



20-21 / 11

# Possibility Reasoning

Logic, Language & Cognition

Université Paris Cité  
45 Rue des Saints Pères  
75006 Paris, France

## Foreword

As humans, we spend a significant amount of our mental life imagining possibilities (non-actual situations). We frequently consider alternative possible worlds or contemplate how different versions of the past would have affected the present. Possibility reasoning is crucial for human survival as it enables us to predict the future, plan our actions and make better decisions. Despite its significance, the origin of possibility reasoning has been debated by philosophers and researchers for centuries. Currently, there is significant disagreement about whether possibility reasoning (and logical thought more broadly) is available, in the absence of language, to non-human animals and pre-linguistic infants, or whether it relies heavily on language and is thus available only to linguistically capable reasoners. Although such questions have been theoretically debated for centuries, recent advancements in psychology, philosophy and linguistics have provided the tools and methods to seek empirical evidence. Still, the science of thinking about the possible has been developing in separate knowledge fields. The goal of the workshop is to promote the understanding of possibility reasoning in various areas of cognition, by bringing together a broad range of researchers working the topic from different scientific perspectives.

This booklet holds the abstracts of the talks presented in the workshop *Possibility Reasoning: Logic, Language & Cognition*, held on November 20-21, at Université Paris Cité, 45 rue des Saint Pères, Paris, France. The workshop was generously supported by a partnership grant between Université Paris Cité and the University of Toronto.

### Workshop Organizers

Olivier Mascaro (Université Paris Cité)

Myrto Grigoroglou (University of Toronto)

Patricia Ganea (University of Toronto)

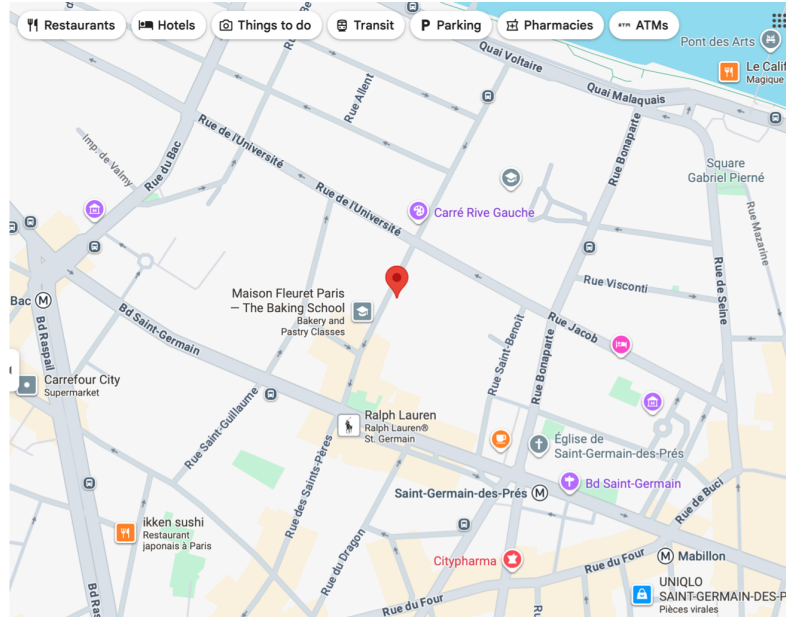
## How to get there

The workshop will take place at  
Université Paris Cité  
45 rue des Saints Pères



The entrance of the building

Nearest underground stations  
 Saint-Germain-des-Prés (line 4)  
 Mabillon (line 10)  
 Rue du Bac (line 12)



