Fodor's puzzle and the semantics of attitude reports

Tillmann Pross, IMS, University of Stuttgart

Abstract Fodor (1970) came up with the following puzzle: in a scenario where Adrian has decided what kind of jacket to buy but has no idea that the kind of jacket he wants is just like Malte's jacket, there is a reading of *Adrian wants to buy a jacket like Malte's* which neither the *de re* nor the *de dicto* reading capture correctly. Based on a review of approaches to Fodor's puzzle in the literature I argue that none of the proposals in the literature provides a general account of Fodor's puzzle. I show that with respect to the scenario provided, Fodor's puzzle decomposes into several distinct readings of *Adrian wants to buy a jacket like Malte's* compatible with Fodor's original setting. Based on a detailed reconstruction of Fodor's puzzle in an extension of Discourse Representation Theory to the representation of attitudes I approach Fodor's puzzle as a problem which points to limitations in current logical form formalisms for the semantic analysis of ambiguous attitude reports and propose an elaboration of Schwager's (2009) purpose-based account of attitude reports in terms of inferences from underspecified representations of ambiguous attitude reports.

Keywords: attitude reports, context, ambiguity, underspecification, discourse representation theory

1 Introducing Fodor's puzzle

1.1 The readings of "Adrian wants to buy a jacket like Malte's"

This paper is devoted to the different readings of the attitude report in (1).

(1) Adrian wants to buy a jacket like Malte's.

There are several cases of Adrian wanting to buy a jacket like Malte's that (1) can be used to express. Two of these readings of (1), the *de re* and the *de dicto* reading, can be distinguished by considering a minimal pair of scenarios for (1), as in (2a) and (2b), where the *de re* reading evaluates as true in (2a) but false in (2b) and vice versa for the *de dicto* reading.

(2) a. Adrian has decided to buy a certain jacket but has no idea that the jacket he wants to buy is like Malte's.

b. Adrian has not decided which jacket he wants to buy but he wants it to be like Malte's.

If (1) is interpreted in scenarios (2a) and (2b) respectively, Adrian's desire can be roughly paraphrased as in (3a) and (3b).

(3) a. There is a jacket like Malte's which Adrian wants to buy.

b. Adrian wants to buy something that is a jacket like Malte's.

The two distinct readings of (1) – the *de re* (3a) and the *de dicto* (3b) reading – correspond to a structural contrast that emerges in the logical form of (1) from placing the phrase *a jacket like Malte's* either outside (4a) or inside (4b) the scope of the attitude verb *want*.

(4) a. De re: $(\exists x)$(jacket(x) & like-Malte's-jacket(x) & wants(Adrian, buy(Adrian,x)))

b. De dicto: wants(Adrian, $(\exists x)$(jacket(x) & like-Malte's-jacket(x) & buy(Adrian,x)))

Against the background of the *de dicto* and *de re* reading of (1), consider the scenario for (1) in (5) proposed by Fodor (1970).

(5) Adrian has decided what kind of jacket to buy but has no idea that the kind of jacket he wants is just like Malte's jacket. (Fodor (1970: cf. 229))[1]

There is a natural interpretation of (1) given the scenario (5) that neither the *de re* (4a) nor the *de dicto* (4b) reading render correctly. The *de re* reading (4a) is wrong for this interpretation of (1) because the quantifier $(\exists x)$ involved in the phrase *a jacket like Malte's* entails that there is some particular jacket of which it is true that Adrian wants to buy it. And the *de dicto* reading (4b) is wrong because it represents the description *like Malte's jacket* as part of the content of Adrian's desire, which in the given scenario it is not. For the sake of convenience, I refer to the reading of (1) in scenario (5) as the *Fodorian reading* of (1). Given that there is such a Fodorian reading of (1) in scenario (5), what is the logical form of the Fodorian reading? Fodor (1970) argued that under the transitivity of scope relations, not all of the three conditions (6a) - (6c) imposed on the Fodorian reading of (1) by the scenario (5)

1 Unless indicated different, I adapt all scenarios retrieved from the literature on Fodor's puzzle to one uniform naming of persons and jacket brands.

can be satisfied by a formula of first-order intensional predicate logic at once (Fodor (1970: cf. 242))[2].

(6) a. The noun phrase *a jacket like Malte's* must be within the scope of the existential quantifier introduced by *a jacket* if its variable is to be co-referential with the object of *Adrian buy* ...

b. The existential quantifier must be within the scope of the verb *wants* if it is to express the narrow scope reading.

c. The noun phrase *a jacket like Malte's* must be outside the scope of *wants* if it is to express the reading which is transparent for descriptive content.

Taken together, the existence of a reading of (1) which is distinct from both the *de re* and the *de dicto* reading but which cannot be formalized with the help of scope relationships constitute what I call *Fodor's puzzle* in what follows. Fodor's puzzle has received a great deal of attention in the literature. In the next section, I will go through a representative selection of approaches to the formalization of the Fodorian reading of (1).

1.2 Fodor's puzzle in the literature

Let us start with a scenario as in (7):

(7) Suppose a store sells some jackets that all look like Malte's and that Adrian does not know anything about Malte. Assume further that Adrian wants one of those jackets and any of them is an option. (Romoli & Sudo 2009: 427)

(7) gives rise to a Fodorian reading of (1) because although (1) is true in (7) it is neither the case that Adrian wants to buy a specific jacket like Malte's nor does Adrian know that the options which he takes into account for his buy are jackets like Malte's. Romoli & Sudo (2009) propose a logical form of the Fodorian reading of (1) in scenario (7) as in (8).

(8) $\exists!X : jackets - like - malte's(X)$ and Adrian wants to buy one of X (Romoli & Sudo 2009: 435)

2 An anymous reviewer noted that Fodor's puzzle does not arise in the form Fodor presented it if opacity is not the consequence of being in the scope of an attitude verb but rather the consequence of a hidden indexical (e.g. Forbes (2000)). I leave the question for how a hidden indexical approach deals with the observations on the Fodorian reading made in this paper open to further research.

The logical form in (8) analyzes the Fodorian reading of (1) as involving a presupposition of a set X of jackets like Malte's, where Adrian wants to buy one of the members of the set X. Next, consider the logical form (8) against the background of the scenario described in (9).

(9) Suppose a store offers some jackets that all look like Malte's and that Adrian does not know anything about Malte. Assume that some of the jackets are on sale while others are not and that Adrian is aware of this. Assume further that Adrian wants one of the jackets on sale and any of them is an option.

Again, a report of Adrian's desire in scenario (9) with (1) gives rise to the Fodorian reading of (1). There is a reading of (1) in (9) which neither the *de re* nor the *de dicto* reading capture. But something seems wrong with characterizing Adrian's desire in (9) with the logical form proposed in (8). (8) says that (1) is true if any jacket like Malte's is an option for Adrian's buy. But this is not how Adrian's desire is described in scenario (9), where there are jackets like Malte's which Adrian doesn't want to buy. (8) fails to capture this additional restriction on the set of actual jackets like Malte's imposed by the content of Adrian's desire: in general, it is not required for the Fodorian reading of (1) to be true that Adrian wants to buy any jacket like Malte's but Adrian's desire may be more specifically directed towards a subset of actual jackets like Malte's. In order to appreciate the relevance of Adrian's desire in scenarios such as (9), Adrian's desire worlds have to be taken into account in the assessment of (1). In (9), Adrian's desire worlds restrict the set of actual jackets like Malte's to those jackets which he wants to buy. This restriction on the set of actual jackets like Malte's which Adrian wants to buy is taken into account in the logical form (10) that von Fintel & Heim (2011) propose for the Fodorian reading of (1).

(10) λw_0 Adrian wants$_{w_0}$ $[\lambda w'[a - jacket - like - maltes_{w_0}]\lambda x_1[\text{PRO } to\ buy_{w'} x_1]]$
(von Fintel & Heim 2011: 102)

In (10), each predicate is annotated with the world in which it is to be evaluated, providing a formalization of the Fodorian reading of (1) according to which there are jackets like Malte's in the actual world w_0 which Adrian wants to buy in all of his desire worlds w'. Note that this approach does not require – unlike the logical form proposed by Romoli & Sudo (2009) – that Adrian wants to buy any actual jacket like Malte's but restricts the set of actual jackets like Malte's which Adrian wants to buy to those jackets singled out by Adrian's desire worlds. Finally, consider (10) against the scenario in (11).

(11) Suppose Adrian has seen a picture of a certain green Burberry jacket in a catalogue and wants to buy one. Unbeknownst to Adrian, Malte happens

to own exactly such a green Burberry jacket. Unbeknownst to Adrian, the type of jacket in the picture which Adrian has seen is sold out and no further jackets of this type have been produced yet: there are no actual jackets like Malte's.

Obviously, a report of Adrian's attitude in scenario (11) with (1) gives rise to a Fodorian reading of (1). But because the existential quantifier in the logical form proposed by von Fintel & Heim (2011) runs over an actual set of jackets like Malte's, the logical form (10) for the Fodorian reading of (1) predicts that the Fodorian reading of (1) in scenario (11) is false albeit it is intuitively true. In general, it is not required that Adrian's desire worlds single out actual jackets like Malte's for the Fodorian reading of (1) to be true. Kaufmann (Schwager (2009)) argues that what is required instead for the Fodorian reading of (1) to be true in scenarios such as (11) is that Adrian's desire worlds single out an actual property of the jackets he wants to buy instead of actual jackets. Building on a proposal by Cresswell & von Stechow (1982), Kaufmann puts forward a logical form of the Fodorian reading of (1) as in (12). In (12), P is a structured proposition and Q' a property which is interpreted outside the context of Adrian's attitude, i.e. *de re*. Q' is analyzed as the *res* of Adrian's want (in the scenario (11) *manufactured by Burberry*) and P is the proposition *buy a jacket with property Q'*.

(12) $Attitude_w(x, \langle P, Q' \rangle)$

Kaufmann's proposal combines the logical form in (12) with a replacement principle for the property Q' involved in Adrian's attitude by a reporting property Q (in (1) *like Malte's jacket*). The Fodorian reading of (1) is then analyzed as a requirement on the relation between the reported property Q' singled out by Adrian's desire worlds and the reporting property Q occurring in the report of Adrian's attitude: "the reported property can be replaced by a different property (the reporting property) as long as the reported property is a subset of the reporting property at all relevant worlds" (Schwager 2009: 409). Formally, this proposal for the analysis of the Fodorian reading is captured by the set of constraints on property replacement as in (13).

(13) $Attitude_w(x, \langle P, Q \rangle)$, iff there is a property Q' s.t. at the w-closest worlds w' where $Q(w') \neq \emptyset$:
$Q'(w') \neq \emptyset$
$Q'(w') \subseteq Q(w')$
$Attitude_w(x, \lambda w' P_{w'}(Q'))$ is true.
(Schwager 2009: 409)

Applied to the logical form in (12), the replacement principle (13) predicts the Fodorian reading of (1) in (11) to be true if the jackets singled out by the property Q' involved in Adrian's desire – that of being made by Burberry – are a subset of the set of jackets singled out by the property Q – that of being like Malte's jacket – in all relevant worlds.

1.3 Outline of the paper

Given the fact that several different accounts of Fodor's puzzle have been put forward in the literature, the informal review of approaches to Fodor's puzzle gives rise to the question whether the logical forms (8), (10) and (12)+(13) are logical forms for the same Fodorian reading of (1) or whether these are logical forms for different Fodorian readings of (1). It is on the basis of answering this question that we should address the further question whether there is a logical form which captures the Fodorian reading of (1) in all scenarios compatible with Fodor's original setting of the puzzle. Obviously, no one of the mentioned approaches to Fodor's puzzle is wrong in that it doesn't capture the Fodorian reading of (1) at all. But there seem to exist subtle differences between the proposals made in the literature based on how the Fodorian reading of (1) can be observed to manifest itself in different scenarios. Making explicit these differences is one of the goals of this paper. Not only do the approaches in the literature discussed in section 1.2 provide different formalizations of the Fodorian reading of (1), they also differ in that they offer different formal frameworks for making the readings they identify explicit. Romoli & Sudo (2009)'s proposal states truth-conditions of (1), von Fintel & Heim (2011) propose a direct interpretation approach of the semantics of (1) and Schwager (2009) uses structured propositions supplemented with a property replacement principle. I have found the framework of Discourse Representation Theory (DRT, Kamp (1984), Kamp et al. (2011)) a helpful framework for reconstructing the implicit and explicit assumptions underlying each of these proposals in order to answer the question whether these are analyses of the same Fodorian reading of (1) or analyses of different Fodorian readings of (1). Section 2 introduces and further motivates the usefulness of DRT in the analysis of attitude reports in general and for the differentiation of approaches to Fodor's reading in the literature in particular. The framework of DRT is employed in section 3 to reconstruct the approaches to Fodor's puzzle informally introduced in the previous section in order to assess how they differ and what they have in common. In section 3.5, I explore the question whether there are additional Fodorian readings to the one or ones identified in the literature and conclude in section 4.

1.4 Scope of the paper

In order to avoid confusion about the scope of my investigation, I sharply delimit the scope of this paper. This paper is exclusively devoted to the discussion of the attitude report given in (1). As long as the semantics of (1) in the Fodorian setup is not fully understood, it seems a bit too hasty to me to claim that Fodor's puzzle is of the same type as certain other puzzles which have been observed to arise in the interpretation of conditionals or tensed sentences (Keshet (2011), Schwarz (2012)). That different issues may be relevant there is suggested by the fact that Schwarz (2012) explicitly excludes from discussion scenarios of the type proposed by Schwager (2009). Also, as long as the semantics of (1) is not fully understood, we lack the grounds for claiming that the same puzzle also arises with other examples such as (14).

(14) Mary wants to buy an inexpensive jacket.

