When coercing means fitting: distributional modeling of psycholinguistic datasets

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Type clash and coercion in logical metonymy

Logical metonymy (*begin the book → begin <u>writing</u> the book*) has traditionally been accounted for by means of type-shift: according to these theories (Pustejovsky 1995), the type clash between the event-selecting verb (*begin*) and the entity-denoting object (*book*) triggers a coercion mechanism that shifts the type of the object into an event (*book → writing the book*). The preferred interpretation (*reading / writing*) is retrieved from complex lexical entries (qualia) associated with the object.

Many psycholinguistic studies have sought for behavioral correlates of the coercion mechanism. Some of the main findings were:

(1) McElree et al. 2001: coerced sentences (*the author began the book*) require higher processing costs compared to both their preferred (*the author wrote the book*) and non-preferred interpretations (*the author read the book*); the study found a main effect of condition ** [1] (coerced vs. preferred vs. non-preferred) and longer reading times for the coerced condition compared to both the preferred *** and non-preferred *** condition;

(2) Traxler et al. 2002: coerced sentences (event-selecting verb + entity-denoting object: *the boy started the puzzle*) require higher processing costs compared to sentences where the selectional restrictions of the verbs are met (*the boy saw the puzzle*; *the boy started / saw the fight*); the study found a main effect of object type ** (entity- vs. event-denoting) and an object x verb interaction **; also, for entity-denoting objects (*started / saw the puzzle*), the coerced sentences require longer reading times than the non-coerced ones *, and for coerced sentences (*started the puzzle / the fight*), entity-denoting objects require longer reading times than event-denoting objects *.

Thematic fit as an alternative account for coercion

Studies on selectional preferences (McRae et al. (1998)) suggest that the selectional behavior of a verb (e.g. the fact that *eat* requires a [+edible] object or that *crook* is a more fitting object for arrest than *cop*) is best depicted not by binary notions such as type clash or selectional restrictions, but rather by graded terms such as selectional preferences or thematic fit, defined as the typicality of a filler for a given argument slot. Besides accounting for selectional restriction violations (e.g. that *laptop* is not a good object of *eat*), thematic-fit based account can also capture differences in processing costs for sentences which do not violate any selectional restrictions, e.g. *The journalist / the mechanic checked the spelling / engine* (Bicknell et al. 2010).

We argue against an account of logical metonymy based on selectional restrictions, suggesting that thematic fit may also provide an alternative coercion trigger: metonymic verbs prefer event-denoting objects, and sentences involving a coercion operation are those with a low thematic fit between the verb and the object.

Distributional models of thematic fit

Distributional Memory and ECU (Lenci 2011) is a distributional model based on corpus-extracted co-occurrences and mutual information. For instance, given a verb, the model can model the most expected objects for that verb (that is, the objects with the highest thematic fit). The ECU models is also able to account for the graded effect of composition on the expectation about upcoming arguments in sentence processing: it combines expectations coming from the verb (e.g. typical objects for *write*) with expectations coming from the

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[1] ***: p<0.001; **: p<0.01; *; p<0.05

subject (e.g. typical objects for *author*), to find a prototypical expected object for the subject-verb combination. The thematic fit for a given object (*book*) and a subject-verb combination (*the author wrote*) is then computed as the semantic similarity between the distributional vector of the object and that of the prototypical expected object.

ECU as described by Lenci (2011) has already proven successful on modeling thematic fit for the dataset in Bicknell et al (2010). The model, which does not encode any information about the semantic type of the arguments, was used to compute thematic fit values for the objects in the sentences from the datasets in (1) and (2), in order to (a) mirror the results from the psycholinguistic studies; (b) suggest an alternative account of logical metonymy interpretation which re-defines the binary notion of type-clash in more graded terms, i.e. as thematic fit.

Results

The computational model successfully replicated the pattern of results of the psycholinguistic experiments, yielding the following results (please note that low thematic fit corresponds to high processing costs):

(1) McElree et al. 2001: main effect of condition ** (coerced vs. preferred vs. non-preferred) and lower thematic fit for the coerced condition compared to both the preferred *** and non-preferred *** condition;

(2) Traxler et al. 2002: main effect of object type ** (entity- vs. event-denoting) and an object x verb interaction **; also, for entity-denoting objects (*started / saw the puzzle*), the coerced sentences yielded lower thematic fit than the non-coerced ones *, and for coerced sentences (*started the puzzle / the fight*), entity-denoting objects yielded lower thematic fit than event-denoting objects ***.

When coercing means fitting

A thematic-fit based distributional model was used to compute thematic fit on the datasets from two psycholinguistic studies. The model effectively replicated the pattern of results from the psycholinguistic experiments, showing that (a) for the coercion conditions the sentences used in the studies indeed have a lower subject-verb-object thematic fit and ultimately that (b) thematic fit can be an alternative trigger for coercion phenomena. It has been suggested (Zarcone et al. 2011) that thematic fit isresponsible for choosing the interpretation for a logical metonymy, by selecting high-typicality interpretations. A thematic-fit account of logical metonymy has the advantage of theoretical economy: traditional accounts of logical metonymy resort to type-clash and qualia; a thematic-fit account provides with an unique mechanism both as an alternative trigger for the coercion operation and as a source for the selected interpretation of metonymies, selecting high-thematic fit (high-typicality) events.

References

Bicknell, K., Elman, J. L., Hare, M., McRae, K., & Kutas, M. (2010). Effects of event knowledge in processing verbal arguments. *Journal of Memory and Language*, *63*(4), 489-505.

Lenci, A. (2011). Composing and updating verb argument expectations: A distributional semantic model. In *Proceedings of the 2nd CMCL* (pp. 58-66). ACL.

McElree, B., Traxler, M. J., Pickering, M. J., Seely, R. E., & Jackendoff, R. (2001). Reading time evidence for enriched composition. *Cognition*, 78, B17-B25.

McRae, K., Spivey-Knowlton, M. J., & Tanenhaus, M. K. (1998). Modeling the influence of thematic fit (and other constraints) in on-line sentence comprehension. *Journal of Memory and Language*, *38*(3), 283-312.

Pustejovsky, J. (1995). *The generative lexicon*. MIT Press.

Traxler, M. J., Pickering, M. J., & McElree, B. (2002). Coercion in sentence processing: evidence from eye-movements and self-paced reading. *Journal of Memory and Language*, 47, 530-547.

Zarcone, A. & Padó, S. (2011). Generalized Event Knowledge in Logical Metonymy Resolution. In L. Carlson, C. Hölscher, & T. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society* (pp. 944-949). Austin, TX: Cognitive Science Society