

# Thematic Proto-Roles and Argument-Predicate Interaction<sup>1</sup>

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Abstract: In their study of argument structure, linguists have focused primarily on the properties of predicates. Contrary to some authors like Foley & Van Valin [1984], for example, I believe that the inherent semantic properties of noun phrases are no less important than predicate entailments when it comes to the interpretation of utterances. This paper, therefore, proposes a formal model for the analysis of the interactions between the semantic entailments of verbal predicates and the semantic properties inherent to noun phrases lexicalizing the obligatory arguments of those predicates.

## 1 INTRODUCTION

Thematic-roles have been the center of attention to a growing number of linguists perplexed by the seemingly impossible task of providing a comprehensive account of them. Dowty [1991:545] claims that “[t]here is perhaps no concept in modern syntactic and semantic theory [...] on which there is so little agreement as to its nature and definition”.

In any case, thematic relations [Gruber 1965] posit very interesting problems from both the linguistic and also the psychological points of view. This is the case mainly due to their use of the notion of semantic primitives. Linguists, nonetheless, have been trying to avoid discussing the fact that these semantics primitives are, most likely, a psychological and not an exclusively linguistic notion (with, of course, noteworthy exceptions like [Pinker 1989]). Furthermore, and perhaps due to this misconception, more often than not linguists have viewed thematic-roles as discrete categories like agent, patient, theme, experiencer, etc. with well known problems as to their complete listing [Chafe, 1970; Gruber 1965; Fillmore 1968; cf. Wechsler 1995; Sells 1985; Dowty 1991; Foley & Van Valin 1984]. As usual, clean boundaries are rarely true in psychological theories. Most entities that are worth analyzing are instantiated in what is generally called a *continuum of activity* [see Garcia 1975; Foley & Van Valin 1984; Dowty 1991; Castel 1994].

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<sup>1</sup> An earlier version of this paper was published in the proceedings of the 1999 Mid-America Linguistics Conference, University of Kansas at Lawrence, Lawrence, KA.

This paper will put forward several related hypothesis as to the psychological nature of argument structure and the relationships that we can observe among verbs and the noun phrases saturating the arguments of those verbs. In section 2 below, I will start by defining the problem and I will lay out the foundations of Dowty's theory of proto-roles [Dowty 1991]. In section 3, I will talk about a possible way of formalizing the principle of argument selection, put forward by Castel [1994] and a formal notation to make verbal entailments clearer for further theorizing. In section 4, I will propose my hypothesis of noun phrases as capable of saturating the entailments of verbs. In section 5, I will present a short exploration of some topics in the framework of the model. Finally, in section 6, I will conclude that the model I am proposing could be useful to understand certain relations that hold in the psychological perception of the world and that, maybe, these relations could help text comprehension in computer intelligent text processing.

Before beginning the discussion, I would like to warn the reader against two important points. First, that I'm in no way committing myself to an exclusively linguistic interpretation of any of the above mentioned hypothesis; namely, the principle of argument selection or even the formalization of said principle. I will be, in a strict sense, extrapolating the hypothesis put forward in [Dowty 1991] and [Castel 1994] from a purely linguistic framework to a more psychological one. In fact, my model is, above all, a psycholinguistic model of argument structure and, *mutatis mutandis*, a model of psychological categorization of the world. Second, that the model I am proposing is in a very early stage of development and raises, undoubtedly, many empirical questions that should be addressed relatively soon. In spite of both these points, I think I will be in a position to make some interesting claims as to both the linguistic and the psychological aspects of argument structure.

## 2 THE BASIS OF THE DISCUSSION

It is quite evident that “[v]erbs subcategorize syntactically for complements [...]” [Wechsler 1995; Chomsky 1965]. For example, the verb ‘frighten’, as shown in (1), subcategorizes for - in a traditional terminology - a subject (the entity that is the potential initiator and/or controller of the action described by the verb) and a direct object (the entity that the action described by the verb is carried upon)<sup>2</sup>. Thus,

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<sup>2</sup> When I speak of subjects and direct objects, I am always referring to them as appearing in active sentences. That I sometimes make this fact explicit amounts to no more than a ‘centavo’ for stylistic variation.

(1) *frighten* <NP<sub>1</sub>, NP<sub>2</sub>>

where NP<sub>1</sub> and NP<sub>2</sub> are the complements that are going to lexicalize the subject and the direct object. Now, if one of these obligatory complements fail to lexicalize, then the whole sentence would be ungrammatical, like (2) and (3) below:

(2) \*frightened Heather.

(3) \*Heather frightened.