Even superficial inspection of Fodor's puzzle shows that *like* in (1) is formally different from *inexpensive* in (14). In *a jacket like Malte's*, *like* is a relation, whereas *inexpensive* in *an inexpensive jacket* is not. One aspect to be identified in the detailed discussion of the Fodorian reading of (1) in section 3 is that *likeness* is crucial to the variation in approaches to Fodor's puzzles in that likeness is a relation which can be set up in quite different ways so as to relate quite different entities (objects, properties) according to different principles of comparison (comparison of objects in the actual world, comparison of properties across worlds). Similar considerations hold for the focus of this paper on the bouletic predicate *want*. As we will see in the course of discussion, particular properties of *want* are important to Fodor's puzzle which set apart desires from other attitudes such as beliefs. This concerns in particular the fact that desires can combine information acquired from different sources such as visual perception, written text or introspective reasoning under a single attitudinal stance.

This being said, the focus of this paper is narrow with respect to the type of attitude reports that is taken into consideration and the directions of investigation pursued. But the lesson to be learned even from the focused analysis of the Fodorian reading of (1) is one which directs future research on attitude reports into a direction orthogonal to quick generalizations about Fodor's puzzle. Instead of putting forward generalizations about Fodor's puzzle to other or similar phenomena, it is the goal of this paper to delve into the details that make Fodor's observation puzzling to semantic theorizing and to learn from the detailed investigation of Fodor's puzzle a more general lesson about ambiguity in natural language semantics.

2 Attitude representation in DRT

The logical form formalism I propose to make use of to represent the different readings my analysis distinguishes is an extension of Discourse Representation Theory (DRT) with a three-place predicate *Att* designed for the representation of attitudinal states (Kamp (1984), Kamp et al. (2011)). In the extension of DRT to the representation of attitudinal states, the distinction between *de re* and *de dicto* readings is not captured in terms of scope relationships but with the help of *anchors*.

2.1 External and internal anchors

For the formalization of the causal role that objects play in the formation of *de re* attitudes and the effect of *de re* acquaintance with objects on the status of discourse referents which represent these objects - being directly referential - the DRT extension provides the concept of an *external anchor*. External anchors represent the acquaintance with an existing object in the real world. In order to distinguish this wide content notion of *de re* acquaintance with objects from the perceived notion of *de re* based on quantifier scope relationships (as in (4a)), I call external anchors *de-re* anchors as opposed to *de re* scope relationships. In its basic form, an external anchor for a discourse referent x in an entity b fixes the reference of x to the value which is assigned to b $\{\langle x, b\rangle\}$ in the course of interpretation of the semantic representation in which the external anchor occurs. In the course of this paper, I introduce additional, more complex types of external anchors, e.g. anchors for properties and sets of individuals.

From the viewpoint of semantic representation, an external anchor displays a non-representational relation between a discourse referent and an entity. That is, an external anchor for a discourse referent is not part of the mental representation of the agent who entertains a semantic representation in which the so-anchored discourse referent occurs. Consequently, an external anchor is not a component of the representation of the mental content which an agent takes as her psychological reality but it is placed outside the scope of the agent's mental representation. Only an external describer of the agent can make a judgement whether the agent is connected to the object b via the discourse referent x that is part of one or more of his mental representations; accordingly, such judgements need to be modelled separately from the describer's ascriptions of mental reference to the agent. On the other hand the DRT extension assumes that external anchors can affect the truth-conditional content of mental representations entertaining the externally anchored discourse referent x only if the agent's mental representation contains an *internal anchor* for x which represents the way in which the agents takes herself to be acquainted (causally related) to whatever it is that x represents to him. An internal anchor takes the form

pictured in (15), where K is a Discourse Representation Structure (DRS) of the acquaintance with x. In some of the DRS representations I present in this paper, the exact specification of the acquaintance representation K is left open when it doesn't matter to my arguments.

(15) $\langle [ANCH, x], K \rangle$

External anchors enter a DRS representing the attitudinal state of an agent as the third argument of the predicate *Att*. The first argument of *Att* represents the bearer of the attitude that *Att* is used to describe and the second argument is for descriptions of the attitudinal state that the *Att*-predicate assigns to the bearer. The descriptions occupying the second argument slot of *Att* consist of pairs $\langle MOD, K \rangle$, where MOD is an attitudinal mode indicator (whether the attitude represented by the pair $\langle MOD, K \rangle$ is e.g. a belief, desire or intention) and K is a representation of the content of the attitude. Unanchored discourse referents occurring in attitude descriptions K are evaluated with respect to a non-specific relation of acquaintance. In parallel to external anchors, I use the term *de-dicto* for the relation of acquaintance that unanchored discourse referents in attitude descriptions represent (narrow content) and *de dicto* for a quantifier scope relationship of the type presented in (4b).
The possibility to make relations of acquaintance explicit is not specific to DRT as an analysis framework. For example, in a non-representational logical form framework quantifying over relations of acquaintance as in Kaplan (1968)) would do a similar job. But the syntax and semantics of the DRS language that I will be using in this paper differs from other approaches to relations of acquaintance in that relations of acquaintance are considered with respect to referential dependencies across different attitudes of one agent and across attitudes of different agents. In his DRT-based analysis of belief reports, Maier (2009) considers only attitude reports involving one attitudinal mode – belief – and proposes a Stalnaker/Lewis style model-theoretic possible world semantics. Capturing referential dependencies between attitudes requires a model-theoretic semantics that is more complicated than possible world semantics in that only information states (world-embedding pairs) provide an adequate basis for the evaluation of cross-attitudinal referential dependencies. Similar restrictions with respect to the types and combinations of attitudes apply to work that has been done in direct interpretation frameworks with concept-generators (functions from individuals to individual concepts, cf. Percus & Sauerland (2003)), which focuses on the analysis of single mode attitudes such as belief which are not referentially connected with the desires which arise from and are supported by these beliefs. In contrast, the DRSs that I propose for the representation of the Fodorian reading of (1) involve complex attitudinal states involving two referentially dependent attitudinal modes, belief *and* desire. Beliefs and desires

may be referentially dependent if e.g., based on the acquisition of internally and externally anchored discourse referents for two jackets, Adrian forms the belief that both jackets are of the same kind. Based on this belief, Adrian then forms the desire to buy one of these jackets. In this case, Adrian's desire referentially depends on his belief in that the same discourse referents for jackets occur in the representation of his 'belief' state and in the representation of his 'desire' state. For the analysis of the Fodorian reading I present in this paper, distinguishing between different attitudinal modes and capturing referential dependencies between attitudinal states is of central importance. I do not claim that other logical form formalisms could not achieve the same as DRT does with respect to the formalization of referential dependencies between attitudes, but the modelling of referential dependencies between attitudes has to my knowledge not been implemented in any other logical form framework of which I am aware. Besides this rather technical motivation for my use of DRT in the analysis of Fodor's puzzle, in section 4 I come up with a semantic motivation for my use of a representationalist account of meaning such as DRT based on an elaboration of Fodor's puzzle in terms of semantic underspecification.

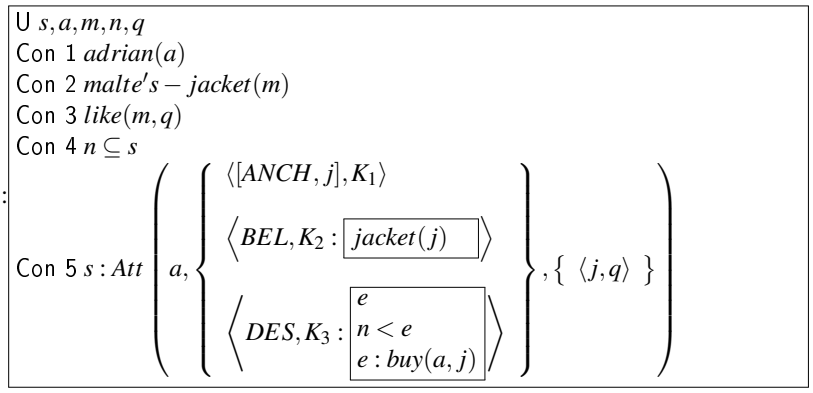
Although I present a formal definition of the syntax and semantics of the DRS language employed in this paper in the appendix to this paper, an informal presentation of the representation of attitudes in DRT may be helpful to readers not familiar with this particular account of attitudinal semantics. Readers already familiar with the extension of DRT to the representation of attitudes may want to skip the following introductory examples.

2.2 Attitude representation in DRT: *de re* and *de dicto*

Let me introduce the representation of attitudes in DRT in more detail by means of a discussion of the *de re* and *de dicto* readings of (1). The *de re* reading of (1) was said to be observed when (1) is interpreted in scenario (2a).

(2a, repeated) Adrian has decided to buy a certain jacket but has no idea that the jacket he wants to buy is like Malte's.

The *de re* reading of (1) is represented in the extended DRT framework as in (16), where for the sake of representation I enumerated and labeled the constituents of the representation.

(16)


A Discourse Representation Structure (DRS) is defined as a pair $\langle \mathsf{U}, \mathsf{Con} \rangle$, where U is the discourse universe and Con a set of conditions. The scope of a DRS is graphically delimited as a box and prefixed for the purpose of discussion with a label 'K_{number} :'. In (16), there is a main DRS K_0 which consists of a discourse universe U and a set of conditions Con consisting of Con 1 - Con 5. U consists of a discourse referent for a state s, discourse referents for individuals a, m, and q and a discourse referent for the constant n representing the current now. The first condition of Con, $adrian(a)$, represents the discourse referent a as being that discourse referent which is identified by the interpretation of the predicate constant for the name *adrian*. Similarly, the second condition represents the discourse referent m as being that discourse referent which is a jacket that belongs to the individual picked out by the name *malte*. The third condition states that there is a discourse referent q which stands in a likeness relation with m. The third condition relates the discourse referent s with the current now n to the effect that s is a state holding at the current now. The state s is elaborated in more detail in the fifth condition with the help of the predicate *Att* which says that s is identified with the attitudinal state of the agent represented by a. The first argument slot of *Att* is occupied by an internal anchor for the discourse referent j, $[ANCH, j]$. The internal anchor represents a's relation of acquaintance with j via the external anchor $\langle j, q \rangle$. The external anchor occupies the third argument slot of the *Att*-predicate. The second slot of the *Att*-predicate is filled by a set of pairs of attitudinal mode indicators and DRSs K $\langle BEL, K_2 \rangle$ and $\langle DES, K_3 \rangle$. K_2 represents a's belief that j is a jacket, K_3 represents a's desire to buy j. It is important to notice that the discourse referent j which occurs as part of the condition $e : buy(a, j)$ in K_3 is not part of the discourse universe of K_3. Instead, the value of j in K_3 and thus the proposition expressed by K_3 is referentially dependent on the value of j in K_2 which in turn is determined by the internal anchor for j which represents the relation of acquaintance of a with j via the external anchor for j.
In order to make formally precise how K_0 captures the reading of (1) that can be observed to arise in scenario (2a), we need to consider the model-theoretic

interpretation of K_0. DRSs are evaluated with respect to models M, each of which is a pair $\langle U, F \rangle$, where U, the universe of M, is a non-empty set of individuals and F is a function that assigns the predicates of the language extensions within U. In DRT, a simple DRS K is true in a model M iff there exists a function f (a so-called verifying embedding) that maps the discourse universe of K into the universe of M, so that for each condition $P(d_1,..,d_n)$ in the condition set of K $f(d_1),..,f(d_n)$ satisfies P in M. The evaluation of simple DRSs can be extended to cover all DRSs of the language proposed (not just the simple ones) by providing 'recursive clauses' for the different types of complex DRS-conditions of the given DRS-language. One such complex DRS-condition is introduced with the *Att*-predicate. The model-theoretic semantics that Kamp (2003) and Kamp et al. (2011) offer for the extension of DRT with attitudes and anchors assigns intensions to the DRSs K that occur in the expressions filling the second argument slot of *Att*. But such an intensional semantics is not optimal, in that it does away with some of the potential of this approach towards the structure of mental states and the meaning of mental state descriptions in natural language to escape the problems of logical omniscience and double vision[3]. Descriptions of attitudinal states that are not just formally different, but are also meant to be different in a cognitively relevant sense – an agent with an attitudinal state answering to the one description can be expected to reason and behave differently from an agent with a state answering to the other description – will collapse under this kind of *intensional* interpretation because cognitively distinct content representations K_1 and K_2 are intensionally equivalent and thus their semantic values coincide. Because of this an intensional model-theory for the *Att*-extension of DRT is a compromise: it captures some of the important inferential properties of complex attitudinal states, and therefore also of some aspects of the cognitive dynamics of such states, but at the same time the coarseness of its granularity conceals many of the finer points of such a dynamics. Attitudinal states are interpreted by assigning anchored attitude DRSs special intensional constructs. These intensional constructs are designed so as to deal with referential dependencies between DRSs which are part of the same attitude representation by defining the information states (i.e. world-embeddings pairs) assigned to referentially dependent DRSs on the basis of a merge of the information states defined by those DRSs occurring as part of an attitude representation which are not referentially dependent on other DRSs.

To see how the extended DRT framework distinguishes the *de re* reading of (1) observed to arise in scenario (2a) from the *de dicto* reading observed to arise in scenario (2b), consider the DRS for the *de dicto* reading in (17).

