Underspecification in anaphoric reference to structured entities

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Background

There is growing evidence that discourse representations may vary in the detail they encode, and may sometimes be underspecified (e.g., Ferreira, Ferraro, & Bailey, 2002; Sanford, 2002; Sanford & Sturt, 2002).

We investigated underspecification in relation to anaphoric reference. Poesio, Reyle, and Stevenson (2003) proposed that anaphoric underspecification may occur if (a) the potential antecedents are part of a single mereological structure, and (b) the structure makes the interpretations equivalent. For example, in sentence (1a), the potential antecedents (*engine* and *boxcar*) are part of a single mereological structure (i.e., *a train*). Using 'it' to refer to any of these entities (*engine*, *boxcar*, or *train*) is equivalent, as hooking up the objects means that they are all going to London. Poesio et al. conducted an offline study, comparing the acceptability of sentences like (1a) and (1b):

(1a) The engineer hooked up the engine and the boxcar and sent *it* to London.

(1b) The engineer saw the engine and the boxcar and sent *it* to London.

Examples like (1a) were judged as being more acceptable than (1b), in which the two potential antecedents (*engine* and *boxcar*) are not part of a single mereological structure. We further investigated Poesio et al.'s findings by assessing disruptions in processing using eye-tracking. Previous research has shown that when two potential antecedents of a singular pronoun occur in a coordinated NP, a processing difficulty results (i.e., a conjunction cost, Albrecht & Clifton, 1998). This difficulty is expected in (2b) and (2d) at, or following the pronoun 'it'. The goal of this experiment will be to confirm the result by Poesio et al. that this difficulty disappears when the antecedents are part of a mereological structure, as in (2a) and (2c). An additional hypothesis was that underspecification may only be licensed when the two NPs form a natural object when conjoined (i.e., a train in (2a), compared to no natural object in (2c)).

Eye tracking study

Forty-eight participants had their eye movements monitored while they read sentences that were either mereology constructing (2a and 2c) or neutral (2b and 2d), in which the two entities described in the sentence conjoined to make a natural object (i.e., a train in 2a and 2b), or not (i.e., no natural object as in 2c and 2d), and in which reference to the NPs was either singular or plural (*it* vs *them*):

(2a) *Mereology constructing/natural object/singular or plural*

There were many delays.$_1$ | The railwayman hooked up$_2$ | the engine and the goods wagon,$_3$ | and sent [it/them]$_4$ | quickly$_5$ | to the central station.$_6$ | He hoped things would improve soon.$_7$ |

(2b) *Neutral/natural object/singular or plural*

There were many delays.$_1$ | The railwayman saw$_2$ | the engine and the goods wagon,$_3$ | and sent [it/them]$_4$ | quickly$_5$ | to the central station.$_6$ | He hoped things would improve soon.$_7$ |

(2c) *Mereology constructing/no natural object/singular or plural*

There were many delays.$_1$ | The manager stapled together$_2$ | the letter of complaint and the revised timetable,$_3$ | and sent [it/them]$_4$ | quickly$_5$ | to the central station.$_6$ | He hoped things would improve soon.$_7$ |

(2d) *Neutral/no natural object/singular or plural*

There were many delays.$_1$ | The manager read through$_2$ | the letter of complaint and the revised timetable,$_3$ | and sent [it/them]$_4$ | quickly$_5$ | to the central station.$_6$ | He hoped things would improve soon.$_7$ |

Pre-tests showed an average agreement with experimenters' intuitions of over 80% across the 48 items that the two objects did, or did not, form a natural object when combined.

Results

Data for each region were subjected to two 2(*mereology constructing* vs *neutral*) x 2(*natural object* vs *no natural object*) x 2(*singular* vs *plural anaphor*) within participants ANOVAs.

Pronoun region (Region 4)

Structure x anaphor type interaction in first pass regressions out (F1 = 3.58, p = .065; F2 = 3.80, p = .057). For *it* sentences: neutral > mereology constructing (F1 = 10.48, p<.01; F2 = 5.50, p<.05). For *them* sentences: no significant differences (Fs <1).

This is in line with singular reference being underspecified for mereology constructing sentences, but there being a conjunction cost for neutral sentences. It is also possible that *it* refers to the new discourse object created in mereology constructing sentences. This effect occurred regardless of whether the two NPs formed a natural object when conjoined.

First pass, regression path, and total times showed longer reading times for *them* than *it* sentences, probably due to different region lengths.
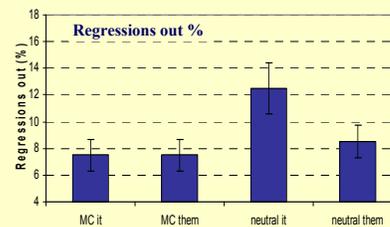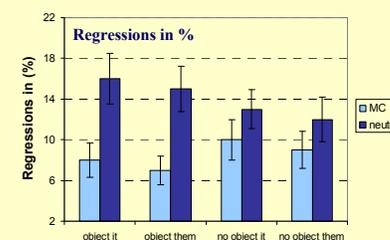

Regressions out %

Adverb (Region 5)

No significant first pass or regression path effects (Fs<1.6). Fewer regressions out for *it* than *them* sentences (F1 = 12.75, p <.01; F2 = 11.96, p <.01). Shorter total reading times for mereology constructing than neutral sentences (F1 = 7.81, p <.01; F2 = 8.13, p <.01).