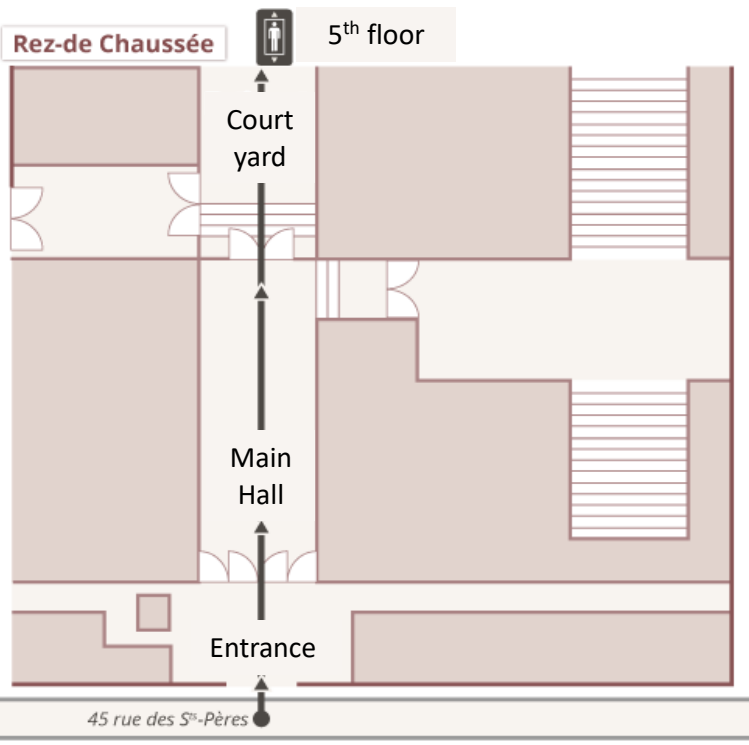
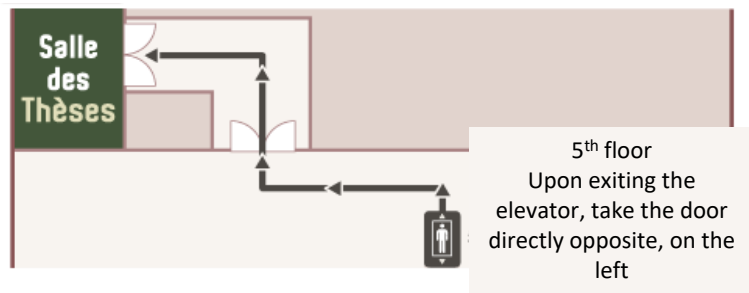
Talks will take place in  
“Salle des thèses”  
Bâtiment Jacob, 5<sup>th</sup> floor

Once at the entrance, 45 rue des Saints Pères, walk across the main hall

Walk across the courtyard to reach the elevator in the Jacob building (bâtiment Jacob)

On the 5<sup>th</sup> floor, upon exiting the elevator, take the door directly opposite, on the left

And follow the signs to reach the Salle des thèses



# Possibility Reasoning: Logic, Language and Cognition

November 20–21, 2025

Université Paris Cité, 45 rue des Saint Pères, Paris

## DAY 1 — November 20

### Morning Session

8h45–9h	Welcome
9h–9h30	S. Beck: <i>Possibilities in time</i>
9h30–10h	O. Mascaro: <i>From push to possibility: The roots of counterfactual reasoning in causal cognition</i>
10h–10h30	A. Nyhout: <i>Causal complexity and reliability in early hypothetical thought</i>
10h30–11h	Coffee break
11h–11h30	W. De Neys: <i>Hypothetical thinking, intelligence, and System 1</i>
11h30–12h	J. Redshaw: <i>On cognitive uncertainty and possibility reasoning</i>
12h–12h40	Discussion (Chair: P. Ganea)
12h40–14h30	Lunch break

### Afternoon Session

14h30–15h	R. Byrne: <i>How people verify possibilities and impossibilities</i>
15h–15h30	M. Grigoroglou: <i>Revisiting the acquisition of conditionals</i>
15h30–16h	Coffee break
16h–16h30	D. Lassiter: <i>Why do non-actual possibilities matter in conditional reasoning?</i>
16h30–17h10	Discussion (Chair: I. Noveck)

## DAY 2 — November 21

### Morning Session

- 9h–9h30 I. Grosu: *Modal force in the production of children's counterfactual conditionals*
- 9h30–10h H. Rakoczy: *Sociality and agency in early modal reasoning*
- 10h–10h30 A. Courmane: *Word-learning challenges and children's non-adult behaviours with modal force*
- 10h30–11h Coffee break
- 11h–11h30 J. Call: *Necessity and possibility in the reasoning of great apes*
- 11h30–12h J. Phillips: *General-purpose modal representations*
- 12h–12h40 Discussion (Chair: S. Mascarenhas)
- 12h40–14h30 Lunch break