3 For further discussion of double vision, I refer the reader to the anchor-based approach in Asher (1986) and to the presupposition-based approach in Maier (2009). An elaboration of the logical omniscience problem in DRT is given in Kamp et al. (2011)

(17) K_4 :

$$\boxed{\begin{array}{l} s,a,m,n,q \\ adrian(a) \\ n \subseteq s \\ s : Att \left(a, \left\{ \begin{array}{l} \left\langle BEL, K_5 : \boxed{\begin{array}{l} m \\ malte's - jacket(m) \end{array}} \right\rangle \\ \left\langle DES, K_6 : \boxed{\begin{array}{l} j,e \\ like(m,j) \\ jacket(j) \\ n < e \\ e : buy(a,j) \end{array}} \right\rangle \end{array} \right\}, \{\} \right) \end{array}}$$

The main representational difference between K_4 and K_0 is that no external anchor for a jacket is involved in the representation of Adrian's attitude in K_4 and that in K_4 the condition predicating likeness of a jacket Adrian wants to buy and Malte's jacket is located inside Adrian's attitude representation. K_4 represents the observed *de dicto* reading of (1), where Adrian does not want to buy a specific jacket but some jacket which is like Malte's. The difference in the semantic representations K_0 and K_4 manifests in a difference of the verifying embeddings for K_0 and K_4. A verifying embedding for K_0 is one in which the discourse referent for the jacket which Adrian wants to buy is assigned a unique individual from the none-empty set of individuals U, whereas a verifying embedding for K_4 is one in which the discourse referent for a jacket which Adrian wants to buy is interpreted unspecifically with respect to the individuals from U.

3 Fodorian readings

The informal assessment of Fodor's puzzle raised the question whether the different logical forms of the Fodorian reading of (1) proposed in the literature are different logical forms for the same Fodorian reading or whether they are different logical forms for different Fodorian readings. Answering this question requires to make precise how one reading r_1 of an ambiguous sentence S can be determined to be distinct from another reading r_2 of S.

3.1 Distinguishing readings

For the time being, let the term *reading* refer to the observation that a sentence S has a certain intuitive interpretation i in scenario s, where s is provided as a sequence of everyday language sentences. Assume that we register the intuitively observed interpretation by means of a paraphrase p of the sentence S, where p is formulated in everyday language enriched with a set of pre-theoretical notions such as 'there is ...' or 'something that is ...'. Assume further that the paraphrase p of S is

captured in an artificial language of semantic theory by assigning a logical form l from a logical form formalism L to S which characterizes the truth-conditions of the observed reading r of S in s paraphrased by p.
In the beginning of this paper we observed that in the scenario s_1 – in which Adrian has decided to buy a certain jacket but has no idea that the jacket he wants to buy is like Malte's – the sentence S_1 *Adrian wants to buy a jacket like Malte's* has the intuitive interpretation i_1, namely the paraphrase of S_1 with p_1: *there is a jacket like Malte's which Adrian wants to buy*. In semantic theory, we rendered the paraphrase p_1 of S_1 in s_1 with the logical form in (4a) which characterizes the conditions under which the observed reading r_1 of S_1 paraphrased with p_1 is true in s_1.

(4a, repeated) $(\exists x)$(jacket(x) & like-Malte's-jacket(x) & wants(Adrian, buy(Adrian,x)))

We also said that another intuitive interpretation i_2 of (1) can be observed to arise in scenario s_2, where Adrian has not decided which jacket he wants to buy but he wants it to be like Malte's. We paraphrased the observed reading as p_2: *Adrian wants to buy something that is a jacket like Malte's* and assigned to S the logical form in (4b), capturing the conditions under which the observed reading r_2 of S is true in s_2.

(4b, repeated) wants(Adrian, $(\exists x)$(jacket(x) & like-Malte's-jacket(x) & buy(Adrian,x)))

The crucial difference between the two observed readings r_1 and r_2 has been said to arise if the scenarios s_1 and s_2 are interchanged: in scenario s_1, r_2 is not a reading observed for (1) and r_1 is not a reading observed for (1) in scenario s_2. In semantic theory, we made precise the observed difference between r_1 and r_2 in terms of depicting the conditions under which each of the observed readings is true via the difference in logical forms assigned to each of the readings r_1 and r_2 of S. It then turned out that the logical forms assigned to r_1 and r_2 capture the difference in observation in that the logical form assigned to r_1 is true in s_1 whereas it is false in s_2 and vice versa for r_2.
In general, assume we start with the observation of one reading r_1 of a sentence S to arise in relation to a scenario s_1 and that we assign a logical form l_1 to S which captures the truth-conditions of the reading r_1 observed for S. As long as we do not make the observation that in a scenario s_2, l_1 predicts S to be false albeit S is observed to have an intuitive interpretation in s_2, nothing requires us to revise our semantic theory about the meaning of S. But once we encounter a scenario s_2 which renders l_1 false while we still observe that S has an intuitive interpretation, we can consider this observation as a strong indicator that our semantic theory about S has to be revised in that S must have an additional reading r_2. In a next step, we can then capture this additional reading with the assignment of an additional logical form l_2

to S which captures the truth of S in s_2 while l_1 is false in s_2. We may then say that S has two readings and that these two readings are identified with the help of the evaluation of the two logical forms of S in scenarios s_1 and s_2, respectively. This procedure can be repeated to discover further readings of S by checking whether S is observed to have an intuitive interpretation in a certain scenario although previously identified logical forms assigned to S are false in this scenario so as to enrich the semantic theory of S step by step with new observations. Let me call the procedure just outlined and summarized in (18) the principle of reading distinctness.

Reading distinctness

(18) Let a reading D for a sentence S be a triple $\langle r, s, l \rangle$, where r is a paraphrase of S, s is a scenario and l is a logical form which captures the truth-conditions of r in semantic theory. A reading D for S is distinct relative to a (possibly empty) set of distinct readings R of S, iff

   a. given the information provided by s, it is observed that r is a paraphrase of S

   b. the logical form l assigned to r is true in s

   c. the logical forms of the other distinct readings $d \in R$ are false in s

The principle of reading distinctness focuses a particular role of scenarios in the identification of ambiguity. Scenarios fuel the discovery process of new readings of a sentence. This role of scenarios has to be kept distinct from several other functions of scenarios that have been emphasized in semantic theory. The notion of a *scenario* as I use it in this paper is to be kept distinct from the notion of an utterance context in the tradition of Kaplan (Kaplan (1977/1989)). Kaplanian utterance contexts only have to do with indexicality, not with ambiguity. What is definitely not part of utterance contexts thus conceived is the situation that the utterance targets as that which it talks about. Barwise & Perry (1983) gave the notion that targeting a given part of reality as that which is being described in a world-oriented utterance is something that cannot be reconstructed from the uttered sentence as such, but that is nevertheless essential to the question whether the utterance is true or false. They drew the distinction between utterance situations, which play the role as utterance contexts in the Kaplanian sense and what they refer to as 'Austinian' situations, the described situation being that part of the world that the utterance is about and without there is no distinguishing between true and false. In the following, the term *scenario* refers to what the utterance should be construed as talking about. At the present time, the notion of a scenario should also be kept distinct from the Stalnakerian notion of a context as the conversational common ground which is updated by a

sentence (Stalnaker (2002)). I discuss the relation of scenarios and common grounds in section 4.

In what follows, I use the principle of reading distinctness to analyze the proposals for the logical form of the Fodorian reading introduced informally in the introduction and to explore the question whether there are further Fodorian readings which have not been recognized yet[4]. For the sake of comparison across different logical form frameworks, I approximate the different proposals with DRS representations, in the hope that these DRS representations provide a neutral starting point for the elaboration of what I take to be the respective relevant insight on Fodor's puzzle.

3.2 The proposal of Romoli & Sudo (2009)

The scenario proposed by Romoli & Sudo (2009) is repeated below as (7).

(7, repeated) Suppose a store sells some jackets that all look like Malte's and that Adrian does not know anything about Malte. Assume further that Adrian wants one of those jackets and any of them is an option. Romoli & Sudo (2009: cf. 427)

A suitable paraphrase of (1) which can be observed in (7) is the one in (19).

(19) There is a set of jackets which, unbeknownst to Adrian, are all like Malte's jacket. Adrian wants to buy one of those jackets and any of them is an option.

The logical form for the paraphrase (19), repeated as (8) below, exploits the *linguistic* fact that in the paraphrase (19), Adrian's attitude is characterized by the anaphoric reference of *those jackets* resulting from the projection of the description *like Malte's jacket* as a presupposition of (1). As an instance of presupposition projection justified by the anaphoric paraphrase of Adrian's desire in (19), the logical form (8) for (1) does not involve any commitment to a specification of the content of Adrian's desire. Of course, *those jackets* is ambiguous in that *those jackets* could also be used to refer to Adrian's acquaintance with jackets sold by the store. But as has also been noted by an anonymous reviewer, nothing in the scenario (7) indicates that the acquaintance reading of *those jackets* is salient and thus available for a paraphrase of Adrian's desire.

4 It should be noted at this point that other criteria may be relevant to the assessment of readings than the criteria on which I draw. E.g. Romoli & Sudo (2009) motivate their proposal by considerations about the theoretical liability of the overt-world-variable approach of von Fintel & Heim (2011), Keshet (2011) and others. Such theory-internal considerations are certainly a relevant dimension of the assessment of readings but they are not taken into account in this paper.

(8, repeated) $\exists!X : jackets - like - malte's(X)$ and Adrian wants to buy one of X (Romoli & Sudo 2009: 435)

Because in scenario (7), Adrian is not aware of the anaphoric characterization of *those jackets* as a set of jackets like Malte's, out of context "Adrian wants to buy one of *those jackets*" cannot be an independent description of his desire. But nevertheless, when the anaphoric description of Adrian's attitude is taken together with its antecedent context *jackets like Malte's* so as to resolve the anaphoric reference of *those jackets*, (8) provides the correct truth-conditions for the paraphrase (19) of Adrian's desire observed to arise for the interpretation of (1) given the information provided by the scenario (7).

Because Romoli & Sudo (2009)'s proposal does not involve a specification of the content of Adrian's attitude, for the reconstruction of Romoli & Sudo (2009)'s proposal in the extended DRS language, a definition of the 'Att' predicate would be required which does not involve the commitment that the specification of the 'Att' predicate is also a specification of the content of the attitude of the bearer of the desire. But what could be such an interpretation of the 'Att'-predicate if not a specification of the content of Adrian's desire? One option would be to say that in cases where the content of the 'Att'-predicate is referentially dependent on an antecedent outside the scope of the 'Att'-predicate, the 'Att'-predicate fails to specify a self-contained propositional attitude but specifies a context-dependent representation of the description of an attitude. How exactly such an interpretation of the 'Att'-predicate and attitude verbs in general should be defined according to Romoli & Sudo (2009) is a matter which I won't investigate further in this paper. Thus, the DRS in (20) is an approximation of Romoli & Sudo (2009)'s proposal, with the caveat that the special interpretation of Adrian's 'want' state in Romoli & Sudo (2009)'s setup requires a notion of 'attitude' which does not rest upon the specification of a mental content of the bearer of the attitude. The star $*$ turns a predicate P of individuals into a predicate of sets of individuals which is true of a set X iff P is true of all members of X.

(20)
$$\begin{array}{|l} s,n,a,m,j,X \\ n \subseteq s \\ adrian(a) \\ malte's - jacket(m) \\ jacket*(X) \\ j \in X \\ like(j,m) \\ s : Att\left(a, \left\{ \left\langle DES, \boxed{\begin{array}{l} l,e \\ l \in X \\ n < e \\ e : buy(a,l) \end{array}} \right\rangle \right\}, \{\}\right) \end{array}$$

Given the scenario (7), the DRSs for the *de re* reading (16) and the *de dicto* reading (17) are both false: there is no specific jacket Adrian wants to buy nor is Adrian aware of the fact that he wants to buy a jacket like Malte's. Thus, (20) is a distinct reading for (1).

3.3 The proposal of von Fintel & Heim (2011)

Romoli & Sudo (2009)'s parsimony with respect to commitments about the content of Adrian's desire in the logical form of the Fodorian reading is easily challenged. Romoli & Sudo (2009)'s scenario shows that (8) is among the conditions that entail the truth of (1). But other scenarios, which require a paraphrases of (1) in which the content of Adrian's attitude plays an essential role, indicate that the entailment only holds in this direction. To illustrate this point, let us turn to a modification of the scenario (7) in which the actual set of jackets like Malte's Adrian wants to buy one of is restricted by Adrian's desire worlds. In the modified scenario (9) repeated below, Adrian does not want to buy just any jacket like Malte's but only one of the jackets that are on sale in the store (and that are *de facto* like Malte's jacket).

(9, repeated) Suppose a store offers some jackets that all look like Malte's and that Adrian does not know anything about Malte. Assume that some of those jackets are on sale while others are not and that Adrian is aware of this. Assume further that Adrian wants one of the jackets on sale and any of them is an option.

For Adrian to form the desire to buy a jacket on sale, he must be acquainted with the property *be on sale* with respect to jackets. In (9), Adrian can be said to be acquainted with the property *be on sale* as a property of the jackets with which he is acquainted as options for his buy. Consequently, a paraphrase of (1) such as (21) can be observed to arise.

(21) Adrian wants to buy a jacket from a set of jackets with which he is acquainted as being a set of jackets with certain properties. Unbeknownst to him, all jackets with which he is acquainted are like Malte's jacket.

The restriction on the set of actual jackets like Malte's imposed by Adrian's desire worlds is captured by the logical form for the Fodorian reading proposed by von Fintel & Heim (2011), repeated in (10), where in all of his desire worlds, Adrian wants to buy jackets on sale which are jackets like Malte's in the actual world.

(10, repeated) λw_0 Adrian wants$_{w_0}$ $[\lambda w'[a-jacket-like-maltes_{w_0}]\lambda x_1[$PRO *to* $buy_{w'}x_1]]$ (von Fintel & Heim 2011: 102)

The DRS in (22) is an approximation of (10) in scenario (9) in which Adrian is acquainted with a set of jackets via an external anchor[5] and forms, on the basis of his belief that some but not all of the jackets with which he is acquainted are on sale, the desire to buy one of those jackets that are on sale but has not decided which. The jackets with which he is acquainted are represented in the main DRS as jackets like Malte's. It should be noted that the predicate $on-sale$ is not to be understood as part of the general logical form for the reading observed to arise in scenarios such as (9) but rather that the predicate $on-sale$ is intended to represent an instance of an extrinsic and accidental property of jackets.

