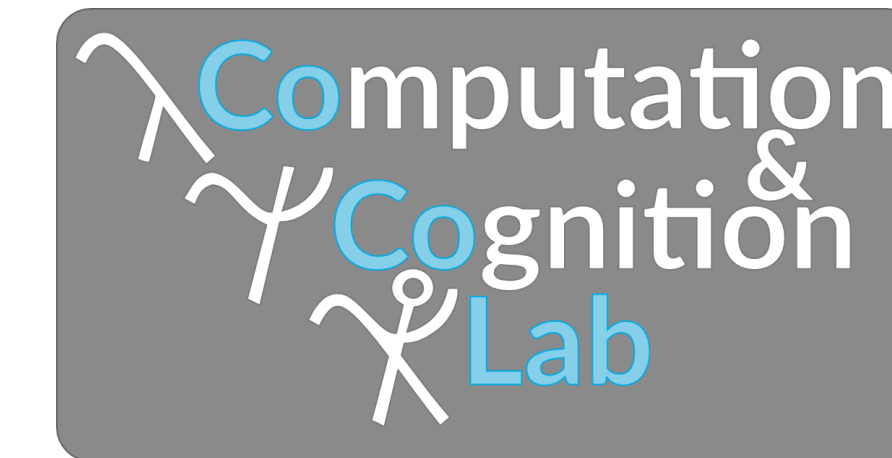




A cost- and information-based account of epistemic *must*

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Introduction

How do we communicate about beliefs, together with the evidence we use to form them? A case study: *must*

***Must* is strong, yet surprisingly weak**

Compare: “It *must* be raining” vs. “It is raining”

Since Karttunen's (1972) *must* is weak mantra, four decades of semanticists cannot agree on the meaning of *must*; but *must* communicates more than strength

Evidentials in language: Why would you say so?

Consider: (standing in rain) “It *must* be raining”

Must q requires/signals weak evidence for q (von Fintel & Gillies; Lassiter; Matthewson, 2014)

Our account: M(arkedness)-implicature

The bare form conveys q , so listeners take marked *must* q to convey a marked meaning: the speaker arrived at q via an evidentially less certain route

We examine speaker & listener behavior as they relate to evidence strength, then implement a formal model of both within the Rational Speech Act framework

Experiment 1: Evidence strength

Rate the probability of q (e.g., rain) given evidence (e.g., *You hear the sound of water dripping on the roof*)

