

Situation Economy

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This paper begins with the assumption that possible worlds and times are represented as situation pronouns in natural language (see Cresswell, 1990; Percus, 2000; Kusumoto, 2005; Keshet, 2008). For simplicity, situations are construed to be world-time pairs, and a predicate taking such a pair as an argument is evaluated in the world and the time specified. Researchers such as Percus (2000) have noted that such a system overgenerates. In this paper, I will explore a constraint on situation pronouns – the Intersective Predicate Generalization – based on and extending work by Renate Musan (1997). I propose an explanation for this generalization involving an economy principle, called Situation Economy.

1. Data

The paper begins with three cases where pairs of phrases must be evaluated with respect to the same world and time – an unexpected result in a system with situation pronouns.

1.1. Existential There Construction

The first such pair of phrases is the NP and predicate in the Existential There Construction (ETC). Musan (1997) shows that these two phrases must be evaluated at the same time:

- (1) The professors in this department are quite young. In fact, . . .
 - a. . . . many professors were in kindergarten in the '80s.
 - b. #. . . there were many professors in kindergarten in the '80s.

In (1-a), the subject *many professors* may be evaluated in the present, meaning something like *many current professors*. The VP *were in kindergarten in the '80s*, on the other hand, is evaluated at a past time. If the two were instead evaluated at the same time, the sentence would sound odd, since professors are much too old to be in kindergarten. And, in fact, (1-b) does sound odd for this very reason: the two contradictory descriptions are required to hold at the same time. According to Musan, this odd reading is due to the fact that *many professors* is a weak NP in (1-b), and she observes that weak NPs must be evaluated at the same time as their main predicates.

As Musan suggests at the end of her dissertation, her observation extends from times to possible worlds. Example (2-a) is true in a scenario where there is someone actually in this room that Mary mistakenly believes to be outside instead; the reading that makes it true is one where *someone in this room* is *de re* and *is outside* is *de dicto*. (2-b), however, sounds odd because it entails that Mary has a contradictory thought, namely that someone is both inside and outside this room in the same world (and at the same time).

- (2)
 - a. Mary thinks someone in this room is outside.
 - b. #Mary thinks there's someone in this room outside.

1.2. Nouns and Intersective Modifiers

- (3)
 - a. Every current U.S. senator who was at Harvard in 1964 got straight A's when he was there.
 - b. #In 1964, every U.S. senator at Harvard got straight A's.

The second pair of phrases which must have the same time of evaluation is a noun and an intersective modifier such as an adjective or prepositional phrase.¹ If the noun *U.S. Senator* in (3-b) and its modifier

¹This idea was first suggested to me by Jon Gajewski, p.c.

at *Harvard* could hold at different times, then the sentence might mean the same as (3-a)². However, this reading is not available; the sentence sounds odd since it entails that there were people who were sitting senators and at Harvard at the same time.

- (4) a. Two years ago, my 10-year-old classmate was in a different class.
 b. Two years ago, a 10-year-old in my class was in a different class.

(4) is a slightly more complex example.³ Presuming a student cannot be in two classes at once (in grade school at least), the subject NPs *my 10-year-old classmate* and *a 10-year-old in my class* must be evaluated at a time other than the time at which *was in a different class* is evaluated; in this case, the most salient reading is where these NPs hold at the speech time. If it were possible for *classmate* and *in my class* to be evaluated at different times than *10-year-old*, then the sentences in (4) should have readings where the speaker's classmate is now twelve years old and was in a different class when he was ten. However, these readings are simply not available.

- (5) #Mary thinks the married bachelor is confused.
 (6) a. Mary thinks a baby from Mars is an adult.
 b. Mary thinks a baby Martian is an adult.

