# Assertability Differences between Epistemic Adverbs and Adjectives

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# Epistemic Adjectives vs. Epistemic Adverbs

▶ Two types of epistemic operators discussed here

    E-adjectives: *It is certain/probable/possible that this rock is a meteorite.*

    E-adverbs: *This rock is certainly/probably/possibly a meteorite.*

▶ Differences between E-adjectives and E-adverbs, for *certain(ly)*

- Under negation (Bellert 1977, Papafragou 2016, Wolf 2015)

  - *It is not certain / uncertain that this rock is meteorite.*
  - *This rock is \*not certainly / uncertainly a meteorite.*

- Divergence of operators (Nilsen 2004, Wolf et al. 2016)

  - *It is possible that Le Pen will win, even though she certainly will lose.*
  - *#Le Pen will possibly win, even though she certainly / it is certain that she will lose.*

# Subjective vs. objective E-operators

▶ E-adverbs are subjective, E-adjectives are objective epistemic operators (cf. Hengeveld 1988, Nuyts 2001)
   - *certainly* $\phi$: S expresses a subjective estimation that $\phi$ is highly likely.
   - *certain* $\phi$: S states that there is a high likelihood that $\phi$ (by a relevant epistemic source)

▶ Consequences for assertability of clauses with E-operators (Lassiter 2016)
   - "a privately held certainty, or denial of possibility, may be felt to be less subject to public scrutiny and approbation if it turns out to be incorrect"
   - "less subject to public scrutiny" = easier to defend = more assertable

## Scenario

Lottery with 1000 tickets, 1 winning ticket, Bill bought 1 ticket.

- *It is certain that Bill did not win the raffle./Bill certainly did not win the raffle.*
- *It is possible that Bill won the raffle./Bill possibly won the raffle.*
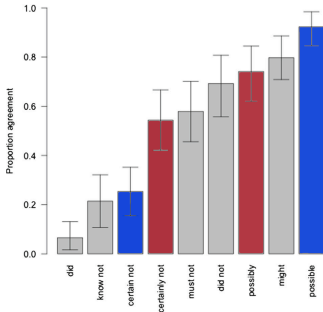


His experiment shows :

- *certain not $\phi$ < certainly not $\phi$*
- *possibly $\phi$ < possible $\phi$*

  $\alpha < \beta$: participants assented less often to $\alpha$ than to $\beta$, i.e.:
  $\alpha$ is "less assertable" than $\beta$

# Beyond Lassiter (2016)

Theoretical explanation

- Lassiter: *certainly* $\phi$ less subject to scrutiny $=$ easier to assert than *certain* $\phi$.
- Why not also: *possibly* $\phi$ less subject to scrutiny, hence easier to assert, than *possible* $\phi$?
- This would lead to the opposite of what Lassiter actually found.
- Our take: With *possibly* $\phi$ speaker wants to put $\phi$ as an option to consider into the Common Ground, not necessarily with *possible* $\phi$
- Hence # *Le Pen will possibly win, even though she certainly / it is certain that she will lose.* is pragmatically infelicitous: It introduces $\phi$ as an option and then rules out that $\phi$ obtains.
- *possibly* $\phi$ has an additional pragmatic purpose over *possible* $\phi$, hence less assertable

Methodological choices

- Test for *certain(ly)* involves negation, which may affect results.
- Lottery scenario invites frequentist view of probability, this may favor assertability of objective E-operators (adjectives).

# Our goals with experiments

Our experiments extend Lassiter's study in two ways:

▶ Compare judgements on assertability in objective/measurable and subjective/non-measurable contexts.

▶ Compare judgments on assertability on propositions with and without negation.

# Experiments

- ▶ Experiment 1:
  - measurable vs. non-measurable contexts
  - probabilities used for measurable contexts: 10% & 95%
- ▶ Experiment 2:
  - the effect of polarity: positive vs. negative
  - the effect of extremeness of probability: probabilities used for measurable contexts: 0.1% vs. 10%, 99.9% vs. 95%
- ▶ One context, one test sentence per participant
- ▶ Amazon MechanicalTurk platform

# Measurable vs. Non-measurable contexts

## Measurable probabilities (numerical evidence)

The elementary school held a raffle to raise money for student activities. A total of 1000 tickets were sold. Of those, . . .

