Processing: free choice at no cost

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A disjunctive sentence such as (1) standardly carries the conjunctive inference that (2)a and (2)b are true.

(1) John is allowed to eat an apple or a banana.

(2) a. John is allowed to eat an apple.
    b. John is allowed to eat a banana.

This phenomenon is known as Free Choice (FC) permission (Kamp, 1973). Current formal models tend to treat FC inferences as a special type of scalar implicature (mostly building on Kratzer and Shimoyama's 2002 insight, see, e.g., Schulz, 2003; Fox, 2006; Klinedinst, 2006; Alonso-Ovalle, 2008; Chemla, 2008, 2009; Franke, 2011). We present the first processing study of FC. Our results go against the expectations of recent formal analyses, and show that, unlike scalar implicatures, FC inferences come at no processing cost.

1 Scalar implicatures

A sentence such as (3) standardly conveys that its sister sentence (4) is false. Here is a derivation: The *alternative* sentence (4) is stronger than (3); (3) is thus not the best sentence to utter, unless (4) is false.

(3) Some elephants are mammals.

(4) All elephants are mammals.

Processing

Since Bott and Noveck (2004) (at least), a variety of experimental studies have investigated how this inference is derived in real time. They consistently found that the verification of a sentence is more demanding when its scalar implicature is taken into account (see Grodner, 2009 for discussion). To prove so, these studies relied on situations in which the target sentence would be (a) true without its scalar implicature, but (b) false with its scalar implicature. (3) is such an example: (a) it is true that there are elephants that are mammals, but (b) it is false that some *but not all* elephants are mammals. True/false judgments thus covary with the derivation of the scalar implicature. In a Truth Value Judgment Task, false answers, that correspond to the derivation of the scalar implicature, are found to be slower than true answers ("logical" answers, without the scalar implicature).

2

2 Free choice (FC)

It has been shown that FC could be explained in a similar fashion. One implementation of this insight relies on the following hypotheses:

(H1) The sentences in (2) are alternatives to (1), in the same sense that (4) is an alternative to (3);

(H2) Sentences (2)a/b with their scalar implicatures become (5)a/b;

(H3) The enriched versions (5) are the sentences that end up negated when (1) is uttered.

In such a view, FC is analyzed as a second order kind of scalar implicature: the scalar implicatures of the alternatives are first derived, and then the alternatives, *enriched with their own scalar implicatures*, enter in the competition process to give rise to further scalar implicatures. The result is obtained because the conjunction of (1) and of the negations of each of the enriched alternatives in (5) entails FC, i.e. the conjunction of (2)a and (2)b.

(5) a. John is allowed to eat an apple, but not a banana.
b. John is allowed to eat a banana, but not an apple.

Such a view leads to the following prediction:

> *Processing prediction.* According to the view sketched above, FC is a second order scalar implicature. Since first order scalar implicatures comes with a visible processing cost, we should be able to detect a similar or higher cost for FC inferences.

3 Design

We capitalized on the seminal idea that was used to test scalar implicatures: true/false answers were used as an indicator of whether FC inferences were derived. The target sentences were constructed with the help of a cover story in which the destruction of the planet was described as imminent, but that certain people were allowed to save certain types of objects. Specifically, zoologists were allowed to save living creatures, and engineers were allowed to save artificial objects. (One object per person at most, the rule says, to avoid issues about exclusive readings associated to disjunctions). We then tested sentences of the following type:

TARGET	Mary-the-engineer // is allowed to save // a monkey or a computer.
Double-true	Mary-the-engineer // is allowed to save // a TV or a computer.
Double-false	Mary-the-engineer // is allowed to save // a monkey or a lion.
Single -true	Mary-the-engineer // is allowed to save // a monkey.
Single -false	Mary-the-engineer // is allowed to save // a computer.

We presented the first bit of these sentences for 750ms, the next four words for 250ms each, and the last bit remained until participants provided their true/false answers. The key example is the first one: "TARGET". According to the cover story, a FC interpretation would result in a false response (engineers are not allowed to save monkeys) whereas a logical interpretation would result in a true response (engineers are allowed to save computers). We compared response times of false responses (FC interpretations) to true responses (logical interpretations). The other conditions were included to control for various possible response biases, e.g., true responses may be faster than false responses, independently of any of the processes we are interested in.

4 Experiment 1

46 native speakers completed a verification task (two were excluded because they failed to answer appropriately to the control conditions). Control sentences were answered very accurately overall ($M = .93, SD = .039$), illustrating that participants understood the task and the cover story. The proportion of free choice (false) responses to the experimental sentences was $M = .66, SD = .33$, and there was significantly greater variability in the experimental sentences than the control sentences. Overall then, the response choice data indicates that multiple interpretations were available for the experimental sentences.

