COERCION IN LANGUAGES IN FLUX

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ABSTRACT

The classical view of semantics that we inherited from Montague is that natural languages are formal languages where semantics specifies the interpretations which can be associated with expressions of the language. In this context coercion might be seen as a slight but formally specifiable disturbance in the formal semantics which shows how the canonical interpretation of an expression can be modified by its linguistic context. In recent years an alternative to the formal language view of natural language has developed which sees the interpretation of language as a more local and dynamic process where the interpretation of expressions can be modified for the purposes of the utterance at hand. This presents linguistic semantics as a dynamic, somewhat chaotic, system constrained by the need to communicate. An interpretation of an expression will work in communication if it is close enough to other interpretations your interlocutor might be familiar with and there is enough evidence in the ambient context for her to approximate the interpretation you intended. On this view of language as a system in flux, coercion is not so much a disturbance in the semantic system but rather a regularization of available interpretations leading to a more predictable system.

I will present some of the reasons why I favour the view of language in flux (but nevertheless think that the techniques we have learnt from formal semantics are important to preserve). I will look at some of the original examples of coercion discussed in the Pustejovskian generative lexicon and suggest that the possibilities for interpretation are broader than might be suggested by Pustejovsky's original work. Finally, I will suggest that coercion can play a central role in compositional semantics taking two examples: (1) individual vs. frame-level properties and (2) dynamic generalized quantifiers and property coercion.

[1] HOW FORMAL ARE NATURAL LANGUAGES?

The view of natural languages as formal language was extremely important in 20th century linguistics since it gave us a mathematical approach to making precise the apparent chaos of natural language. The formal approach includes formal grammar where languages are seen as sets of strings and associating such strings with structural descriptions as in various forms of transformational grammar. With the advent of formal semantics interpreted languages could be seen as sets

of string-meaning pairs. There is, of course, the famous quote from Montague's *Universal Grammar* which became a slogan for a formal approach to semantics:

There is in my opinion no important theoretical difference between natural languages and the artificial languages of logicians; indeed I consider it possible to comprehend the syntax and semantics of both kinds of languages within a single natural and mathematically precise theory.

(Montague 1974, pg. 222)

How well does coercion fit with such a formal language view? Perhaps it can be regarded as a slight disturbance or adjustment, rather similar to Montague's treatment of ambiguity, a feature of natural languages which is not shared with formal languages, by allowing more than one derivation tree to be associated with single strings in the language. I think many current approaches to coercion are attempting to include it with minimal disruption to a general view of natural language as a formal language.

However, there are a number of other aspects of natural languages which give pause for thought. Consider the notion of *grammaticality*. The idea in a formal language is that you characterize the set of (grammatical) expressions in the language. However, grammaticality judgements by speakers of natural languages are often in terms of degrees of grammaticality. An expression which seems ungrammatical can often be "improved" by thinking of it used in a particular context. Speakers adapt the language to new situations and domains, changing grammaticality judgements (Clark & Clark 1979, a classic paper). When it comes to *meaning* it seems that words and phrases do not have a fixed range of interpretations as would be suggested by the formal language view but rather that speakers adapt the meaning to fit the subject matter under discussion. Furthermore speakers seem to negotiate the interpretation of expressions during the course of a dialogue. Examples of this include using the same proper noun to refer to different individuals and discussion of the interpretation of words referring to abstract or theoretical concepts such as *democracy* or *meaning* (as a concept in linguistic theory).

In order to meet this kind of consideration Cooper & Ranta (2008) proposed to think of a language as a collection of resources (a "toolbox") which can be used to construct a language in the formal language sense. The idea here was to maintain the insights and precision gained from the formal language view while at the same time taking account of the fact that speakers of a natural language are constantly in the process of creating new language to meet the needs of novel situations in which they find themselves. Such innovation can be a motor for historical change in language, as discussed for example in the Introduction to Cooper & Kempson (2008).