The reasoning follows similarly for the cases in (5) and (6), shifting to worlds instead of times. In (5), *bachelor* and *married* must be in the same world, despite the fact that this leads to an odd reading. In (6), since nothing – not even an alien – can be a baby and an adult, neither *a baby from Mars* nor *a baby Martian* can be evaluated at the same world as *is an adult*. Therefore, in both cases, the subject must be *de re*, evaluated in the real world. It is conceivable that part of each subject (i.e., *from Mars* or *Martian*) might still be *de dicto* even if the word *baby* were *de re*. However, this is simply not the case; a speaker uttering either sentence in (6) must believe in Martians, showing that *from Mars* and *Martian* must be *de re* as well.

1.3. Depictives and VPs

The third pair of phrases I will consider is a subject-oriented depictive and a VP:

- (7) Bob left the meeting angry. (≈ Schultze-Berndt & Himmelmann (2004) (1))
 (8) a. Bob left the meeting angry, #but he was happy when he left.
 b. John thinks Bob left the meeting angry, #but John doesn't think he was angry.

A depictive secondary predicate is a phrase, outside of any DP, which modifies one of the DPs in the sentence. For instance, (7) means that as Bob left the meeting, he was angry. Depictives are canonically described as holding at the same time as the VP of the sentence (Schultze-Berndt & Himmelmann, 2004). For instance, as shown in (8-a), Bob must be angry at the same time that he left the meeting. However, evidence suggests that depictives also must hold in the same world as their VPs. For instance, *angry* cannot be *de re* in (8-b). Instead, the depictive and the VP must be evaluated at the same world and time.

2. Intersective Predicate Generalization

In this section, I will argue that all three of the pairs above are combined via Predicate Modification⁴. Nouns and most modifiers have long been analyzed as being interpreted intersectively (see Jackendoff, 1977), but the rest of this section argues that the other cases are Predicate Modification as well. (For simplicity, I will use an extensional system while arguing this, switching to a system with situation pronouns in the next section.) Once it has been established that these three cases are all intersective predicates, the following generalization will emerge:

²I will not treat relative clauses in this paper; see Keshet (2008) for discussion.

³Thanks to Danny Fox, p.c., for suggesting this kind of example.

⁴For generalized versions of the Predicate Modification rule, as defined in Heim & Kratzer (1998), see Winter (1996), Gazdar (1980), Keenan & Faltz (1985), and Partee (1987).

- (9) **Intersective Predicate Generalization:** Two predicates composed via Predicate Modification may not be evaluated at different times or worlds from one another.

2.1. The Existential There Construction

- (10) a. There is a man in the garden.
b. A man is in the garden.

Milsark (1974) analyzes an ETC sentence like (10-a) as being derived from (10-b). In keeping with more recent assumptions, I will assume instead that both structures in (10) originate in a structure akin to that labelled **PredP** in (11) (see Stowell, 1978). In the ETC, the PredP remains as shown, and a dummy subject *there* is inserted. As for interpretation, both the NP and the XP are of type *et*, and they combine via Predicate Modification before a freely inserted existential closure applies:

- (11) $[\text{VP}_t \text{ There } [\text{VP}_t \exists [\text{VP}_{et} [\text{v is/are}] [\text{PredP}_{et} \text{ NP}_{et} \text{ XP}_{et}]]]]$

For NPs in the ETC having articles, I will adopt what Landman (2004) calls the Adjectival Theory of indefinite determiners, namely that the type of determiners in weak NPs is *et* as shown in (12). Therefore, the combination of such an adjectival “determiner” is still of type *et*, as shown in (13).

- (12) a. $[\mathbf{a}] = \lambda x_e . |x| = 1$; $[\mathbf{two}] = \lambda x_e . |x| = 2$; $[\mathbf{many}] = \lambda x_e . |x| = n$, for some large n
 (13) a. $[\text{NP}_{et} [\text{AP}_{et} \mathbf{a}] [\text{N}_{et} \text{ fly}]]$
 b. $[\mathbf{(13-a)}] = \lambda x_e . x \text{ is a fly and } |x| = 1$.