*10% probability continuation*
100 tickets were purchased by Jay, a wealthy local business person. 900 tickets were purchased by other members of the community.

*Please indicate whether you agree or disagree with the following statement.*

**Jay possibly won the raffle.**     ○ Agree  ○ Disagree

(1)     Participants read one of the two sentences:

    a.    It is possible that Jay won the raffle.
    b.    Jay possibly won the raffle.

## Non-measurable probabilities (non-numerical evidence)

A murder took place on a yacht in the middle of the Atlantic Ocean. The victim was stabbed. The police concluded that the murderer must have been one of the passengers on the yacht. Jay is one of the passengers. The amount of information the police has gotten so far is as follows:

- Jay was seen having a friendly conversation with the victim on the yacht shortly before the murder.

- The murder was most likely committed by a left-hander. Jay is right-handed.

- The murder weapon was found in the cabin of another passenger, not Jays.

- Finger prints from several passengers, including Jay, were found at the crime scene.

- Jay does not stand to benefit from the victim's death.

(2)  a.  It is possible that Jay committed the murder.
     b.  Jay possibly committed the murder.

## Predictions

- ▶ Low probabilities:
  - possibly leads to fewer **agree** responses than possible.
  - The acceptability difference is greater in the non-measurable condition than in the measurable condition.
- ▶ High probabilities:
  - certainly leads to more **agree** responses than certain.
  - The acceptability difference is greater in the non-measurable than measurable condition.

(3)  a.  H1a: possible $\phi$ > possibly $\phi$
     b.  H1b: certain $\phi$ < certainly $\phi$

(4)  H2: DIFF(adverb, adjective)$_{\mathrm{NONMEAS}}$ > DIFF(adverb, adjective)$_{\mathrm{MEAS}}$

# Experimental conditions (Experiment 1)

| operators | probability | measurability |
|---|---|---|
| certain/certainly | 95% | measurable |
| certain/certainly | (∼95%) | non-measurable |
| possible/possibly | 10% | measurable |
| possible/possibly | (∼10%) | non-measurable |

## Note

- For Experiment 1, we needed the perceived likelihood for the non-measurable contexts to be closely matched to the numerical probability of the measurable contexts.

- We conducted a norming study for the non-measurable contexts, and used the data to determine the probabilities of the measurable contexts.

# Results: experiment 1



Proportions of Agree responses (high probability)

Proportion of Agree responses (low probability)
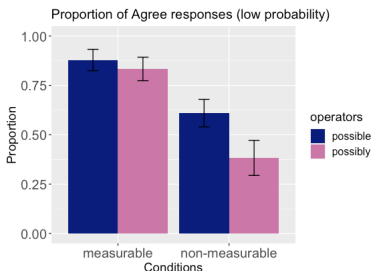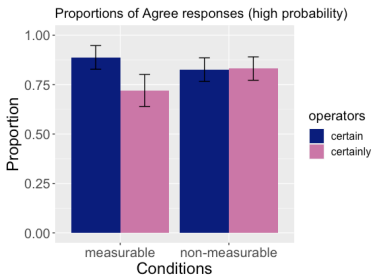
### certain < certainly (95%)

▶ Hypothesis H1a is not supported in non-measurable (p=0.9) condition.

▶ The difference is significant in measurable condition (p<.01), but in the opposite direction from predicted.

### possible > possibly (10%)

▶ Hypothesis H1b isn't supported in measurable (p=.276) but is in non-measurable condition (p<.01).

▶ H2: numerically supported, but not significant (p=.222026).

## Interim Summary

Questions:

- ▶ Why was H1b possible $\phi$ > possibly $\phi$ not supported in the measurable condition (contra Lassiter's study)?

- ▶ Why was H1a certain $\phi$ < certainly $\phi$ not supported in either the measurable or non-measurable conditions?