Strength estimates used in subsequent analyses

Experiment 2: Utterance choice

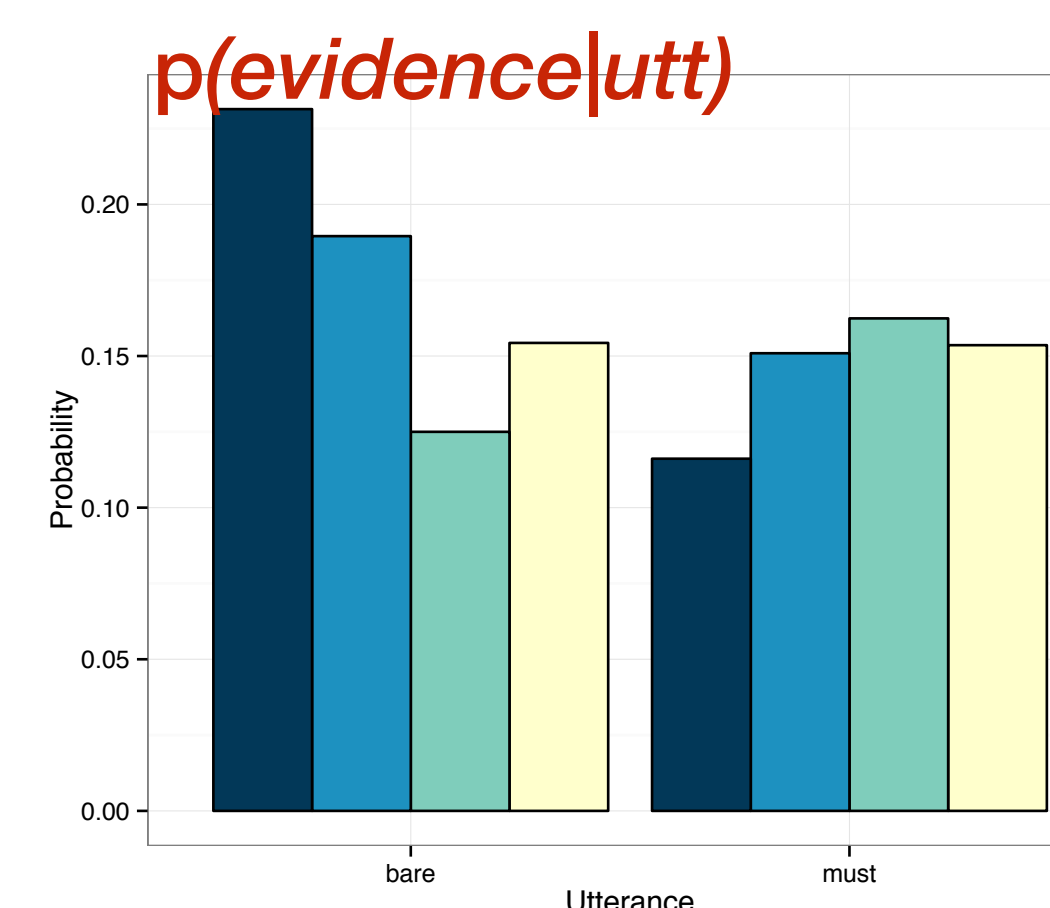
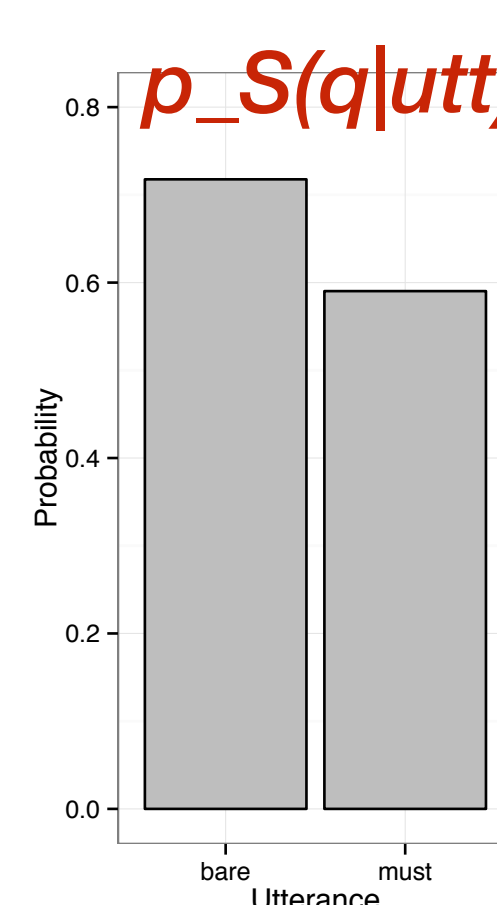
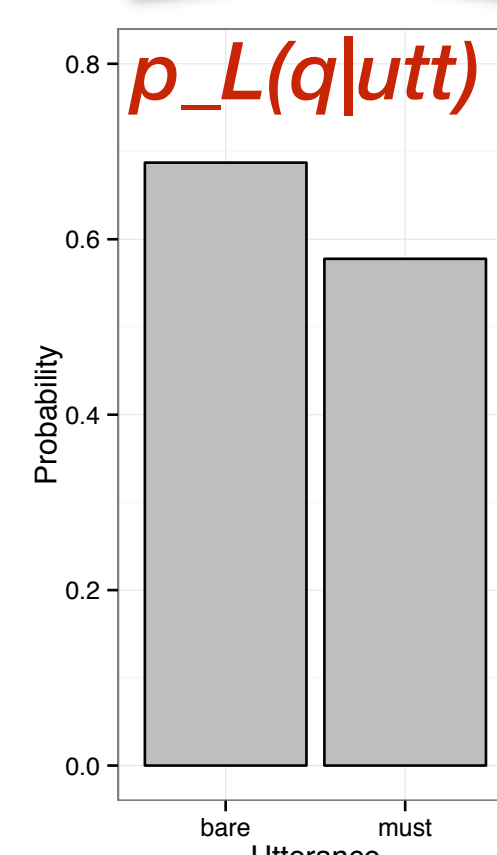
How likely are speakers to use the marked *must* p utterance as evidence strength decreases?