In (2), the nature of the ungrammaticality is the fact that there is no argument that will lexicalize the argument associated with the subject of the utterance. In (3), it is the same problem; namely, the lack of lexicalization of an obligatory argument, though this time it is the argument associated with the direct object that fails to lexicalize. There is, however, one more problem at the level of argument structure. What we have been discussing are instances of syntactic subcategorization. There is the case that an utterance will be ill-formed at the semantic level; that is, at the level of the interpretations of the lexicalized arguments [Wechsler 1995]. Consider (4) and (5) below:

(4) Heather frightened the squirrel.

(5) !Heather frightened the rock.

There is, in (4) and (5), an evident asymmetry that lexical semantics has to explain. Basically, the problem has to do with the kinds of direct objects that the relation 'frightened' allows; namely, one for which the direct object, or, more specifically the direct object of all active utterances, will be a sentient being. Foley & Van Valin [1984:33] make a similar point. They write: "[*Frighten*], by virtue of its meaning, requires an animate undergoer or one with somewhat animate-like properties". [Chafe 1970:68] alludes to the same kind of oddity when the example "the house ate a banana" is discussed. Though I am aware that the notions of 'direct object' and undergoer are not equivalent, that does not affect the discussion here. That is so because in active sentences with psychological predicates of the 'frighten' style, the undergoer is always equivalent to the direct object. The formal differences among, say, the notions of 'proto-patient', 'direct object' and 'undergoer' is an interesting one that I will explore in future work.

It is important to keep in mind, then, that unlike the examples in (2) and (3) above, this problem in (4) and (5) is a (psycho)semantic one. This paper then addresses the following issues: first, the question of how verbs “subcategorize” semantically and second, the role NPs play in these subcategorizations.

Following [Garcia 1975] and later work by [Foley & Van Valin 1984], I will take theta-roles to belong to a continuum of activity; that is, the idea that there is a relative degree and nature of involvement of the various entities and relations referred to in the utterance [see Garcia 1975:78]. To try to give an account of how relations among verbal entailments and noun phrases work, I will use the notion of proto-role proposed by Dowty [1991]. For this author, the continuum of activity in which roles are embedded is delimited by two role-like concepts. Dowty [1991:571-572] writes: “when we accept that arguments may have different ‘degrees of membership’ in a role type, we can see that we really need only two types to describe argument selection efficiently [...]”. Dowty will call these two types the *Agent Proto-Role* and the *Patient Proto-Role* (henceforth PA and PP respectively). These concepts are in reality *cluster concepts*, which, interestingly, Dowty [1991:571] considers akin to Rosch’s hypothesis of the existence of psychological prototypes that help us categorize the world [see Rosch & Mervis 1975]. There is, again, a resemblance between [Dowty 1991] and [Foley & Van Valin 1984]. In the case of the latter, these authors propose the existence of only two “primitive” roles. On the one hand, there is that of the actor, which initiates, performs, controls, etc. the action denoted by the verb. On the other hand, there is the role of undergoer, which does not perform any of the actions of the actor but is rather affected somehow by the event stated by the verb. The difference between PA/PP and actor/undergoer seems to be that the latter are taken to be discrete, while the former are definitely not. As I said some lines above, PA and PP are cluster concepts.

Being cluster concepts, the PA and PP roles are decomposable into contributing properties that verbs will entail for their arguments. Following Dowty [1991], I will call a predicate’s semantic subcategorization an *entailment*. I will present the contributing properties of the Agent Proto-Role in (6) and the contributing properties of the Patient Proto-Role in (7) below:

(6) Contributing Properties for PA

- a. volitional involvement in the event or state named by the verb
- b. sentience and/or perception
- c. causing an event or change of state in another participant
- d. movement (relative to the position of another participant)

e. exists independently of the state named by the verb

(7) Contributing Properties for PP

- a. undergoes change of state
- b. incremental theme
- c. causally affected by another participant
- d. stationary relative to the movement of another participant
- e. does not exist independently of the event, or not at all

Before I go on, I would like the reader to notice that, like Dowty [1991:572], I am in no way implying that these lists are exhaustive or that they could not be reworked in a different (and much better) way. Actually, I think that this will most likely be the case. What I am committing myself to, however, is that the lists are not merely convenient linguistic labels but also psychological entities of some sort. In other words, I think that the contributing properties of PA and PP are in fact psychological primitives, primitives we humans use to efficiently and quickly categorize the world around us. A sort of shorthand for complex stimuli. The model I am proposing of course allows for parametric variations in predicate entailments across languages, as I shall exemplify below, but the contributing properties in (6) and (7) are taken to be universal.

In (8) and (9) below, I will provide an example of each of the contributing properties mentioned in (6) and (7) above.

(8)

- a. *Heather* is being polite to her linguistics teacher.
- b. *Heather* knows/sees *Dakota*.
- c. *The car* caused an accident.
- d. *The car* overtook the truck.
- e. *Heather* needs new scissors.