For experiment 2, we made changes to Experiment 1:

- ▶ Focus on mathematically measurable condition

- ▶ Test sentences with and without negation

- ▶ Probabilities moderate (95%/10%) vs. extreme (99.9%/0.1%)

# Experimental conditions: experiment 2

| operators | probability | polarity | |
|---|---|---|---|
| certain/certainly | 95% | positive | from Experiment 1 |
| certain/certainly | 95% | negative | |
| certain/certainly | 99.9% | positive | |
| certain/certainly | 99.9% | negative | Lassiter replication |
| possible/possibly | 10% | positive | from Experiment 1 |
| possible/possibly | 10% | negative | |
| possible/possibly | 0.1% | positive | Lassiter replication |

# Experiment 2: certain < certainly without negation

Conditions:
- ▶ 95% positive (Experiment 1)
- ▶ 99.9% positive



Probabilities of Agree responses (high positive)
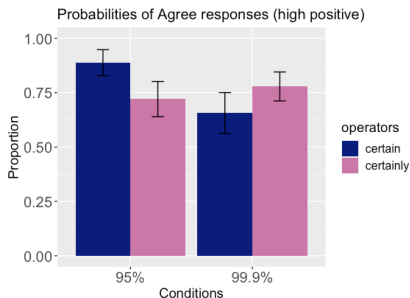
### H1a: certain < certainly

- ▶ Operator type is a significant effect: At 99.9%, hypothesis is supported without negation (p<.05)

- ▶ Model: lmer with operator type and extremeness of probabilities as fixed effects

- ▶ Operator type is a significant effect (p<.01).

- ▶ Extremeness of the probability, too (p<.01).

# Experiment 2: certain not < certainly not

Conditions:

- ▶ 95% negative
- ▶ 99.9% negative (Lassiter replication)



Proportions of Agree responses (high negative)
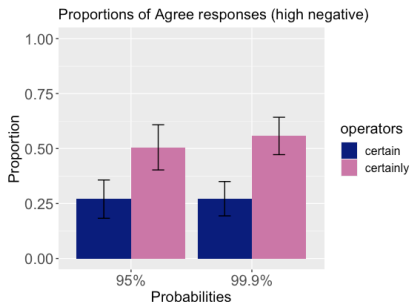
### H1a: certain not < certainly not

- ▶ Model: lmer with operator type and extremeness of probabilities as fixed effects
- ▶ Operator type is a significant effect (p<.01).
- ▶ Extremeness of the probability is not (p=.627).

# Experiment 2: possible > possibly (0.1% vs. 10%)



Proportions of agree responses (positive)

operators
- possible
- possibly
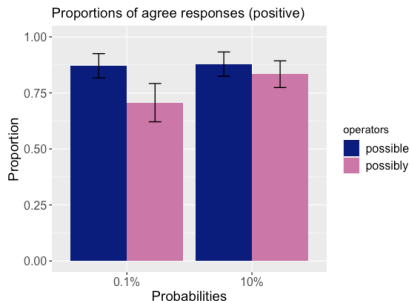
## H1b: possible > possibly (0.1%)

▶ With more extreme probability, the difference in the proportion of agree responses between possible and possibly became significant (p<.01).

▶ Model: lmer with operator type and extremeness as fixed effects

▶ Operator type (p<.01)

▶ Extremeness of the probabilities (p=0.18386).

▶ No interaction (p=0.18386)

# Experiment 2: possible (not) > possibly (not) at 10%



Proportions of agree responses (10%)
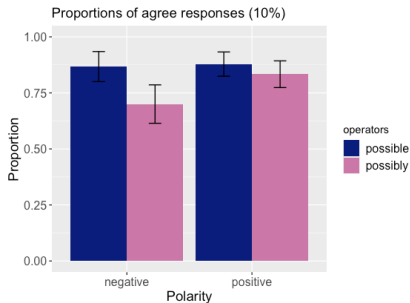
## H1b: possible > possibly (10%)

▶ With negation, the difference in the proportion of agree responses between possible and possibly became significant (p<.01).

