Probabilistic accounts of the proviso problem: experimental evidence

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DRT meets RSA

- Discourse Representation Theory (DRT)[1] can derive alternative interpretations, taking context into account.
  - But it has few capabilities to select among them.
- Rational Speech Act (RSA)[2] framework uses Bayesian reasoning to select among possible interpretations.
  - But they must be supplied externally.
- Hence, the two theories complement each other:
  - DRT generates interpretations, RSA selects one.
- Combining DRT with RSA could yield a more comprehensive theory of pragmatics.
- Proof of concept: The proviso problem.

Proviso problem[3]

- The problem of presupposition projection from the consequent of conditional sentences "if A, then B(P)":
  - Does presupposition project conditionally (if A, then P) or unconditionally (P)?

(1) If John is a scuba diver, he will bring ***his wetsuit****.*
⟶ *If John is a scuba diver, he has a wetsuit.*
(2) If John wants to impress her girlfriend, he will bring ***his wetsuit***
⟶ *John has a wetsuit*

Satisfaction theory[4]

- A presupposition must be satisfied (i.e., entailed) by the local context.
- For the consequent of the conditional "if A, then B(P)" the local context in the global context augmented with A.
- This is equivalent to conditional projection.
- No ambiguity is expected.
- Unconditional presupposition projection can be explained by pragmatic strengthening:
  - In (2), P is likely to be independent of A.
  - It must therefore be presupposed on truth-functional grounds: either A is false or P is true.
  - However, if A is false, the speaker would not utter a conditional.
  - Hence, P must be true.
- However, this reasoning does not apply to genuine conditional presuppositions:

(3) Mary knows that ***if John wants to impress his girlfriend, he has a wet suit***

Binding theory in DRT[5]

- Presuppositions are anaphoric expressions.
- They must find an antecedent (or be accommodated) along the path from the local context to the global one.
- There may be multiple potential antecedents:

(4) If John has sons, ***his children*** *are happy*

- RSA can help resolve this ambiguity.

Rational Speech Act[2]

- The literal listener selects among alternative interpretations based on their prior probabilities.
- The more plausible an interpretation, the more frequently it is selected.

Probabilistic satisfaction theory[6]

- A presupposition is licensed if its probability in the local context is relatively high : $pr(P) > \theta$.
- For a presupposition in the consequent, this becomes $pr(P|A) > \theta$ in the global context.
- If A and P are independent or negatively dependent, then $pr(P) \geq pr(P|A)$, allowing us to infer that $pr(P) > \theta$.
  - This licenses the unconditional presupposition.
- But under positive dependence ($pr(P) < pr(P|A)$), the inference that $pr(P) > \theta$ does not follow.
  - Only the conditional presupposition is licensed.

Predictions:

- A binary distinction based on a fixed threshold.
- If the conditional probability exceeds the unconditional one, only the conditional presupposition is licenced.
- Otherwise, both of them are.



Our DRT + RSA account

- The presupposition can either be accommodated locally or project to the global context, resulting in a conditional or unconditional reading, respectively.
- The prior probabilities of these readings correspond to $pr(P|A)$ and $P(A)$, respectively.
- Provided that both readings are compatible with the common ground, their selection rates should be proportional to their prior probabilities.
  - $pr_{L_0}(S|U) \propto pr(S) \cdot [\![U]\!](S)$

Predictions:

- A gradual effect of conditional probability, holding the unconditional probability constant.
- The higher the conditional probability, the more frequently the conditional reading should be selected.



Norming study

- This study evaluated prior probabilities (n=320; Prolific).
- Participants rated with a slider how likely this is:

(5) A random (person | guitarist | artistic person | married person | tone-deaf person) has a guitar.

- Four levels of conditional probability (owner descriptions): *low*, *independent*, *high*, and *very high*.
- And an unconditional probability (*a random person*).
- 40 possession objects were tested.
- 12 objects were selected for the main experiment.