(9)

- a. Heather frightened *the cat*.
- b. Heather mowed *the lawn*. [Dowty 1991: 567]

- c. Smoking causes *cancer*. [Dowty 1991:573]
- d. The bullet entered *the target*. [Dowty 1991:573]
- e. Heather built *a wooden bookcase*.

In (8a-e) above, the entailments of the verbs at stake are for the argument that would lexicalize the subject in an active utterance with this verb. In (8a) there is, in the state named by the predicate ‘being polite’, an element of volition. ‘Heather’ here “chooses” to be polite to her teacher. It is important to keep in mind that volition, as Dowty [1991:573] makes clear, is also the voluntary refraining from action. The sentience and perception entailments are exemplified in (8b). Verbs of perception (see, hear, etc.) and propositional attitude verbs (knows, believes, desires, etc.) are the ones that most typically entail sentience. In (8c), the verb ‘cause’ entails the causing of an event or a change of state par excellence. Every verb of motion like ‘fall’, ‘fill’, ‘overtake’, etc. will, by default, entail some kind of movement for the subject. This is shown above in (8d). It is important to notice that the entailment of movement is relative to the *position* of another participant. In (8d), ‘overtake’ entails movement to the subject argument relative to the direct object argument. In fact, both the car and the truck could be moving but that is not at issue. To repeat, what is at issue is the movement of the subject argument *relative* to the direct object argument. Finally, (8e) the referent will not be brought into existence or destroyed by the event named by the verb, instead, “[it] is presumed to exist before and after the event” [Dowty 1991:573].

In (9a-e) above, the entailments of the verbs at stake are for the direct object argument, instead of the subject, in active sentences. In (9a), change of state is taken to be as general as possible. Dowty [1991:574] writes: “Under ‘change of state’ I intend to include coming into existence, going out of existence, and both definite and indefinite change of state”. Because of the meaning of the verb ‘mow’ in (9b), the state of parts of the lawn will reflect a part-whole relationship that will tell us a degree of completeness of the event named by the verb<sup>3</sup>. The last three contributing properties for the PP role (9c-e) are the opposites of those in (8c-e); namely, the property of being causally affected by another participant instead of causing the event or state, the property of being stationary instead of moving, and the property of existing *because* of the event named by the verb, instead of existing independently of it.

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<sup>3</sup> Incremental theme is a rather complicated property. Anyone wishing to know more about it can consult Dowty [1987]. It is however, of no particular importance in the scope of this paper due to the fact that I will be most concerned with the contributing properties for the PA role.

### 3 The Formalization of [Dowty 1991]

At the heart of Dowty's [1991] theory lies the hypothesis of verbal entailments. In his theory, each verb entails, for its arguments, some or all of the contributing properties mentioned in (8a-e) and (9a-e) above. To make this clear and a little more formal, I will follow Castel [1994] and Castel & Rossi [1994]. These authors have proposed a formalization of [Dowty 1991]'s *Principle of Argument Selection*. I will not take every piece of formalization these two authors propose. I will take mainly the formalization of the two sets of properties and their notation for making their case.

Castel and Rossi [1994] define two sets of properties that correspond to the contributing properties of the PA and PP roles as discussed above. They are repeated in (10) and (11) below.

$$(10) \text{ PA} = \{v, s, c, m, e\}$$

where **v** = volitional involvement, **s** = sentience and/or perception, **c** = causing an event or change of state, **m** = movement (relative to another participant), and **e** = exists independently of the event named by the verb. And

$$(11) \text{ PP} = \{ch, it, af, st, de\}$$

where **ch** = undergoes change of state, **it** = incremental theme, **af** = causally affected by another participant, **st** = stationary relative to the movement of another participant, **de** = does not exist independently of the event named by the verb, or not at all.

Before going on, I would like to say a word on the notation. Since for each argument the verb entails both PA and PP properties, then for a two-place predicate *X* the story might go, generically, as follows:

$$(12) \quad \text{-----Argument 1-----} \quad \text{-----Argument 2-----}$$
$$X[(v, s, c, m, e \mid ch, it, af, st, de) / (v, s, c, m, e \mid ch, it, af, st, de)]$$

A definite example is given in (13) below.

