On the Semantics of Modal Adjectives

Octav Eugen DeLazero
Cornell University

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Abstract

I examine the semantics of modal adjectives based on their selectional properties, arguing that they only combine with nouns describing situations or participants in situations (entities in context), and I propose a formal treatment. I attempt an extension of this analysis to temporal adjectives, thereby outlining a unitary treatment of non-subsective adjectives. The analysis involves the assumption, for nouns, of denotations and semantic types consistent with what they describe, and a revision of the denotations of intensional operators when used with nouns describing or involving situations.

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1 Preliminaries

I start with the observation that modal adjectives, such as *possible*, *probable*, or *likely*, combine only with common nouns, which describe or presuppose a situation, i.e., an event or a state. In combinations like *possible victory*, or *likely murder*, the nouns *victory* and *murder* describe events; in *probable relationship*, the noun *relationship* describes a state—namely, the existence of a relationship, of whatever nature.

On the other hand, modal adjectives can also combine with common nouns describing entities (physical objects or living beings): *possible winner*, *probable father*, etc. However, it is crucial to note that those entities are always regarded in a context (situation), rather than by themselves. A *winner* is most commonly a person, but in order to be qualified as a winner, that person must have won a contest, competition, etc., so that there is always an event (the contest, etc.) that is presupposed. Likewise, a *father* is a man who is considered within a situation (state) of paternity, while a *model* can be either an entity which serves as a model in a certain context, or a theoretical construct consisting of a set of relationships (a state).

Numerous apparent counterexamples can be proposed, which on closer inspection turn out to confirm the empirical generalizations made above. For instance, in (1), the noun *house* describes an entity (a building), yet what is qualified as being possible is not the building itself, but rather the presupposed situation where that building is used as a dwelling; if no such situation is presupposed, the building cannot be described as a house. By contrast, in *big/red/nice house*, the adjective refers to the size of the entity 'house', not to a situation involving that entity.

(1) I found a possible house.

Many collocations of modal adjectives with common nouns describing entities can come to mind, which, even if found acceptable in discussions among linguists, are hardly ever encountered in daily conversation. In *possible cat*, the noun apparently describes an entity in itself, with no reference to a context. In fact, much like in the previous example, what is qualified as being possible is not the entity (the animal) qua physical object, but a situation which is presupposed, such as the occurrence of a cat as in (2), or somebody's performing the part of a cat in a play as in (3). Likewise, in *probable planet*, what is possible is the existence of a planet in some part of the universe.

(2) (?)I mentioned a possible cat in my house.
(3) John is a possible cat.
(4) There is a probable planet there.

In (2)–(4), as in (1), there is always a presupposed context (situation) in the background; (3) is similar to (1), in that in both sentences the noun (*house*, *cat*) indicates a function, or role, performed by an entity in a context. When a context is more difficult to imagine, the collocation is odd, e.g., ?*likely stone*. Such unlikely examples can always be paraphrased to reveal the fact that what the modal adjective actually qualifies is situations, which are described by the nouns in the paraphrase (*existence*, *occurrence*, *performance*). This is not the case with adjectives like *large* or *white*: e.g., *white cat* cannot be paraphrased as #*the white existence of a cat*.

(2') I mentioned the possible existence / occurrence of a cat in my house.

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[1]With regard to the distinctive properties of relational nouns: "Relational nouns refer to relational categories; categories whose membership is determined by common relational structure (including extrinsic relations to other entities), rather than by common properties […]. For example, for X to be a *bridge*, X must

(3') John is a possible performer for the cat's part. =
= The performance by John of the cat's part is possible.
(4') The existence of a planet there is probable.

What these examples suggest is that, in discussing the semantics of modal adjectives, we should examine the adjectives in conjunction with the nouns they modify. I will argue in the following sections that this approach can be used as a probe into the semantics of both modal adjectives and nouns. First I will define the relevant classes of nouns and adjectives, then I will proceed to discuss the formal semantics of those classes.