### Afternoon Session

- 14h30–15h L. Tieu: *Children's reasoning about disjunctive possibilities*
- 15h–15h30 A. Kovács: *Reasoning about possibilities through the lens of others: evidence from infants and adults*
- 15h30–16h Coffee break
- 16h–16h30 N. Cesana-Arlotti: *Core Logic: cross-domain logical reasoning in human infants*
- 16h30–17h I. Dautriche: *Negation in and outside language*
- 17h–17h40 Discussion (Chair: E. Téglás)

DETAILED PROGRAM AND ABSTRACTS  
Possibility Reasoning: Logic, Language and Cognition  
November 20–21, 2025

DAY 1 — November 20

MORNING SESSION

8:45–9:00 — Welcome

9:00–9:30 — Sarah Beck

*Possibilities in Time*

In this talk I will pull together findings from work on counterfactuals and future thinking along with epistemic and physical uncertainty. Previous studies have suggested that children find counterfactual thinking harder than speculating about hypothetical events in the future. Similarly children seem better able to acknowledge multiple possibilities when they remain in the future compared to when they were in the past. I will explore the role of possibilities in these tasks suggesting that whether possibilities are known to be true or not as well as mental time travel influence children's thinking. I will argue that a temporal perspective is important for fully understanding possibilities.

9:30–10:00 — Olivier Mascaró & Patricia A. Ganea

*From Push to Possibility: The Roots of Counterfactual Reasoning in Causal Cognition*

Are infants already capable of thinking about what might have been? Adult causal cognition is known to depend on counterfactual reasoning —the capacity to imagine how events might have unfolded differently in order to identify their causes. Infants, however, already show sensitivity to simple causal patterns, such as one object setting another in motion. The key question is whether this early causal reasoning is already relying on counterfactual reasoning, or whether it reflects a fundamentally different kind of cognition.

This talk will detail preliminary findings from two ongoing studies with infants and preschoolers designed to disentangle these possibilities. According to the developmental continuity hypothesis, children's causal reasoning is grounded in the consideration of alternative possibilities from the earliest stages of development, mirroring that of adults. The developmental discontinuity hypothesis instead predicts that early causal cognition operates without counterfactual reasoning and, thus, is fundamentally distinct from that of mature adults. Resolving this debate promises to advance our understanding of both the origins of counterfactual thought and the developmental trajectory of human causal cognition.

10:00–10:30 — Angela Nyhout

*Causal Complexity and Reliability in Early Hypothetical Thought*

In this talk, I will synthesize findings from two experimental programs exploring how children aged 3.5 to 7 years navigate causal structure and causal reliability in counterfactual and future hypothetical reasoning. The first set of studies examined children's reasoning about hypothetical interventions to three causal structures—causal chain, common cause, and common effect—using animated systems (e.g., windmills, lights, bouncy balls). Results showed that although children were able to answer causal questions about the systems, they struggled to reason about what would happen under hypothetical interventions, both when framed as a past counterfactual and a future hypothetical. Surprisingly, children's performance was slightly better when asked to reason about overdetermined (common effect) models in which two causes led to an outcome compared to the other structures.

The second study set investigated how causal reliability (deterministic versus probabilistic) affects children's counterfactual judgments using a blicket-detector paradigm. Across two experiments, 4- to 5-year-olds were presented with blocks that activated a box with varying probabilities (100%, 75%, 50%, 25%). Children reasoned more accurately about deterministic causes and showed declining performance as causal reliability decreased. Overdetermined trials were easier than trials with a single cause, especially under uncertainty. Together, both sets of findings deviate in notable ways from some past findings that have suggested that children cannot reason counterfactually about overdetermination under middle childhood. These findings indicate that both causal structure and reliability influence children's ability to simulate alternative outcomes, suggesting that developmental shifts in reasoning are sensitive to the reliability, but not always the structure, of causal systems.

10:30–11:00 — Coffee Break

11:00–11:30 — Wim De Neys

*Hypothetical Thinking, Intelligence, and System 1*

Counterfactual, hypothetical thinking has long been considered a hallmark, defining feature of reflective, deliberate reasoning (i.e., "System 2"). The capacity for deliberate thinking is typically measured with fluid intelligence test such as the Raven. I'll present recent evidence using a two-response paradigm that shows that performance on fluid intelligence tests can be driven by intuitive ("System 1") processing. High fluid intelligence is not necessarily indicative of good deliberation but rather of sound intuiting. I'll discuss implications for our view of hypothetical thinking as a defining feature of deliberation. A speculative conclusion is that hypothetical thinking can be automatic and intuitive—and does therefore not require "language" or "logic".

