by the might-claim. Consequently, the pronominal sentence eliminates the assignments relating to individuals  $b$  and  $c$  given that they do not exhibit the predication expressed by the pronominal sentence. Furthermore, because world  $w_2$  only has individual  $c$  as a value for the discourse referent  $y$ ,  $w_2$  is eliminated from the context due to a lack of individuals that satisfy the predication expressed by the

second sentence of (18). So, after an update with both sentences of (18), we will be left with the following context:

$$c = \{ \langle (y \rightarrow a), w_1 \rangle, \langle f, w_3 \rangle \}$$

An interesting point, which can also be seen as an opportunity to further deepen our understanding of this interpretation of anaphoric constructions originating from might-claims, comes from combining this interpretation of anaphora with the epistemic contradictions discussed previously. While the epistemic contradictions encountered so far had no importance for our interpretation due to their lack of pronominal anaphora, recasting these contradictions as anaphoric construction makes them relevant in our current discussion. So, without further ado, let us look at this new set of cases.

(23) A police officer is at the bar. She might not be at the bar.

(24) A police officer might be at the bar. She wouldn't be at the bar.

Let us start with the first case. The anaphoric construction in (23) sounds intuitively bad. It is most likely that this infelicity originates for the same reasons that make non-anaphoric epistemic contradictions bad. Does our interpretation of might-claims align with these intuitions? While the epistemic contradiction has changed via the addition of an anaphoric link, we should be fooled by this. First and foremost a might-claim triggers a test regarding the compatibility of its prejacent with the context. The presence of an anaphoric pronoun does not change this notion. Hence, given that the prejacent is not compatible with the context, the test introduced by the might-claim will be unsuccessful. Consequently, the might-claim will lead the conversation to the empty context. Therefore, the infelicity of (23) can be explained in the same way as we explained the unassertability of (15).<sup>35</sup>

The second anaphoric construction, the two sentences in (24), seems also quite bad. Yet, it is interesting how transforming (24) into a dialogue makes it felicitous.

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<sup>35</sup> For clarity's sake I have decided to avoid a discussion about might-claims containing an anaphoric pronoun that successfully pass the test. However, the formal definition of might-claims that I give in the third chapter of this dissertation appropriately accounts for them. I will leave it up to the reader to use said definition and determine what kind of contextual update follows from these constructions.

(26) Tom: a police officer might be at the bar.

Max: she wouldn't be at the bar.

Why is there a difference in asserability between (24) and (26)? The most reasonable assumption that we can make is that we perceive the second sentence of (24) to be a correction of the previous sentence. Therefore, in a dialogue with different speakers a correction seems fine, yet uttering a sentence and correcting it in the same breath is odd and contradictory because it puts the speaker in an incoherent epistemic state. Nevertheless, imagine a speaker that really wants to determine where a police officer might be. Imagine further that he is talking to himself while considering different hypotheses. The following monologue does not seem impossible: "A police officer might be at the bar. No, she wouldn't be at the bar. A police officer might be at the theater but definitely not the bar.". So, if we do not consider our dynamic model for a moment and just follow our intuitions, in which context would we find ourselves after listening to (24) in that monologue or after hearing Max's line in (26)? The context that intuitively comes to mind is one in which there are no police officers at the bar, but it still can be the case that there are police officers that are somewhere else depending on how the context develops.

Now, if we apply our interpretation of anaphoric constructions that originate from a might-claim, we will realize that we get exactly the same context that our intuitions suggest. First of all, a successful update with the first sentence of (24) will introduce a discourse referent and assign it to all the individuals that satisfy the predication of the sentence while not eliminating the worlds that do not contain such individuals. Then, an update with the second sentence of (24) will eliminate all the assignments to individuals that do not satisfy the ulterior predication expressed by the pronominal sentence. However, given that the predication carried by the pronominal sentence is in contrast with the one of the might-claim, the second sentence of (24) will preserve only those assignments that map the discourse referent onto individuals that are police officers that are at the bar and that also are not police officers that are at the bar. Obviously, there are no such individuals. Hence, due to the lack of assignments, the pronominal sentence will eliminate from the context all the assignment-function-world-pairs in which the discourse referent introduced by the might-claim had an assignment. Nevertheless, the eliminated worlds are just those worlds in

which there are police officers at the bar. Consequently, the resulting dynamic context still contains worlds in which there are police officers that are somewhere else. So, in the end, our interpretation is able to exactly deliver the context that aligns with our intuitions.