2 The Relevant Nominal Classes

2.1 Modal Adjectives are Non-Subsective (Kamp and Partee 1995)

Kamp and Partee (1995:137–138) propose a classification of adjectives based on their meaning postulates:

(5) subsectivity: [[Adjective Noun]] ⊆ [[Noun]]
(6) non-subsectivity: [[Adjective Noun]] ⊄ [[Noun]]

The combination of a subsective adjective with a noun (a set of individuals) yields a subset of the set of individuals denoted by the noun: a *tall tree* is a tree, and a *skilled surgeon* is a surgeon. This is not the case with non-subsective adjectives: during the evaluation time, a *possible war* is not a war in the base world, and a *former president* is not a president at the reference time. Modal adjectives, like *possible*, and temporal adjectives, like *former*, are non-subsective.

2.2 Nouns Describing Situations or Entities in Context are Relational (Gentner 2005)

Gentner (2005) classifies common nouns into relational and sortal (non-relational). Sortal nouns denote sets of individuals (entities)—for instance, the noun *cat* denotes the set of all cats. On the other hand, relational nouns denote relations between entities—for instance, the noun *friend* is a relational noun because "[…] a person counts as a friend only in virtue of standing in a particular relationship with another individual" (Barker 2010:1), whereas a sortal noun like *person* denotes a human being without any external reference. Relational nouns can express any kind of conceivable relations—e.g., *relationship* (between A and B), *war* (between A and B), *victory* (of A), *defeat* (of A), *redness* (of A), *murder* (of A), etc.—and they have distinctive semantic and syntactic properties which set them apart from sortal nouns. For instance, a relational noun like *friend* behaves as if it contained a variable—*friend-of*-x in—which can be bound (Jacobson 1999:153–156).

Gentner defines "relational categories" as "categories whose meanings consist either of (a) relations with other entities, as in *predator* or *gift*, or (b) internal relations among a set of components, as in *robbery* or *central force system*" (Gentner 2005:245). She divides relational categories into "*relational role categories* (or *role categories*) and *relational schema categories* (or *schema categories*). Role categories, such as *thief*, are defined by extrinsic relations: their members all play the same role in a relational schema. Schema categories, such as *robbery*, are defined by *internal relational structure*. Schema categories denote relational systems, and they generally take arguments. Role categories often serve as the arguments of implicit or explicit schema categories" (Gentner 2005:246).[1]

[1]With regard to the distinctive properties of relational nouns: "Relational nouns refer to relational categories; categories whose membership is determined by common relational structure (including extrinsic relations to other entities), rather than by common properties […]. For example, for X to be a *bridge*, X must connect two other points or entities; for X to be a *carnivore*, X must eat animals. Relational categories contrast with entity categories like *radish* and *penguin*, whose members share many intrinsic properties. […] Relational nouns have some commonalities with verbs and prepositions, in that their meanings are centered around extrinsic relations with other concepts. Relational nouns are also similar to verbs in that they are semantically unsaturated (i.e., they take arguments). A relational noun takes an argument (often not obligatory)

2.3 Modal Adjectives Combine only with Relational Nouns

Considering the collocations of modal adjectives with nouns discussed in Section 1, it is apparent that the noun classes which can combine with modal adjectives correspond to Gentner's "schema categories" and "role categories": the former describe situations, while the latter describe entities in context, where a situation (the context) is presupposed. The conclusion which follows from this observation is that modal adjectives select only relational nouns. When the noun modified by a modal adjective appears to be non-relational, a closer look shows that it is in fact used with a relational meaning. In (2)–(4), the nouns *cat* and *planet*, which are otherwise non-relational in most contexts of use, behave as "role categories," since they describe participants in situations; even in in (2) and (4), where the situation consists only in the existence or occurrence of the entity (*cat*, *planet*), which is the sole participant in that situation (existence or occurrence).

3 The Analysis: A Type-Driven Approach

3.1 Definite Descriptions of Type *s*

A world has the semantic type *s* (Heim and Kratzer 1998:303). A situation lasts during a time interval in a world (cf. Davidson 1980, Lewis 1986). In time, a situation is included in a time interval, which is a part of a world as space-time. Just as John's nose (an entity: type *e*) is a part of John's head (an entity: type *e*), which is a part of John (an entity: type *e*) in space, a situation (event or state) is part of a time interval, which is part of a world as space-time.