11:30–12:00 — Jonathan Redshaw

*On Cognitive Uncertainty and Possibility Reasoning*

Theories of human possibility reasoning must account for the fundamental role of cognitive uncertainty in animal decision-making. If uncertainty itself entails sensitivity to alternative possibilities across animals, then what could be special about the human case? Drawing on analogies with classic perceptual phenomena, I will suggest that animals (and young children) tend to explicitly represent one possible world state while implicitly tracking other possible world states in situations of uncertainty. In the perceptual case of binocular rivalry, the brain maintains evidence for two percepts but only one percept reaches awareness. In the representational case of mutually exclusive possibilities, the brain likewise maintains evidence for multiple world states but only one world state is explicitly represented. On this view, cognitive uncertainty can still function as an internal stimulus driving information seeking and learning in animals, all the while only one representation dominates at the level of phenomenology (because representing a probability cloud would be evolutionarily catastrophic). Humans, by contrast, can represent that their dominant representation of the world is just a representation, and thus reason about the mutually exclusive relations among alternative representations implied by cognitive uncertainty.

12:00–12:40 — Discussion (Chair: Patricia Ganea)

12:40–14:30 — Lunch Break

#### AFTERNOON SESSION

14:30–15:00 — Ruth Byrne

*How People Verify Possibilities and Impossibilities*

I consider how people revise their understanding of possibilities and impossibilities. I outline experimental results on how people verify compound assertions, such as “Ann is in Dublin or London”, that show that their judgments of an assertion’s truth are influenced by information about alternative possibilities, e.g., “In fact, Ann is in Dublin, but otherwise she would have been in Paris.” I also outline experimental results on how people judge assertions about impossibilities, such as “if people were made of steel they would not bruise”, that show that they judge some impossibilities to be true and others to be false. I discuss how people update a possibility to think of it as a fact or as a counterfactual possibility, and how they imagine impossibilities as if they were possibilities.

15:00–15:30 — Myrto Grigoroglou

*Revisiting the acquisition of conditionals*

Children acquire conditionals late for reasons that are poorly understood. In this talk I will present evidence from a research program on children's acquisition of conditional if...then statements. Study 1 investigates how hypothetical thoughts are expressed through language in the speech of 3- to 6-year-old children and adults. Participants were presented with a toy with a simple causal structure (box that lights up when you put the 'right toy' on it) and were asked to teach a student how the box works (or could have worked). Results from this study show that both children and adults use a variety of linguistic means to express hypothetical thoughts, and, unlike prior claims, if-clauses are not produced later than other constructions of similar grammatical complexity. Study 2 examines interpretation of conditional if-clauses in the same group of children and adults and finds protracted difficulties understanding the logical meaning of conditionals even in 6-year-olds. Study 3 modifies the paradigm to introduce a broader set of alternative enablers for the causal toy and asks a new group of 5-year-olds, 7-year-olds and adults to answer questions about the classic conditional reasoning inferences (Modus Ponens, Modus Tollens, Denying the Antecedent, Affirming the Consequent). Findings show that both children and adults are less likely to commit logical fallacies in conditional reasoning when evaluating conditional statements against a broader set of alternatives. This research revisits the acquisition of if-clauses during development in language production and comprehension and demonstrates that difficulties often presented as conceptual may be pragmatic in nature.

15:30–16:00 — Coffee Break

16:00–16:30 — Dan Lassiter

*Why Do Non-Actual Possibilities Matter in Conditional Reasoning?*

Until recently, philosophers and linguists have almost universally agreed that indicative conditionals have a modal semantics: their truth and falsity depends on what possibilities are left open by relevant information is available, and not just on how the world is. I will argue that this consensus is wrong. Alternative possibilities are relevant to the meaning of "If it rained, the party was moved inside" only inasmuch as they are to "The party was moved inside": conversational norms prohibit a speaker asserting either claim without sufficient evidence. I'll sketch an alternative approach that combines a model of conversational context with a three-valued semantics that has long been popular in psychological research and has enjoyed a recent surge of interest in philosophical logic. Moving possibilities from the semantics of conditionals into their pragmatics helps in a number of thorny problems in how we speak and reason with conditionals.