(22)

$$
\begin{array}{l}
s,n,a,m,j,J \\
n \subseteq s \\
adrian(a) \\
malte's-jacket(m) \\
j \in J \\
jacket*(J) \\
like(j,m) \\
s_0 : Att \left(a, \left\{ \begin{array}{l}
\langle [ANCH, L], K_1 \rangle \\
\left\langle BEL, \boxed{\begin{array}{l} l,q \\ l \in L \\ q \in L \\ jacket*(L) \\ on-sale(l) \\ \neg on-sale(q) \end{array}} \right\rangle \\
\left\langle DES, \boxed{\begin{array}{l} l',e \\ l' \in L \\ on-sale(l') \\ n < e \\ e : buy(a,l') \end{array}} \right\rangle
\end{array} \right\}, \{ \langle L, J \rangle \} \right)
\end{array}
$$

The DRS (22) is true in scenario (9) while neither of the DRSs for the *de re* (16), the *de dicto* (17) nor the previously identified Fodorian reading (20) are true. Adrian is not aware that he wants to buy a jacket like Malte's nor does he want to buy a specific jacket. (20), the approximation of (8), is false in (9) because Adrian does not want

5 It is not easy to state in general terms what must be the case in order that someone can be said to have such a representation of externally anchored collections of objects. In many cases the agent must associate some delineating description – such as *the jackets on this rack* – as well as the kind of contact with one or more elements of the set that could also have given rise to anchored representations for those elements on their own. What form the cognitive difference between plural and singular anchors takes for Adrian is a topic that will not be further discussed in this paper.

to buy just any jacket like Malte's but only one of those jackets which he believes to be on sale. In general, Romoli & Sudo (2009)'s proposal is challenged by scenarios in which the content of Adrian's attitude is relevant because presuppositions project from (1) – in which the content of Adrian's attitude is not specified – but not from paraphrases of (1) in which Adrian's attitude is specified.
The other way round, and I take this to be an important point, the reading of von Fintel & Heim (2011) represented in (22) is not a reading of (1) which can be *observed* in the scenario (7). This is because the paraphrase of von Fintel & Heim (2011)'s logical form requires a specification of a property of jackets to be involved in Adrian's attitude so as to determine the content of Adrian's desire (i.e. Adrian's desire worlds). No specification of the content of Adrian's desire is provided by the scenario (7). Consequently, the readings proposed by Romoli & Sudo (2009) and von Fintel & Heim (2011) are distinct from each other.

3.4 The proposal of Schwager (2009)

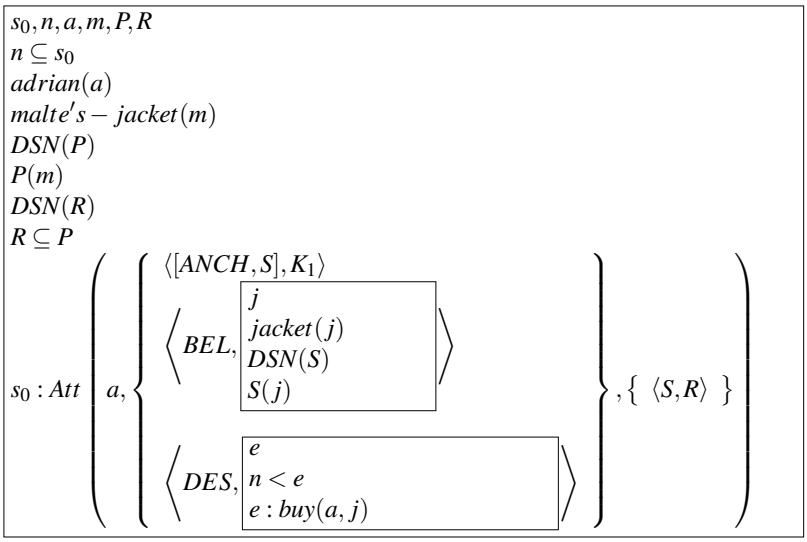
Consider the scenario in (11) in which a Fodorian reading of (1) can be observed to arise which is paraphrased as in (23).

(11, repeated) Suppose Adrian has seen a picture of a certain green Burberry jacket in a catalogue and wants to buy one. Unbeknownst to Adrian, Malte happens to own exactly such a green Burberry jacket. Unbeknownst to Adrian, the type of jacket in the picture which Adrian has seen is sold out and no further jackets of this type have been produced yet: there are no actual jackets like Malte's.

(23) Adrian wants to buy a jacket with properties which, unbeknownst to Adrian, happen to be properties of Malte's actual jacket, too.

The scenario (11) involves a delicate matter: what is it that pictures reveal to their observers? Once we follow Schwager (2009) and commit to the existence of properties, it seems right to take second-order properties to be the kind of information that customers extract from catalogues displaying jackets, i.e. the second order predication of a certain property *S* to be a 'design' property *DSN* of jackets (e.g. red stripes being a design property of a certain brand). The kind of jacket Adrian wants to buy is like Malte's jacket because the design property *S* relevant to Adrian's desire is a design property that Malte's jacket actually has. The DRS (24) approximates Kaufmann's Fodorian reading in that there is no requirement for Adrian to stand in a relation of acquaintance to one or more actual jackets that are like Malte's jacket resp. that there do not need to exist jackets like Malte's in the actual world.

(24)



The DRS in (24) is true in scenario (11), while the other distinct readings of (1) identified so far are false in it. There is no actual jacket like Malte's Adrian wants to buy nor is Adrian aware that the kind of jacket he wants to buy is like Malte's jacket. Kaufmann's punchline is that she disagrees with "the assumption that sentences like (1) are about actual jackets" and she shows convincingly that in scenarios in which the extension of the description *like Malte's jacket* is empty in the actual world approaches involving overt world variables such as (10) von Fintel & Heim (2011) or its approximation (22) cannot be applied. Similar conclusions hold for Romoli & Sudo (2009)'s proposal (see (8) and its approximation (20)), where the lack of actual jackets like Malte's causes a presupposition failure for the logical form (8). But does Kaufmann's claim imply that the logical form of (1) is never about actual jackets, i.e. that for any scenario in which a Fodorian reading of (1) can be observed, a logical form can be given which does not require the existence of actual jackets like Malte's?

To assess this question, recall the logical form proposed by Kaufmann for the Fodorian reading of the attitude report (1) repeated below as (12).

(12, repeated) $Attitude_w(x, \langle P, Q \rangle)$

Kaufmann's logical form rests on the assumption that in scenarios for the Fodorian reading of (1), the content of Adrian's desire is always specified for a reported property term Q' which can be replaced with the reporting property term Q. E.g. in scenario (11), Adrian's attitude before the application of the replacement principle is formalized according to Kaufmann's proposal as in (25).

(25) $want_{@}(Adrian, \langle \lambda w \lambda Q.\exists x[Q_w(x) \wedge buy_w(Adrian,x)], \lambda w \lambda x.green-burberry-jacket_w(x)\rangle)$

To satisfy the requirement of a reported property to be involved in Adrian's desire, a scenario such as Romoli & Sudo (2009)'s (7) must allow for a paraphrase of the content of Adrian's desire as involving a reported property Q' such that Adrian's desire is to buy a jacket with property Q' on the basis of the information provided by the scenario. One option would be to assume that the description of Adrian's desire with *one of X* characterizes a property $Q'' = \lambda w \lambda x.x \in X$, where X is a rigidly denoting constant. But for X to play a role in the content of Adrian's desire, Adrian must have some delineating descriptions associated with X. Given scenario (7), the delineating description of X cannot involve the anaphoric or the acquaintance interpretation of *those*, for the anaphoric interpretation does not specify a content of Adrian's desire and the acquaintance interpretation is not warranted by the scenario. Also, the relevant description cannot be *the set of jackets sold by the store* because not all jackets sold by the store are like Malte's jacket (cf. Romoli & Sudo (2009)'s scenario: "a store sells *some* jackets that all look like Malte's"). The delineating description of X warranted by the scenario is that X =*the set of jackets that are sold by the store and look like Malte's*. But if Adrian is aware of the fact that he wants to buy a jacket like Malte's then (1) has the *de dicto* reading.
A further option to reconcile the content of Adrian's attitude in (7) as involving a property would be to perceive of X not as a constant but as a variable and to quantify over this variable outside the scope of the reported property as in (26).

(26) $\exists L.jackets-like-malte's(L) \wedge \lambda w \lambda x.x \in L$

The only reasonable combination of the reported property (26) with (12) is (27):

(27) $\exists L.jackets-like-malte's(L) \wedge want_{@}(Adrian, \langle \lambda w \lambda Q.\exists x[Q_w(x) \wedge buy_w(Adrian,x)], \lambda w \lambda x.x \in L\rangle)$

The logical form (27), however, decidedly is about actual jackets and in fact, it is quite similar to Romoli & Sudo (2009)'s original proposal. But unlike Romoli & Sudo (2009)'s proposal, (27) involves the additional assumption that the *content* of Adrian's desire in scenario (7) is to buy a jacket with the property to *be one of* X, where Adrian is not aware that X =*jackets like Malte's*. But if readings are to be observed from just the information provided by a scenario, then the – although reasonable – assumption that Adrian wants to buy a jacket with a certain property is not warranted by the scenario (7): (7) remains silent about the content of Adrian's attitude. Consequently, the proposal of Romoli & Sudo (2009) is distinct from Schwager (2009)'s proposal not because Kaufmann's proposal is false for (7) but

because a property can not be *observed* to be involved in the content of Adrian's desire given just the information provided by (7).
The next question is how Kaufmann's proposal applies to scenarios in which a set of actual jackets like Malte's *and* a property involved in Adrian's desire are specified as in scenario (9), where Adrian wants to buy one of those jackets with which he is acquainted as being on sale. As in the previous scenario, the reported property term could be formalized as in (28).

(28) $\exists L.jackets-like-malte's(L) \wedge \lambda w \lambda x.x \in L \wedge on-sale(x)$

Combined with Kaufmann's general logical form, the result would be (29).

(29) $\exists L.jackets-like-malte's(L) \wedge want_{@}(Adrian, \langle \lambda w \lambda Q.\exists x[Q_w(x) \wedge buy_w(Adrian,x)], \lambda w \lambda x.x \in L \wedge on-sale(x) \rangle)$

The formalization of the Fodorian reading of (1) in (29) decidedly is about actual jackets like Malte's and it is quite similar in spirit to the logical form (10) of von Fintel & Heim (2011), where Adrian wants to buy a jacket on sale which is a jacket like Malte's in the actual world. In fact, as it stands, it is hard to decide whether (29) is a logical form which preserves Schwager (2009)'s original intention because the property replacement principle is superfluous for the logical form (29), in which the kind of jacket Adrian wants to buy is determined as being like Malte's jacket independent of the content of Adrian's desire. Consequently, the decision about whether Kaufmann's proposal is distinct from von Fintel & Heim (2011)'s proposal depends on whether Kaufmann's proposal should be considered to allow for logical forms such as (29) so as to preserve the original intention underlying her account. If Kaufmann's theory can be extended so as to cover cases involving actual jackets like Malte's, then von Fintel & Heim (2011)'s reading is not a distinct reading but is subsumed by Kaufmann's reading, if Kaufmann's proposal doesn't allow for logical forms such as (29), then Kaufmann's reading is distinct from von Fintel & Heim (2011)'s reading.

The uncertainty involved in distinguishing Kaufmann's and von Fintel & Heim (2011)'s proposal reveals a problem of semantic theorizing about ambiguous attitude reports: it seems as if the distinction of readings is not only grounded in truth or falsity of a logical form in a certain scenario but also that the scope, motivation and design of a certain logical form formalism which provides logical forms play a crucial role. This holds for the application of Kaufmann's proposal to scenarios involving actual jackets like Malte's, but a similar problem arises for Romoli & Sudo (2009)'s account which involves a semantic interpretation of the 'want'-predicate

that is quite different from the structured proposition interpretation of attitude verbs involved in Kaufmann's approach and von Fintel & Heim (2011)'s 'unstructured' possible worlds semantics: Romoli & Sudo (2009)'s 'want' doesn't specify the content of an attitude at all. Ultimately, this leads to the question for what we expect a semantic theory of attitude reports to accomplish, a question which I address in full detail in section 4. But in order to make this issue even more pressing, in the remainder of this section I present a Fodorian reading of (1) which none of the proposals in the literature discussed in this paper captures correctly.

3.5 A further Fodorian reading: the Adidas case

The heuristics for the discovery of readings suggested by the discussion of the proposals by Romoli & Sudo (2009), von Fintel & Heim (2011) and Schwager (2009) is to construct a scenario in which the specific ontological commitments of previously identified logical forms of the Fodorian reading of (1) are not fulfilled, albeit a Fodorian reading is observed. Consider the scenario in (30).

(30) Adrian has seen a jacket which has three stripes on its sleeves and wants to buy such a jacket. However, he has read that Adidas uses child labour in the production of its jackets, so the additional condition for his purchase is that the jacket is not from Adidas. If Adrian does not know that Adidas is the brand with the three stripes, he has a desire that he would paraphrase as "I want to buy a jacket from the brand with the three stripes but not from Adidas." Fritz hears Adrian's utterance and as he has seen Malte's jacket which has three stripes and as he also knows about the problem with child labour and Adidas he believes that Malte would never buy a jacket which is made using child labour. Fritz also doesn't know that Adidas is the brand with the three stripes. He reports Adrian's desire as "Adrian wants to buy a jacket like Malte's".

Intuitively, we observe a Fodorian reading of (1) to arise in scenario (30) which can be paraphrased as in (31).