If this process of innovation is unconstrained, how can it be that we manage to communicate with each other? Let us look at some examples of how wild it can be:

- (1)
 - a. a common noun meaning ‘step’ $\Rightarrow$ a negative particle: French *pas*
 - b. a proper noun referring to a sandwich spread $\Rightarrow$ an adjective, *A*, such that *A N* means ‘*N* which people either love or hate’: *Marmite*
 - c. mass noun meaning ‘small stones’ $\Rightarrow$ verb meaning ‘spread something on roads to stop traffic skidding in winter weather’: *grit*
 - d. a noun/adjective referring to nationals of a country $\Rightarrow$ noun/adjective meaning ‘of smugly narrow mind and of conventional morality whose materialistic views and tastes indicate a lack of and an indifference to cultural and aesthetic values’ (Wikipedia): *Philistine*
 - e. a noun referring to bread browned by radiant heat $\Rightarrow$ a predicative expression meaning ‘finished’ (in terms of career): *toast*

At a more micro-level of lexical semantics, Cooper (2010, 2012) discusses subtle variation in meaning of the verb *rise* which we summarize here:

- (2)
 - a. *the temperature rises* (temperature changes, location – or path – constant)
 - b. *the price rises* (price changes, product and location constant)
 - c. *the Titan rises*¹ (location of Titan changes, Titan constant)
 - d. *China rises*² (‘gains in economic power and political influence’)
 - e. *Mastercard rises*³ (‘value of shares goes up’)
 - f. *dog hairs rise*⁴ (explanation after clarification request: *they rise upstairs*)

Basically, as de Saussure (1916) pointed out, you can use a linguistic sign to express any arbitrary meaning. But there is an important constraint provided by the fact that people have to use language for more or less successful communication. This means that the speaker tries to maximize the probability that the hearer will understand what is said in approximately the way it was intended. The hearer, for her part, tries to adjust her semantic interpretation so that what the speaker says makes sense (or is true) in the context in order to maximize the probability that she has understood what the speaker intended. This will not happen if people assign random interpretations to linguistic expression. There has to be a

[1] description of a video game, [http://en.wikipedia.org/wiki/Risen_\(video_game\)](http://en.wikipedia.org/wiki/Risen_(video_game)), accessed 4th February, 2010

[2] <http://www.foreignaffairs.com/articles/63042/g-john-ikenberry/the-rise-of-china-and-the-future-of-the-west>, accessed 4th February, 2010.

[3] http://blogs.barrons.com/stockstowatchtoday/2010/02/03/visa-up-on-q1-beat-forecast-mastercard-moves-in-sympathy/?mod=rss_BOLBlog, accessed 4th February, 2010

[4] BNC file KBL, sentence 4201

way for the speaker and hearer to compute a novel meaning for an expression on the basis of meanings that they have already associated with words in an expression. One way to do this is through *semantic coordination* which has been discussed extensively in the psycholinguistic literature (Clark & Wilkes-Gibbs 1986; Garrod & Anderson 1987; Pickering & Garrod 2004; Brennan & Clark 1996; Healey 1997; Mills 2007; Healey et al. 2007) but less so in the theoretical linguistic literature (Cooper & Ranta 2008; Larsson 2010; Larsson & Cooper 2009).

On this view of language, coercion, rather than being a slight disturbance as it was on the formal language view, emerges as an additional technique providing helpful regularities which enable people to predict how meaning may be changed. Consider a classic example discussed by Pustejovsky (1995):

- (3) a. The child began a new book
- b. The author began a new book

Here we tend to assume that the child began *reading* a new book and that the author *writing* one. Reading and writing are standard activities associated with books and Pustejovsky puts this information into the lexical entry for *book*. However, coercion based on information contained in the lexicon will not alone be sufficient to explain how we interpret such sentences. Consider:

- (4) Sam began a new book

Which interpretation you get depends on what you know about Sam. Is she a child or an author? But still there may be questions the answers to which may not be decidable. Note, for example, that it is not just straightforward probability that decides which reading you get: most authors read more books than they write. Furthermore, there are many other things that Sam might be which might suggest an alternative relation to books that could be used in the coercion: an illustrator, an editor, a translator, a Nazi, a goat, a copying machine, Furthermore the general context might influence which exact coercion we use to interpret the sentence. In the unlikely scenario that the world suddenly lurches to a philistine extreme right in which the possession and reading of books is proscribed, it is possible that the most probable interpretation of the sentence is that Sam began destroying a book in order to remove the evidence.

Nevertheless it seems important to know that *begin* followed by a noun-phrase coerces the interpretation of that noun-phrase into a property and that the result behaves like a subject-control construction, that is, what begins is an event of the subject having the property resulting from the coercion. Exactly which property is involved may not be decidable in the general case but at least we know that we are looking for a relation that might hold between the subject and the object of the sentence. Such general coercion patterns are, I believe, an important part of

our linguistic knowledge which help us to efficiently compute interpretations for utterances despite that fact that our language is in a constant state of flux.