(13)            -Arg1--Arg2-  
                   *frighten*[(10) / (11)]

If my reading of [Castel 1994] and [Castel & Rossi 1994] is correct, then the derivation of (12) to (13) might have taken the following schematic form:

(14)            -----Argument 1-----   -----Argument 2-----  
                   *X*[(v, s, c, m, e | ch, it, af, st, de) / (v, s, c, m, e | ch, it, af, st, de)]  
                   *frighten*[(0, 0, 1, 0, 0 | 0, 0, 0, 0, 0) / (0, 1, 0, 0, 0 | 1, 0, 0, 0, 0)]  
                   *frighten*[(0+0+1+0+0 | 0+0+0+0+0) / (0+1+0+0+0 | 1+0+0+0+0)]  
                   *frighten*[(10) / (11)]

In (12) we supposed a predicate *X* with two obligatory arguments: ‘Argument 1’ and ‘Argument 2’. Each of these has the two lists of contributing properties as defined in (10) and (11) above, hence the two sets of 0s and 1s on each argument. The slash ‘/’ separates the two arguments in this example, but it will not appear when we analyze particular instances. In (13), in turn, we take as an example the verb ‘frighten’, which is also a two-place predicate. Speaker’s intuition will assign this verb with one property for the agent proto-role in its first argument, this property being the causing of an event or change of state in another participant; and one property for the agent proto-role and one for the patient proto-role for its second argument; these being the property of sentience and the property of undergoing a change of state, for the proto-agent and the proto-patient roles respectively.

I will try to make things clearer by also stating, in the examples, which properties the verb is actually entailing. Thus, for the verb ‘frighten’, the complete example would be as follows:

(14) *frighten*[(1c0) / (1s1ch)]

Let me now provide some examples taking into consideration the notation provided by Castel & Rossi [1994], which we have been discussing above. It is important to notice that the question of which entailments are to be assigned to which predicates is empirical question to be addressed by psychology or psycholinguistics. Because of this, I do not think that the ascription of one or another entailment in the examples in (15) below jeopardizes the main claim of



this paper, should the entailments be different from the ones I propose. Nonetheless, I think all speakers of the language will agree at least on the most important ones, say the verb ‘frighten’ entailment of ‘sentience’ for its second argument, the one that will lexicalize the direct object in active utterances.

(15)

- a. *Heather* (3v,e0) is being polite to her linguistics teacher (1e0). (30,11)
- b. *Heather* (1s0) sees Dakota (00). (10,00)
- c. *The car* (2c,e0) caused an accident (01af). (20,01)
- d. *The car* (2m,e0) overtook the truck (01st). (20,01)
- e. *Heather* (1e0) needs new scissors (01de). (10,01)

In (15a), the predicate ‘being polite to’ entails two properties for the PA role (volition and an independent existence) and none for the PP role for its first argument. For its second argument, the predicate entails one property for the PA role (independent existence) and none for the PP role. In (15b), the verb ‘see’ entails one property for the PA role (sentience) and none for the PP role of its first argument. In turn, there seem to be no entailment for its second argument, so both are zero. Whether we can assume that the direct object of (15b) undergoes a change of state (from not being seen to being seen) is a matter of empirical research, as I said before. Due to the scope of this paper, I will not discuss the issue here, though I will be in future papers. In (15c), the predicate ‘caused’ entails two contributing properties for the PA role (causing an event or change of state and independent existence) and none for the PP role for its first argument. In turn, this predicate entails no contributing property for the PA role and one property for its PP role (causally affected by another participant) [Dowty 1991; Castel & Rossi 1994]. In (15d), the predicate ‘overtook’ entails two contributing properties for the PA role (movement and independent existence) and none for the PP role for its first argument. In turn, this predicate entails no contributing property for the PA role and one property for its PP role (stationary). Finally, the verb in (15e) entails one contributing property for the PA role (independent existence) and no property for its PP role for its first argument. In turn, for its second argument, the predicate in (15e) entails no property for the PA role and one (dependent existence) for the PP role.

This is, roughly, the way in which the model works. In the next section, I will discuss a related idea; namely, the hypothesis that nouns – and noun phrases in general – somehow saturate the entailments of verbs. I now turn to this hypothesis.

## 4 NOUN PHRASES AND THEIR SEMANTIC PROPERTIES

As we have been discussing above, verbs entail properties for their arguments. However, nouns and noun phrases intuitively play a big role in these entailments. Dowty [1991:572, footnote, my emphasis] writes “It is important here to distinguish entailments of the [predicate] from what follows from any one sentence as a whole (*e.g. entailments that may arise in part from NP meanings, etc.*)”. If this is the case, I will take noun phrases themselves to entail properties of some sort. By entailment here I mean properties that NPs have because of the objects they denote. There is therefore a difference between verbal entailments and NP entailments; namely, the fact that verbal entailments are functors while NP entailments are properties capable of saturating those functors. In spite of this, I am quite happy to call *entailment* to both the semantic subcategorizations of verbs and the inherent semantic properties of NPs<sup>4</sup>. What are then the properties that NPs entail?