(31) Adrian wants to buy a jacket of a certain kind but has not decided which. Fritz believes that it (the jacket Adrian wants to buy) will be like Malte's jacket.

The *de re* reading of (1) is out for (30) because there is no specific jacket which Adrian wants to buy. The *de dicto* reading is out because Adrian is not aware that the jacket he wants to buy is like Malte's. But according to the following line of reasoning a Fodorian reading of (1) as paraphrased in (31) is true in the scenario (30). Assume that Adidas *is* the brand with three stripes in the actual world but

that Adrian does not know this[6]. According to the principle of substitution *salva veritate* in extensional contexts, if *from the brand with the three stripes but not from Adidas* is interpreted outside of Adrian's attitude we are allowed to substitute *brand with the three stripes* with *Adidas salve veritate*. But if *from the brand with the three stripes but not from Adidas* is interpreted inside Adrian's attitude, the substitution of *from the brand with the three stripes* with *Adidas* is not allowed. In other words, substitution in the extensional expression *from the brand with the three stripes but not from Adidas* yields the contradiction *from Adidas but not from Adidas* (and thus both predicates, the one before and the one after the substitution, have an empty extension in the actual world) whereas no similar contradiction arises in the scope of Adrian's attitude in which substitution is not allowed. This implies the following asymmetry: Adrian's desire is contradictory from the perspective of an omniscient observer who knows that Adidas is the brand with the three stripes but Adrian's desire is consistent from the perspective of Adrian who does not know that Adidas is the brand with the three stripes in the actual world [7]. The underlying problem is that because Adrian is not omniscient but epistemically limited, and so is Fritz, they are not able to infer the contradiction that their beliefs about Adidas involve. Hence, Fritz' report is true when judged on the basis of the information that Adrian and Fritz possess, as long as they (and we) don't know that Adidas is the brand with the three stripes in the actual world, if Adrian buys a jacket from the brand with the three stripes and thus a jacket from Adidas (and thus a jacket like Malte's jacket), this buy realizes *his* desire. But, and this is what I take to be crucial to the Fodorian reading observed in (30), even if we take into account the information that Adrian and Fritz do not possess, namely that Adidas is the brand with the three stripes in the actual world, Fritz' report is still true. Again, if Adrian buys a jacket of which he doesn't know that it is from Adidas but satisfies the other criteria the desire reported in (1) imposes on it, then Adrian's jacket is like Malte's in the actual world and consequently, Fritz' report is true. Thus, as long as Adrian and Fritz cannot infer or learn that in the actual world Adidas is the brand with the three stripes, Adidas-type Fodorian readings of a report like (1) do not change their truth-value under omniscience. In other words, the truth of reports of contradictory but consistent desires is not affected by information that is available only to external

6 For the scenario under discussion it is sufficient that Adidas is the brand with the three stripes in the actual world. However, nothing changes for my argument if Adidas is a rigid designator and thus the brand with the three stripes in all or all relevant possible worlds.

7 Contradictory desires (i.e. desires that cannot be realized from the viewpoint of an external observer) are different from inconsistent desires as discussed e.g. by Heim (1992). An inconsistent desire arises in cases where the agent of the desire knows that the desire cannot be realized. In the scenario under discussion in this paper, Adrian believes that his desire can be realized – it is thus consistent – but an external observer may notice that his desire cannot be realized and thus is contradictory.

observers of the desire [8].

Let me make the point more precise with a representation of the Adidas case in the extended DRT formalism. (30) involves the sharing of mental contents across agents and this sharing rests upon a connection which isn't mediated through actual jackets like Malte's or actual properties of jackets like Malte's, but it concerns the intentionality of attitudes themselves. Intuitively, what we want to say about the way in which the discourse referent that the reporter uses as bearer of the predicate *like Malte's jacket* and the discourse referent which represents the object of Adrian's desire is the following: whatever value the embedding of Adrian's attitude assigns to the discourse referent for the jacket he wants to buy, it will be this jacket which is judged to be like Malte's by the reporter. Such cases of shared reference are reminiscent of what is called 'vicarious' anchoring in DRT (see e.g. Kamp & Bende-Farkas (2006)), a modified version of which I adopt in this paper as 'intentional' anchors. Intentional anchors take the form in (32), where v is a discourse referent and y_z a discourse referent stemming from an attitude which is entertained by an agent z.

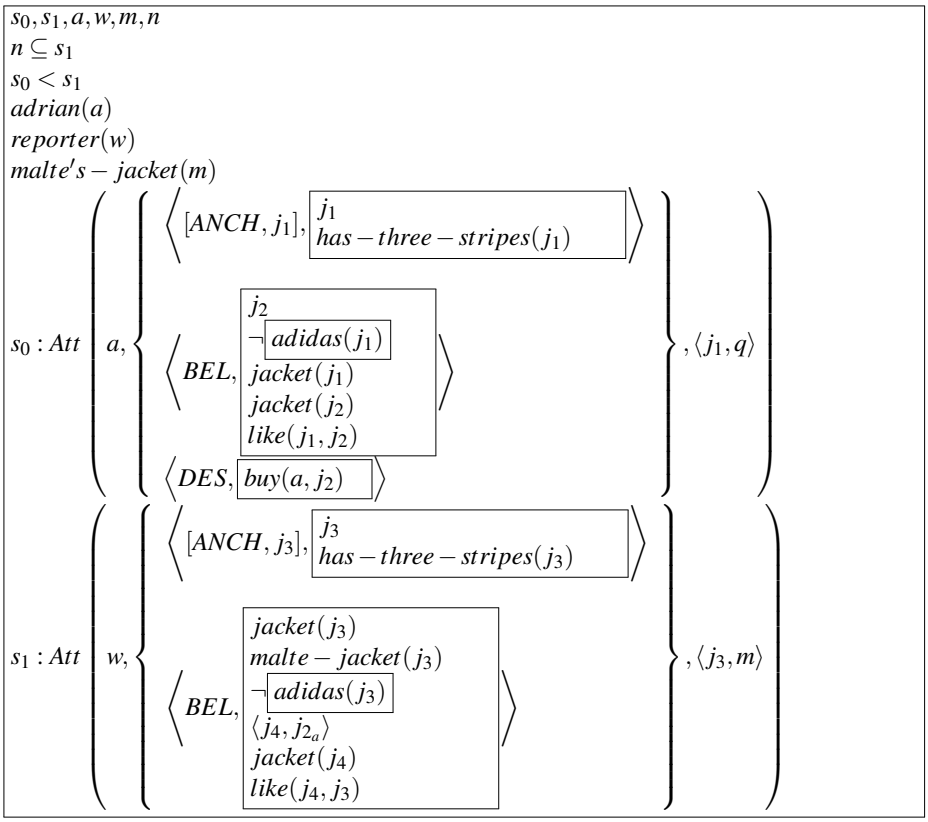
(32) $\langle v, y_z \rangle$

(33) gives a representation of the reading of (1) observed in the scenario (30). The reporter Fritz holds a belief involving a discourse referent which is introduced in the attitude representation of Adrian. The predicates $has-three-stripes$ and $adidas$ are not meant to be crucial to the general logical form of (33). Rather, those predicates serve to represent an instance of the more general case of a property which is contradictory outside the scope of a bouletic attitude but consistent inside the scope of a bouletic attitude[9].

8 Note that in contrast, other types of Fodorian readings change their truth-value under omniscience. Consider e.g. the scenario proposed by Romoli & Sudo (2009). If the reporter is wrong in her belief that all jackets Adrian would consider as jackets he would want to buy are like Malte's, then the truth-value of the attitude report changes from the point of view of an omniscient observer who knows that none of the options Adrian considers are jackets like Malte's.

9 A reviewer noted that externally contradictory but internally consistent desires as exemplified by (30) do not arise in the same way for doxastic predicates. A reason for this may be that – as already mentioned – bouletic predicates, unlike e.g. doxastic predicates, 'fuse' different modes of acquaintance under one attitudinal stance which is not meant to be sensitive to differences in acquisition. In the present example, the desire fuses the perception of three stripes with a proposition acquired from the newspaper. For a desire it does not seem to be important from which epistemological sources the desire derives, as this is not what a desire is about. The distinction between modes of acquaintance, however, is relevant to doxastic predicates. I leave the further exploration of this point as a question for future research.

(33)



A model-theoretic semantics for intentional anchors is developed in formal detail in the appendix A.3.7, but I want to highlight the basic problem which this case poses to the semantics that Kamp et al. (2011) develop and to the formal semantics of attitude reports in general. The semantics for anchored DRSs in Kamp et al. (2011) takes into account only referential dependencies between DRSs which are part of the attitude representation of the same agent. The problem with which we are faced in capturing intuitions about dependencies between attitudes of different agents is that the interpretation of Fritz' attitude referentially depends on the interpretation of Adrian's attitudinal state. Consequently, we need to decompose the interpretation of DRSs containing referentially dependent attitudes of different agents into separate units and evaluate conditions of the form $s : Att(a, K, EA)$ incrementally according to the temporal relation in which they stand (in the DRS (33), the temporal relation is $s_0 < s_1$). I propose that conditions of the form $s : Att(a, K, EA)$ enforce an interpretation of the DRS K the interpretations of K must be accessible for later interpretation in order to interpret DRSs which occur in the scope of another attitudinal state predicate and which are referentially dependent on K. Put another way: the evaluation of referential dependency across agents requires a dynamic semantics

for attitude reports which is able to take into account discourse in the interpretation of referentially dependent attitude reports. I will have to say more on the dynamics of attitude report semantics in section 4.
Given that (1) has a true Fodorian reading in scenario (30) which can be formalized as in (33), the question arises whether the observed reading is distinct from the other Fodorian readings we identified so far.

(33) is distinct from Romoli & Sudo (2009)'s proposal because there are no actual jackets like Malte's one of which Adrian wants to buy and thus Romoli & Sudo (2009)'s proposal would predict (1) to be false albeit it is true.

The Adidas case is problematic for von Fintel & Heim (2011)'s approach because Adrian's actual *buying* a jacket from Adidas does not imply that he *wants* to buy a jacket from Adidas since he can be mistaken about the jacket he is buying. Adrian can realize his desire by *buying* a jacket from Adidas in the actual world without *wanting* to buy a jacket of Adidas just in case he doesn't know that the jacket he is buying in the actual world is from Adidas. The analysis of von Fintel & Heim (2011) involves the assumption that the characterization of Adrian's desire in (1) is given in terms of what jackets like Malte's there are in the actual world. But this is not the case for the Adidas scenario, because – as has already been pointed out – the jackets singled out by Adrian's desire worlds are not like Malte's jacket in the actual world. Consequently, von Fintel & Heim (2011)'s approach predicts (1) to be false in scenario (30), although intuition tells us it is true.

The Adidas case is also problematic for Kaufmann's approach. According to Kaufmann's analysis, there should be a property Q' that satisfies all the conditions in (31). But which property should Q' be? The only obvious candidate is the property of *being a jacket from the brand with three stripes but not from Adidas*. But this property doesn't give us what we want, if it is true that in all relevant worlds Adidas is the brand with the three stripes; for in that case Q' will have an empty extension in all those worlds. Consequently, Kaufmann's replacement principle predicts the report of Adrian's attitude in scenario (30) with (1) to be false albeit it is intuitively true.

I conclude from this discussion that the Adidas scenario identifies a Fodorian reading of (1) distinct from the other Fodorian readings identified so far. It may well be the case that there are more Fodorian readings of (1) but for the more general conclusion that I want to draw from the discussion in this section, the existence of three or more different Fodorian readings is sufficient.

4 Reflections on Fodor's puzzle

In the previous section, I discussed a range of distinct Fodorian readings of (1) that are true of scenarios in which Adrian wants to buy a jacket of a certain kind but does not know that this kind of jacket is just like Malte's and which neither the *de dicto* nor the *de re* reading is able to capture. I showed that none of the proposals in the literature predicts the correct Fodorian reading of (1) for all cases where Fodor's initial scenario is spelled out in more detail. I argued that at least three distinct Fodorian readings of (1) can be identified: a Fodorian reading identified by scenarios in which there are several actual jackets like Malte's Adrian wants to buy one of, a Fodorian reading in which Adrian wants to buy a jacket with some property that Malte's jacket actually has and a reading according to which if Adrian buys a jacket of the type he wants to, it will be like Malte's but where there is neither an actual set of jackets like Malte's from which he wants to buy one nor an actual property he wants the jackets he intends to buy to have and that Malte's jacket does have. This finding answers the question raised at the beginning of this paper for whether the proposals in the literature are about the same Fodorian reading or not.
But I think that the discussion of Fodor's puzzle in this paper reveals a further, more general insight which I would like to elaborate in some more detail in this last section of the paper. The general lesson to be learned from Fodor's puzzle is that semantic theorizing about ambiguity is subject to the uncertainty principle in (34).

(34) The more precisely we pin down an ambiguity in semantic theory, the more fuzzy the ambiguity becomes in semantic theory.

With respect to the leading sentence (1) of this paper, the attempt to identify *the* Fodorian reading in semantic theory caused the target of our investigation to dissolve into several distinct readings, none of which characterizes this target exhaustively. An immediate upshot of the uncertainty principle is that the more precise and fine-grained a semantic theory is, the more ambiguities the theory produces and captures. Consequently, further refinement of semantic theory will not pin down Fodor's puzzle more precisely. From this point of view, Fodor's puzzle is not a puzzle of semantic theorizing about the correct logical form for Fodor's reading. Fodor's puzzle is a puzzle of semantic theorizing about ambiguity. The observation in which this puzzle manifests is the one in (35)[10].