Any quantification force for this NP comes from the existential closure operator above the copula in the ETC, not from the article *a*.⁵

2.2. Depictives

Pykkänen (2002) argues that a depictive combines with the verb phrase via Predicate Modification⁶, and therefore the subject is the argument of both the verb and the depictive, as in (14).

- (14) $[\text{VP}_t [\text{DP}_e \text{ John}] [\text{VP}_{et} [\text{VP}_{et} \text{ left the room}] [\text{AP}_{et} \text{ angry}]]]$

This explains why the adjective is truly a predicate modifying the subject and not, for instance, a manner modifier of the VP.

3. Situation Economy

The previous section argued, using an extensional system, that the pairs of phrases discussed in section 1 are evaluated using Predicate Modification and suggested the Intersective Predicate Generalization to capture the fact that each pair must be evaluated at the same time and world. This section explores what happens when we move to a system with situation pronouns. In such a system, certain words take type-*s* (for situation) arguments, as shown in (15-b) and (15-c):

- (15) a. $[\mathbf{the}] = \lambda P_{et} . \text{if there is only one } x \text{ such that } P(x) \text{ then this } x$; otherwise, undefined.
 b. $[\mathbf{professor}] = \lambda s_s . \lambda x_e . x \text{ is a professor at } s$.
 c. $[\mathbf{in kindergarten}] = \lambda s_s . \lambda x_e . x \text{ is in kindergarten at } s$.

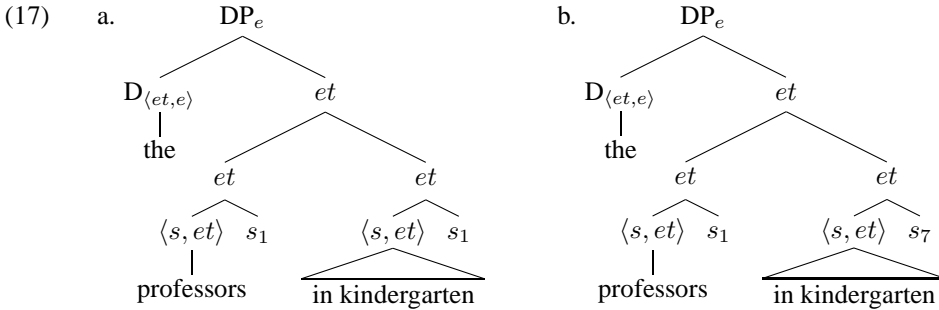
These arguments may be filled by situation pronouns, and the least restrictive theory possible concerning the distribution and indexing of these pronouns might be as in (16):

- (16) **Free Situation Pronoun Hypothesis:** A situation pronoun may be freely inserted and indexed wherever it is the complement to a node of type $\langle s, \alpha \rangle$.

⁵This assumption does bring up a problem with the adjectival theory of weak NPs, involving non-monotone-increasing determiners. See Landman (2004) for a solution to this problem.

⁶Pykkänen credits Yatsushiro (1999) with having a similar proposal.

The Free Situation Pronoun Hypothesis predicts several structures, for instance, for combining the three expressions in (15). First, consider the two structures in (17), where both *professor* and *in kindergarten* take situation pronouns:



The situation pronouns might be either coindexed, constraining *professor* and *in kindergarten* to be evaluated at the same world and time (as shown in (17-a)), or indexed differently, allowing the possibility that the two nodes be evaluated at different worlds and times (as shown in (17-b)). The structure in (17-a) is consistent with the Intersective Predicate Generalization, since the verb and its modifier must be evaluated at the same time and world. The structure in (17-b), on the other hand, is not consistent with this generalization, since the nodes may be evaluated at different times and worlds. So, one way to enforce the Intersective Predicate Generalization would be to only allow structures like (17-a).

Another structure, though, that combines the NP and PP to eventually form a node of type *et* is shown in (18). This structure is equivalent in meaning to (17-a), because there is only one situation pronoun and therefore the two predicates are necessarily evaluated at the same world and time.