It is appropriate to mention that, while (24) can be understood as expressing a correction of the context, it is quite different from the correction that we discussed in § 1.2. while talking about the informative nature of modals. Linguistic constructions like (14), here presented again as (27), express a correction via pragmatics.

(27) Tom: John is at the bar.

Max: John might be in the alley next to it.

As we said, in (27) Max's line is a pragmatic tool for blocking Tom's claim before it updates the context. So, their dialogue never truly affects the context, it is rather a pragmatic exchange that originates when speakers disagree on the common ground. On the other hand, linguistic constructions like the one in (24) express corrections that can be captured by our dynamic semantics.

Finally, in order to avoid misunderstandings it seems important to highlight that this discussion about interpreting (24) as a felicitous correction of the context should not be seen as an attempt to hide the contradictory nature of the claim. In fact, supposing (24) is impossible without lacking coherence. Yet, our interpretation of modals does not deny this. If (24) is subordinated under the propositional attitude 'suppose' and it updates the context, then the supposition state of the individual that is supposing (24) is either trivially empty or it is incoherent. This is because the resulting supposition state for the embedded (24) is one in which there are and are not police officers that come to the bar. Nevertheless, this discrepancy in results between the supposed (24) and the uttered (24) should not be seen as problematic for our account. On the contrary, the different results show how this interpretation of modals is able to account for the different uses of (24). If a speaker utters (24) as a correction then the interpretation will deliver the appropriate corrected context, and if the speaker utters (24) as a supposition then the interpretation will supply the desired conversational failure.

With this last remark we can say that we discussed the interpretation of might-claims sufficiently. Furthermore, this puts us in a position in which we can confidently conclude that our new interpretation of modals is able to license pronominal anaphora that originates from

might-claims as well as one that starts from a must-claim. Consequently, we have shown that this account satisfies the final and fourth point on our list of desiderata. Hence, we managed to successfully argue that the new interpretation of modals presented here is able to account for all four desiderata that we set at the beginning in this section.

What can be said as a conclusion for this second chapter? At the beginning of this chapter we set out to solve a problem: Veltman's test-like interpretation of epistemic modals does not license indefinite-linked pronominal anaphora that originates from a must- or might claim, even if these linguistic constructions are completely assertable. While analysing this test-like interpretation we found two reasons that support it. First of all, the test-like interpretation conveniently integrates the static understanding of epistemic modals into dynamic semantics. Secondly, the interpretation is able to account for the unassertability of certain epistemic contradictions. Yet, we did not just find reasons in favour of the test-like interpretation, we also found two reasons against it, i.e. the test-like interpretation violates the Gricean maxim of quantity and it is unable to license pronominal anaphora.

By contemplating these virtues and flaws of the interpretation, a dialectic between two opposing ways of understanding epistemic modals transpired. The two opposing positions were represented by the traditionalist, which supported the test-like interpretation, and the radicalist, which opposed said interpretation. In an effort to determine which side could offer the more promising theory for solving our original problem, we compared them and considered possible strategies for filling their respective lacunas. Unfortunately, both sides turned out to be problematic and we reached an impasse.