A situation is a time interval identified in a proposition or a definite description containing a schema category (cf. Portner 1992). For instance, the situation of John eating lunch between 2pm and 3pm is the time interval 2pm–3pm identified by the proposition in the linguistic expression *John eating lunch*. Likewise, the time interval between September 1, 1939, and May 9, 1945, is identified by the definite description *World War II*, which contains the schema category *war*. On the other hand, the time interval between June 5, 1941, and August 17, 1952, is not a situation (in English), because it cannot be expressed by means of a proposition or a definite description containing a schema category. For the purposes of the discussion in this paper, since a world has type *s*, its parts (time intervals), together with the subparts of those parts (situations: events and states), are uniformly assigned the semantic type *s*, transferring the same semantic type along the part-whole relationship as happens in the case of entities. Although entities and situations are intuitively distinct from each other (the proof, if needed, being the discussion of this topic in philosophy, e.g., by Davidson and Lewis), I assume that the semantic types are not properties of the entities or situations in ontology, but are assigned to the referents (entities or situations) of definite descriptions in semantics.

To sum up: the subject of a copular sentence with a sortal noun as nominal predicate refers to an entity, having type *e*, but the subject of a copular sentence with a schema category as predicate refers to a situation, and as such has semantic type *s*. In the sentence *This act is a crime*, the subject *this act* has type *s*, referring to a situation, and as such cannot combine by functional application with the nominal predicate *crime* (a schema category), if this predicate is assigned the same type *et* as the sortal nouns. Therefore, it is necessary to assume another semantic type for schema categories.

3.2 The Denotation of Relational Nouns

I will assume that nouns have semantic types which reflect their meaning. Since a situation (event or state) is described by a proposition, of semantic type *st*, a noun describing a situation, i.e., a schema category, will have likewise type *st* (in (7)). A noun describing an entity in context, i.e., a role category, will have type *set* (in (8)), because it describes an entity (type *e*) considered in a context, which is a situation (type *s*). In (7) and (8), the variable e stands for a situation: the one

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and assigns a thematic role. For example, *barrier* implies three arguments, not all of which need be explicit: a figure, something that blocks access, and a goal. This greater syntactic complexity more closely approximates the behavior of verbs than of nouns." (Asmuth & Gentner 2005:163).

described by a "schema category" in (7), and the context in which the entity is considered in (8).

(7) schema category: [[murder]]= $\lambda e_s.[\underline{murder}(e)] = \lambda e_s.$[e is a murder]
(8) role category: [[king]]= $\lambda e_s \lambda x_e.[\underline{king}(e)(x)] = \lambda e_s \lambda x_e.$[x is king in/of/… e]

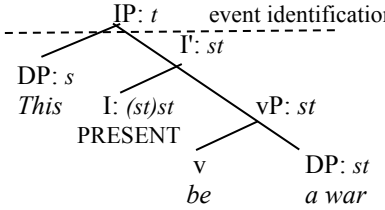
A schema category has the type *st* of propositions, but can be a syntactic predicate. In (9), the subject *this* is understood to refer to a given situation (event), therefore must be assigned type *s*. Zucchi (1993) uses the label "event" for a DP like *John's arrival*; this too is a definite description of type *s*, containing the "schema category" *arrival*, of type *st*.

(9) This is a war.

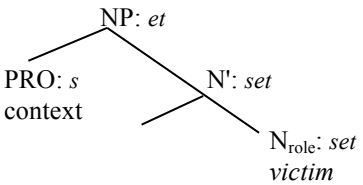
A role category describes an entity (type *e*) in a context, which is a situation (type *s*): a *father* is somebody's father (context: situation of paternity—a state), and a *murderer* has killed (context: act of murder—an event). If no context is presupposed, the noun will be sortal, describing an entity (type *e*) in itself, e.g., *cat* (type *et*).

As I mentioned in Section 3.1, in this approach, a noun per se does not have a semantic type, or it has a default semantic type given by world knowledge. The noun *relationship* has the default type *st*, but in *nice relationship*, it combines with an adjective which is most commonly used to qualify entities, and I can see no discernible difference in the meaning of *nice* between *nice painting* (entity) and *nice relationship* (situation). As such, the noun *relationship*, although by default describing a situation, is 'reified' in *nice relationship*, and has the type *et* of nouns describing entities. The semantic type of a noun is given by the discourse context, as in (2) and (3), where the noun *cat*, which by default is sortal (type *et*), functions as a "schema category" (type *st*) and a role category (type *set*) respectively.

