Adaptation to Variable Use of Expressions of Uncertainty

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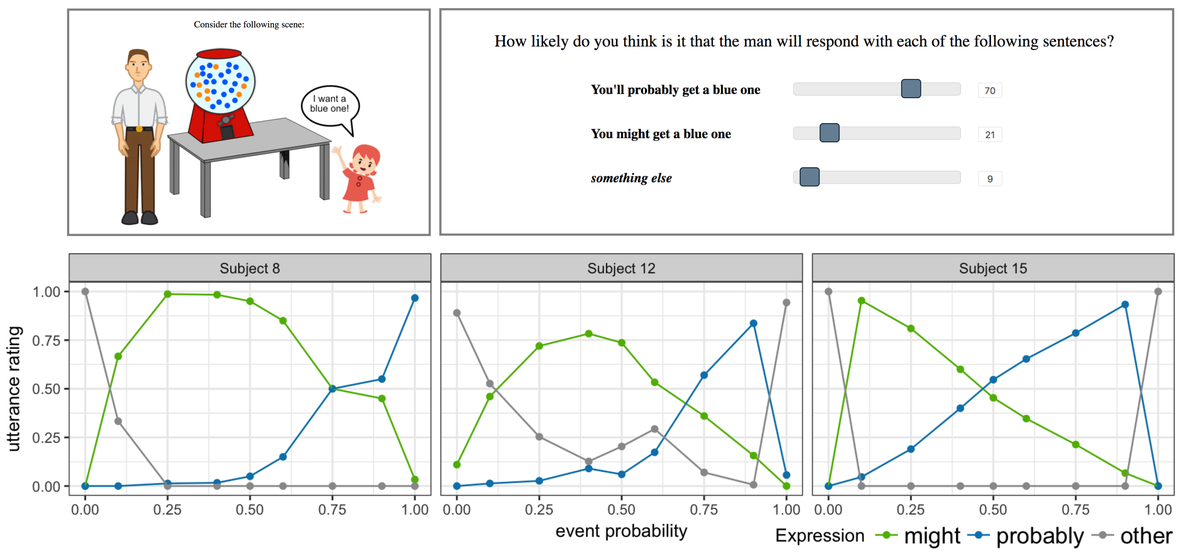
Introduction

- Uncertainty expressions (e.g., *might, probably*) can be used to express uncertainty about whether an event will happen
- No direct mapping between uncertainty expressions and probability of an event

Research questions:

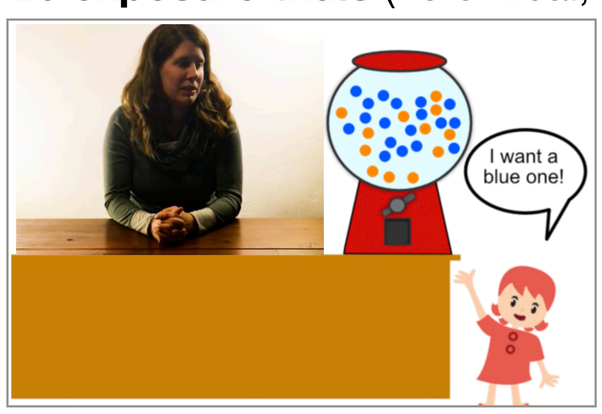
- Is there **variability in the use of uncertainty expressions** across speakers?
- Do listeners' **expectations adapt** to a specific speaker's use of uncertainty expressions?
- Do listeners' **interpretations adapt**?

Variability in use of uncertainty expressions



Experiment 1: Do listeners' expectations adapt to specific speakers?

20 exposure trials (10 critical, 10 filler)



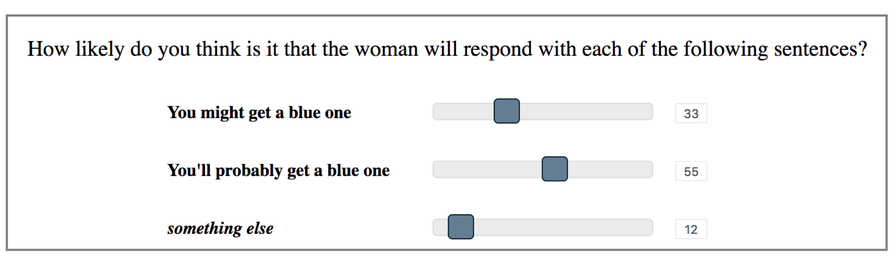
Cautious speaker condition:

10 trials: *might* and 60% blue gumballs
5 trials: *probably* and 90% blue gumballs
5 trials: *bare* and 100% blue gumballs