Nevertheless, in order to overcome this stalemate we developed a new interpretation of modals with the intention of finding a middle ground between the two opposing sides. The account that was proposed, represented epistemic modal claims containing indefinite nouns as triggering a purely additive mechanism, and it promised to integrate the virtues and overcome the flaws of the test-like interpretation. This new interpretation maintained certain features of the test-like interpretation and was therefore able to successfully preserve its virtues. Moreover, by introducing an additive mechanism within the semantics of 'must' and 'might' after their successful test, also the problems that came with the traditional interpretation were solved. On the one hand, must-claims containing an indefinite noun were conceived as introducing a discourse referent assigned to all individuals that satisfy the predication of the

prejacent of the must-claim. On the other hand, might-claims with an indefinite noun in them introduced a discourse referent that only had assignments in those assignment-function-world-pairs that possessed worlds containing individuals that satisfy the predication. While no modification were necessary for the interpretation of pronominal sentences preceded by a must-claim, pronominal sentences expressing a non-factual mood were interpreted as triggering an eliminative mechanism confined to the contextual subset of assignment-function-world-pairs containing worlds that could boast individuals assigned to the discourse referent introduced by the might claim. So, in the end, we successfully argued for an interpretation of epistemic modal claims that license pronominal anaphora.

## **A Toy Dynamic Semantics for Uniqueness Ascriptions and Epistemic Modals**

This third and final chapter aims to tie the conclusions drawn in the previous two chapters together by representing them in a more formal manner. The modifications presented in this dissertation so far can be expressed as the following four points:

- i. The introduction of uniqueness constraint in unembedded sentences containing an indefinite noun.
- ii. Transforming must-claims containing an indefinite noun so that they introduce a discourse referent assigned to all individuals that satisfy the predication of the prejacent of the must-claims, if they do not lead to conversation to the empty context.
- iii. Modifying might-claims containing an indefinite so that they partially introduce a discourse referent that only has assignments in those assignment-function-world-pairs that possess worlds containing individuals that satisfy the predication of the prejacent of the might-claims, if the might-claims do not lead the conversation to the empty context.

- iv. Interpreting pronominal sentences that express a non-factual mood so that the pronouns can pick up partially introduced discourse referents and attach to them the relevant predication expressed by the pronominal sentence.

In order to give a sufficiently clear formal treatment of these points, the chapter will start with some general remarks on the nature of dynamic systems. Furthermore, we will define some formal terminology and signs so that semantic values for sentences expressed later can be grasped without confusion. Finally, we will give a toy dynamic semantics in which the four modifications above will be implemented while showing how they change our understanding of dynamic semantics. It must be noted here that my work has the intention of modifying a system rather than giving a completely new one. Therefore, a lot of the definitions and semantic values that will follow are taken from other authors like Heim, Veltman and Rothschild and might already be familiar to some.<sup>36</sup>

On another note, the presence or absence of uniqueness constraints for the interpretation of a given sentence will be justified on the basis of the general rule that we stated at the end of the first chapter of this dissertation. Therefore, the application of uniqueness constraints will be formally expressed to the extent that sentences with uniqueness constraints will express them in their interpretation while sentences that do not possess uniqueness constraints will not.

## 1. Definitions and Notations

The meaning of a sentence in dynamic semantics is its context change potential. It expresses how, relative to its meaning, a sentence changes a context so that another context is reached. The meaning of a sentence can, therefore, be grasped as a function from one context to another context. Following Veltman,<sup>37</sup> to establish this idea we can define a dynamic system  $\langle L, C, [ ] \rangle$  where  $L$  is a language containing sentences,  $C$  is a set containing context sets and  $[ ]$  is an interpretation function that allows sentences of  $L$  to operate on context sets of  $C$ . Defining this dynamic system abilitates us to represent the operation viz. update that a sentence  $\psi$  triggers on a context  $c$  as  $[\psi](c)$  where  $[\psi]$  is a function with  $c$  as its argument that will output another or the same  $c$ . Nevertheless, we will adopt, like Veltman, a postfix

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<sup>36</sup> Heim (1982), Veltman (1996), Rothschild & Mandelkern (unpublished)

<sup>37</sup> Veltman (1996)

notation that expresses  $[\psi](c)$  as  $c[\psi]$ . The advantages of this notation will quickly become apparent later, when discussing the semantic values of sentences, but the general motivation for employing this notation is that it provides a more intuitive representation of a context being updated by a sentence.