In the remainder of the paper I will look at a couple of coercions which I have worked on previously from this perspective. They represent two different kinds of coercions that occur in natural language. The first, in Section [2], is a kind of coercion which yields an additional interpretation for an expression above and beyond what we might think of as the basic interpretation. The second, in Section [3], is a coercion which is so to speak part of the fabric of compositional semantics, that is, it is involved in computing what we might regard as the basic meaning of a certain kind of expression. As we will see, the exact nature of the coercions varies from utterance to utterance in the manner one might expect from a system in flux. Nevertheless there is a common pattern which puts some order into the chaos.

[2] COERCION OF INDIVIDUAL LEVEL PROPERTIES TO FRAME LEVEL PROPERTIES

Cooper (2016) makes a connection between the following two puzzles:

(5) **Partee puzzle**

From

The temperature is rising

The temperature is 90

we cannot conclude

90 is rising

(Montague 1973)

(6) **Individual to event coercion**

A sentence like

Four thousand ships passed through the lock

has a reading where there are four thousand ship-passing-through-the-lock events, some of which may involve the same ship. (Krifka 1990)

The claim is that these two puzzles can be seen as related if we introduce a notion of frame into our semantics. Here we think of a frame (or frame type) as being intuitively the same as an event or situation (type) modelled as a record (type) in TTR, a type theory with records (Cooper 2012, *in prep*; Cooper & Ginzburg 2015). The use of frames for the Partee puzzle has been suggested by Löbner (2014, *in prep*) although his view of frames is rather different from mine. However, there are important similarities between the proposals by Cooper (2010, 2012, 2016) and Löbner's proposals.

We define a record type *AmbTempFrame* corresponding to a very stripped down version of the *Ambient_temperature* frame⁵ in the Berkeley FrameNet:

(7) ***AmbTempFrame***

$$\left[\begin{array}{ll} x & : \text{Real} \\ \text{loc} & : \text{Loc} \\ e & : \text{temp}(\text{loc}, x) \end{array} \right]$$

A *record type* is a set of fields which are ordered pairs of a label (displayed to the left of the ‘:’ above) and a type (displayed to the right of the ‘:’). It must define a function on the labels (no label more than once as the first member of a pair). A *record* is a similar structure except that objects rather than types occur as the second members of the fields. In the display we use ‘=’ rather than ‘:’. A record is of the above type if it has the following form:

$$(8) \quad \left[\begin{array}{ll} x & = n \\ \text{loc} & = l \\ e & = s \\ \dots & \end{array} \right]$$

where n is of type *Real* (in symbols, $n:\text{Real}$), that is, n is a real number, $l:\text{Loc}$, that is, l is a location and $s:\text{temp}(l,n)$, that is, s is a situation where the temperature at l is n . Note that there may be more fields in the record than required by the type.

A temperature rise is modelled in Cooper (2016) as a string of two records of the type *AmbTempFrame* where the location is the same in both records and the number in the ‘x’-field of the second is higher than that in the first. This analysis uses an adaptation of Fernando’s (2004; 2006; 2008; 2009; 2011; 2015) *string theory of events* to TTR.

What is important for present purposes is that the analysis of Cooper (2016) makes a distinction between individual-level properties and frame-level properties:

- (9) a. $\text{dog} - \lambda r: [\text{x:Ind}] . \left[\begin{array}{ll} e & : \text{dog}(r.x) \end{array} \right]$
 b. $\text{temperature} - \lambda r: [\text{x:Rec}] . \left[\begin{array}{ll} e & : \text{temperature}(r.x) \end{array} \right]$
 c. $\text{run} - \lambda r: [\text{x:Ind}] . \left[\begin{array}{ll} e & : \text{run}(r.x) \end{array} \right]$
 d. $\text{rise} - \lambda r: [\text{x:Rec}] . \left[\begin{array}{ll} e & : \text{rise}(r.x) \end{array} \right]$

This makes a neat division between *dog* and *run* on the one hand where the predication is of individuals and *temperature* and *rise* on the other where the predication is of records (modelling frames/situations). However, Cooper (2016) points out

[5] https://framenet2.icsi.berkeley.edu/fnReports/data/frameIndex.xml?frame=Ambient_temperature

the Partee puzzle crops up again in cases where we have individual level properties:

(10) **Partee puzzle with individual level properties**

From

The dog is getting older

The dog is nine

we cannot conclude

Nine is getting older

The proposed solution to this is that individual-level properties can be coerced to frame-level properties. Thus the noun *dog* actually has two interpretations:

- (11) a. $\lambda r: [x:Ind] . [e : dog(r.x)]$
 b. $\lambda r: [x:Rec] . [e : dog_frame(r.x)]$

A dog frame is a record of type:

- (12)
$$\left[\begin{array}{ll} x & : Ind \\ e & : dog(x) \end{array} \right]$$

What additional information we put in a dog frame depends on the context and the purposes at hand. For example, if we are interested in the age of a dog, a dog frame of the following type would be appropriate:

- (13)
$$\left[\begin{array}{ll} x & : Ind \\ e & : dog(x) \\ age & : Real \\ c_{age} & : age_of(x,age) \end{array} \right]$$

Cooper (2016) makes a connection between this kind of example and cases where we get event readings as with the ships passing through the lock examples. First consider a classic example from the literature on event readings as a variant of the Partee puzzle:

(14) **Partee puzzle with event readings**

From

National Airlines served at least two million passengers in 1975

Every passenger is a person

we cannot conclude

National Airlines served at least two million persons in 1975

(Gupta 1980)

As [Carlson \(1982\)](#); [Krifka \(1990\)](#) point out, the first premise in this is ambiguous between an individual reading on which the inference goes through and an event reading on which it does not. The availability of the event reading is made clear by the acceptability of the following discourse:

- (15) *National Airlines served at least two million passengers in 1975. Each one of them signed the petition.*

The analysis in [Cooper \(2016\)](#) involves coercing the interpretation of *passenger* to be a property of passenger frames rather than individual passengers using the following types and constraint:

- (16) a. *PassengerFrame*
- $$\left[\begin{array}{ll} x & : \text{Ind} \\ e & : \text{passenger}(x) \\ \text{journey} & : \text{TravelFrame} \\ c_{\text{travel}} & : \text{take_journey}(x, \text{journey}) \end{array} \right]$$
- b. *TravelFrame*
- $$\left[\begin{array}{ll} \text{traveller} & : \text{Ind} \\ \text{source} & : \text{Loc} \\ \text{goal} & : \text{Loc} \end{array} \right]$$
- c. constraint on ‘take_journey’
If $a:\text{Ind}$ and $e:\text{TravelFrame}$, then the type ‘take_journey(a, e)’ is non-empty (“true”) just in case $e.\text{traveller} = a$.

The types *PassengerFrame* and *TravelFrame* here represent natural assumptions about what is involved in events of being a passenger and travel events respectively but they are far from the only frame types that could be considered in connection with the interpretation of *passenger*. Depending on the type of journey involved we could consider boarding cards, ID numbers and booking numbers among other things. I would like to suggest that this kind of coercion yielding additional readings for expressions is very much part of the general process of creating language on the fly related to the view of language as a system in flux. While coercions give us some kind of regularity associated with this process, perhaps at least in part associated with the kind of enthymematic reasoning which [Breitholtz \(2014a,b\)](#) has talked about, it seems very likely that the frames involved can be generated on the fly given the needs of the current communicative act.

[3] DYNAMIC GENERALIZED QUANTIFIERS AND PROPERTY COERCION

In Section [\[2\]](#) we talked of coercions which allow us to generate additional interpretations for expressions. In this section we will discuss a property coercion which is part of the basic compositional semantics associated with generalized

quantifiers.

In Cooper (2011, 2013, 2016, in prep) and elsewhere, we have been developing a view of generalized quantifiers as relations between properties in the TTR sense. This view is based on classical generalized quantifier theory. Properties are functions of the type:

$$(17) \quad ([x:Ind] \rightarrow RecType)$$

Examples of properties are:

$$(18) \quad \begin{array}{ll} \text{a. } \text{dog}' & \\ & \lambda r:[x:Ind] . [e : \text{dog}(r.x)] \\ \text{b. } \text{run}' & \\ & \lambda r:[x:Ind] . [e : \text{run}(r.x)] \end{array}$$

The “type of situations in which every dog runs” is represented by a ptype constructed using the predicate ‘every’:

$$(19) \quad \text{every}(\text{dog}', \text{run}')$$

In characterizing what it means for something to be of a type like this, we characterize how it relates to classical generalized quantifier theory. Here we will just illustrate this on the basis of the example with ‘every’. First we will introduce some notation. We will use $[T]$ to represent the set of witnesses of type T :

$$(20) \quad [T] \text{ represents } \{a \mid a : T\}$$

We use $[\downarrow P]$ to represent the set of individuals which have property P :

$$(21) \quad \{a \mid [\neg P([x=a])] \neq \emptyset\}$$

Now we can say that ‘every(P, Q)’ has a witness just in case everything which has property P also has property Q :

$$(22) \quad [\neg \text{every}(P, Q)] \neq \emptyset \text{ iff } [\downarrow P] \subseteq [\downarrow Q]$$

Generalizing this to other quantifier relations will give us a TTR version of classical generalized quantifier theory.