A copular sentence with a schema category as a predicate is equivalent to an event identification in the sense of Kratzer (1996). In (9), the referent of *this* (a definite description of type *s*) is a given event, which is identified as a war by the predicate *a war* (a schema category of type *st*):

(10)


I assume that the most likely structure of an NP headed by a role category is as in (12), with the context in SpecNP, ultimately by analogy with Ritter's (1988) analysis of the Hebrew construct state, with the possessor in SpecNP: in a sense, the participant in a situation "belongs" to that situation in a part-whole relationship, as the possessed belongs the to context of possession (a state). Since the context is presupposed, constituting background knowledge, it is 'absorbed' in semantic composition inside the NP, and type of the NP comes out as *et*: in (11), it is background knowledge what event John is a victim of, so that the DP *a victim*, of type *et*, can combine with the DP *John* (type *e*) in a sentence.

(11) *John is a victim*.
(12)


Multiplying the semantic type of nouns obviously has wide repercussions in compositional semantics, but I cannot treat these issues in this paper. Instead, I will confine the discussion to the

combinations of relational nouns with modal adjectives; changing the semantic types of nouns appears to be necessary in order to formulate denotations of modal adjectives which will account for the semantic composition in a way consistent with the intuition.

3.3 The Denotation of Modal Adjectives

The canonical denotation of the sentence-level modal operator for possibility is as in (13), cf. Portner (2009:18).[2] In (13), w_0 is the base world, A is an accessibility relation, and $A_{w0}(w)$ means that the world w is accessible from the base world w_0.

(13) $[[\Diamond]]^{w0} = \lambda p_{st}.[\exists w_s[A_{w0}(w) \rightarrow [[p]]^{w} = 1]]$

When a sentence like *We could win the war* or a phrase like *possible victory* is uttered, what the speaker has in mind is not entire worlds accessible from the base world, but rather situations in these accessible worlds: one imagines the situation of winning the war, rather than the state of the entire universe in the event of a victory. As such, it is legitimate to adapt the denotations of the modal operators by replacing the reference to possible worlds by a reference to possible situations, understood as situations occurring in possible worlds. This is feasible only if worlds and situations are assigned the same semantic type *s*. In (14), $A_{w0}(e)$ means that the situation e occurs in a world accessible from w_0:

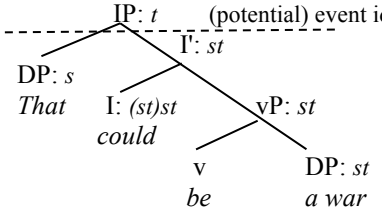
(14) $[[\Diamond]]^{w0} = \lambda p_{st}.[\exists e_s[A_{w0}(e) \rightarrow [[p]]^{e} = 1]]$

In a sentence like (16), the referent of *that* is a datum: the speaker and hearer already know which specific event is being referred to, and the sentence only states that that event could become a war, or could turn out to be a war. Since the event already exists, the denotation in (14) must be reformulated as a function of type *(st)st* by binding the event variable in a λ-expression, as in (15): the sentence (16) is about a given event, in an accessible world, which could be(come) describable as a war.[3] The denotation in (15) does not say that there is an event in the base world, and that in some accessible world that event is a war, because, as I explained in Section 3.1, I assume that an event constitutes a part of a world. The possibility in (16) is the possibility of identifying a given event in an accessible world as a war, not the possibility of the occurrence of a war in an accessible world. It must also be noted that in (17), the modal operator does not need to raise in order to get clausal scope, but is interpreted in situ.

(15) $[[\Diamond_{[+schema]}]]^{w0} = \lambda p_{st} \lambda e_s.[A_{w0}(e) \,\&\, [[p]]^{e} = 1]$

(16) That could be a war.

(17)



I further assume that the NP-level modal operator has the same denotation as the corresponding sentence-level operator in (19), because, as far as I can tell, the sentences in (18) have the same truth-conditions:[4]

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[2]For ease of notation, in the denotations of modality I am ignoring the model variable M (Portner 2009:18), which is irrelevant for this discussion.