The set  $C$  contains context sets which in turn are sets of assignment-function-world-pairs, in short, files. A file  $\langle f, w \rangle$  is a pair made out of a partial function  $f$  and a possible world  $w$ , where  $f$  maps variables onto individuals. So, let us define a set of possible worlds  $W$ , a set of variables  $V$  and a set of individuals viz. objects  $O$ , in order to represent the maximal context set as:

$$c = \{ \langle f, w \rangle : f : V \rightarrow O, w \in W \}$$

From this we can define a domain of a context  $dom(c)$  such that  $dom(c)$  expresses all the variables that are defined as an argument for all the assignment functions in  $c$ . Furthermore, we can define a partial domain of the context  $pardom(c)$  such that it contains all the variables defined as an argument for some of the assignment functions in  $c$  but not all.

Given our definition for  $dom(c)$  and the fact that assignment functions in  $c$  are partial functions, we can define a partial ordering on assignment functions. If we take an assignment function  $f$  of a context  $c$  and another assignment function  $f'$  of context  $c'$ , then  $f \geq f'$  if  $f$  agrees with  $f'$  in the contextual domain of  $f'$  but  $f$  might have a greater domain.

Finally, before we start developing our toy dynamic semantics it seems appropriate to define some notations that might be unfamiliar to some. First of all, if two assignment functions  $f$  and  $f'$  agree everywhere except for argument  $x$ , then we will use the notation  $f[x]f'$  to express it. Furthermore, if we want to say that a context  $c$  supports an update with a sentence  $\psi$ , then we will write  $c[\psi] \sim c$ , such that  $c[\psi] \sim c$  iff  $c[\neg\psi] = \emptyset$ .<sup>38</sup>

## 2. A Toy Dynamic Semantics

Let us start this section by listing the atomic sentences that will be used in our toy dynamic semantics.

Atomic sentences:

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<sup>38</sup> Rothschild & Mandelkern (unpublished)

‘There is [a police officer]<sub>x</sub>.’

‘She<sub>x</sub> is drinking’

‘it is raining’

As we can see, pronouns and indefinite nouns in these atomic sentences will be indexed by variables, in this case variable  $x$ . Moreover, for complex sentences we will stipulate that if  $\alpha$  and  $\beta$  are sentences of the language, then also the following linguistic constructions are sentences of the language.

Complex sentences:

‘ $\alpha$  and  $\beta$ ’

‘not  $\alpha$ ’

‘it must be  $\alpha$ ’

‘it might be  $\alpha$ ’

‘would  $\alpha$ ’

‘if  $\alpha$  then  $\beta$ ’

‘ $\alpha$  or  $\beta$ ’

‘John supposes  $\alpha$ ’

Let us now look at the atomic sentence ‘There is [a police officer]<sub>x</sub>.’ that contains the indefinite noun ‘a police officer’ and is an unembedded sentence. As I argued in the first chapter of this dissertation, unembedded sentences containing an indefinite noun introduce a discourse referent that, among other things, is assigned to a unique individual for each world. While keeping this in mind, we can give the following semantic value for the atomic sentence ‘There is [a police officer]<sub>x</sub>.’