As I said, I will propose that NPs also entail properties, and that the properties they entail are those corresponding to the agent proto-role [Ferres in press]. My argument in favor of this hypothesis is in a rather exploratory stage and again relies heavily on the assumptions put forward in [Dowty 1991]. Basically, my argument has to do with the fact that while not all NPs taken in isolation have all proto-agentive properties, thus saying something about the nature of the object they denote; all of them potentially have all proto-patient properties, thus being totally uninformative. I will say something more about this below. What I want to do in this paper is to put forward the hypothesis that NPs are capable of saturating the PA role in verbal entailments.

Let NPs be “capable of” a particular combination of the following agentive properties:

- (16) Noun phrases may be
- a. “capable of” volitional involvement in the event or state named by the verb
  - b. “capable of” sentence and/or perception
  - (c. “capable of” causing an event or change of state in another participant)
  - d. “capable of” movement (relative to the position of another participant)
  - e. “capable of” existence independently of the state named by the verb

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<sup>4</sup> I thank Sam Scott for crystallizing this point for me.

Take (16a). If I am correct, not all NPs are capable of being in a volitional involvement. Thus, I take NPs of the style [the man]<sub>NP</sub>, [my sister]<sub>NP</sub>, [we]<sub>NP</sub> as being capable of volitional involvement as opposed to, say, [a rock]<sub>NP</sub>, [the wind]<sub>NP</sub>, [the cat]<sub>NP</sub>, [the plant]<sub>NP</sub>, etc. Likewise, in (16b), I understand that, for example, [the cat]<sub>NP</sub>, [an animal]<sub>NP</sub>, etc. are maybe capable of sentience and/or perception, while [the plant]<sub>NP</sub>, [the car]<sub>NP</sub>, etc. seem not to be. The next NP entailment, the one in (16c) is a special case. I think it is not informative at all in the linguistic framework of this model (though it could be at the psychological level). This is so because I believe that all NPs in the language are capable of causing an event or change of state in another participant<sup>5</sup>. I will, for the purpose of this paper, consider it as not relevant for the reasons given above; namely, that in principle it will apply to all predicate/argument relationships. To continue, take (16d). Movement is in fact, again, something that not all NPs are capable of entailing. Thus, [a plant]<sub>NP</sub>, [the rock]<sub>NP</sub>, etc. cannot move. By movement I understand, following Dowty [1991], those things that are, to use a term from [Premack 1990], self-propelled. Thus, [a car]<sub>NP</sub> would count as a self-propelled object, while [the leaves]<sub>NP</sub>, even if they are moving, would not. In fact, technically it is something else that is making them move; the wind, for example. Finally, (16e) implies an independent existence. The only objects that can be independently existent are, for me, those objects that have not been man-made. For example, while [a plant]<sub>NP</sub> would count as independently existent thing, i.e. something that has not been *designed*. In turn, [a car]<sub>NP</sub>, [a book]<sub>NP</sub>, [a house]<sub>NP</sub> would not.

Before I go on, let me say that what I assume might be taken as controversial is not that NPs have semantic properties – of course they do – but rather the fact that the semantic properties that they have are only capable of saturating Dowty's [1991] agentive proto-role entailments and not patient proto-role entailments. I believe the latter not to be entailed by NPs; rather, proto-patient entailments seem to be ascribed to the NP by the relation to the verb. Thus, the property of being 'causally affected' in (15c) is not inherent to the NP [the accident]<sub>NP</sub>, but given to it by the verb entailment. A similar idea is discussed by [Foley & Van Valin 1984]. They claim that "[...] the inherent lexical content of the actor NP plays an important role in its interpretation in some instances, but its importance is constrained by the semantics of the predicate itself. [...] The interpretation of the undergoer [...] is almost exclusively determined by the semantics of the predicate [...]" [Foley & Van Valin 1984: 33].

Now, let me define the set of properties PAN (Proto-Agentive properties for Nouns) as follows:

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<sup>5</sup> My argument in favor of only PA properties for NPs stems from this idea of 'uninformativeness'. I think, following the example above, that all NPs can be thought of as having all the properties contributing to the PP role. I will provide more evidence of this in future work.

(17) PAN = {vo, se, mo, ie}

where **vo** = capable of volitional involvement, **se** = capable of sentience and/or perception, **mo** = capable of movement, **ie** = capable of independent existence. We now have the formal tools to analyze some relationships that arise between the entailments of verbs and the entailments of NPs lexicalizing the arguments of those verbs.