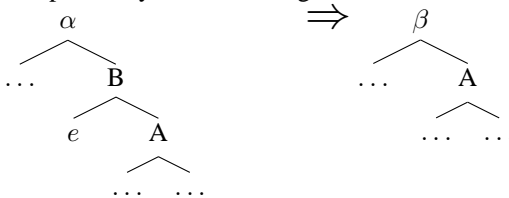


The proposal defended here is not that (17-a) is preferred over (17-b), but rather that (18) is preferred over both structures in (17). This preference is achieved through the economy principle in (19), which favors structures having fewer situation pronouns over alternatives having more. The relevant definition of alternative is given in (20).

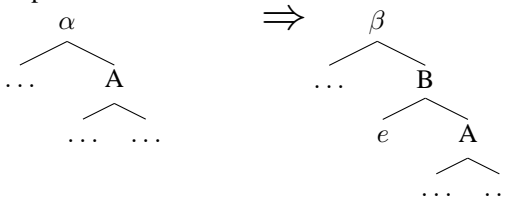
(19) **Situation Economy:** Rule out a structure α if there is a grammatical alternative to α that has fewer situation pronouns.

(20) **Alternatives:** β is an alternative to α if β is derivable from α via one or more applications of the following two operations:

a. **Null item deletion:** A node **B** in α , one of whose daughters is an unpronounceable item *e*, is replaced by the other daughter of **B**.



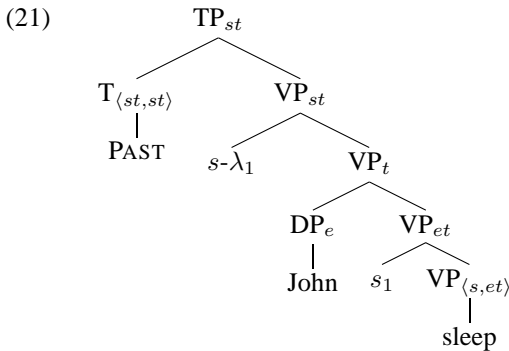
b. **Null item insertion:** A node **A** in α is replaced by a node **B**, one of whose daughters is an unpronounceable item *e* and the other of which is **A**.



Under these definitions (18) is a grammatical alternative to (17-b) with fewer situation pronouns, and therefore (17-b) is ruled out under Situation Economy. Any other noun and modifier that combine in an analogous way will also be subject to Situation Economy in a similar manner and therefore also conform to the Intersective Predicate Generalization.