Given a piece of evidence for q , then asked to choose one of four utterances to tell friend about the situation

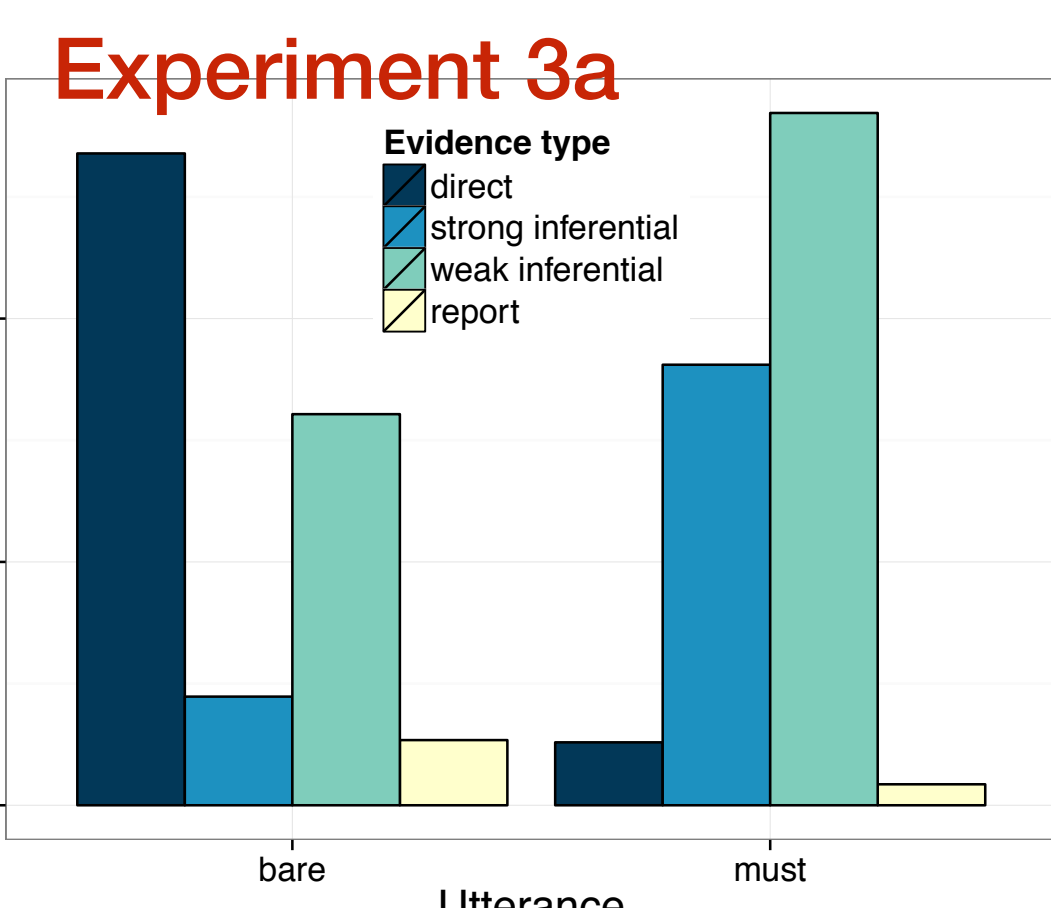
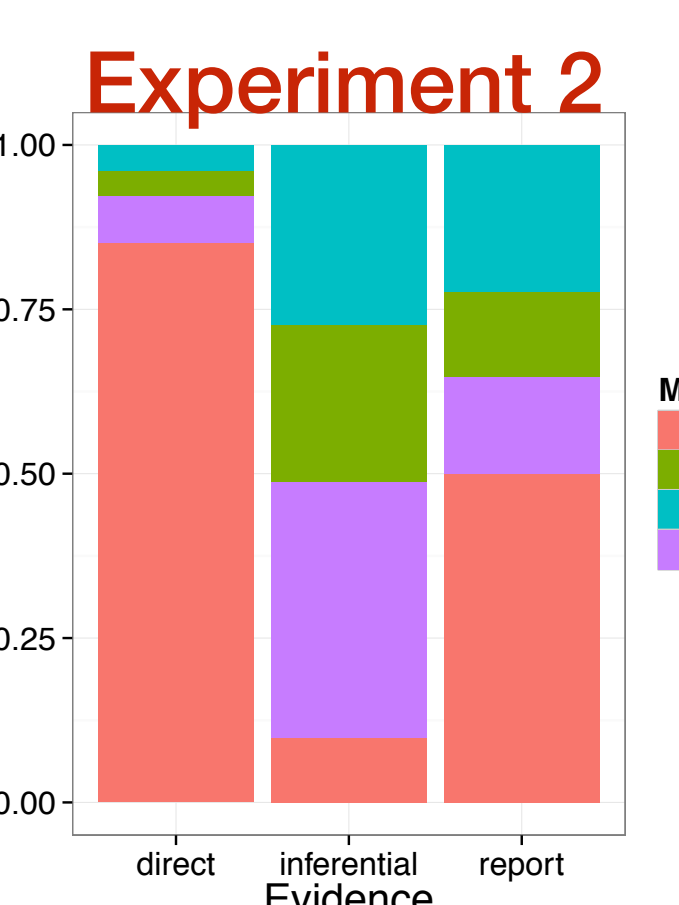
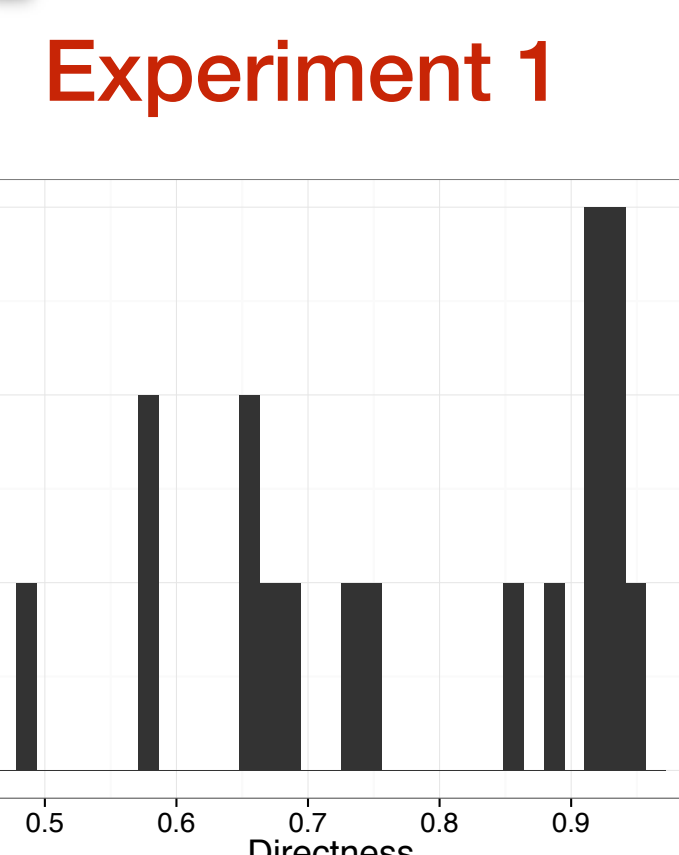