16:30–17:10 — Discussion (Chair: Ira Noveck)

## DAY 2 — November 21

MORNING SESSION

9:00–9:30 — Ioana Grosu & Patricia A. Ganea

*Modal Force in the Production of Children’s Counterfactual Conditionals*

We use counterfactual conditionals in our everyday language to talk about the state of the world given a change from reality (e.g., “If the store had the doll, Sally would’ve wanted to go there.”) In English, the consequents of counterfactual conditionals (e.g., “Sally would’ve wanted to go there”) typically include a modal auxiliary verb such as ‘would’ or ‘could’. In this work, we focus on the force of the modal verb and analyze whether children’s distribution of possibility vs. necessity modals varies from that of adults in counterfactual contexts. We adapt the procedure in Cournane et al. 2024 to counterfactual conditionals, setting up contexts for epistemic modality, root modality, possibility and necessity. We then compare adult distributions of modal verbs to those of children, focusing on the distribution of possibility vs. necessity modals. We additionally compare distributions of modal verbs between counterfactual and non-counterfactual contexts, analyzing whether modal force usage for children differs between utterance types. In doing so, we aim to better understand how children quantify over different types of possibilities and gain more insight into their use of counterfactual language.

9:30–10:00 — Hannes Rakoczy

*Sociality and Agency in Early Modal Reasoning*

When and how does modal and meta-cognition – reasoning about what is possible, necessary, known or uncertain, and the like – emerge? This has been a hotly debated question in recent comparative and developmental cognitive science. In my talk, I will focus on two factors that may be crucial for the early developments of the capacities in question, but that may have failed to receive as much attention as they deserve: sociality and agency. Meta-cognition may be primarily for social usage: not thinking about what one knows privately, but communicating, in the service of cooperation and coordination, to others the sources and degrees of one’s own beliefs (Shea et al., 2014). Modal cognition may be primarily for agentive usage: not thinking about what could be the case in detached and passive ways, but thinking about what one could do as an agent in the world (Vetter, 2023). I will present several lines of research from our lab to suggest that modal and meta-cognition may indeed primarily emerge in social and agentive contexts.

10:00–10:30 — Ailis Cournane

*Word-Learning Challenges and Children’s Non-Adult Behaviours with Modal Force*

We argue that preschoolers' errors with modal force stem from a non-adult lexical semantics: they initially interpret necessity modals like *have to* as possibility modals. Across two new experiments testing modal force in teleological (root) contexts with input-consistent modals (*can*, *have to*), children over-accepted *have to* in possibility scenarios at ceiling rates, treating it identically to *can*. This replicates and extends prior findings from epistemic tasks (e.g., Papafragou & Ozturk, 2014; Moscati et al., 2017) but suggests the problem is not merely conceptual difficulty with possibility, but rather word-learning challenges disproportionately affecting necessity modals. More broadly, our findings show how modal flavor and force interact: epistemic studies yield persistent chance-level behavior, likely due to metacognitive demands not yet robust in preschoolers (e.g., Phillips & Kratzer, 2023), whereas root studies reveal a specific necessity-as-possibility pattern.

10:30–11:00 — Coffee Break

11:00–11:30 — Josep Call

*Necessity and Possibility in the Reasoning of Great Apes*

Much of the empirical work in comparative cognition aimed at elucidating the nature of inferences in nonhuman animals has focused on distinguishing inferential processes from those based on associative learning or low-level attentional mechanisms. In contrast, relatively little attention has been paid to whether modal conceptual reasoning—such as reasoning about necessity and possibility—plays a role in the inferences made by nonhuman primates. In this talk, I will present a series of object search studies demonstrating that ape inferences are probabilistic rather than deterministic, and not attributable to non-inferential processes. While we found no evidence that apes represent necessity, the question of whether they consider possibilities remains open.