$c[\text{There is [a police officer]}_x] =$

i. undefined if  $x \in \text{dom}(c)$  or  $x \in \text{pardon}(c)$ ,

ii.  $\{ \langle f, w \rangle : \exists \langle f', w \rangle \in c, f[x]f', f \text{ assigns } x \text{ to exactly one police officer in } w \}$

Point i. of this semantic value expresses the novelty condition introduced by Heim<sup>39</sup> and simply guarantees that the discourse referent introduced by the indefinite noun is a new discourse referent. Point ii., on the other hand, provides the new contextual set that emerges from the successful update. As we can see, due to the sentence requiring uniqueness constraints, the discourse referent  $x$  is assigned to unique police officers.

$$c[\text{She}_x \text{ is drinking}] =$$

- i. undefined if  $x \notin \text{dom}(c)$  or  $x \notin \text{pardon}(c)$ ,
- ii.  $\{ \langle f, w \rangle \in c : \text{drinking}(f(x)) \text{ in } w \}$

$$c[\text{It is raining}] = \{ \langle f, w \rangle \in c : \text{it is raining in } w \}$$

For this semantic entry for ‘ $\text{She}_x$  is drinking’, point i. expresses Heim’s familiarity condition,<sup>40</sup> while the second point defines a new context set where there are no files in which the referent(s) of  $x$  does not drink. Moreover, the semantic entry for ‘it is raining’ simply delivers an updated context set in which no file contains a world in which it is not raining.

Let us now discuss the semantics for must-claims. In the first chapter of this dissertation we concluded that unembedded claims containing an indefinite noun that do not appear to require uniqueness constraints should be actually interpreted as having a covert must-operator. Furthermore, in chapter two we argued that must-claims should not just be understood as a test, but also as trigger an additive mechanism without eliminating worlds from the context. Hence, the semantics value for must-claims has to, first of all, be able to introduce a discourse referent with its relative assignments without eliminating worlds and also allow said discourse referent to be (possibly) assigned to multiple individuals at a world. Based on this, we can offer the following semantics of must-claims:

$$c[\text{it must be } \alpha ] =$$

- i. defined in  $c$  only if  $c[\alpha]$  is defined.
- ii.  $\emptyset$  if  $c[\neg\alpha] \neq \emptyset$ .

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<sup>39</sup> Heim (1982)

<sup>40</sup> *ibid.*

iii. otherwise  $c[\alpha]$

Given that we are mainly interested in must-claims containing an indefinite noun, let us insert ‘There is [a police officer]<sub>x</sub>.’ for  $\alpha$ .

$c[\text{It must be that there is a [police officer]}_x] =$

i. undefined if  $x \in \text{dom}(c)$  or  $x \in \text{pardon}(c)$ ,

ii.  $\emptyset$  if  $c[\text{there is not a [police officer]}_x] \neq \emptyset$ ,

iii. otherwise  $\{ \langle f, w \rangle : \exists \langle f', w \rangle \in c, f[x]f', \text{police officer}(f(x)) \text{ in } w \}$

So, if we look at the latest definition, then point i. represents the same novelty conditions defined above for the semantics of unembedded sentences containing an indefinite noun. If the conditions set by i. are satisfied, then the computation path leads to ii.

Point ii. expresses the traditional test-like conditions in which, if the negation of the prejacent is contained in some worlds of the context, then the must-claim leads the context to the empty set. However, while the traditional interpretation would return  $c$  as an alternative to the empty context, here we can see how the computation path expressed by ii. offers iii. as an alternative to the empty context.

This leads us to point iii., which defines a context that has been updated with the prejacent of the must-claim. Therefore, a new discourse referent  $x$  has been introduced and assigned to individuals that are police officers, while files exhibiting worlds that contain the negation of the prejacent have been eliminated. As some might have already noticed, the interpretation described here is able to guarantee that must-claims containing an indefinite noun never eliminate worlds through the computation described in iii.. Given that point ii. proceeds iii. on the computation path and it guarantees that, by the time that we reach iii.,  $c$  supports the prejacent of the must-claim. Hence, context sets that allow us to reach iii. already lack worlds that would be eliminated by an update with the prejacent of the must-claim. Consequently, iii. only triggers an additive mechanism. Furthermore, the introduced discourse referent does not have any uniqueness constraints as shown by the fact that  $f$  does not assign  $x$  to unique police officers in iii.. Thus, the discourse referent  $x$  can be assigned to multiple individuals at a world in this case.