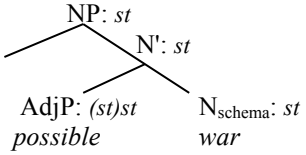
[3]The impossibility of applying this operation to the universal quantifier of necessity explains why there are no non-intersective adjectives expressing necessity: adjectives like *necessary*, *obligatory*, *compulsory*, *inescapable*, *unavoidable*, *sine qua non*, etc., are intersective—e.g., *Waterloo was a necessary defeat* entails that *Waterloo was a defeat*, and any *inescapable consequence* is still a *consequence*.

[4]I find it quite difficult to come up with a context where the sentences in (18) are not equivalent in meaning, but I must leave this issue open. In any case, it seems to me that in both of them, the referent of the

(18) [[That could be a war]] = [[That is a possible war]]
(19) phrase-level $[[\text{possible}_{[+\text{schema}]}]]^{w0}$ = sentence-level $[[\text{could}_{[+\text{schema}]}]]^{w0}$ =
$= [[\Diamond_{[+\text{schema}]}]]^{w0} = \lambda f_{st}\lambda e_s.[A_{w0}(e) \,\&\, f(e)]$

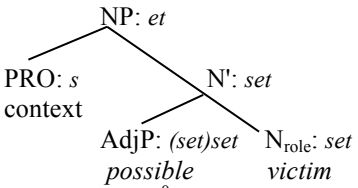
Modal adjectives will combine then by functional application, rather than predicate modification, even if they are syntactic adjuncts:

(20)



Turning now to the role categories, one can talk about a *possible victim* only knowing the context (murder, robbery, etc.) in which the respective individual is a victim, since a role category presupposes a context. In (21), the NP *possible victim* describes an individual, hence has type *et*, and the modal adjective combining with a role category has the denotation in (22), which is similar to the denotation of the same adjective when combined with a schema category, except that the context argument must be taken into account. The possibility expressed by the adjective in (22) refers to the possibility for an entity (variable x) to become a victim in a context (variable e); in (21), the context has been absorbed at NP level, being understood that the referent of PRO is given (known or assumed).

(21)



(22) $[[\text{possible}_{[+\text{role}]}]]^{w0} = \lambda f_{set}\lambda e_s\lambda x_e.[A_{w0}(e) \,\&\, f(e)(x)]$

With this denotation, the compositional semantics yields results consistent with the intuition; in (23) and (24), the adjective combines with both the role category and the context c.

(23) $[[\text{possible murderer}]]^{c,w0} = [[\lambda f_{set}\lambda e_s\lambda x_e.[A_{w0}(e) \,\&\, f(e)(x)]]([[\text{murderer}]])]^{c} =$
$= [\lambda e_s\lambda x_e.[A_{w0}(e) \,\&\, \underline{\text{murderer}}(e)(x)]]^{c} = \lambda x_e.[A_{w0}(c) \,\&\, \underline{\text{murderer}}(c)(x)]$
(24) $[[\text{John is a possible murderer}]]^{c,w0} = [[[\text{possible murderer}]](\text{John})]^{c,w0} =$
$= [[\text{possible murderer}]]^{c,w0}(\text{John}) = [\lambda x_e.[A_{w0}(c) \,\&\, \underline{\text{murderer}}(c)(x)]](\text{John}) =$
$= 1$ iff $[A_{w0}(c) \,\&\, \underline{\text{murderer}}(c)(\text{John})] =$
$= 1$ iff c is accessible from w_0 and John is a murderer in c

Unlike the denotation of a modal adjective used with schema categories, which I assumed to be identical to the denotation of a sentential operator as in (19), (22) is different from the denotation of a sentential modal operator used in a sentence where a role category is the predicate. For the example in (25), I assume the traditional analysis, in which the modal operator raises to get clausal scope, despite the semantic equivalence in (28), which seems to me to hold to the same extent as the one with schema categories in (18).

(25) John could be a victim.

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subject *that* can only be a given event, whether ongoing or foreseen; even if the event is only foreseen, the subject *this* will still be a definite description of type *s*. If *That is a possible war* is paraphrased as *That could become a war*, the question arises what the referent of *that* is in each of these two sentences. With "role categories," the paraphrase with *become* seems acceptable to me only when the predicative modal adjective is used with the future tense: *John will be a possible victim* vs. *John could become a victim*.