The problem, in short, is that some NPs can lexicalize certain arguments while others cannot. Consider the following predicate/argument relations:

(18)

- |  |                               |
|--|-------------------------------|
| a. <i>frightened</i> (the rock, Margie)  | “The rock frightened Margie”  |
| b. <i>frightened</i> (a cat, Margie)     | “A cat frightened Margie”     |
| c. <i>frightened</i> (Peter, Margie)     | “Peter frightened Margie”     |
| d. <i>frightened</i> (the car, Margie)   | “The car frightened Margie”   |
| e. <i>frightened</i> (the plant, Margie) | “The plant frightened Margie” |
| f. <i>frightened</i> (love, Margie)      | “Love frightened Margie”      |
| g. <i>frightened</i> (the wind, Margie)  | “The wind frightened Margie”  |

All predicate/argument relations (and their surface structure correspondences) in (18a-g) are possible in the language. Now consider the following:

(19)

- |  |                                |
|--|--------------------------------|
| a. ! <i>frightened</i> (Margie, the rock)  | !“Margie frightened the rock”  |
| b. <i>frightened</i> (Margie, a cat)       | “Margie frightened a cat”      |
| c. <i>frightened</i> (Margie, Peter)       | “Margie frightened Peter”      |
| d. ! <i>frightened</i> (Margie, the car)   | !“Margie frightened the car”   |
| e. ! <i>frightened</i> (Margie, the plant) | !“Margie frightened the plant” |
| f. ! <i>frightened</i> (Margie, love)      | !“Margie frightened love”      |
| g. ! <i>frightened</i> (Margie, the wind)  | !“Margie frightened the wind”  |

It is evident that relations (19a, d, e, f and g) have a semantic ill formation that (19b and c) do not. Moreover, I firmly believe that this ill formation is psychological in nature, having to do with the way we see the world, not with the world itself. In other words, I cannot assume that a rock, a car, a plant, love or the wind could be frightened – except maybe metaphorically, while a cat and Peter definitely could.

It is now time to put everything together. I will give examples with the predicate *frightened*, which is straightforward in its entailments (and has been discussed at length in [Dowty 1991]). Let me repeat the entailments of the verb frighten:

(14) *frighten*[(1c0) / (1s1ch)]

Now, let me provide NPs with possible entailments; namely the ones in (16a-e) above. For simplification, however, I will take (16c) to be present in all the NPs, so I will not make this property evident in my examples.

(20)

- a. [the rock 1ie]<sub>NP</sub>
- b. [a cat 3se,mo,ie]<sub>NP</sub>
- c. [Peter 4vo,se,mo,ie]<sub>NP</sub>
- d. [the car 1mo]<sub>NP</sub>
- e. [the plant 1ie]<sub>NP</sub>
- f. [love 1ie]<sub>NP</sub>
- g. [the wind 2mo,ie]<sub>NP</sub>

Like for verbs in (15) above, we take the number at the right of the NP itself to be the number of entailments it has. In addition, at the right of this number we specify which entailments it has. Since I believe that NPs are inherently agentive, as I said before, therefore they only possess one kind of proto-property, that of the agentive proto-role. Thus, [the rock]<sub>NP</sub> in (20a) has just one PAN; namely, independent existence, it has not been created by man. In (20b), [the cat]<sub>NP</sub> has three proto-agentive properties, that of being sentient, the possibility of self-propulsion and an independent existence. In (20c), [Peter]<sub>NP</sub> has four (all) of the proto-agentive properties for nouns. It has volition,

sentience, movement and independent existence<sup>6</sup>. In other words, it can act out of free will, it can perceive and feel, it is self-propelled and it has a natural existence. In (20d), the NP [the car]<sub>NP</sub> does not have volition, does not have sentience or independent existence (it has been built in the car company) but it does have self-propelled motion as long as it is not being pulled or pushed by another agent. (20e) and (20f) are much like (20a), they have just one property; namely that of having an independent or natural existence. Finally, [the wind]<sub>NP</sub> has two proto-agentive property for NPs; namely, being self-propelled and having a natural existence.

The move now is to allow PAN properties to saturate the PA properties that are entailed by a particular verb. Thus, I will take **vo** to saturate the verbal entailment **v**, **se** to saturate the verbal entailment **s**, **mo** will saturate **m** and **ie** will saturate **e**. Let me now provide an example:

(21)

a. [the rock 1ie] <sub>NP</sub>		[frightened (1c0, 1s1ch)] <sub>VP</sub>		[Margie 4vo,se,mo,ie]
b. [a cat 3se,mo,ie] <sub>NP</sub>				
c. [Peter 4vo,se,mo,ie] <sub>NP</sub>				
d. [the car 1mo] <sub>NP</sub>				
e. [the plant 1ie] <sub>NP</sub>				
f. [love 1ie] <sub>NP</sub>				
g. [the wind 2mo,ie] <sub>NP</sub>				

Notice that in (21a-g) the NPs that are the subject of the sentence will, by default, saturate the entailment of the verb for its first argument; namely, the change of state. This is so because, as we discussed above, all NPs are capable of the causation of an event or a change of state. In turn, the second argument, which will lexicalize direct object, has saturated the verbal entailment **s** by having the NP entailment **se**. Now consider the following:

---

<sup>6</sup> The question whether the PAN properties are hierarchical, i.e. if a NP has volition therefore it has all the other properties below, is an interesting one. I will, again, address this question in future work.