When it comes to the semantics of might-claims containing an indefinite noun, we came to the conclusion that, if certain conditions are met, they should be interpreted as partially introducing a discourse referent that only has assignments in those assignment-function-world-pairs that possess worlds containing individuals that satisfy the predication of their prejacent. in view of these remarks the following semantic entry can be defined:<sup>41</sup>

$c[\text{it might be } \alpha ] =$

- i. defined in  $c$  only if  $c[\alpha ]$  is defined.
- ii.  $\emptyset$  if  $c[\alpha ] = \emptyset$ .
- iii. otherwise  $(c \cup c[\alpha ]) - c'$ , where  $c'$  is the largest subset of  $c$  : if  $\langle f, w \rangle \in c$  and  $\langle f', w' \rangle \in c[\alpha ]$  and  $w = w'$ , then  $\langle f, w \rangle \in c'$

$c[\text{It might be that there is a [police officer]}_x] =$

- i. undefined if  $x \in \text{dom}(c)$  or  $x \in \text{pardon}(c)$ ,
- ii.  $\emptyset$  if  $c[\text{there is a [police officer]}_x] = \emptyset$ ,
- iii. otherwise  $(c \cup c[\text{there is a [police officer]}_x]) - c'$

Again, point i. introduces novelty conditions that, if accounted for, lead to ii.. Point ii. represents the traditional test-like conditions for might-claims, for which the empty set is outputted if all the worlds in the context contain the negation of the prejacent. If both these conditions are satisfied then the computation path will reach iii.

This last step defines a context set which is a subtraction of the union of  $c$  and  $c$  updated with the prejacent of the might-claim, with  $c'$ . The union in clause iii. is implemented in order to add files to  $c$  without eliminating any. So, in this case, the union  $(c \cup c[\text{there is a [police officer]}_x])$  defines a context set where we keep all the files in  $c$  but also add files of  $c$  that were updated by the prejacent of the might-claim. The subset  $c'$  has as members files that are in  $c$  and that share the same worlds with the members of  $c$  updated by the prejacent of the might claim. In other words,  $c'$  contains the files of  $c$  that would survive an update with the prejacent of the might-claim. Consequently, via the subtraction we define a context in which a

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<sup>41</sup> notation ‘-’ signifies set subtraction so that  $c - c' = \{ \langle f, w \rangle : \langle f, w \rangle \in c, \text{ and } \langle f, w \rangle \notin c' \}$

discourse referent is only present in files that have worlds that satisfy the predication but that also has the same number of files as  $c$ . To put it simply, clause iii. partially introduces a discourse referent in  $c$  which is assigned in just those worlds that satisfy the predication, i.e. worlds that have police officers.

At this point, there is only one last modification of the dynamic model that needs to be accounted for and it relates to the semantics of non-factual pronominal sentences. When it comes to interpreting non-factual pronominal claims, the crucial point that transpired from the previous chapter, is to interpret them so that, when they pick up a partially introduced discourse referent, they only trigger an eliminative mechanism with regards to those files in which the discourse referent is defined. Keeping this in mind we can offer the following interpretation:

$c[\text{would } \alpha ] =$

- i. undefined if  $c = c'$ ,
- ii. otherwise  $\{c + c' [\alpha], \text{ where } c' \text{ is the largest subset of } c : c'[\alpha] \text{ is defined}\}$

$c[\text{She}_y \text{ would be drinking}] =$

- i. undefined unless  $y \in \text{pardon}(c)$ ,
- ii. otherwise  $\{ \langle f, w \rangle \in c : \text{if } f(y) \text{ is defined in } w \text{ then is-drinking}(f(x)) \text{ in } w \}$

Now that the modifications proposed in this dissertation have been formally integrated into our toy dynamic semantics, we will conclude this chapter by giving interpretations for the remaining complex sentences listed above. So that one can easily see that the modified semantic entries appropriately interact with these complex sentences.