▶ Model: lmer with operator type and polarity as fixed effects

▶ Operator type (p<.01)

▶ Polarity (p=0.8043).

▶ No interaction (p=0.2067)

# Summary of Experiment 2

▶ Overall, the polarity had an effect on the proportion of agree responses for certain/certainly.

▶ Except for the results from the 95% probability with the E-adjective certain without negation, the extremeness of the probability did not seem to have an effect on the proportion of agree responses.

## Discussion

▶ Good evidence that E-adverbs and E-adjectives are used in distinct ways.

▶ Surprising effect of the level of probability on certain

▶ Surprising influence of negation

Why?– possible explanations:

▶ levels of probability: possibly related to the granularity level of the two probabilities used. 95% is rounder than 99.9%, and as a result, it may be that objective E-operator is used in a more approximate way.

▶ negation: unusual nature of the scenario, as a person buys most tickets.

Appendix

## Theoretical Motivation: Lassiter 2016

*"Participants would be less strict in their use of subjective possibly and certainly, on the ground that **a privately held certainty, or denial of possibility**, may be felt to be less subject to public scrutiny and approbation if it turns out to be correct."*

▶ Reading *privately held certainty or denial of possibility* as two separate cases: presupposes that with *possib(ly)* S always denies what an opponent has said, this is unjustified.

▶ Reading *denial of possibility* as elaboration of *certainty*, and recalling that Lassiter uses negation:

| | | | |
|---|---|---|---|
| (1) *certainly* $\neg\, \phi$ | less subject to public scrutiny than | *certain* $\neg\, \phi$ | |
| (2) $\neg$ *possibly* $\phi$ | less subject to public scrutiny than | $\neg$ *possible* $\phi$ | by modal laws |
| (3) *possibly* $\phi$ | more subject to public scrutiny than | *possible* $\phi$ | by logic of less/more |

But why should providing a **subjective** possibility be **more** subject to public scrutiny than an objective possibility?
There must be something flawed in the argument, e.g., (2) *possibly* $\phi$ cannot be in the scope of negation.

# Theoretical motivation: our proposal

E-adverbs do not belong to the asserted content, but specify the nature of the assertion itself.

- ▶ *possibly* $\phi$ is subjective, hence, easier to defend than *possible* $\phi$, but
- ▶ with *possibly* $\phi$, S considers the evidence sufficient that $\phi$ should be considered,
- ▶ this is not the case with *it is possible that* $\phi$, where S asserts a possibility of $\phi$
- ▶ hence *possibly* $\phi$ is usable in fewer circumstances
- ▶ *I consider it possible that* $\phi$ aay be more assertable than *it is possible that* $\phi$

## Procedure

(5)    a.    Participants were first told that they would read a short text and answer some questions about it.

          b.    They then read the context story.

          c.    After the context story was provided, one of the test sentences was presented below the context story.

          d.    Participants were asked whether they agree or disagree with the statement by clicking on a button for Agree or Disagree, placed side-by-side, while the context story and the prompt for a response was still visible. After the response, the page cleared.

          e.    Comprehension questions and demographic questions were then asked.

Only one of the test sentences was presented to each participant. There were three comprehension questions that each participant was required to respond to check their attention.

# Participants: Experiment 1

▶ 200 participants were recruited for each list at Amazon MechanicalTurk.

▶ Different number of participants were taken out of the data from each list because of the responses to the comprehension questions.

| | measurable | | | |
|---|---|---|---|---|
| operator | possible | possibly | certain | certainly |
| N | 140 | 150 | 107 | 118 |

| | non-measurable | | | |
|---|---|---|---|---|
| operator | possible | possibly | certain | certainly |
| N | 187 | 115 | 155 | 154 |

# Experiment 1: results (high probability contexts)

| Measurability | Measurable | | Non-measurable | |
|---|---|---|---|---|
| Operator | certain | certainly | certain | certainly |
| N of Participants | 107 | 118 | 155 | 154 |
| N of agree responses | 95 | 85 | 128 | 128 |
| % of agree | 88.8 | 72.0 | 82.6 | 83.1 |
| upper confidence interval | 94.8 | 80.1 | 88.6 | 89.0 |
| lower confidence interval | 82.8 | 63.9 | 76.6 | 77.2 |