(22)

[Margie 4vo,se,mo,ie] <sub>NP</sub>	[frightened (1c0, 1s1ch)] <sub>VP</sub>	![the rock 1ie] <sub>NP</sub>
		[a cat 3se,mo,ie] <sub>NP</sub>
		[Peter 4vo,se,mo,ie] <sub>NP</sub>
		![the car 1mo] <sub>NP</sub>
		![the plant 1ie] <sub>NP</sub>
		![love 1ie] <sub>NP</sub>
		![the wind 2mo,ie] <sub>NP</sub>

As we see, only [a cat]<sub>NP</sub> and [Peter]<sub>NP</sub>, both having the property of being sentient, will saturate the entailment of the verb. All the others will fail to do so and the sentence will have the kind of semantic malformation that I have been discussing here.

## 5 DISCUSSING THE MODEL

The hypotheses explored in this paper are two: a) the hypothesis that verbs entail properties, put forward by Dowty [1991] and b) the hypothesis that noun phrases also entail properties that are capable of saturating those entailed by verbs. In this section, I will discuss some more examples to make clear how the model would work with verbs other than psychological ones, plus a speculation as to the use of this model in order to explain a particular kind of phenomena; namely, the utterances of subjects who are mentally ill.

Up to this point, we have only analyzed the predicate ‘frighten’, a psychological verb that entails the proto-agentive property of sentience for the argument that will lexicalize the direct object of the utterance. I take it to be uncontroversial that all psychological predicates (‘frighten’, ‘scare’, ‘startle’, etc) will entail the property of sentience for the argument lexicalizing the direct object in active utterances. This generalization, i.e. that all psychological verbs entail the property of sentience for its undergoer role is, however, an empirical question that I will not address here.

What I will discuss briefly is the question whether there are also predicates that entail restrictive properties for the argument lexicalizing the subject of the utterance instead of the direct object. I believe there are actually many verbs of this kind. Consider the predicate ‘listen’ in (23) below.

(23)

- |  |                                 |
|--|---------------------------------|
| a. <i>!listened to</i> (the rock, Margie)  | !"The rock listened to Margie"  |
| b. <i>listened to</i> (a cat, Margie)      | !"A cat listened to Margie"     |
| c. <i>listened to</i> (Peter, Margie)      | "Peter listened to Margie"      |
| d. <i>!listened to</i> (the car, Margie)   | !"The car listened to Margie"   |
| e. <i>!listened to</i> (the plant, Margie) | !"The plant listened to Margie" |
| f. <i>!listened to</i> (love, Margie)      | !"Love listened to Margie"      |
| g. <i>!listened to</i> (the wind, Margie)  | !"The wind listened to Margie"  |

The set of sentences in (23) above provides some evidence that it is now the subject that will necessarily entail at least sentience. The example in (23b) is interesting and I will come back to it below. I will now provide an intuitive assignment of entailments to the predicate 'listened to'.

(24) *listened to*(3(v),s,e1ch|2c,e0)

Once more, the fact that there could be different intuitions as to the assignment of entailments does not affect my point in this paper. As I said before, it is an empirical question to be answered by psycholinguistics, maybe. In (24) above, my point is that the predicate 'listened to' will entail, beyond any doubt, i.e. necessarily, at least the property of sentience for the actor of the utterance. Most likely, it will also entail volition. Consider the set of sentences in (24) below:

(25)

- |                                       |  |                       |
|---------------------------------------|--|-----------------------|
| a. ![the rock 1ie] <sub>NP</sub>      | [listened to (3(v),s,e0, 2c,e0)] <sub>VP</sub> | [Margie 4vo,se,mo,ie] |
| b. (!)[a cat 3se,mo,ie] <sub>NP</sub> |  |                       |
| c. [Peter 4vo,se,mo,ie] <sub>NP</sub> |  |                       |
| d. ![the car 1mo] <sub>NP</sub>       |  |                       |
| e. ![the plant 1ie] <sub>NP</sub>     |  |                       |
| f. ![love 1ie] <sub>NP</sub>          |  |                       |
| g. ![the wind 2mo,ie] <sub>NP</sub>   |  |                       |



The only arguments that can saturate the verbal entailment ‘sentience’ in (23) and (25) above are the NPs [a cat 3se,mo,ie]<sub>NP</sub>, and [Peter 4vo,se,mo,ie]<sub>NP</sub>, both of which have the property of being sentient. It is interesting to notice, however, that the predicate ‘listened to’ involves a certain degree of volitionality. Under this intuition, the NP [a cat 3se,mo,ie]<sub>NP</sub> would not satisfy the requirement, not having the property of being volitional itself. However, I would not go as far as to say that ‘listened to’ involves the property of volition. I would just say that it only involves the property of ‘sentience’, since [the wind 2mo,ie]<sub>NP</sub> *cannot* by any means listen to anything, except again in a metaphorical use. In any case, the issue has to do with the fact that certain verbs can entail obligatory properties for the argument that will lexicalize the subject instead of the direct object of the sentence.