11:30–12:00 — Jonathan Phillips

*General-Purpose Modal Representations*

Much of high-level cognition relies on a capacity to represent the relevant possibilities in a given situation. To judge that someone is morally responsible for a given action requires assessing what other actions were available to that person. To decide what caused something to happen requires determining what else could have happened instead. To make a decision requires representing possible options and deciding between them. And so on. An important but unanswered question is whether each different high-level judgment relies on a domain-specific representation of the possibilities relevant for that judgment, or whether humans have a more general-purpose representation of

possibilities that is recruited across various forms of high-level cognition. I'll provide evidence for the latter hypothesis. I'll introduce a general method for empirically measuring the set of possibilities that people consider to be relevant in a particular situation (through sequential sampling), quantitatively characterize both this generation process and the structure of the space of possibilities represented, and show that the same representation of possibility is

recruited across distinct forms of high-level reasoning, namely decision making, force judgments, causal judgments, and blame attribution.

12:00–12:40 — Discussion (Chair: Salvador Mascarenhas)

12:40–14:30 — Lunch Break

#### AFTERNOON SESSION

14:30–15:00 — Lyn Tieu

##### *Children’s Reasoning About Disjunctive Possibilities*

Children’s understanding of disjunction has been a topic of interest in the developmental literature since at least the 1950s. Studies find that while adults interpret disjunctive words like “or” exclusively (A or B, but not both), children tend to interpret disjunction either inclusively (A or B, or both) or conjunctively (both A and B). In this talk, I will first present some experimental evidence for the inclusive/conjunctive pattern in children, and a possible account of this data that relates children’s behavior to the alternatives they access. We will then examine some recent evidence that logical or pragmatic (in)compatibility of the disjuncts (thus reasoning about whether both disjuncts can hold simultaneously) may help children to home in on the exclusive interpretation of disjunction.

15:00–15:30 — Ágnes Kovács

##### *Reasoning About Possibilities Through the Lens of Others: Evidence from Infants and Adults*

Considering alternative possible worlds, as well as tracking others’ models of the world has special epistemic value, allowing navigating the social world. Others often have access to different evidence, thus to predict their behavior we should represent their larger/narrower space of possibilities, or can even rely on others to restrict our own alternatives. Here we present three studies targeting the emergence and nature of these processes. The first study investigated whether infants rely on others to restrict their alternatives via integrating logical and mental state reasoning, considering others’ contextual preferences (from A and B, agent prefers A; from B and C, agent prefers B). After seeing an agent choosing an ambiguous object (A or C) over a non-ambiguous one (B), infants used disjunction and others’ contextual preferences to infer the identity of the ambiguous object. The second study suggests that infants understand the behavioral consequences of having a larger space of possibilities (A or B) in third person, interpreting others’ epistemic actions accordingly. In a third study we found that such abilities are not only early emerging, but also spontaneously deployed by adults, who represented the alternatives another agent considered possible, even when it was not necessary (Fogd, Teglas, Kovacs, 2025).

15:30–16:00 — Coffee Break

16:00–16:30 — Nicolò Cesana-Arlotti

*Core Logic: Cross-Domain Logical Reasoning in Human Infants*

Philosophers, cognitive scientists and evolutionary psychologists have long debated whether general-purpose logical reasoning is a primitive feature of the human mind, a result of language acquisition, or transmitted via formal education. In this talk, I will share a set of experiments probing deductive inferences that combine knowledge of inanimate objects and animate agents. Our results trace this capacity from adulthood to infancy, challenging the notion that abstract, cross-domain logical thought requires linguistic scaffolding or extensive experience. Instead, human infants may possess irreducible core logical competences, helping them to integrate knowledge from both physical and social domains into a coherent understanding of the world.

16:30–17:00 — Isabelle Dautriche

*Negation In and Outside Language*

Is language necessary for representing abstract compositional operations? In this talk, I focus on negation as a case study. I first present evidence that 20-month-old English-learning children already understand linguistic negation, establishing an upper bound for investigating non-linguistic forms of negation. I then show that by 12 months, infants can combine a negative facial expression with an object, suggesting that the basic components of negation are available before children acquire a linguistic label for it. Finally, I will show extension of this work in non-human animals (Guinea Baboons), providing insights into the building blocks of negation beyond the human species.

17:00–17:40 — Discussion (Chair: Ernő Téglás)