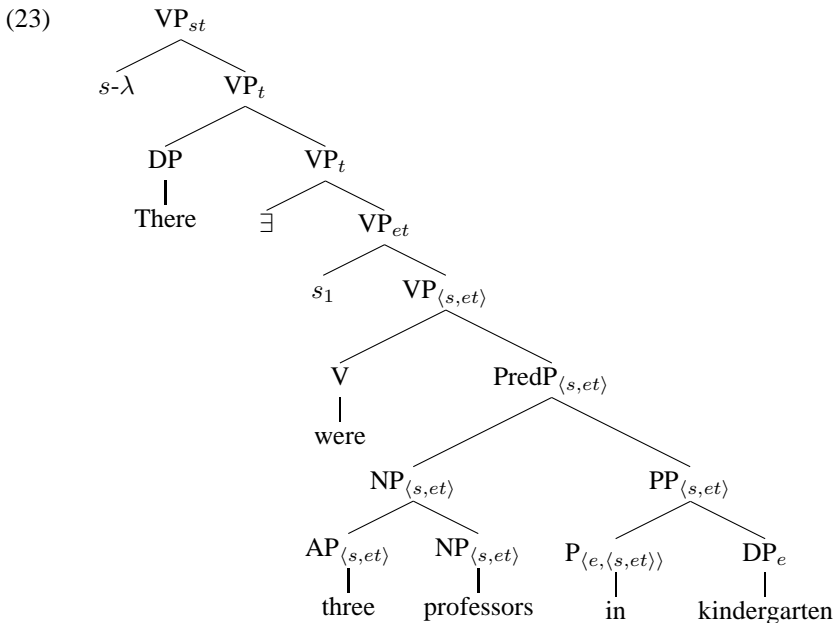
3.1. Assumptions

I assume that all one-place predicates, whether they are verbs, nouns, adjectives, or prepositional phrases, are of type $\langle s, et \rangle$. Furthermore, I assume that VPs obligatorily combine with a situation pronoun which is bound by a λ operator at the top of the clause.⁷ So, for instance, the verb *sleep* is of type $\langle s, et \rangle$, but when it combines with the situation pronoun s_1 , it forms a node of type et , as shown in (21). This higher node is now of the proper type to combine with an argument, such as *John* below. (To simplify the structures, I assume that the subject reconstructs to a position within the VP before LF.) This works similarly for copular sentences (as in (22)), although I assume the copula has no meaning.



(22) $[[_{TP_{st}} [_{T_{\langle st, st \rangle}} \text{PRES}] [_{VP_{st}} s-\lambda_1 [_{VP_t} [_{DP_e} \text{John}] [_{VP_{et}} s_1 [_{VP_{\langle s, et \rangle}} [v \text{ is}] [_{DP_{\langle s, et \rangle}} \text{a painter}]]]]]]]]]$

3.2. Existential There Construction



(24) $[[\text{(23)}]] = \lambda s . \text{there was an } x \text{ such that } |x| = 3 \text{ in } s, x \text{ comprised professors in } s, \text{ and } x \text{ comprised students in kindergarten in } s.$

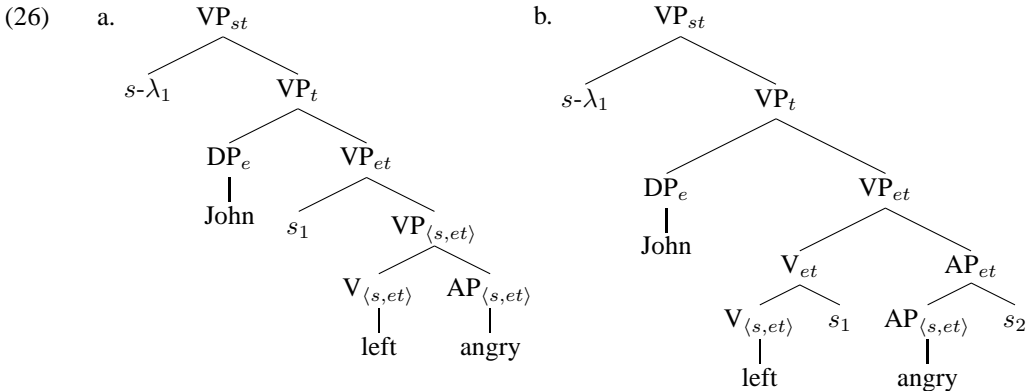
⁷This implements a constraint on situation pronouns due to Percus (2000). Also, what I represent as $s-\lambda$'s are similar to the numerical indices assumed in Heim & Kratzer (1998), only typed to bind situations.

Given the structure above, the predicates *three professors* and *in kindergarten* must be evaluated at the same time and world, since they combine before taking the situation pronoun s_1 . However, consider another grammatical structure for the sentence above:⁸

(25) $[\text{VP}_{st} s-\lambda_1 \text{ There } \exists s_1 \text{ were } [\text{PredP}_{\langle s, et \rangle} s-\lambda_2 [\text{PredP}_{et} [\text{NP}_{et} 3 \text{ profs. } s_7] [\text{PP}_{et} \text{ in kindergarten } s_2]]]]]$

In (25), *three professors* and *in kindergarten* take differently-indexed situation pronouns and therefore might be evaluated at different worlds or times from one another. However, under the definitions in (20), (23) is an alternative to (25) and (23) has fewer situation pronouns than (25); therefore, (25) is (correctly) ruled out by Situation Economy.