10 It seems to me as if the observation in (35) involves a general property of reports. Reports summarize certain scenarios and thus do not convey information which goes beyond the information contained in the scenario which they report. If the scenario which an ambiguous report is about is the same scenario which is required to disambiguate the report, as it is the case for Fodor's reading, then the ambiguous report cannot be intended as a report of the scenario which disambiguates the report. However, I leave the evaluation of the extent to which this impression generalizes to other types of

(35) (1) makes sense as an utterance of a speaker only if the hearer of (1) is not able to disambiguate (1) to one of its specific readings.

If the scenario which identifies a distinct reading of (1) is common ground between the speaker and the hearer, then (1) does not convey information which is not already implied by the common ground. Thus, if the hearer is aware of the common ground, the update of the common ground with (1) is empty and consequently, no specific meaning can be identified with (1) against the common ground. Given this observation, the meaning of (1) to a hearer cannot be a matter of the disambiguated truth-conditions of (1). Instead, there must be a different kind meaning of (1) which can be determined by a hearer without disambiguation of (1) if (1) is to make sense as a report.

One option to deal with the observation in (35) has been brought up in connection with a type of ambiguity for which – just like the Fodorian reading – it is notoriously difficult to determine the exact truth-conditions: the interpretation of so-called Hob-Nob-Pronouns[11]. van Rooy & Zimmermann (1996) conclude that if ambiguities such as the intentional identity interpretation of Hob-Nob pronouns "were merely one of several possible readings, it would be hard to explain why one does not think of it if the sentence is uttered out of the blue". Instead, van Rooy & Zimmermann (1996) propose that there is a default reading – the *de re* reading of a Hob-Nob-Pronoun – and that "all other readings only become available if there is reason to rule out this literal reading. Inspection of [...] examples [...] shows that they only seem to work fine when accompanied by a longer text setting up the background that eliminates all unwelcome reading" van Rooy & Zimmermann (1996: 134). But what is the default reading of an attitude report such as (1)? One problem in the identification of default readings is that semantic theory may suggest a different default reading than common wisdom, e.g. (Heim 1992: 211) proposes that "*de re* construals are *ceteris paribus* preferred wherever possible" while "common wisdom certainly has it the other way round: *de dicto* readings are the unmarked choice" (Heim 1992: 210). The default theory may be well worth further exploration, but I would like to focus on a different account of ambiguity which has been proposed to capture in a quite

reports as a question for further research.

11 Hob-Nob-Pronouns have their name from the example (36) with which (Geach 1967: 627) introduced the problem.

(36) Hob thinks a witch has blighted Rob's mare and Nob wonders whether she (the same witch) killed Cob's sow.

The problem that (36) exemplifies is that in a context where it is not presupposed that witches do exist, neither the *de re* nor the *de dicto* analysis of (36) gives the right truth-conditions, so there must be an additional reading of (36) of which its exact truth-conditions are subject to debate.

natural way observations like (35). Consider the example (37) from (van Deemter 1996: 204).

(37) Watch out! He's dangerous.

In order for a hearer to grasp the intended meaning of (37) – to infer from (37) that he or she is in danger and should rush into hiding – no disambiguation of the deictic pronoun *he* is necessary. Proponents of underspecification (for an overview see van Deemter & Peters (1996)) maintain that the relevant inference from (37) can be executed on an underspecified semantic representation of (37) in which the disambiguation of the deictic pronoun is left to further specification of (37) in context. With respect to attitude reports, the underspecification-in-context approach has been successfully applied to the *de re/de dicto/de se* ambiguity by Maier (2009). He proposed an underspecified logical form for belief reports, which, when applied to an input context gives the right truth-conditions for the belief report based on the relations of acquaintance provided by the context. But the purpose of an underspecified representation of (37) is more than just to facilitate disambiguation of a compact representation. What is of primary importance is that the hearer is able to infer the right consequences on the basis of the underspecified representation. Reyle (1996) puts it this way:

> "[I]n almost all of the cases there is not enough information available to identify exactly one reading. (It is not even clear that the speaker of the sentence had exactly one reading in mind.) But nevertheless, we may accept such sentences as true and will, therefore, use the underspecified representations as premises for our arguments. It is thus not enough to say what the underspecified representations look like and how they may be disambiguated. We also must be able to define a suitable consequence relation and to formulate inference rules for them."

From this point of view, Schwager (2009)'s account of the Fodorian reading puts forward an important insight. Central to her proposal is that the replacement principle is driven by "the sake of reporting an attitude" (Schwager 2009: 400) and consequently that "we need a proper pragmatic theory to explain when and why speakers choose to rely on the replacement rule" (Schwager 2009: 411). Bringing Reyle (1996) and Schwager (2009) together, the purpose of reporting Adrian's attitude with (1) and not with *Adrian wants to buy a Burberry jacket* may be that on the basis of an underspecified representation of (1), the interpreter is able to *infer* from (1) that she should revise her own plans for buying a jacket like Malte's if she wants to avoid buying a jacket like Adrian does. Or, if Adrian doesn't want to buy

a jacket like Malte's, telling him that the kind of jacket he wants to buy actually is like Malte's may allow him to *infer* from (1) that he should revise his desire[12]. From this perspective, there is no need for the interpreter of to disambiguate (1) to one of the specific readings of which it is true that Adrian wants to buy a jacket like Malte's. Instead, what is important to the hearer is to be able to derive a partial or underspecified representation of (1) which allows her to infer appropriate consequences from (1). In other words, important to the hearer is the way in which (1) can serve as an input to her reasoning. From this perspective, the type of semantics which reports such as (1) seem to require is one in which their meaning is not defined in terms of the set of disambiguated possible readings but with respect to the way in which an underspecified representation of (1) updates beliefs, desires and intentions of the hearer so as to feed inference. This very much reminds us of the basic idea underlying dynamic semantics, in which the meaning of a linguistic expression is defined in terms of its context change potential, i.e. the potential to update a given information state so as to yield a new information state. The task of a dynamic semantics of attitude reports would then consist in elucidating the context change potential of underspecified representations of attitude report in terms of the types of inferences sanctioned by a certain representation and to consider their effect on the agents involved in the communicative act[13]. What these considerations suggest as the meaning of (1) to a hearer who is not required to disambiguate (1) is its potential to update an input context – the information state of the hearer of the attitude report – with an underspecified representation so as to facilitate inferences by the hearer on the basis of the output context, i.e. the updated information state of the hearer. Consequently, to a hearer, (1) may not appear ambiguous at all if all she wants from it are certain appropriate inferences. Koralus (2011) reaches a similar conclusion from the discussion of yet another type of ambiguity which is hard to reproduce as a structural ambiguity, the so-called referential-attributive ambiguity[14] Donnellan (1966). (Koralus 2011: 288) argues "that sentences including

12 Spelling out the purpose of attitude reports with respect to the inferential assessment of attitudes and behaviour has been emphasized in the philosophy of action, where the meaning of attitude reports is e.g. defined in terms of their having an impact on future plans of the interpreter of an attitude report (Bratman (1987)) or in terms of their rationalizing action (Davidson (1963)).

13 Focusing on inferences instead of truth-conditions in accounting for the meaning of ambiguous attitude reports has the virtue of pointing to an interesting connection with the debate surrounding inferential semantics in the sense of Brandom (1994).

14 The referential-attributive ambiguity has been observed to arise in the interpretation of sentences involving descriptions such as (38).

(38) Smith's murderer is insane.

Depending on the scenario in which (38) is interpreted, (38) can either be paraphrased as *Whoever killed Smith is insane* (e.g. when looking at the dead body of Smith) or *The person who murdered*

descriptions are not ambiguous (or indexical), even though they allow for a range of possible interpretations with distinct truth conditions". Koralus concludes that this "gives new support to the notion that the correct theory of descriptions requires a representationalist theory of interpretation." In fact, I would like to consider the proposal for underspecification of (1) outlined in this section as a strong motivation for the use of a representationalist account of meaning such as DRT in the analysis of ambiguous attitude reports.

The remarks in this final section of the paper have actually carried us beyond the horizons of Fodor's puzzle. In the light of what has been said, it seems doubtful to me whether talk about *the* phenomenon exemplified by Fodor's puzzle, the *de dicto* or the *de re* interpretation of attitude reports is really all that helpful. The discussion suggests that it is not so much a distinct phenomenon, e.g. "the intensional independence of DPs" (Schwarz (2012)) that is involved in the examples that Fodor first brought up, but rather that these examples show that we need a different semantics for ambiguous attitude reports generally. This new semantics applies not only to the cases that Fodor recognized as problematic for the semantic methods and frameworks that were available at the time when she wrote – and that appears to be a situation that seems to have changed but little since that time – but also to those cases that we knew, or thought we knew, what to do with then, including most saliently the classical *de re* cases such as that where Adrian has seen a particular jacket and decides that that is the jacket he wants to buy. Fodor's puzzle still clearly depicts the methodological limitations of the current state of the art in the analysis of attitudinal semantics and this holds for both direct interpretation approaches and representationalist theories like DRT. The development of a dynamic semantics of attitudes and their reports which is able to deal with the pervasive ambiguity *and* the cognitive relevance of attitude reports is a methodological challenge which requires a perspective on formal semantics that takes into account that language is not a cognitively isolated phenomenon but stands in close relation to other modules of cognition such as sensing, representation and planning. If the thoughts developed in this paper are on the right track, then the implications of Fodor's observations may in the end be even more dramatic than seems implied by recent treatments of the cases she has brought to our attention.

A Syntax and Semantics of the extended DRS language

In this appendix, I present a model-theoretic semantics for the language of DRSs with the *Att*-Predicate which is employed in this paper. The presentation closely follows Kamp (2003) and Kamp et al. (2011) but contains a few extensions which

Smith is insane (e.g. when describing the person who is accused of being the murderer of Smith)

are not implemented in Kamp et al. (2011): an extension of the concept of an external anchor to external anchors in properties and plural referents; an extension to second-order predication required for the analysis of Schwager (2009)'s proposal and an extension of the concept of anchoring to intentional anchors. Elaborations on the standard semantics presented in Kamp et al. (2011) are restricted to a minimum and the reader interested in a detailed development of the semantics is referred to Kamp et al. (2011).

A.1 The DRS Language $\mathscr{L}_{Att}$

A.1.1 Vocabulary

Definition 1 *The vocabulary for the DRS Language* $\mathscr{L}_{Att}$

- *Sorts of Discourse Referents: The set* Ref *is the union of the following mutually disjoint sets of discourse referents*
  - $Ind = \{x_1, \ldots, x_n, \ldots\}$, *a set of referents for individuals*
  - $Plu = \{Q_1, \ldots, Q_n, \ldots\}$, *a set of referents for sets of individuals*
  - $Prop = \{X_1, \ldots, X_n, \ldots\}$, *a set of referents for properties*
  - $Event = \{e_1, \ldots, e_n, \ldots\}$, *a set of referents for events*
  - $State = \{s_1, \ldots, s_n, \ldots\}$, *a set of referents for states*
- *Relation Symbols: The set Rel is the union of the following sets of relation symbols:*
  - Pred_1*: a set of n-place predicates of individuals*
  - Pred_2*: a set of 1-place predicates of* Pred_1*-predicates*
  - Event*: a set of* $(n+1)$*-place predicates (with* $n \geq 0$*) where the first argument is of type 'event' and the remaining arguments are of type individual*
  - State*: a set of* $(n+1)$*-place predicates (with* $n \geq 0$*) where the first argument is of type 'state' and the remaining arguments are of type individual*
  - TRel*: a set of 2-place predicate symbols denoting temporal relations between events and states* $<, \subseteq$
  - Rel*: a 2-place predicate symbol denoting set-theoretic inclusion* $\subseteq$

- *The indexical discourse referents i and n*[15]
- *A three-place predicate symbol Att*
- *A set Name : of 1-place relation constants*
- *A 2-place predicate symbol* $*$

A.1.2 Syntax of DRSs and DRS conditions

Definition 2 *Syntax of DRSs and DRS conditions of* $\mathscr{L}_{Att}$

- *If* $U \subseteq Ref$ *and Con a (possibly empty) set of conditions, then* $\langle U, Con \rangle$ *is a DRS.*
- *If* $x_i, x_j \in Ref$ *then* $x_i = x_j$ *is a condition.*
- *If* $N \in Name$ *and* $x \in Ind$ *then* $N(x)$ *is a condition.*
- *If P is a n-place predicate constant in* $Pred_1$ *and* $x_i, \ldots x_n \in Ind$*, then* $P(x_1, \ldots, x_n)$ *is a condition.*
- *If P is a 1-place predicate constant in* $Pred_1$ *and* $Q \in Plu$*, then* $P*(Q)$ *is a condition.*
- *If* $X \in Pred_2$ *and* $Y \in Prop$*, then* $X(Y)$ *is a condition.*
- *If* $Z, Y \in Prop$ *and* $R \in Rel$*, then ZRY is a condition.*
- *If* $e \in Event, x_1, \ldots x_n \in Ind$ *and* $R \in Event$ *an* $(n+1)$*-place event predicate, then* $e : R(x_1, \ldots, x_n)$ *is a condition.*
- *If* $s \in State, x_1, \ldots x_n \in Ind$ *and* $R \in State$ *an* $(n+1)$*-place state predicate, then* $s : R(x_1, \ldots, x_n)$ *is a condition.*
- *If* $\tau, \delta \in Event \cup State \cup Time$*, R one of the predicates* $\subseteq, <$ *then* $\tau R \delta$ *is a condition*
- *If K is a DRS then* $\neg K$ *is a condition.*
- *If* $x_i \in Ind$ *and* $X_j \in Plu$ *then* $x_i \in X_j$ *is a condition.*
- *If* K_1 *and* K_2 *are DRSs, then* $K_1 \vee K_2$ *is a condition.*
- *If* K_1 *and* K_2 *are DRSs, then* $K_1 \Rightarrow K_2$ *is a condition.*

15 I do not elaborate on the semantic interpretation of *i* and *n* in the following, but refer the interested reader to Kamp et al. (2011).

