Do 2-year-olds understand epistemic *maybe*? Maybe!

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Introduction

- **Epistemic language is often argued to be absent until age 3** [1,2]
  - → studies rely on syntactically complex forms (e.g., modal or belief verbs: *must*, *know*) & taxing explicit behavioral tasks

BUT, by age 2:

- children exhibit possibility and belief reasoning
  - → precursors to epistemic reasoning [3,4,5]
- children productively use epistemic adverbs like *maybe* [6]
  - → syntactically less complex than modal or belief verbs [7]

→ **SO** epistemic adverb '*maybe*' **&** an implicit online comprehension task reduce complexity and allow us to probe children's understanding of epistemic possibility.

Research Q: Do 2-year-olds understand that ***maybe*** expresses epistemic possibility?

Background: Children's understanding of epistemic possibility

Epistemic Reasoning & Talk

- **Epistemic reasoning involves inferring over open possibilities, given what is known or perceived**
- **Epistemic language** is "**notionally defined**" [9] and can be achieved via many grammatical categories and constructions, both within and between languages [9, 10].

a.	*I can ride one.*	(= a toy horse)	Sarah 2;04,12	Root (Ability)
b.	*I can't do it.*	(=hurt her mom)	Sarah 2;11,28	Root (Deontic)
c.	*Must be gone.*	(=missing toy dishes)	Sarah 3;00,27	Epistemic

- Most prior work on epistemic talk has tracked emergence of **modal verbs** in spontaneous production (i.e., **root-before-epistemic** asymmetry) [cf. 11]
- Production milestones argued to reflect conceptual advancements [e.g., 12]. Epistemic use of modal verbs onsets **around 3-years-old**, linked to ***Theory of Mind*** development [1].
- Epistemic language experiments utilize explicit behavioral tasks (e.g., [13] with 5-years-olds] and usually test modal force (*can* vs. *has to*; see [14]).

Possibility Reasoning

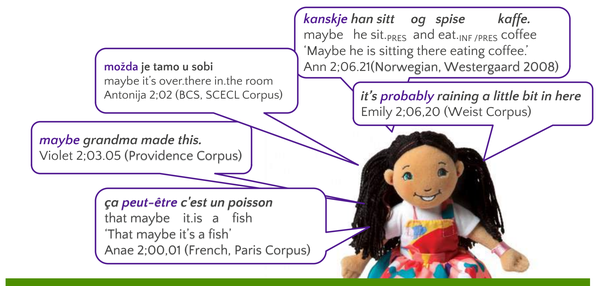
- Prior work provides convincing evidence that 2-years-olds possess the conceptual scaffolding for epistemic reasoning:
  - → 12-month-olds engage in possibility reasoning [3]
  - → 15–24-month-olds exhibit belief reasoning [4,5]
  - → 27-month-olds behaved differentially during eye-tracking for German '*believe*' vs. '*know*' [15]
- **BUT** "Premature Closure": Children before 5 have trouble maintaining >1 open possibility, and eliminate one possibility to resolve uncertainty [14, 16, 17]

Modal verbs – functional (e.g., auxiliaries in English) & polysemous (i.e., deontic and epistemic interpretations of the same form) ← Focus of most linguistic and L1A modal research
(1) ***She** might **be Irish***

Modal adverbs – adjunctival (i.e., non-central syntax, flexible) & monosemous (i.e. *maybe* is only epistemic). ← Give kids the best shot at form-meaning mapping
(2) ***(**Maybe**) she's (**maybe**) Irish (**maybe**)***

Early Productions of *maybe*

- Epistemic adverbs are well-attested in remarkably informative utterances in early child production.
  - → Even among earliest uses (~2nd birthday): reference to internal states (e.g., *want*) & variability in distribution [7]
- **2-years-olds produce ostensibly epistemic modal adverbs cross-linguistically:**



Methods

Figure 1. Example Trial with ROIs

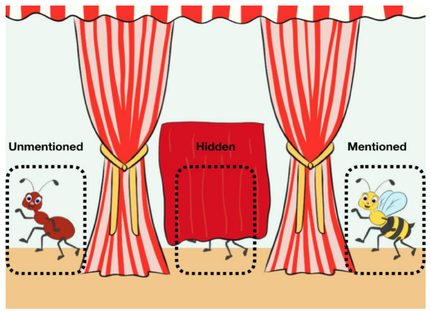


Table 1. Sample Auditory Stimuli

Sample Trial (Bee and Ant)	
Trial set-up	
	Look, this is a bee! [bee bounces]
	Look, this is an ant! [ant bounces]
	Who's hiding?
Conditions	
Positive	It's also a bee!
Negative	It's not a bee!
Modal	It's maybe a bee!