### certain $\phi$ < certainly $\phi$

▶ the acceptability difference between certain and certainly is greater in the non-measurable condition

# Experiment 1: results (low probability contexts)

| Measurability | measurable | | non-measurable | |
|---|---|---|---|---|
| operator | possible | possibly | possible | possibly |
| *N* of Participants | 140 | 150 | 187 | 115 |
| *N* of agree responses | 123 | 125 | 114 | 44 |
| % of agree | 87.9 | 83.3 | 61.0 | 38.3 |
| upper confidence interval | 93.3 | 89.3 | 68.0 | 47.1 |
| lower confidence interval | 82.4 | 77.4 | 54.0 | 29.4 |

### possible $\phi$ > possibly $\phi$

▶ the acceptability difference between possible and possibly is greater in the non-measurable condition

# Participants: Experiment 2

| | probability | 99.9% | 95% |
|---|---|---|---|
| operator | certain not | 125 | 100 |
| | certainly not | 131 | 91 |
| | certain | 99 | |
| | certainly | 149 | |

| | probability | 10% | 0.1% |
|---|---|---|---|
| operator | possible not | 98 | |
| | possibly not | 110 | |
| | possible | | 147 |
| | possibly | | 109 |

| Operator | certain not | certainly not | certain | certainly |
|---|---|---|---|---|
| $N$ of participants | 125 | 131 | 99 | 149 |
| $N$ of agree responses | 34 | 73 | 65 | 116 |
| % of agree | 27.2 | 55.7 | 65.7 | 77.9 |
| upper confidence interval | 35.0 | 64.2 | 75.0 | 84.5 |
| lower confidence interval | 19.4 | 47.2 | 56.3 | 71.2 |

**certain $\phi$ > certainly $\phi$**

▶ with or without negation, we obtained the pattern (p-value)

# Experiment 2: certain(ly) not at 99.9% vs. 95%

| % | 99.9% | | 95% | |
| --- | --- | --- | --- | --- |
| Operator | certain neg | certainly neg | certain neg | certainly neg |
| N of participants | 125 | 131 | 100 | 91 |
| N of agree responses | 34 | 73 | 27 | 46 |
| % of agree | 27.2 | 55.7 | 27.0 | 50.5 |
| upper ci | 35.0 | 64.2 | 35.7 | 60.8 |
| lower ci | 19.4 | 47.2 | 18.3 | 40.3 |

## certain $\phi$ > certainly $\phi$

▶ with negation, we obtained the pattern at both probabilities (p-value)

# Experiment 2: with vs. without negation (at 10%)

| negation | with negation | | without negation | |
|---|---|---|---|---|
| Operator | possible not | possibly not | possible | possibly |
| N of participants | 98 | 110 | 140 | 150 |
| N of agree | 85 | 77 | 123 | 125 |
| % of agree | 86.7 | 70.0 | 87.9 | 83.3 |
| upper confidence interval | 93.5 | 78.6 | 93.3 | 89.3 |
| lower confidence interval | 80.0 | 61.4 | 82.4 | 77.4 |

**possible $\phi$ > possibly $\phi$**

▶ with negation, the difference between possible and possibly became significant (p-value)

# Experiment 2: possib(ly) at 0.1% vs. 10%

| probability | 0.1% | | 10% | |
|---|---|---|---|---|
| Operator | possible | possibly | possible | possibly |
| N of participants | 147 | 109 | 140 | 150 |
| N of agree | 128 | 77 | 123 | 125 |
| % of agree | 87.1 | 70.6 | 87.9 | 83.3 |
| upper confidence interval | 92.5 | 79.2 | 93.3 | 89.3 |
| lower confidence interval | 81.7 | 62.1 | 82.4 | 77.4 |

## possible $\phi$ > possibly $\phi$

▶ at 0.1%, the difference between possible and possibly became significant (p-value)