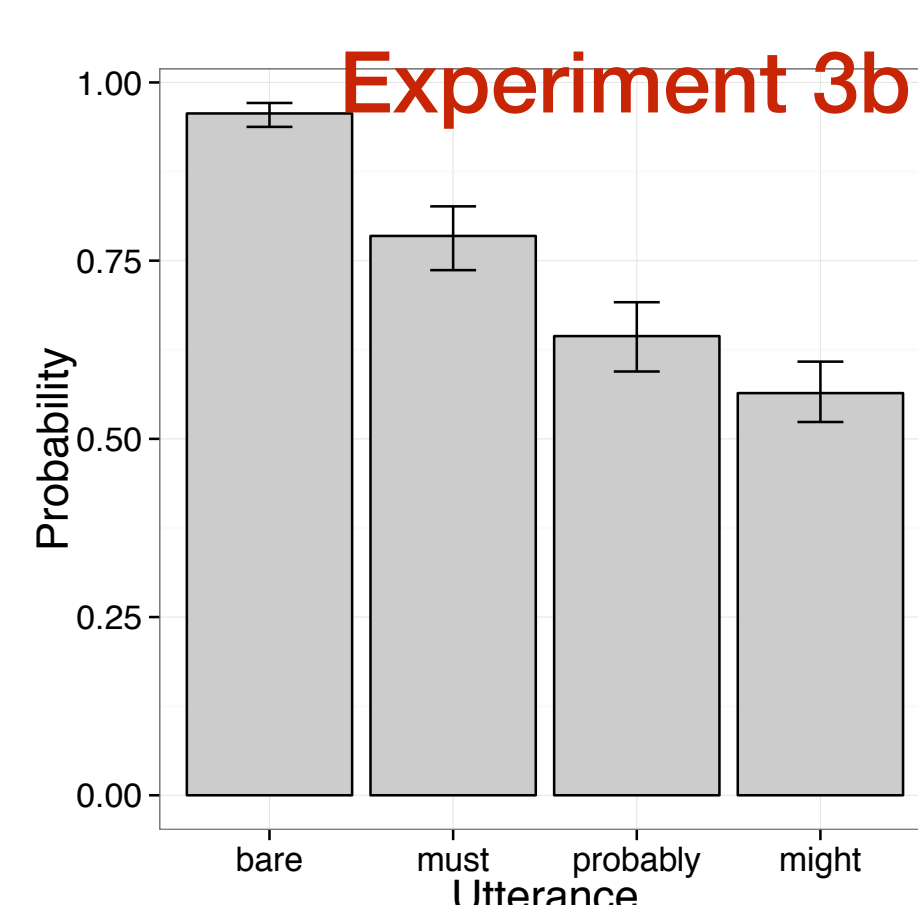
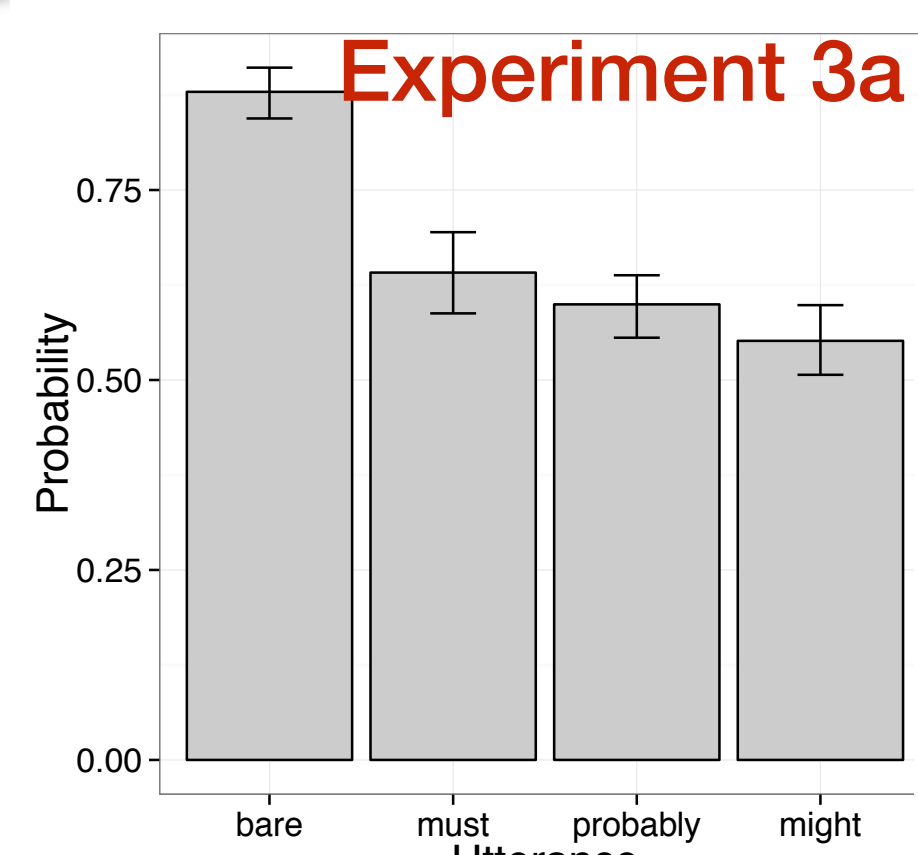
– bare q , *must* q , *probably* q , *might* q –

