Embedded Scalars in Probabilistic Pragmatics

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The question whether and when pragmatic enrichments, like scalar implicatures, can occur in non-matrix position is crucial for understanding pragmatic inferences and processing in general. Many recent theoretical and experimental contributions have tried to shed more light on the issue, taking inspiration in particular from what is often called a *syntactic approach* to (scalar) implicature, according to which the available pragmatic enrichments of a sentence are generated by the presence or absence of silent exhaustivity operators in the syntax-driven computation of the sentence's meaning (e.g. Chierchia, 2004; Chierchia et al., 2012). Most of the recent debate has focused on the **existence problem**, i.e., whether "local enrichments" of scalar items in embedded position exist. Here, we would like to address a more fine-grained question, an answer to which may also entail an answer to the previous issue. We may call it the **disambiguation problem** (c.f. Chemla and Singh, 2014): any theory of implicature-like meaning enrichments should ideally specify, for any sentence and context pair, which candidate readings are preferred, and to what extent even dispreferred readings may be selected.

With this goal in mind, we turn to probabilistic computational pragmatics, which is a rather novel approach to bridging classical formal pragmatic theory and the demands of empirical data analysis (see Franke and Jäger, 2016, for overview). In particular, we pick up the approach of Potts et al. (to appear) who apply the probabilistic joint-inference model of Bergen et al. (2012, to appear). The general idea of a joint-inference model is that listeners jointly or holistically infer several parameters of interest. Potts et al. (to appear) model the possibility of "local enrichments" for sentences with embedded scalars by assuming that listeners draw inferences not only about the most likely world state, but also about the speaker's lexical entry for *some*. This makes it possible to (i) account for "local enrichments" as the outcome of a global pragmatic inference and to (ii) predict the probability with which these "local readings" should be expected.

Here, we will generalize the "lexical uncertainty" model of Potts et al. (to appear) and compare different probabilistic approaches to solving the disambiguation problem based on experimental data. Concretely, we look at five probabilistic models, all of which make distinct predictions about strength and salience of putative pragmatic enrichments for our experimental sentences (see below): (M1) the vanilla rational speech act model of Frank and Goodman (2012), (M2) the lexical uncertainty model of Potts et al. (to appear), (M3) a variation on M2 where the speaker chooses lexical meanings as speaker-intended meaning enrichments, (M4) a generalization of M3 which allows the speaker to choose an intended parse from the set of all parses entertained by a syntax-driven grammaticalist approach to embedded implicatures (e.g. Chierchia, 2004; Chierchia et al., 2012), (M5) a probabilistic version of disambiguation by the strongest meaning hypothesis (e.g. Dalrymple et al., 1998) as suggested by (Chierchia et al., 2012) as a solution to the disambiguation problem.

We turn to experimental data as a first step towards statistical model comparison. Materials consisted of sentences with Aristotelian quantifiers, nested to depth one:

(1) [none | some | all] of the monsters drank [none | some | all] of their water

80 participants, recruited via Mechanical Turk, first completed a production, then a comprehension part. The experiment introduced a science fiction scenario in which friendly aliens had arrived on earth and were treated very well. To find out more about our new friends, researchers study their eating habits.

In production trials, participants saw pictures of aliens with variably filled mugs of water, showing how much they had consumed, and were instructed to select a sentence of the form in (1) to describe their observation to the researchers (see Figure 1). In the comprehension trials, participants took the role of the researchers rating how likely a particular scene may have triggered the observed description.

Statistical model comparison based on the *Bayesian information criterion* for the production data ranks models as follows: M3 > M4 > M2 > M5 > M1. This (preliminary) result suggests that the vanilla rational speech act model M5 is rather clearly not enough to account for participants' production choices. Predicting production probabilities by means of logical strength (as in M5) is notably worse than the best models, which allow for speaker-choice of intended enrichments. The data does not decide stringently whether the full set of intended parses (M4) is necessary or whether a restricted set to speaker-intended lexical enrichments (M3) is sufficient. This is why, in current work we look at model comparison based on the comprehension data, while also extending the experimental data to include additional quantifier *most*, as this will provide more grip on telling model variants apart.

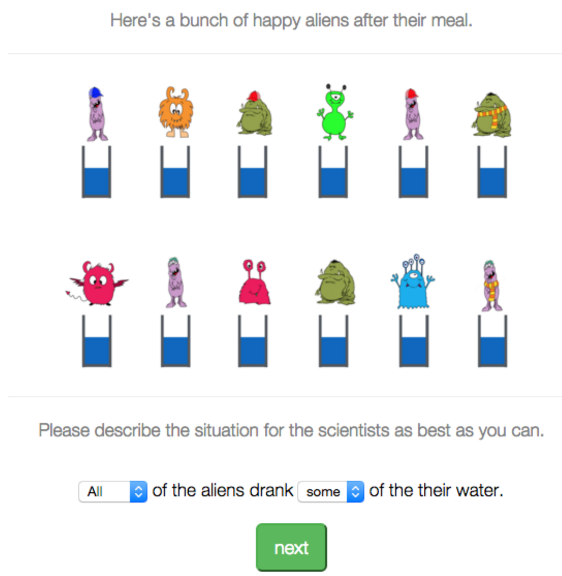

Figure 1: Examples of production trial.

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