3.3. Subject Depictives

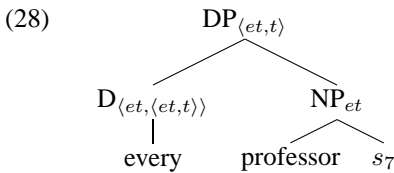


The correct structure for depictives is shown in (26-a). Once again, any alternative structure with more situation pronouns, such as (26-b), will be ruled out by Situation Economy. In this way, given this analysis of depictives, Situation Economy predicts that these secondary predicates must be evaluated at the same time and world as the main predicate of the sentence.

3.4. Extensional Type Hypothesis

(27) $[s-\lambda_1 \text{ Mary thinks } [s-\lambda_2 [\text{the/every professor } s_1] \text{ is a student}]]]$

In a system with situation pronouns, a strong DP may be *de re* when its situation pronoun complement is bound by a non-local λ , as shown in (27). The structure of the DP and definitions are as follows:



- (29) a. $[\mathbf{the}] = \lambda P_{et} . \text{ if there is only one } x \text{ such that } P(x), \text{ then this } x; \text{ otherwise, undefined.}$
 b. $[\mathbf{every}] = \lambda P_{et} . \lambda Q_{et} . \forall x . P(x) \rightarrow Q(x)$

The only argument of a one-place strong determiner such as *the* is of type *et*, forcing the introduction of a situation pronoun. The restrictive clause of a generalized quantifier determiner such as *every* is also *et*, again forcing a situation pronoun to appear. Situation Economy does not rule these structures out because there is no grammatical alternative where *the* or *every* combines with *professor* without using a situation pronoun.

NPs with adjectival determiners may also be *de re*, but in these cases, there is a silent generalized quantifier-determiner SOME that turns weak NPs into strong DPs (see again Landman, 2004):

⁸I assume the null hypothesis whereby a λ operator may appear freely and be interpreted by the rule of Predicate Abstraction (Bittner, 1994).

$$(30) \quad \llbracket \text{SOME} \rrbracket = \lambda P_{et} . \lambda Q_{et} . \exists x . P(x) \ \& \ Q(x)$$

Since these structures are entirely parallel to the ones with overt generalized quantifiers, they have the exact same range of meanings: if the situation pronoun below SOME is bound locally, the DP receives a *de dicto* reading; otherwise it receives a *de re* reading.

This analysis of *de re* phrases depends crucially on the the semantic types stipulated above. To explain these types, I propose the following constraint:

- (31) **Extensional Type Hypothesis** (informal)⁹: If a lexical item is definable without reference to worlds or times, it cannot take a situation argument.

Lexical predicates like *sleep*, *boy*, and *married* intrinsically must be evaluated at a world or a time. However, most traditional meanings for *every* simply define it as a subset relation between two sets of individuals – not involving worlds or times at all. The Extensional Type Hypothesis claims that no word definable without a situation argument is allowed to take such an argument. More formally, this hypothesis is a constraint on the arguments of functions representing the meanings of lexical items:

- (32) **Extensional Type Hypothesis** (formal): An n -place function f representing the meaning of a lexical item whose arguments include a type- s argument s and m type- $\langle s, \alpha \rangle$ predicates $P^1 \dots P^m$ (among k other arguments $a^1 \dots a^k$) is disallowed if there is an $(n - 1)$ -place function g such that $\forall s_s . \forall P^1 \dots P^m \in D_{\langle s, \alpha \rangle} . \forall a^1 \dots a^k . f(s, P^1, \dots, P^m, a^1, \dots, a^k) \leftrightarrow g(P^1(s), \dots, P^m(s), a^1, \dots, a^k)$.