(25)

[Margie 4vo,se,mo,ie]	[listened to (3(v),s,e0, 2c,e0)] <sub>VP</sub>	![the rock 1ie] <sub>NP</sub>
		[a cat 3se,mo,ie] <sub>NP</sub>
		[Peter 4vo,se,mo,ie] <sub>NP</sub>
		[the car 1mo] <sub>NP</sub>
		![the plant 1ie] <sub>NP</sub>
		![love 1ie] <sub>NP</sub>
		[the wind 2mo,ie] <sub>NP</sub>

In the set of sentences in (26) above, it is interesting to see how the model shows us that a volitional subject can listen to anything, provided the thing listened to does not only have the property of being independently existent. [the rock 1ie]<sub>NP</sub>, [the plant 1ie]<sub>NP</sub>, [love 1ie]<sub>NP</sub> all have only independent existence and hence yield semantically anomalous sentences. [Peter 4vo,se,mo,ie]<sub>NP</sub> and [the wind 2mo,ie]<sub>NP</sub> both have independent existence. However, they also have other properties that yield the sentence semantically interpretable. Movement in the case of [the wind 2mo,ie]<sub>NP</sub> and volition, sentience and movement in the case of [Peter 4vo,se,mo,ie]<sub>NP</sub>.

A final point I would like to discuss has to do with the fact that for certain cultures, some properties are very important as to be lexicalized in surface structure. The morphology seems in fact to change the entailments of the NP as to make it more specific. Consider the case of volition: volition is the contributing property of the PA role that is most easily taken to be true. In Amharic, for example, a language spoken in Ethiopia, there is a difference in the entailment of volition in certain verbs and this shows at surface structure level.

Thus, for example, the morphology for the action ‘to bring people’ is different from the morphology from the action ‘to bring an object/baby/prisoner’. This is so because the latter arguments of the verb ‘to bring’ do not have (or are taken not to have) the proto-agentive NP property of having volition. The example goes as follows (Unseth, 1999: personal communication).

If you tell a person to “bring” somebody, the usual form is to use the “indirect causative” prefix: as-. To tell a male ‘bring our father’:

(26) abbatlhln asmIt’a<sup>7</sup>

However, if you tell a person to bring an object (e.g. a book, a dish), they use the simple causative prefix: a-, like in (27) below.

(27) sahlnun amIt’a  
‘bring the dish’

In the model described above, this would be treated as follows:

(28) asmIt’a (4v,c,m,e1ch, 1v3ch,af,(st))

while (27) would be characterized along the lines of (29) below:

(29) amIt’a (4v,c,m,e1ch, 03ch,af,(st))

Here we see how a particular view of the world characterizes the morphology of a particular language. In this essay, I am relying, mostly, on the hypothesis of universal primitives and their different uses by different cultures. The differences with other current works on semantic primitives are two. First, I consider primitives to be psychological as opposed to linguistic in nature. Second, I think that primitives work at the level of argument structure; that is, among relations and singular terms. I take argument structure to be the semantic structure of language par excellence.

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<sup>7</sup> I= the epenthetic high central unrounded vowel; t’ = an ejective alveo-dental consonant

Whether primitives appear in the form of lists like those [Dowty 1991] proposes or in any other form, that is not important here. There is, in any case, good reason to believe that we categorize the world around us by applying a kind of (psycholinguistic) grid that helps us make sense of the chaotic nature of the stimuli we perceive.

There are lots of links between psychology and computer science. Psychologists interested in formal models of how the mind works have a lot to offer to artificial intelligence. One of the purposes of this paper has been to present a formal model of language comprehension and production that is at the same time recognizing the importance of linguistics, psychology and the formality needed for future implementation in computers.

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The author would like to thank Fundación YPF in Argentina, Dr. Víctor Castel at Universidad Nacional de Cuyo, Mendoza, Argentina, Carleton University and the Institute of Interdisciplinary Studies, especially Prof. Andrew Brook, Sam Scott and Heather Roy for their support and valuable comments during the writing of this paper. The author would also like to express his gratitude to Dr. Alexander Gelbukh at Laboratory of Natural Language Processing at the Center for Computing Research, Mexico D.F., Mexico for valuable comments that made this a stronger paper. Of course, none of the people mentioned above can be held responsible for errors contained herein.