Participants were more likely to choose the more marked *must* form over the bare form as the strength of evidence decreased (Fig. 1; $\beta=5.4$, $SE=2.4$, $p<.05$)

Model



Empirical results



Exp. 3a: Utterance interpretation

How do listeners' beliefs about q and the strength of speakers' evidence for q depend on the utterance?

Given an utterance, then asked a) to rate the probability of q ; and b) to select one out of five pieces of evidence that the speaker must have had about q

Belief in q weaker after *must* q than after bare q (Fig. 2; $\beta = -.21$, $SE = .02$, $t = -10.1$, $p < .0001$)

Evidence strength lower after *must* q than after bare q (Fig. 3; $\mu = .87$, $sd = .1$, $\beta = -.08$, $SE = .01$, $t = -6.8$, $p < .0001$)

Exp. 3b: Inferring speaker belief

How do listeners' beliefs about speakers' beliefs about q depend on the utterance?

Same procedure as Exp 3a; asked to rate speakers' probability of q (e.g. *Does John think it's raining?*)

Listeners' estimates of speakers' beliefs stronger than their own beliefs (Fig. 2; ...)

Model

Something coherent about a model

Following Lassiter and Goodman (2013) we present an extension of the Bayesian Rational Speech Act framework (Frank and Goodman, 2012) using lexical uncertainty to derive the implicature. In this model, the semantics of the bare utterance and *must* q are relatively unconstrained. We define the semantics of the utterances such that $p(q|bare) > \theta_b$ and $p(q|must) > \theta_m$, where the pragmatic listener is uncertain about θ_b and θ_m and infers the values through pragmatic reasoning. When the cost of uttering *must* q is greater than the bare form, the pragmatic listener infers that $p(q)$ is smaller than when the utterance is the less costly bare q . Given the weakened certainty of q , the listener then infers that the speaker has weak evidence of q .

A new perspective on *must*

Weakened meaning derives straightforwardly from an M-implicature, which drives inference about evidence