(26) $[\![\text{victim}]\!]^{w0} = \lambda e_s \lambda x_e \lambda w_s.[\text{in w, x is a victim in e}]$ – type *sest*
(27) phrase-level $[\![\text{possible}_{[+role]}]\!]^{w0} = \lambda f_{set} \lambda e_s \lambda x_e.[A_{w0}(e) \,\&\, f(e)(x)] \neq$
$\neq$ sentence-level $[\![\text{could}]\!]^{w0} = \lambda p_{st}.[\exists w_s[A_{w0}(w) \rightarrow [\![p]\!]^w = 1]]$
(28) [[John could be a victim]] = [[John is a possible victim]]

It appears that this analysis of modal adjectives can be immediately extended to the other class of non-subsective adjectives, namely temporal adjectives like *former*, *previous*, or *future*.

4 Extension to Temporal Adjectives

4.1 The Denotation of Temporal Adjectives

Applying to temporal operators the same reasoning as in the previous section, the denotation of the sentence-level temporal operator used in (29) will be as in (30), where i_0 is the reference time. The function description in the square brackets says that the event must be prior to the reference time and describable by the schema category p.

(29) That was a war.
(30) $[\![\text{PAST}_{[+schema]}]\!]^{i0} = \lambda p_{st} \lambda e_s.[e << i_0 \,\&\, [\![p]\!]^e = 1]$

In (29), the referent of *that* is an event which is known to belong to the past, since the sentence cannot be felicitously uttered if that event is ongoing or foreseen. In this case, the tense operator does not raise above sentence level, because what is talked about as belonging to the past is not the act of identification of some timeless event as being a war, but that event itself: the past tense on the verb stands in a sort of "agreement" in tense with the past to which the event referred to by *that* belongs. If the equivalence in (31) holds, the denotation of the adjective *past* used with schema categories will be as in (32).

(31) [[That was a war]] = [[That is a past war]]
(32) phrase-level $[\![\text{past}_{[+schema]}]\!]^{w0}$ = sentence-level $[\![\text{PAST}_{[+schema]}]\!]^{w0}$ =
$= [\![\text{PAST}_{[+schema]}]\!]^{w0} = \lambda p_{st} \lambda e_s.[e << i_0 \,\&\, [\![p]\!]^e = 1]$

By analogy with (22), the denotation of a temporal adjective modifying a role category will be as in (33), where the context e in which a *former president* was president (his term in office) belongs to the past ($e << i_0$).

(33) $[\![\text{former}_{[+role]}]\!]^{i0} = \lambda f_{set} \lambda e_s \lambda x_e.[e << i_0 \,\&\, f(e)(x)]$

Applied to an example parallel to that in (24), the resulting denotation is consistent with the intuition; as in (23), the non-intersective adjective combines with both the relational noun and the context c (which, in this case, is the situation consisting of John's term in office).

(34) $[\![\text{former president}]\!]^{c,i0} = [[\lambda f_{set} \lambda e_s \lambda x_e.[e << i_0 \,\&\, f(e)(x) = 1]]([\![\text{president}]\!])]^c =$
$= [\lambda e_s \lambda x_e.[e << i_0 \,\&\, \underline{\text{president}}(e)(x)]]^c = \lambda x_e.[c << i_0 \,\&\, \underline{\text{president}}(c)(x)]$
(35) $[\![\text{John is a former president}]\!]^{c,i0} = [[\![\text{former president}]\!](\text{John})]^{c,i0} =$
$= [\![\text{former president}]\!]^{c,i0}(\text{John}) = [\lambda x_e.[c << i_0 \,\&\, \underline{\text{president}}(c)(x)]](\text{John}) =$
$= 1$ iff c is prior to i_0 and John is a president in c

5 Conclusions

I have examined the semantics of modal adjectives based on their selectional properties, arguing that they only combine with nouns describing situations or participants in situations (entities in context); I also extended the discussion to temporal adjectives, thereby outlining a unitary treatment of non-subsective adjectives. The analysis involves the assumption, for nouns, of denotations and semantic types consistent with what they describe. I also proposed a modification of the deno-

tations of intensional operators when used with nouns describing or involving situations.

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Department of Linguistics
Cornell University
Ithaca, NY 14850
od32@cornell.edu