- *If* $x_i, x_j, z \in Ref$ *then* $\langle x_i, x_{j_z} \rangle$ *is an intentional anchor.*
- *An Attitude Description Set (ADS) of* $\mathscr{L}_{Att}$ *is a set of pairs each of which has one of the following two forms:*
  - $\langle MOD, K \rangle$ *where* $MOD \in \{BEL, DES\}$ *and K is a DRS of* $\mathscr{L}_{Att}$.
  - $\langle [ANCH, \Upsilon], K \rangle$ *where* Υ *is a discourse referent and K is a DRS of* $\mathscr{L}_{Att}$ *such that* $\Upsilon \in U_K$.
- *If K is an ADS, then* $IA(K)$ *is the set of internal anchors of K, i.e. those members of K whose first component is of the form* $[ANCH, \Upsilon]$.
- *If K is an ADS, then an external anchor for K is a function f s.t.* $Dom(f) \subseteq IA(K)$*, i.e.*
  - $\{x$: *for some DRS* $K_1, \langle [ANCH, x], K \rangle\} \in K_1$ *if* $x \in Ind$ *or*
  - $\{Q$: *for some DRS* $K_1, \langle [ANCH, Q], K \rangle\} \in K_1$ *if* $Q \in Plu$ *or*
  - $\{X$: *for some DRS* $K_1, \langle [ANCH, X], K \rangle\} \in K_1$ *if* $X \in Prop$[16]
- *If s is a state discourse referent, x a discourse referent for individuals, K an ADS and EA a set of external anchors for K, then* $s : Att(x, K, EA)$ *is a DRS condition.*

A.1.3 Free discourse referents and properness

Next, we define the set of free discourse referents of a DRS K, $FV(K)$ and properness of a DRS.

Definition 3 $FV(K)$*, the set of free discourse referents of K is defined by:*

- $FV(\langle U_K, Con_K \rangle) := (\bigcup_{\gamma \in Con_K} FV(\gamma)) - U_K$
- $FV(x_i = x_j) := [x_i, x_j]$
- $FV(P(x_1, \ldots x_n) := [x_1, \ldots, x_n]$
- $FV(P(X) := [X]$
- $FV(\neg K) := FV(K)$
- $FV((K_1 \vee K_2)) := FV(K_1) \cup FV(K_2)$

16 In the following, I abstract over the different sorts of discourse referents occurring in external anchors. Variables x occurring in an external anchors are henceforth to be understood as either a referent for an individual, a collection of individuals or a property.

- $FV(K_1 \Rightarrow K_2) := FV(K_1) \cup (FV(K_2) - U_{K_1})$

A DRS K is proper iff $FV(K) = \emptyset$.

A.1.4 Accessibility

Definition 4 *K_1 is an immediate sub-DRS of K, $K_1 < K$, if any of the following conditions holds:*

- $\neg K_1 \in Con_K$
- *There is a DRS K_2 s.t. $K_1 \Rightarrow K_2 \in Con_K$ or $K_2 \Rightarrow K_1 \in Con_K$*
- *There is a DRS K_2 s.t. $K_1 \vee K_2 \in Con_K$ or $K_2 \vee K_1 \in Con_K$*

Definition 5 *Accessibility between DRSs*
Given DRSs K and K_1m K is accessible from K_1, in symbols K acc *K_1, iff*

- *$K_1 \leq K$; or*
- *there exist DRSs K_2 and K_3 s.t. $K_2 \Rightarrow K_3$ and K* acc *K_2 and K_3* acc *K_1.*

Definition 6 *Accessibility between Discourse Referents*
Given DRSs K, K_1 and K_2 such that K_1 and K_2 are both sub-DRSs of K (i.e. K is accessible from both K_1 and K_2) and discourse referents $x \in U_K$ and $y \in U_{K_2}$ then x is accessible from y, in symbols x acc *y iff K_1 is accessible from K_2.*

A.2 Semantics for DRSs

The semantic scaffolding for the interpretation of $\mathscr{L}_{Att}$ is an intensional model theory. The central definition of this section is that of a context change potential *CCP* of a DRS *K* relative to a model $\mathscr{M}$. This section discusses only the standard part of an intensional model-theoretic semantics for DRS, the evaluation of ADSs is considered in the next section.

A.2.1 Intensional Models

Definition 7 *An intensional model $\mathscr{M}$ for the DRS language specified in definition 2 is a tuple $\langle W, U, \mathscr{I}, EV, P \rangle$, where*

- *W is a set of possible worlds*
- *U is a non-empty set of individuals*

- *for names,* $\mathscr{I}_{\mathscr{M}}: Name \mapsto \{\{d\}|d \in U_{\mathscr{M}}\}$
- *for n-ary relations,* $\mathscr{I}_{\mathscr{M}}: Rel^n \rightarrow (W_{\mathscr{M}} \mapsto \mathscr{P}(U^n))$

- *P is a non-empty set of properties,* $\mathscr{I}_{\mathscr{M}}: P \mapsto \{\{p\}|p \in Pred_1\}$
- $\mathscr{I}: Name \mapsto \{\{u\}|u \in U\}$
- $\mathscr{I}: Pred_1^n \mapsto \mathscr{P}(U^n)$
- $\mathscr{I}: Pred_2 \mapsto \mathscr{P}(P)$
- *EV is an eventuality structure (see Kamp & Reyle (1993: 667f.))*

In order to keep track of the different embeddings for discourse referents for inviduals, plural referents and property referents, I define the embedding of a DRS as the extension of an embedding of discourse referents for individuals to embeddings of plural discourse referents and discourse referents for predicates. Formally, the extension is captured as an overriding union[17] of the embedding function for discourse referents for individuals.

Definition 8 *An embedding* $h\ (Ind \cup Plu \cup Pred) \rightarrow (U \cup \mathscr{P}(U) \cup \mathscr{P}(P))$ *is defined as an overriding union of g,* $g \oplus g' \oplus g''$*, that relates any element of the domain of* g'' *to its image under* g''*, any element of the domain of* g' *to its image under* g' *and any other element of the domain of g to its image under g, where*

- $g : Ind \mapsto U$
- $g' : Plu \mapsto \mathscr{P}(U)$[18]
- $g'' : Prop \mapsto P$

A.2.2 DRS verification

The core of the dynamic notion of truth involved in the semantics of DRSs is that of a verifying embedding. The notation $g \subset_X h$, where X is a (possibly empty) set of discourse referents, states that embedding h extends g to the discourse referents in X, i.e. $Dom(h) = Dom(g) \cup X$.

Definition 9 *Verifying embeddings for DRSs and DRS conditions of* $\mathscr{L}_{Att}$*:*

- $\langle g, h\rangle \vDash_{\mathscr{M},w} \langle U, Con\rangle$ *iff* $g \subset_U h$ *and for all* $\gamma \in Con : h \vDash_{\mathscr{M},w} \gamma$

17 An overriding union $g : X \mapsto Y$ by $g' : Z \mapsto Y$ is an extension of g' denoted as $(g \oplus g') : (X \bigcup Z) \mapsto Y$.
18 For a more adequate treatment of the plural, see Kamp & Reyle (1993: chapter 4)

- $g \vDash_{\mathscr{M},w} x_i = x_j$ *iff* $g(x_i) = g(x_j)$
- $g \vDash_{\mathscr{M},w} N(x)$ *iff* $\mathscr{I}(N) = \{g(x)\}$
- $g \vDash_{\mathscr{M},w} P(x_1, \ldots x_n)$ *iff* $\langle g(x_1), \ldots, g(x_n)\rangle \in \mathscr{I}(P)$
- $g \vDash_{\mathscr{M},w} X(Q)$ *iff* $g(Q) \in \mathscr{I}(X)$
- $g \vDash_{\mathscr{M},w} \neg K$ *iff there does not exist an h s.t.* $\langle g,h\rangle \vDash_{\mathscr{M},w} K$
- $g \vDash_{\mathscr{M},w} K_1 \vee K_2$ *iff there is some h s.t.* $\langle g,h\rangle \vDash_{\mathscr{M},w} K_1$ *or there is some h s.t.* $\langle g,h\rangle \vDash_{\mathscr{M},w} K_2$
- $g \vDash_{\mathscr{M},w} K_1 \Rightarrow K_2$ *iff for all m such that* $\langle g,m\rangle \vDash_{\mathscr{M},w} K_1$ *there exists k s.t.* $\langle m,k\rangle \vDash_{\mathscr{M},w} K_2$
- $g \vDash_{\mathscr{M},w} e : R(x_1, \ldots, x_n)$ *iff* $\langle g(e), g(x_1), \ldots, g(x_n)\rangle \in \mathscr{J}(R)(w)$
- $g \vDash_{\mathscr{M},w} s : R(x_1, \ldots, x_n)$ *iff* $\langle g(s), g(x_1), \ldots, g(x_n)\rangle \in \mathscr{J}(R)(w)$
- $g \vDash_{\mathscr{M},w} P*(X)$ *iff for all* $u \in g(X)$, $g[x/u] \vDash_{\mathscr{M},w} P(x)$
- $g \vDash_{\mathscr{M},w} x \in X$ *iff* $g(x) \subseteq g(X)$
- $g \vDash_{\mathscr{M},w} P \subseteq Q$ *iff* $g(P) \subseteq g(Q)$

Definition 10 *Truth of a proper DRS K*

- *A proper DRS K is true in a model* $\mathscr{M}$ *at world w* ($\vDash_{\mathscr{M},w} K$) *iff there exists a verifying embedding h of* U_K *such that* $\langle \Lambda, h\rangle \vDash_{\mathscr{M},w} K$, *where* Δ *is the empty assignment.*

A.2.3 Propositions and Information States

Definition 11 *Given a proper DRS K, the proposition* $[\![K]\!]^p_{\mathscr{M}}$ *expressed by K relative to an intensional model* $\mathscr{M}$ *is defined as:*

- $[\![K]\!]^p_{\mathscr{M}} := \{w | \vDash_{\mathscr{M},w} K\}$

Definition 12 *Given a proper DRS K, the information state* $[\![K]\!]^s_{\mathscr{M}}$ *expressed by K relative to an intensional model* $\mathscr{M}$ *is defined as:*

- $[\![K]\!]^s_{\mathscr{M}} := \{\langle w, f\rangle | \langle \Lambda, f\rangle \vDash_{\mathscr{M},w} K\}$

Definition 13 *Given an intensional model* $\mathscr{M}$, *a DRS K and a set of discourse referents X we define*

- *$\mathscr{I}$ is an information state relative to $\mathscr{M}$ and X iff $\mathscr{I} \subseteq \{\langle w,f\rangle | Dom(f) = X \wedge Ran(f) \subseteq U_{\mathscr{M}} \wedge w \in W_{\mathscr{M}}\}$*
- *$\mathscr{I}$ is an information state relative to $\mathscr{M}$ iff there is an X such that $\mathscr{I}$ is an information state relative to $\mathscr{M}$ and X*
- *when $\mathscr{I}$ is an information state relative to $\mathscr{M}$ and X, X is called the base of $\mathscr{I}$*
- *the empty information state $\Lambda^{\mathscr{I}}_{\mathscr{M}} := \{\langle w,\emptyset\rangle | w \in W_{\mathscr{M}}\}$*
- *the proposition $Prop(\mathscr{I})$ determined by $\mathscr{I}$: $Prop(\mathscr{I}) := \{w | \exists f \langle w,f\rangle \in \mathscr{I}\}$*

A.2.4 Context Change Potentials

Definition 14 *The context change potential $[\![K]\!]^d_{\mathscr{M}}$ of a DRS K relative to a model $\mathscr{M}$ is defined as a partial function from information states to information states s.t.:*

- *$[\![K]\!]^d_{\mathscr{M}}$ is defined for those information states $\mathscr{I}$ relative to $\mathscr{M}$ s.t. $FV(K) \subseteq X_{\mathscr{I}}$*
- *if $\mathscr{I}_i \in Dom([\![K]\!]^d_{\mathscr{M}})$, then $[\![K]\!]^d_{\mathscr{M}}(\mathscr{I}_i) = \{\langle w,g\rangle | \exists f(\langle w,f\rangle \in \mathscr{I}_i \wedge \langle f,g\rangle \vDash_{\mathscr{M},w} K)\}$*

Definition 15 *Let $\mathscr{M}$ be an intensional model and $\mathscr{S}$ a set of information states relative to $\mathscr{M}$ The consistent merge of the $\mathscr{I} \in \mathscr{S}$, denoted $\underline{\cup}\mathscr{S}$ is the information state defined by:*

- *$\underline{\cup}\mathscr{S} := \{\langle w,h\rangle |$ there exists a function F s.t. $Dom(F) = \mathscr{S}$, for all $\mathscr{I} \in \mathscr{S}$, $\langle w, F(\mathscr{I})\rangle \in \mathscr{I}$ and $h = \cup\{F(\mathscr{I}) | \mathscr{I} \in \mathscr{S}\}$ is a function. $\}$*

Definition 16 *Let $\mathscr{M}$ be an intensional model, $\mathscr{J}$ a CCP relative to $\mathscr{M}$ and $X_{\mathscr{J}}$ a set of discourse referents. $\mathscr{J}$ is regular with base $X_{\mathscr{J}}$ iff*

- *for arbitrary information states $\mathscr{I}$ relative to $\mathscr{M}$, $\mathscr{I} \in Dom(\mathscr{J})$ iff $X_{\mathscr{J}} \subseteq X_{\mathscr{I}}$; the set of discourse referents $X_{\mathscr{J}}$ is called the referential presupposition of $\mathscr{J}$: $PRES(\mathscr{J})$*
- *for $\mathscr{I} \in Dom(\mathscr{J})$, $\mathscr{I} \preceq \mathscr{J}(\mathscr{I})$*

A Context Change Potential $\mathscr{J}$ is total iff $\mathscr{J}(\Lambda)^{\mathscr{I}}_{\mathscr{M}}$ is defined.