Response times

Figure 1 shows the pattern of RTs for the correct responses to all five types of sentences. The TARGET sentences are broken down into FC responses (false) and logical responses (true). For both types of control sentences there is bias towards true sentences ($t_1\text{s}(43) > 3.4, t_2\text{s}(19) > 2.0, \text{all } p\text{s} < .05$). For the TARGET sentences, however, FC responses (false) RTs are faster than logical (true) responses. While the simple comparison between FC and logical responses failed to reach significance, a repeated measures ANOVA with sentence type (single, double or target) and response (true or false) as factors revealed a significant interaction between sentence type and response type ($F_1(2, 76) = 3.1, F_2(2, 38) = 6.5, p\text{s} < .05$). The difference between the FC and logical interpretations is therefore significantly smaller than the difference between the true and false responses for the different control sentences.

One explanation for our pattern of results is that FC interpretations are fast, but that a bias against false responding slowed down the FC responses. We therefore conducted an analysis in which the response bias was removed from latencies. For each participant, we computed the difference between the FC interpretations (false) and the false control sentences, and compared these scores against the difference between the logical responses (true) and the true control sentences. Any bias towards fast true responding in the TARGET condition should be removed by subtracting away the relevant control responses. This analysis revealed faster FC responses than logical responses (although only marginally so in the participants analysis, $p = .069$).

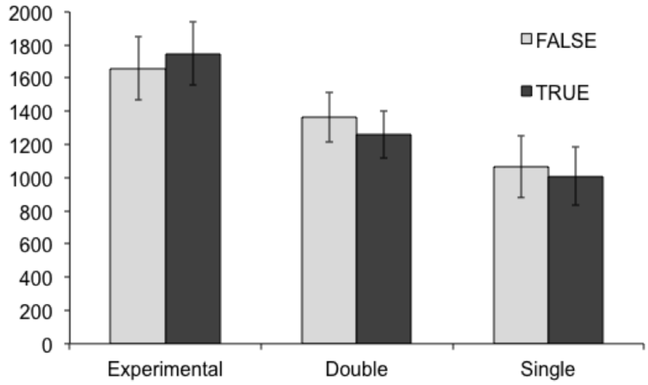

Fig. 1. Response times (ms) for experiment 1

5 Experiment 2

One of the difficulties of allowing participants to choose which interpretation they made to the experimental sentences is that is not possible to determine which responses are errors and which responses are correct interpretations. This means that the RT analysis contains noise and consequently has low power. Experiment 2 was similar to experiment 1, except that the 67 participants (7 excluded) were trained on sentences of the TARGET type with corrective feedback in a preliminary phase: half of them were trained to answer true (logical) and the other half to answer false (FC). Accuracy was high and approximately equal across conditions, both for the control sentences and for the TARGET sentences, in both groups ($M > .92, SD < .05$).

Response times

Figure 2 shows the pattern of RTs. For control sentences, true responses were significantly faster than false responses (t_1s$(59) > 4.0, t_2$s$(19) > 2.8, p$s $< .01$). But for the experimental sentences the reverse was true: FC responses (false) were derived marginally faster than logical (true) responses ($t_1(58) = 1.7, p = .10, t_2(19) = 5.0, p < .0005$). This replicates the pattern observed in experiment 1. As an extra test of the difference between FC and logical responses we used a mixed model regression analysis that combined participants and items. This analysis demonstrated significantly faster FC responses responses ($p < .05$).[3] We also controlled for response bias, just as we did in experiment 1, by removing true control RTs from logical responses to the TARGET sentences, and false control

[3] We were unable to conduct this analysis for experiment 1 because of the large number of missing cells for many participants.

RTs from FC responses. This revealed significantly faster FC responses when using single or double sentences as controls ($ts(58) > 2.5, ps < .05$).

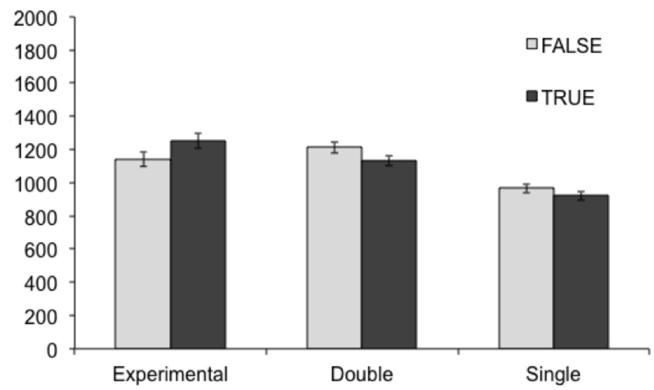

Fig. 2. Response times (ms) for experiment 2

6 Conclusion

We provide data from two studies modeled after the original experiments that detected a cost associated to the derivation of scalar implicatures. Our results show that, contrary to arguments coming from the theoretical literature, free choice inferences are different from scalar implicatures: they come with no processing cost, if not at a *negative* cost. In fact, this pattern of result is closer to the behavior of presuppositions (see Chemla and Bott, ress).

These results call for a greater differentiation between FC and scalar implicatures. They could lead to a reevaluation of the theoretical status of free choice. Alternatively, they could lead to a finer study of the origin of the cost found for scalar implicatures, which may tease apart scalar implicatures and free choice at a more superficial level. The alternatives involved in the two cases are of a different nature for scalar implicatures and for free choice (see Katzir, 2007). If processing cost for scalar implicature is mostly associated with alternatives (alternative derivation or comparison), then it could save the current, parsimonious scalar implicature accounts of free choice.

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