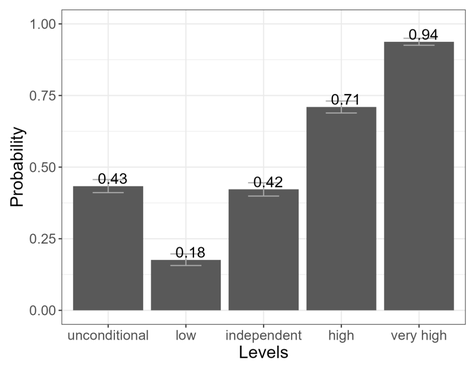


Figure 1. Prior probabilities

Main experiment

- This experiment evaluated presupposition projection (n=400; Prolific).
- Participants rated with a slider which assumption the speaker was more likely to have made – a) or b):

(6) If Peter is (a guitarist | artistic | married | tone-deaf), ***his guitar*** *is good-sounding.*
a) Peter has a guitar.
b) If Peter is (a guitarist | artistic | married | tone-deaf), he has a guitar.

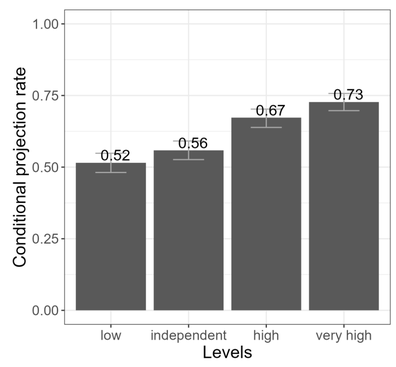


Figure 2. Projection results

Conclusions

- We replicated previous results[7,8] that positive dependence increases conditional presupposition projection.
- We also investigated the effect of negative dependence for the first time (to our knowledge).
- The results provide partial support for both theories.
- The contrast between the *high* and *very high* condition is consistent with DRT + RSA account.
  - Model predictions for the last three levels closely match the experimental results.
- The main discrepancy occurs in the *low* condition, where the observed rate exceeds the model prediction.
  - Its value is compatible with the probabilistic satisfaction theory.
- Future work: Test RSA models that incorporate common ground and QUD reasoning.[9,10]

- The contrast between *high* and *very high* conditions is significant ($\beta = -0.057$, SE = 0.019, $z = -3.04$, $p = 0.006$)
- While the contrast between *low* and *independent* is not ($\beta = -0.046$, SE = 0.023, $z = -2.00$, $p = 0.074$).



Figure 3. Model predictions

References

1. Kamp, H., Van Genabith, J., & Reyle, U. (2010). Discourse representation theory. In *Handbook of Philosophical Logic: Volume 15* (pp. 125-394). Dordrecht: Springer Netherlands.
2. Goodman, N. D., & Frank, M. C. (2016). Pragmatic language interpretation as probabilistic inference. *Trends in cognitive sciences, 20(11),* 818-829.
3. Geurts, B. (1996). Local satisfaction guaranteed: A presupposition theory and its problems. *Linguistics and philosophy*, 259-294.
4. Karttunen, L. (1974). Presupposition and linguistic context.
5. Van der Sandt, R. A. (1992). Presupposition projection as anaphora resolution. *Journal of semantics*, *9*(4), 333-377.
6. Lassiter, D. H. (2012). Presuppositions, provisos, and probability. *Semantics and Pragmatics*, 1-37.
7. Romoli, J., Sudo, Y., & Snedeker, J. (2011). An experimental investigation of presupposition projection in conditional sentences. In *Semantics and Linguistic Theory* (pp. 592-608).
8. Çağırıcı, E. (2022). *An Investigation of Conditional Presuppositions in Turkish* (Master's thesis, Middle East Technical University (Turkey)).
9. Qing, C., Goodman, N. D., & Lassiter, D. (2016). A rational speech-act model of projective content. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 38).
10. Warstadt, A. (2022, December). Presupposition triggering reflects pragmatic reasoning about utterance utility. In *Proceedings of the Amsterdam Colloquium* (pp. 451-458).

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