A.3 Semantics of anchored attitude DRSs

We now turn to the main point of the semantics of $\mathscr{L}_{Att}$, the definition of a semantics for anchored attitude DRSs. The challenge of such a semantics is to assign ADSs the right type of intensional constructs which can be used for their evaluation. Those intensional constructs are called "Information-State-Based-Attitudinal-State-Descriptions" (ISBAS). They are designed to resolve the problem that not all DRSs which are part of an ADS are proper, but may referentially depend on other DRSs which are part of the same ADS. ISBASs deal with this problem by defining information states for improper DRSs on the basis of a merge of the information states defined by the proper components of an ADS. Two assumptions are necessary as a basis that the referential dependence relation between DRSs in the ADS is well-founded and that the merge of DRSs of an ADS contains no free discourse referents.

A.3.1 Well-foundedness of ADSs

A basic assumption that underlies the commerce with referential dependencies of some components of a mental state on others is that we deal only with ADSs which satisfy the following well-foundedness constraint.

Definition 17 *Well-foundedness*
The transitive closure of $\prec_K$ of the relation $\prec$ between the DRS components K_1 and K_2 of a DRS K is well-founded: $K_1 \prec_K K_2$ iff there is a discourse referent x which occurs free in K_2 and belongs to the universe of K_1

A.3.2 Proper-over-all ADSs

In addition, we restrict attention to ADSs K_1 which are 'proper over all' in that for each pair $\langle MOD, K\rangle \in K_1$ the set of free discourse referent FV of K is included in the union of the universes of DRSs occurring in pairs $\langle MOD', K_2\rangle \in K_1$ s.t. $K_2 \prec_{K_1} K_1$.

Definition 18 *K_1 is a 'proper over all' ADS iff*

- $FV(K_1) \subseteq \cup(U_{K_2} | \exists MOD' \langle MOD', K_2\rangle \in K_1 \wedge K_2 \prec_{K_1} K_1)$

A.3.3 Relating Attitudes and Information States

The definition of the intensional constructs for the evaluation of ADSs proceeds in two steps. First, we define the notion of a Potential Information State Based Attitudinal State Description (PISBAS) and then narrow this concept down to that of

an ISBAS. ISBAS are those objects that we use for the definition of the semantics of ADSs.

Definition 19 *Let $\mathscr{M}$ be a model and let $\mathscr{J}$, $\mathscr{J}_1$, $\mathscr{J}_2$, $\mathscr{J}'$ be CCPs:*

- *A Potential Information State Based Attitudinal State Description (PISBAS) relative to $\mathscr{M}$ is any set of pairs $\langle MOD, \mathscr{J} \rangle$ with MOD a mode indicator and $\mathscr{J}$ a regular CCP relative to $\mathscr{M}$.*
- *Let J be a PISBAS relative to $\mathscr{M}$. Let $\prec_J$ be the transitive closure of the relation $\prec$ between the members of J. $\prec$ is defined as*
  - *$\mathscr{J}_1 \prec \mathscr{J}_2$ iff there is a discourse referent x which belongs to $PRES(\mathscr{J}_2)$ and to the base of $\mathscr{J}_1$.*
- *We say that a PISBAS J relative to $\mathscr{M}$ is an Information State Based Attitudinal State Description (ISBAS) relative to $\mathscr{M}$ iff*
  - *$\prec_J$ is well-founded and*
  - *it is possible to assign, by induction along $\prec_J$, to each CCP $\mathscr{J}$ occurring in J, an information state $I(\mathscr{J})$ as follows:*
    - *Suppose that $\mathscr{J}$ has no predecessors according to $\prec_J$. Then $\mathscr{J}$ is a total CCP.*
    - *Suppose that for all $\mathscr{J}$' occurring in J s.t. $\mathscr{J}' \prec_J \mathscr{J}$, $I(\mathscr{J}')$ has been defined. Then $\mathscr{J}$ is defined on $\cup\{I(\mathscr{J}'))\}|\ \mathscr{J}' \prec_J \mathscr{J}\}$ and $I(\mathscr{J}) = \mathscr{J}(\sqcup\{\mathscr{I}(\mathscr{J}'))\}|\ \mathscr{J}' \prec_J \mathscr{J}\})$.*

A.3.4 Models for ADSs

Definition 20 *We extend the definition of an intensional model $\mathscr{M}$ with two new components CA and AS:*

- *for each world w of CA, CA is the set of cognitive agents of $\mathscr{M}$ in each possible world w of $\mathscr{M}$*
- *$AS_{\mathscr{M}}(a,w,t)$ is a function defined on worlds w, intervals of time t and members of CA_w, such that $AS_{\mathscr{M}}(a,w,t)$ is an ISBAS which identifies a's mental state at t in w in $\mathscr{M}$.*

A.3.5 Truth of an ADS

The discourse referents of an ADS K need not be the same as those occurring in the bases of the CCPs of the ISBAS in relation to what the ADS is evaluated. So we must allow for renaming[19] the discourse referents occurring in the ADS. To simplify matters, we assume that the discourse referents occurring in ISBAS are disjoint from those which belong to the language $\mathscr{L}_{Att}$. $r(K)$ is the DRS obtained by replacing each discourse referent x occurring in K throughout K by $r(x)$.

Definition 21 *Truth-conditions of an unanchored ADS*

- $f \vDash_{\mathscr{M},w} s : Att(x,K,\emptyset)$ *iff there exists*
  - *a renaming function r s.t. Dom(r) consists of the discourse referents occuring in K and*
  - *a function H with* $Dom(H) = r(K)$ *s.t.*
    - $H(\langle MOD,K\rangle)$ *is of the form* $\langle MOD, \mathscr{J}\rangle$
    - *for all* $t \in dur(f(s))$ *and each* $\langle MOD,K\rangle \in r(K)$, $H(\langle MOD,K\rangle)$ *belongs to* $AS_{\mathscr{M}}(f(x),w,t)$ *and*
    - *for each* $\langle MOD,K\rangle \in r(K)$, $[\,[K]\,]^s_{\mathscr{M},w,t,K} \preceq I(\mathscr{J})$, *where* $I(\mathscr{J})$ *is the information state determined within* $AS_{\mathscr{M}}(f(x),w,t)$ *by the CCP* $\mathscr{J}$ *of* $H(\langle MOD,K\rangle)$.

A.3.6 Truth of an anchored ADS

Two requirements should be captured by a semantics of ADSs that takes into account the role of external anchors. First, the verification condition for $s : Att(a,K,EA)$ should be undefined when K contains discourse referents which are internally but not externally anchored. The idea adopted here is to remove all internal anchors of such discourse referents in K, via a reduction of K with respect to the set of external anchors EA.

Definition 22 *Reduction of K with respect to EA,* $Red(K,EA)$

- $Red(K,EA) := K \setminus \{\langle [ANCH,x],K\rangle \mid \langle [ANCH,x],K\rangle \in K \wedge \neg\exists x' \langle x,x'\rangle \in EA\}$

19 Suppose that r is a 1-1 map from the set of discourse referents occuring in an ADS K onto some other set of discourse referents. Then the alphabetic variant of K determined by r is the set of all pairs $\langle MOD, r(K)\rangle$ such that $\langle MOD,K\rangle$ belongs to K together with the pairs $\langle [MOD, r(K)]\rangle$ such that $\langle [ANCH,x]\rangle$ belongs to K.

Second, a DRS K in which an external anchor for x (individual, plural or property) occurs should be considered to express a proposition that is singular with respect to the value x' of the external anchor for x. This is achieved by evaluating the proposition expressed by K with respect to embeddings $f \cup (EA \circ f)$, which has each of the externally anchored discourse referents x in its domain and assigns to x the value that f assigns to x'.

Definition 23 *Truth conditions for externally anchored ADSs.*

- $f \vDash_{\mathscr{M},w} s : Att(a,K,EA)$ *iff*
  - *for all* $t \in dur(f(s))$ *there exists a function* H *from* $Red(K,EA)$ *into* $AS_{\mathscr{M}}(f(a),w,t)$ *s.t.*
  - *for each* $\langle MOD,K\rangle \in Red(K,EA)$, $[\![K]\!]^{s}{}_{\mathscr{M},w,f\cup(EA\circ f),K^{\preceq I(\mathscr{J})}}$
  - *where* $I(\mathscr{J})$ *is the information state determined within* $AS_{\mathscr{M}}(f(a),w,t)$ *by the CCP* $\mathscr{J}$ *of* $H(\langle MOD,K\rangle)$

The truth conditions in definition 23 capture the wide content interpretation of an ADS (see e.g. Stalnaker (1990) for the philosophical discussion surrounding wide and narrow content of attitudes). For the narrow content interpretation, i.e. that content of an attitude which does not depend on the environment of the agent who entertains it, we must ignore the external anchor set EA and treat internally anchored discourse referents of K existentially. That is, the idea which is adopted here is to replace each internal anchor $\langle [ANCH,x],K\rangle$ in K is to be replaced by $\langle [BEL,K]\rangle$.

Definition 24 *Existentialization of internal anchors*

- $NC(K) = (K \setminus \{\langle [ANCH,x],K\rangle \mid \langle [ANCH,x],K\rangle \in K\}) \cup \{\langle [BEL,K]\rangle : \langle [ANCH,x],K\rangle \in K\}$

Definition 25 *Narrow content verification of an ADS*

- *The narrow content verification of an ADS* $s : Att(a,K,\emptyset)$ *is the verification of the condition* $s : Att(a,NC(K),\emptyset)$ *according to definition 23.*

A.3.7 Semantics of intentional anchors

The semantics for anchored DRSs does not take into account the interpretation of intentional anchors. The definitions in the preceding paragraphs considered only referential dependencies between DRSs which are part of the same ADS. In order to

deal with intentional anchors, we define the evaluation of ADSs against the ISBASs assigned to the agent x whose mental state is represented by an ADS K_1 for cases where the interpretation of discourse referents in K_1 depends on the values that are assigned to discourse referents from an ADS K_2 of an agent y. The problem that we are faced with in capturing intuitions about dependencies between attitudes of different agents is obvious: the semantics which was defined for the mapping from ADSs to information states is not a dynamic one in that it does not consider the mapping from ADSs to information states to depend on 'previous' mappings from ADSs to information states. But the value of an intentional anchor occuring in an ADS K_1 of an agent x should not be determined with respect to the function $AS_{\mathscr{M},x,w,t}$ but with respect to the value that $AS_{\mathscr{M},y,w,t}$ assigns to the ADS K_2 of agent y in which the second argument of the intentional anchor occurs. That is, the objects that were singled out by Adrian's desire as jackets he wants to buy should constitute the set of objects with respect to which conditions involving an intentionally anchored discourse referent in the reporter's ADS should be evaluated. But while the evaluation of ADSs takes into account the difference between agents in the function $AS_{\mathscr{M},\alpha,w,t}$, this difference is lost at the level of information states, which are defined only with respect to embeddings and possible worlds and not with respect to agents.

What I propose in the following is a simplified approach to the problem of cross-agent referential dependencies. For the evaluation of intentional anchors of the form $\langle x, y_z \rangle$ I assume that the dependency between attitudes manifests itself in two ways: first there is a temporal order. Before the reporter can say something about Adrian's attitude, he needs to have a representation of Adrian's attitude. This temporal dependency must be captured as a much stronger claim: the representation must also have an interpretation at the time that the attitude report as a whole is evaluated. That is, we need to decompose the interpretation of DRSs containing referentially dependent attitudes of different agents into separate units of meaning and evaluate conditions of the form $s : Att(a, K, EA)$ incrementally, according to the temporal order in which they stand. But because the definition of truth in DRT pertains to DRSs and not to DRS conditions, we must bypass this limitation by assuming that there are stopping points in the interpretation algorithm for DRSs and that conditions of the form $s : Att(a, K, EA)$ are such stopping points, which enforce an embedding of the DRS in which they occur. For each ADS K we store its verifying embeddings g together with the agent who is the first argument of the ADS K. Given that we rename ADSs in order to assign them CCPs, we have to ensure that we are able to link intentional anchors to their values in the right manner. That is, we also have to store the translation function r_z associated with a certain ADS K_1 of which the first argument is z. The proposition expressed by K should not be evaluated with respect to embeddings $f \cup (EA \circ f)$ but with respect to their extensions $f \cup (EA \circ f) \cup (VA)$,

where VA has each of the intentionally anchored discourse referents $\langle x, y_z \rangle \in K$ in its domain and assigns to x the value that g_z assigns to $r(y_z)$. Thus, VA is a function from discourse referents y intentionally anchored to x_z to $g_z(r_z(x_z))$

Definition 26 *Verification of an anchored ADSs with intentional anchors.*

- $f \vDash_{\mathscr{M},w} s : Att(a, K, EA)$ *iff*
  - *for all* $t \in dur(f(s))$ *there exists a function* H *from* $Red(K, EA)$ *into* $AS_{\mathscr{M}}(f(a), w, t)$ *s.t.*
  - *for each* $\langle MOD, K \rangle \in Red(K, EA)$, $[\![K]\!]^s{}_{\mathscr{M}\, w, f \cup (EA \circ f) \cup (VA), K^{\trianglelefteq I(\mathscr{J})}}$
  - *where* $I(\mathscr{J})$ *is the information state determined within* $AS_{\mathscr{M}}(f(a), w, t)$ *by the CCP* $\mathscr{J}$ *of* $H(\langle MOD, K \rangle)$

Definition 27 *Narrow content verification of an anchored ADSs with intentional anchors.*

- *The narrow content verification of an ADS* $s : (Att(a, K, \emptyset)$ *is the verification of the condition* $s : (Att(a, NC(K), \emptyset)$ *according to definition 26.*

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