4. Bare Plurals

Without any further assumptions, the system above predicts that a bare plural will have the same meaning as a plural DP headed by the determiner *some*, since bare plurals can take the silent version of this determiner, SOME. However, most bare plurals actually have a different range of meanings from DPs with determiners:¹⁰

- (33) Mary is confused about whether my friends are married.
 a. She thinks some bachelors are married.
 b. #She thinks bachelors are married.

Although (33-a) describes a coherent scenario where Mary mistakenly believes that a few of my friends who happen to be bachelors are married, (33-b) can only perhaps mean that Mary is mistaken about the definition of the word *bachelor*.

To solve this problem, I turn to a proposal by Chierchia (1998), who assumes that certain bare plurals in English can be reconstrued as denoting kinds. Chierchia assumes an ontology where kinds are individuals (type e in my system), each of which is in a one-to-one correspondence with a property (type $\langle s, et \rangle$). He defines two meta-language operators, \cap and \cup , which convert to and from kinds, respectively. For the purposes of my analysis, I will define an object language operator \cap , as given in (35), which is freely insertable into English sentences.

$$(34) \quad \begin{array}{ccc} & \text{'down'} & \\ & \cap & \\ \text{PROPERTIES} & \begin{array}{c} \longleftarrow \\ \longrightarrow \end{array} & \text{KINDS} \\ \text{(type } e \text{)} & \cup & \text{(type } \langle s, et \rangle \text{)} \\ & \text{'up'} & \end{array} \quad (\approx \text{Chierchia's (13)})$$

- (35) $\llbracket \cap \rrbracket = \lambda P_{\langle s, et \rangle} . \cap P$, if $P \in \text{dom}(\cap)$; otherwise undefined.

(36) shows an example of \cap used with a predicate which selects for kinds, *widespread in Cambridge*. I will indicate variables over kinds with the subscript k and variables over atoms or pluralities with the

⁹A version of this was first suggested to me by Danny Fox.

¹⁰See Carlson (1977) for details.

subscript o for object.

(36) $\llbracket \text{widespread in Cambridge} \rrbracket = \lambda s_s . \lambda x_k \in D_e .$ the distribution of the x_o such that $[\cup x_k](s)(x_o)=1$ is equal over all of Cambridge

(37) a. $[\text{VP}_t [\text{DP}_e [\text{D} \cap] [\text{NP}_{\langle s, et \rangle} \text{students}]] [\text{VP}_{et} s_1 \text{ are widespread in Cambridge}]]$
 b. The distribution of the x_o such that x_o comprises students in s_1 is equal over all of Cambridge

Additionally, in order for a kind-denoting bare plural to be the argument of a predicate over atoms or pluralities, I assume that there is an operator called DKP (for Derived Kind Predication) that turns such a predicate into a predicate over kind individuals – encapsulating a semantic rule in Chierchia’s system:

(38) $\llbracket \text{DKP} \rrbracket = \lambda P_{\langle s, et \rangle} . \lambda s_s . \lambda x_k . \exists x_o . [\cup x_k](s)(x_o) = 1 \text{ and } P(s)(x_o) = 1$

(39) a. $[\text{VP}_t [\text{DP}_e [\text{D} \cap] [\text{NP}_{\langle s, et \rangle} \text{students}]] [\text{VP}_{et} s_1 \text{ DKP are sick}]]$
 b. $\exists x_o . x_o$ comprises students in s_1 and x_o is sick in s_1

In order to fully derive the facts in (33), namely that a bare plural may not be *de re*, Chierchia must force the bare plural to take the \cap operator and denote a kind rather than taking SOME and being existentially quantified over. Otherwise, (33-b) could have a reading identical to (33-a), which it does not. I would like to suggest a possible explanation for this fact. Notice that the structure proposed for a sentence involving DKP such as (39-a) only has one situation pronoun, the pronoun required by the verb. Next, notice that (39-a) is in fact an alternative to the structure in (40), according to the definitions in (20). Since (39) has fewer situation pronouns, however, (40) is ruled out by Situation Economy. So, with a few standard assumptions about bare plurals and kinds, Situation Economy is able to explain why bare plural subjects must be *de dicto*: when bare plurals are interpreted as kinds, the resulting structures have fewer situation pronouns.