Stimuli:

- To test 2-year-old comprehension we rely on partially-obscured animals, where epistemic uncertainty is linked to **category membership** [3]
- Videos of 10 animal pairs sharing one common feature (**Figure 1**)
- 4 POSITIVE, 4 NEGATIVE, 8 MODAL
- prompt: "Who's hiding?"
- probed again (after 2500 ms) with: "Who is it?"

Participants: 13 2-year-olds, M =2;04; SD=0;04 (5 excluded, projected N=25)

Procedure: Visual world eye-tracking

- adapted preferential looking paradigm [18]
- guessing game
- reveal hidden in NEGATIVE and POSITIVE condition
- animal pairs pseudo-randomized across participants (max 2 same pair)
- balanced screen and introduction order

Hypotheses:

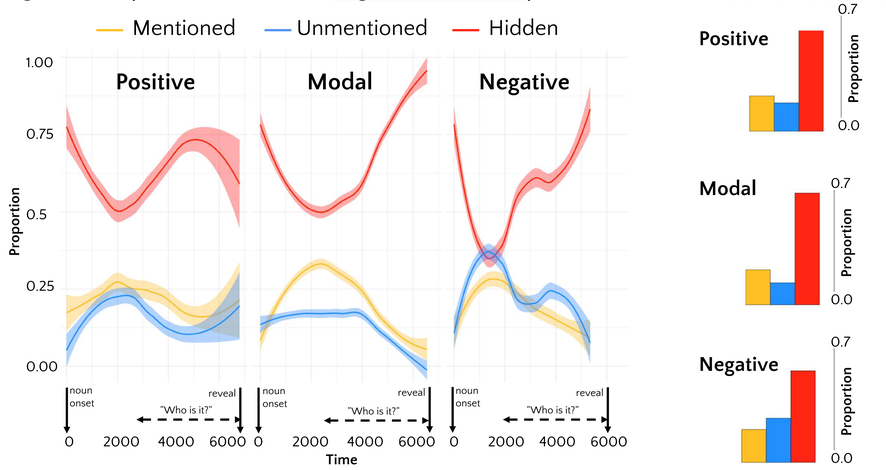
1. Proportion of looks to mentioned animal highest in **POSITIVE** condition (unmentioned lowest)
2. Proportion of looks to unmentioned animal lowest in **NEGATIVE** condition (mentioned highest)

3A. MODAL condition split – both animals open possibilities, given the available evidence

3B. Secondary, expect more looks to hidden in **MODAL** – search for disambiguating cues

Results

Figure 2. Proportion of Looks to Regions of Interest per Condition



Window: 0 – 5000 ms

Descriptive preliminary results:

- greater proportion of looks to unmentioned in NEGATIVE condition (***expected***)
- greater proportion of looks to mentioned in POSITIVE (***expected***) and MODAL condition (***unexpected***)
  - → trend clearer for MODAL condition
- greater proportion of looks to hidden in MODAL than POSITIVE condition

Discussion

Main Finding: looking behavior does not suggest consideration of multiple possibilities for ***Maybe***

- MODAL condition patterns as predicted for POSITIVE
  - → increased looking to mentioned vs unmentioned animal and no expected back-and-forth looking behavior
  - **BUT** more looks to hidden animal suggests consideration of evidence or anticipation of (unknown) reveal
- "Reverse" asymmetry between production and comprehension of epistemic (evidential) component [19]
  - **Why?** Still an open question. Some possibilities:
  - 1. They *don't* understand that *maybe* expresses epistemic possibility
  - 2. They understand *maybe* as an item that prompts *guessing* [Leahy & Carey 2019]
  - 3. They understand *maybe* but *prematurely close*
  - → avoid the cognitive load and endorse one possibility [14, 16, 17]; if so, the time-course suggests this happens rapidly [c.f. 17]
- clearest results emerging for NEGATIVE condition
  - → more looks to unmentioned vs mentioned animal
  - → corroborates previous findings that 2-year-olds understand negation [e.g., Carvalho et al. 2019]
- trending results emerging for POSITIVE condition
  - → slight increase in looks to mentioned vs unmentioned

Limitations and Future directions

- Complete data-collection ($N_{projected}$ =25)
- Our sample of 2-year-olds skews young (mean 2;4)
- Skewed trial loss for *also* condition (and less trials POS/NEG than MOD)

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