Fewer regressions in for mereology constructing than neutral sentences (F1 = 17.51, p <.01; F2 = 14.46, p <.01), and a sentence structure x object type interaction (F1 = 4.87, p <.05; F2 = 3.79, p = .058). For *natural object* sentences: mereology constructing < neutral (F1 = 18.88, p<.01). For *no natural object* sentences: no difference (Fs<2.8). This interaction was mirrored in second pass reading times.

This interaction could suggest that objects that naturally go together are easier to represent when they are joined than when they are not joined. When objects don't naturally go together, it doesn't matter whether they are joined or not, in terms of how they are represented.


Regressions in %

Final region (Region 6)

First pass and total reading times showed no robust effects.

Structure x anaphor type interaction in regression path times (F1 = 8.79, p <.01; F2 = 6.71, p <.05). For *it* sentences: neutral > mereology constructing (F1 = 10.48, p<.01; F2 = 5.50, p<.05). For *them* sentences: no significant differences (Fs <1). This interaction was also found in regressions out of Region 4.

Fewer regressions out of mereology constructing than neutral sentences (F1 = 3.85, p = .056; F2 = 3.78, p = .058). Sentence structure x object type interaction in regressions out (F1 = 3.46, p = .069; F2 = 3.06, p = .087). For *natural object* sentences: mereology constructing < neutral sentences (F1 = 6.73, p<.05; F2 = 7.23, p < .05), for *no natural object* sentences: no difference (Fs<1). This interaction was also found for regressions in and second pass times for Region 5.

Regression path times (msec)
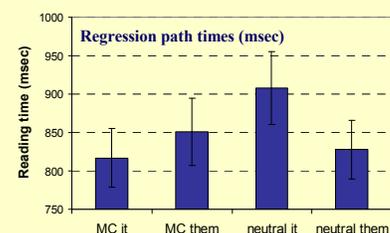
Change detection study

Text change detection has recently been used to study depth of semantic processing (e.g., Sanford & Sturt, 2002). In this task, participants have to detect changes across two consecutive presentations of a piece of text. This study examined whether participants would detect the word 'them' changing to the word 'it'.

MC stimuli: The engineer hooked up the engine and the boxcar and sent [them -> it] to London.

Neutral stimuli: The engineer saw the engine and the boxcar and sent [them -> it] to London.

28 participants, 16 items, 84 filler items (52 with no change, 32 with random changes).

Predictions: If the meaning of 'it' is underspecified in the MC condition, participants should detect fewer changes from 'them' to 'it' in the MC condition than in the Neutral condition.

Results: Participants correctly detected more changes in Neutral than MC conditions, t1 = 2.15, p<.05; t2 = 2.18, p<.05. If you remove participants who had scores of zero in both conditions: Neutral > MC, t1 = 2.27, p<.05; t2 = 2.18, p<.05
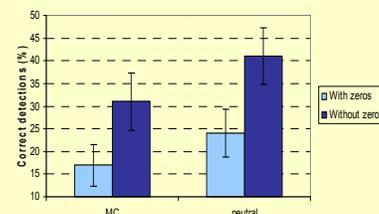
Discussion

(1)   The eye movement data provide support for Poesio et al.'s hypothesis that anaphoric reference may be underspecified when potential antecedents are part of a single mereological structure, and the structure makes the interpretations equivalent.

(2)   There is also some evidence for objects that naturally go together being easier to represent when they are joined than when they are not joined. When objects don't naturally go together it doesn't matter whether they are joined or not.

(3)   In the change detection study, participants noticed fewer changes from 'them' to 'it' in mereology constructing than neutral conditions, providing further support for the notion that the semantic representation may be underspecified in mereology constructing conditions.

References

Albrecht, J., & Clifton, C. (1998). Accessing singular antecedents in conjoined phrases. Memory & Cognition, 26, 599-610.

Ferreira, F., Ferraro, V., & Bailey, K. G. D. (2002). Good-enough representations in language comprehension. Current Directions in Psychological Science, 11, 11-15.

Poesio, M., Reyle, U., & Stevenson (2003). Underspecification in reference. In H. Bunt and R. Muskens (eds.), Computing Meaning 3, Kluwer.

Sanford, A. J. (2002). Context, attention and depth of processing during interpretation. Mind and Language, 17, 199-206.

Sanford, A. J. & Sturt, P. (2002). Depth of processing in language comprehension: not noticing the evidence. Trends in Cognitive Sciences, 6(9), 382-386.

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