$c[\alpha \text{ and } \beta ] = c[\alpha ][\beta ]$

$c[\text{not } \alpha ] = \{ \langle f, w \rangle \in c : \neg \exists f' \geq f : \langle f', w \rangle \in c[\alpha] \}$

$c[\text{if } \alpha \text{ then } \beta ] = c[\neg[\alpha \text{ and } \neg\beta ]]$

$$c[\alpha \text{ or } \beta] = \{ \langle f, w \rangle \in c : \exists f' \geq f : \langle f', w \rangle \in c[\alpha] \vee \langle f', w \rangle \in c[\neg\alpha][\beta] \}$$

$$c[\text{John supposes } \alpha] = \{ \langle f, w \rangle \in c : \pi(\text{sup}_{\text{John}})[\alpha] \sim \pi(\text{sup}_{\text{John}}) \}^{42}$$

## Conclusion

The goal of this dissertation was to overcome two lacunas of dynamic semantics. The first lacuna was concerned with uniqueness and the second one related to epistemic modals. In the first chapter, by addressing the criticism put forward by philosophers like Robert van Rooij, we tackled the first problem. These philosophers judged the dynamic interpretation of unembedded indefinite-linked pronominal anaphoras to be inappropriate. Because they considered anaphoric pronouns contained in these linguistic constructions to refer to unique individuals. By analysing this critique, we were able to determine that just some uses of indefinite-linked pronominal anaphora intuitively required the pronoun to refer to a unique individual while others did not. Moreover, we realized that this behaviour was governed by a conceptual notion. Therefore, we used this conceptual notion to differentiate between cases that required uniqueness and ones that did not. The discerning notion was about the evidential grounds that speakers have when uttering an indefinite-linked pronominal anaphora. More specifically, a direct evidential access to the identity of the referred individual required the anaphoric pronoun to have uniqueness constraints, while pronouns uttered on the basis of an indirect evidential inference did not require these constraints. From there we were able to link the term ‘must’ with the cases that did not require uniqueness, given that ‘must’ signals an indirect evidential inference. We concluded that cases that do not require uniqueness constraints should be interpreted as having a covert ‘must’. With this we overcame the criticism expressed by Robert van Rooij. Because we were able to accurately introduce uniqueness constraints for just those cases that require them, i.e. unembedded indefinite linked pronominal anaphoras.

In the second chapter of this dissertation we faced a problem with the dynamic interpretation of the epistemic modals ‘must’ and ‘might’. Veltman’s dynamic interpretation

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<sup>42</sup> As defined in §1.1. of the second chapter,  $\text{sup}_{\text{John}}$  is defined as the supposition state of John such that  $\text{sup}_{\text{John}} = \{w : w \text{ compatible with John's suppositions}\}$ , while function  $\pi$  is defined as a function that maps supposition states onto set of files with no discourse referents which contain the same worlds as the supposition states such that  $\pi(\text{sup}_{\text{John}}) = \{ \langle \emptyset, w \rangle : w \in \text{sup}_{\text{John}} \}$ .

of must- and might-claims does not license pronominal anaphora even if anaphoric sentences preceded by a must- or might-claims containing an indefinite noun are completely felicitous. In order to solve this problem, we evaluated the virtues and flaws of Veltman's interpretation and ended up developing a modified version of it. The modified interpretation was able to incorporate the virtues of the original interpretation by maintaining some of the test-like features that came with it. Moreover, the introduced modifications were able to overcome the flaws of Veltman's interpretation by regarding must- and must-claims as sentences that trigger a purely additive mechanism. With this, anaphoric constructions expressed by might- and must-claims were appropriately interpreted. Thus, in the end, by defining a toy dynamic semantics in the final chapter, we were able to fulfill the goal set at the beginning of this dissertation.

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