(40) $[\text{VP}_{st} s-\lambda_1 [\text{VP}_t [\text{DP}_{\langle et, t \rangle} [\text{D}_{\langle et, \langle et, t \rangle} \text{SOME}]] [\text{NP}_{et} s_7 \text{students}]] [\text{VP}_{et} s_1 \text{are sick}]]]$

Additionally, since for Chierchia \cap is always preferred to SOME, he must assume that DKP applies inside the ETC. However, under this proposal, nothing special need be said about bare plurals in the ETC. Here, since they can receive an interpretation without the kind-forming operator (and in fact could not receive an interpretation with the \cap), there is no kind reading in such contexts:

(41) $[\text{VP}_t [\text{DP} \text{There}] [\text{VP}_t \exists [\text{VP}_{et} s_1 [\text{VP}_{\langle s, et \rangle} \text{are} [\text{PredP}_{\langle s, et \rangle} [\text{NP}_{\langle s, et \rangle} \text{students}]] [\text{AP}_{\langle s, et \rangle} \text{sick}]]]]]]]$

To finish off the analysis of bare plurals, I will assume a GEN operator, analogous to the DKP operator, only having generic, rather than existential quantification.

(42) $\llbracket \text{GEN} \rrbracket = \lambda P_{\langle s, et \rangle} . \lambda s_s . \lambda x_k . \forall x_o \text{ (given the property opportunity) .}$
 $[\cup x_k](s)(x_i) \rightarrow P(s)(x_i)$

5. Conclusion

This paper first showed that several pairs of linguistic expressions must be evaluated at the same time and world as one another: the postcopular NP and the predicate in the Existential There Construction, an intersective modifier and the noun it modifies, and a subject depictive and the VP with which it combines. The Intersective Predicate Generalization was proposed to link these phenomena together: the generalization assumes that each of the pairs in this list comprises two nodes which are evaluated via the Predicate Modification rule and claims that no item of such a pair may be evaluated at a world or time different from its pair-mate.

Next, an explanation was proposed for the Intersective Predicate Generalization based on a syntactic economy principle which disallows certain structures for sentences and hence certain readings. In particular, the rule of Situation Economy was proposed to rule out structures that have more situation pronouns than relevant alternative structures. We have seen how such a rule explains the Intersective Predicate Generalization for nouns and intersective modifiers, the Existential There Construction, and subject depictives. The Extensional Type Hypothesis was next proposed to explain why strong

determiners must have extensional types and therefore must take arguments which have already combined with situation pronouns. This obviated the Situation Economy rule and allowed *de re* readings for strong DPs and weak NPs with strong readings. Last, it was shown that the Situation Economy approach may explain why bare plurals must have kind readings: namely, since such readings involve fewer situation pronouns.

Some interesting questions remain for this analysis. For instance, where exactly does the economy principle apply? And why is it situation pronouns which are economized? As for the first question, it seems that Situation Economy could easily be classified as a parsing constraint. Notice that the process of generating alternatives, as defined in (20), never involves adding or removing a word that was actually spoken or heard. At a certain point during the process of understanding an utterance, a hearer must generate possible structures for what she has heard. Part of generating these structures is determining which covert words are in these structures. Situation Economy is a way of ruling out a good number of such structures – namely those with more than the necessary number of situation pronouns – and hence making the hearer’s job that much easier. As for why situation pronouns are economized, this, too, makes sense. Situation pronouns add a great deal of power to the semantic system. As such, the fewer of these items, the fewer possible ambiguities there will be involving different bindings for the pronouns. Other remaining questions include how the situation economy account interacts with the copy theory of movement, and whether unpronounced individual variables, such as *pro*, *PRO*, and traces could come under a similar economy principle.

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