Contextual predictability facilitates processing of negation — or, does it facilitate a strategy for making anti-predictions?

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There is evidence that although in some cases comprehenders cannot update their online predictions about upcoming words in a sentence based on the presence of a negating element [1], this may be possible given sufficient pragmatic support for the negation within a discourse context [2,3].

Providing pragmatic support for negation involves envoking implicatures concerning the relevance of preceding context. Combined with the comprehender's world knowledge, this imposes constraints on upcoming words in a sentence, in other words altering their predictability (generally cloze probability). It is therefore uncertain whether the increased symmetry of processing between affirmative and negated sentences in this type of context is accounted for by pragmatic support per se, or by how predictable the critical word is, since predictability can also be manipulated independently of pragmatic felicity.

In this study, we moved away from reliance on comprehenders' world knowledge and presented them with sentences that were based on episodic scenarios and always pragmatically felicitous. There were no pre-existing associations between entities mentioned in the sentences, which made it possible to tightly control predictability. Participants first viewed an image containing 4 objects arranged in a 2x3 grid (see Figure 1, left panel). The configuration varied depending on condition, such that in STRONGLY PREDICTABLE conditions, there was always one object whose location could be uniquely described using a single location descriptor (e.g. the left side), whereas in WEAKLY PREDICTABLE conditions, no object could be picked out uniquely in this way. After viewing the image, participants heard an AFFIRMATIVE or NEGATIVE sentence (see Figure 1, right panel) which could be true or false within the context. Participants were instructed to listen to the sentence and use the mouse to verify it with respect to the image by clicking on either True or False. On each trial, the participant's cursor began at the bottom centre of the screen and they selected the correct answer (True/False) at the top left or right corner. We recorded the trajectories of participants' mouse movements as they completed this task.

Visual contexts for strongly predictable condition (left) and weakly predictable condition (right)

Affirmative (true / false)
The left side contains the feather / burger

Negation (true / false)
The right side doesn't contain the feather / burger

Figure 1: Visual contexts and sentences for each condition

If pragmatic support for negation is the critical variable in dictating whether negation is processed incrementally online, responses to these sentences should be symmetrical for negations and affirmatives, because the context provides good support for all negated sentences heard.

We did not observe this symmetry; instead, the average trajectory for negations followed a less direct path towards the correct response than the average trajectory for affirmatives. This cannot be attributed to negations being simply more difficult to process overall, because we also found that this difference was largely driven by negations in the weakly predictable condition, with negations in the strongly predictable condition exhibiting relatively direct trajectories, much more similar to the affirmatives (see Figure 2). This outcome suggests that some factor beyond pragmatic support is

relevant to the processing of such sentences and the construction of predictions about upcoming words. There are at least two possible interpretations of the data, and at least one possible re-interpretation of preceding research in light of this finding.

One possibility is that predictability is a critical factor underlying to what extent a comprehender is able to incorporate negation online in order to use it in upcoming predictions. Thus previous findings that pragmatic support facilitates processing of negation could be due to the constraining effect of the supporting context, resulting in a highly predictable critical word.

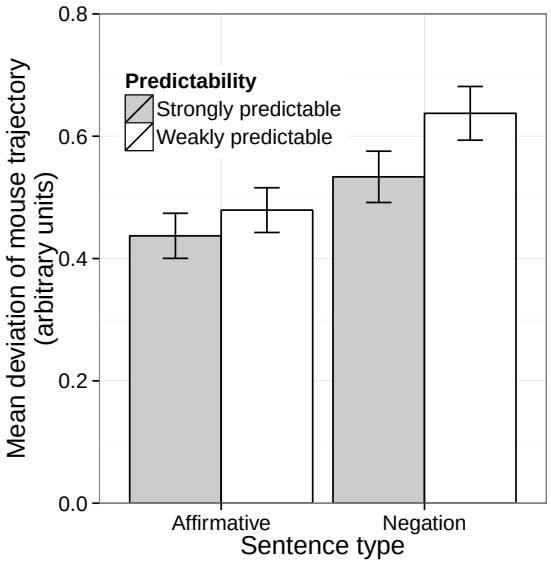

Figure 2: Mean area under the curve for mouse trajectories in each condition (true and false collapsed within conditions)

Another possible interpretation of these results is that comprehenders do not update their predictions for upcoming words based on *not* in any of the above cases, and instead the pattern of results observed is caused by a side-effect of the predictability manipulation, where it also affects the choices of prediction strategy that are available to the comprehender. In particular, if participants did not incorporate the meaning of *not* into their predictions in the strongly predictable, negated sentences in this paradigm, they would be predicting the critical word to be one of three possible items (i.e., *ring*, *feather*, or *candle*). Rather than predicting 3 items in this situation, a preferred strategy may be to predict *not burger*; and doing so (thus priming *burger*) could cause early behavioural (and neural) responses to look very similar to the situation in which the exact opposite, *burger*, is predicted.

There is some evidence that comprehenders do use this anti-prediction strategy in certain situations [e.g., 4]; and furthermore, use of this strategy where possible provides an alternative account for several other findings where pragmatic felicity is manipulated. By heavily constraining the context of an utterance, the manipulation in such paradigms reduces the number of candidate comparison sets the comprehender needs to consider for a prediction, thus making the anti-prediction strategy much more appealing and perhaps more likely. Taking an example from [2], the contextual information in the sentence *With proper equipment, scuba diving is (not) very ...* allows for prediction of a critical word that falls along a dimension that is directly affected by the use of proper equipment, possibilities perhaps including *(not) dangerous* and *(not) difficult*. Without the initial context, no particular aspect of scuba diving is made more salient, so multidimensional possibilities remain whose negations are not clear: e.g., *exciting* might be negated by *boring*, *depressing*, *disgusting*, etc.

It remains unclear whether the pattern of results in this and other such studies is best explained because a highly predictable context facilitates processing of negation, or because it facilitates this anti-prediction strategy which produces the false appearance of ability to process negation incrementally. Nevertheless, it is apparent that the predictability of a critical word is a crucial factor in how information earlier in the sentence is processed, manipulated and represented. We plan further experiments dissociating predictability and tendency to make anti-predictions, in order to distinguish these two new hypotheses regarding exactly what form this manipulation takes.

References

[1] Fischler et al. (1983) [2] Nieuwland & Kuperberg (2008) [3] Dale & Duran (2011) [4] Orenes et al. (2014)