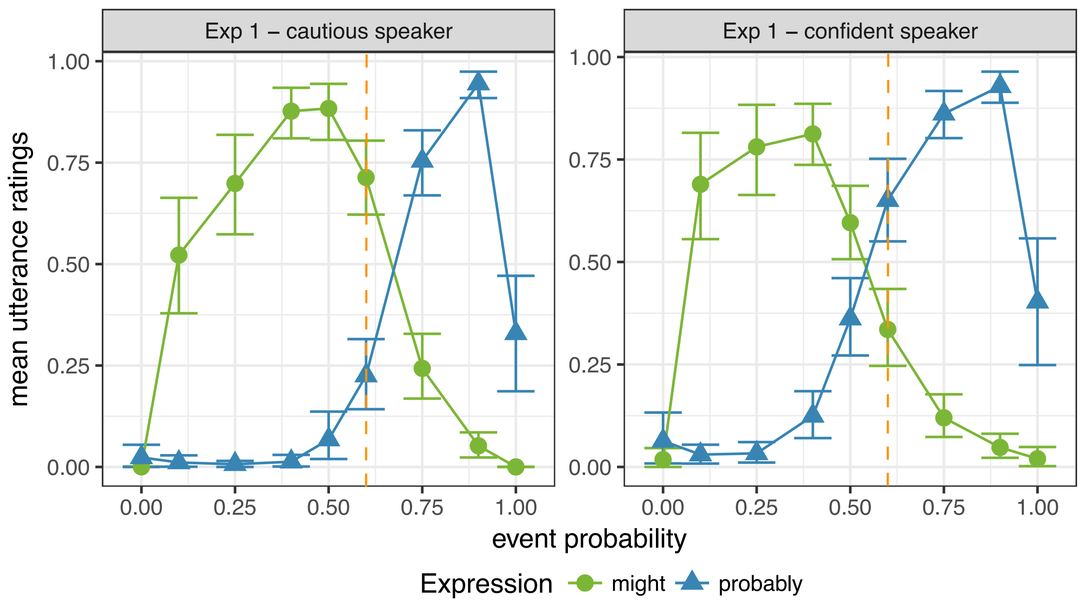
Confident speaker condition:

10 trials: *probably* and 60% blue gumballs
5 trials: *might* and 25% blue gumballs
5 trials: *bare* and 100% blue gumballs

36 test trials



61 participants on Mechanical Turk

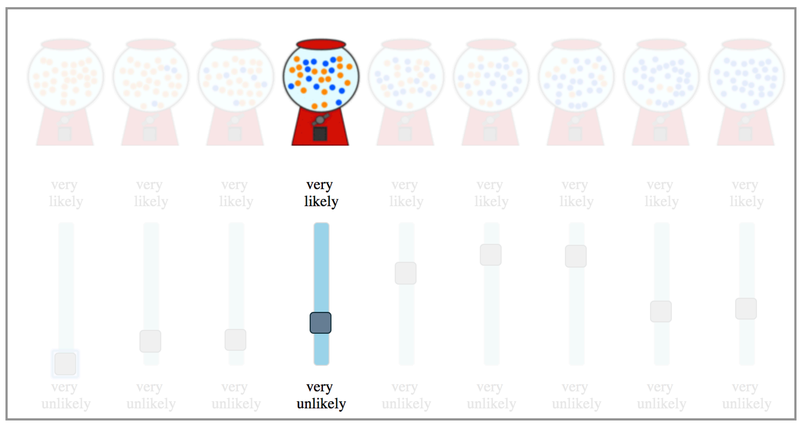


AUC(might) - AUC(probably) is significantly smaller in confident speaker condition ($t(59) = -4.98$, $p < 0.001$)

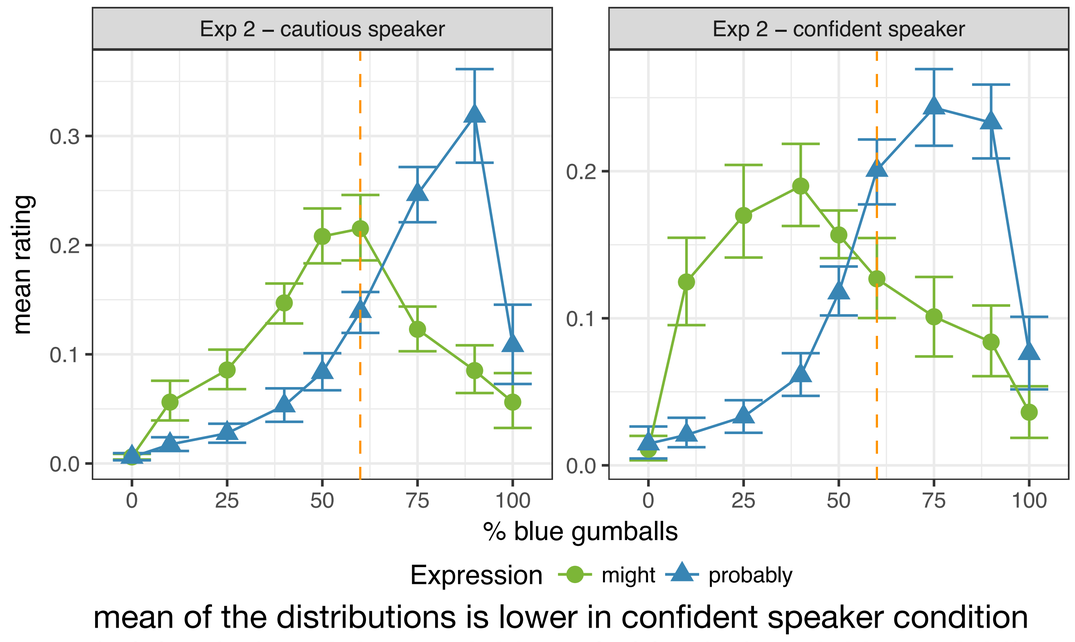
Experiment 2: Do listeners' interpretations adapt?