Now let us consider dynamic generalized quantifier theory, something along similar lines to that defined by Chierchia (1995). In order to do this we will need two more new notions. Firstly, T is a *fixed point type for a property* P just in case $r : T$ guarantees $r : P(r)$. In Cooper (in prep) and elsewhere we define a function $\mathcal{F}$ which will compute a fixed point type for a property. We will not go into the details here but just give an example:

$$(23) \quad \mathcal{F}(\lambda r: [x:Ind] . [e : \text{dog}(r.x)]) =$$

$$\left[\begin{array}{l} x : Ind \\ e : \text{dog}(x) \end{array} \right]$$

Intuitively, $\mathcal{F}$ yields the result of merging the domain type of the property with the type returned by the property. There are details involving getting this to work out with the dependencies involved which would take us too far afield to discuss here.

Secondly, we will need a notion of restricting a property by a type (also defined by Cooper (in prep) and elsewhere) such that the restriction of property, P , by type, T , $P|_T$, is that property like P except that its domain type is the merge (as defined in Cooper (in prep) and elsewhere) of the domain type of P with T . Again, rather than go into the details of the definitions here, we will give an example. Suppose we want to restrict the property of running with the fixed point type derived from the property of being a dog:

$$(24) \quad \lambda r: [x:Ind] . [e : \text{run}(r.x)] \Big| \left[\begin{array}{l} x:Ind \\ e:\text{dog}(x) \end{array} \right] =$$

$$\lambda r: \left[\begin{array}{l} x:Ind \\ e:\text{dog}(x) \end{array} \right] . [e : \text{run}(r.x)]$$

Intuitively, the restriction takes us from the property of running to the property of being a dog that runs. We can use this notion of restriction to characterize dynamic generalized quantifiers. Here we give the dynamic version of ‘every’:

$$(25) \quad [\sim \text{every}(P, Q)] \neq \emptyset \text{ iff } [\downarrow P] \subseteq [\downarrow Q|_{\mathcal{F}(P)}]$$

Of course, this restriction of the second argument of the quantifier by the first argument is related to the conservativity property of quantifiers, a connection that Chierchia (1995) also points out, though in rather different terms than we have introduced here. As Chierchia points out, this gives us a way of getting donkey pronouns bound since the binder is repeated in the second argument. The sentence *every farmer who owns a donkey feeds it* gets interpreted as *every farmer who owns a donkey is a farmer who owns a donkey and feeds it*.

From the perspective of the current discussion we can see the second argument of the quantifier as being coerced to be the original property expressed by the second argument restricted by the first argument. Given the plethora of subtly different interpretations of *rise* we discussed in connection with (2) this could be the beginning of an explanation why whenever we have a sentence of the form *an X rises* the interpretation of *rises* is always a rise-property of X ’s, not

any of the other interpretations available.⁶

On this view we have a kind of coercion here which is, so to speak, built into the fabric of dynamic interpretation. While it is in this sense perfectly regular, the result of the coercion will be defined by whatever is expressed by the first argument of the quantifier, which can basically be any arbitrary property. This seems to be a distinct kind of coercion from those which can be used to create additional interpretations for expressions.

CONCLUSION

We started with an argument that natural languages are not quite as formal as we might have thought. They are in fact systems in a state of flux although constrained by the fact that people need to be able to use them to communicate. Thus the meaning associated with expressions must at least relate in some way to meanings that have previously been associated with similar expressions according to the memory of people participating in a dialogue. On this kind of view coercion appears to provide regularities which assist in the prediction of novel meanings that might be associated with an expression.

We looked at two kinds of coercion: one where coercion is used to create extra interpretations on the basis of a standard interpretation and one where coercion is used in deriving the standard compositional semantic interpretation. For coercion used to derive additional interpretations we looked at an example of coercion related to the Partee temperature puzzle and related this to the discussion of event quantification coerced from quantification over individuals (as in ships passing through the lock). For coercion integrated into standard interpretation we looked at dynamic generalized quantifiers.

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[6] This would follow directly from what we have been discussing if we take the perhaps “old-fashioned” interpretation of indefinite descriptions as generalized quantifiers.

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