20 exposure trials (identical as in Exp. 1)

6 test trials



77 participants on Mechanical Turk



mean of the distributions is lower in confident speaker condition (*might*: $t(75) = -3.05$, $p < 0.01$, *probably*: $t(75) = -3.08$, $p < 0.01$)

Computational model

- We model production and comprehension within the Rational Speech Acts framework [1, 2]
  - Each uncertainty expression has a threshold semantics [3,4]:

$$L_0(\phi \mid u) \propto 1\left[\phi > \theta_u\right]$$

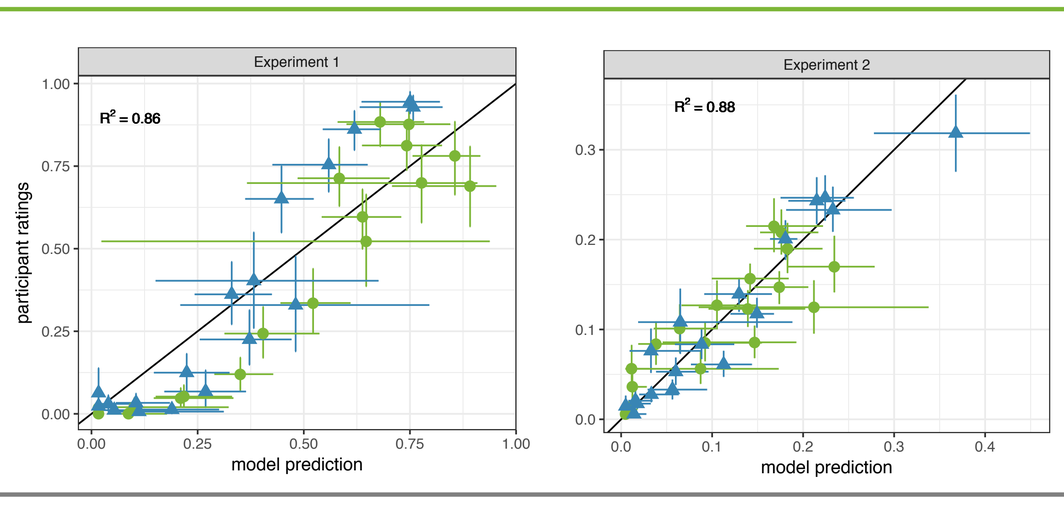
  - Thresholds θ_u are sampled from a Beta distribution $P(\theta_u)$
  - Production is modeled by pragmatic speaker:

$$S_1(u \mid \phi) \propto \exp(L_0(\phi \mid u) - c(u))$$

  - Comprehension is modeled by pragmatic listener:

$$L_1(\phi \mid u) \propto P(\phi) S_1(u \mid \phi)$$

- We assume that listeners have speaker-specific production and comprehension models parameterized by threshold distributions
- We model adaptation as Bayesian belief updating of the threshold distributions [5, 6]



Conclusions

- Semantic/pragmatic adaptation simultaneously affects production and comprehension
- Adaptation processes can be captured by a Bayesian cognitive model which suggests a communicatively efficient system

References:
[1] Goodman and Frank. 2016. TICS. [2] Franke & Jäger. 2016. Zeitschrift f. Sprachwissenschaft. [3] Lassiter & Goodman. 2015. Cognition. [4] Herbstritt & Franke. 2017. unpublished manuscript. [5] Kleinschmidt and Jaeger. 2015. Psych. Review. [6] Qing. 2014. MSc thesis, Univ. of Amsterdam. [7] Kamide. 2012. Cognition. [8] Fine et al. 2013. PLOS ONE. [9] Yildirim et al. 2016. JML.