

Conversing with machines: How AI is changing the way scientists think

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1 | THE LINGUISTIC TURN IN SCIENTIFIC REASONING

Consider a molecular biologist exploring transcriptomic data through an AI interface. A simple query about an expression outlier triggers a cascade of speculative exchanges—rapid, iterative, and dialogical. For the first time, researchers can engage in sustained, dialogical exchanges with computational systems. AI—particularly large language models (LLMs)—has turned computation into dialog [1]. This shift marks a deeper epistemic reconfiguration: reasoning becomes dialogical, evolving through feedback between representation and interpretation. In philosophical terms, LLMs function as mediating artifacts that shape what can be inferred and how hypotheses are articulated [2]. Where past generations of scholars had to master the syntax of code or statistical languages, today's scientists can explore ideas in plain language, asking why as easily as how. Until recently, the rhythm of research followed a linear path: read the literature, form a hypothesis, design the experiment, publish the results [3]. Creativity often lived in the margins—half-written notes or sporadic conversations—whereas much thinking happened in isolation.

Historically, however, science had evolved differently. The first academies of science—such as the Royal Society—thrived on correspondence and disputation [4]. Knowledge emerged through dialog and collective reasoning. Yet, over time, that conversational culture gave way to specialization, formal reporting, and the economy of publication.

LLMs now may be reopening that space for dialog, though the interlocutor is nonhuman [5]. Scientists can brainstorm, translate, and critique ideas with systems that respond instantly and fluently. The interaction is not peer review, nor is it mere automation. It is something in between: a private conversation that amplifies reflection [6]. Researchers can test a line of reasoning, rephrase a hypothesis, or probe a gap in logic before bringing it to colleagues. In this sense, AI does not replace collaboration; it extends it, relocating conversational energy inside the researcher's workflow [7]. The chat interface becomes a cognitive scaffold—a space where individual reasoning can be externalized and iteratively refined [8]. Inquiry becomes less a sequence of procedural steps and more a recursive exchange between human judgment and algorithmic suggestion [1].

Science, long defined by its formal languages and methods, is becoming increasingly interactive and conversational. And in that rediscovered conversation, researchers may find not only new answers but a renewed way of asking questions [1].

2 | TALKING TO MACHINES: A NEW GENRE OF SCIENTIFIC THOUGHT

When scientists first began using computers, they had to learn the machine's language. Every analysis, every model, had to be translated into code or a specific way to interact with a software interface. Thought became instruction, and curiosity was constrained by syntax.

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Yet today that boundary is rapidly eroding. LLMs—systems such as generative pre-trained transformer (GPT) and the now-household name ChatGPT—allow researchers to ask questions, test ideas, and explore data in plain language. A biologist can request a statistical summary, or a historian can have an AI summarize archival material [1].

This transformation introduces a qualitatively different mode of reasoning with computational systems. Each exchange builds iteratively on the previous one, creating a continuous feedback loop in which questions and answers co-evolve. In quantitative research, this can alter the modeling workflow, allowing hypothesis refinement and interpretation within a single dialog. In practice, interaction with an LLM feels less like consulting software and more like externalizing one's own reasoning process [9]. A researcher might prompt the model to surface alternative explanations or identify conceptual analogies across fields. The responses are not always correct—hallucinations remain a significant limitation—but they often introduce unexpected conceptual connections that sustain exploratory reasoning [10]. They turn reasoning into a continuous process of revision rather than a single step of execution [11].

This conversational rhythm is emerging as a distinctive mode of scientific reasoning [12]. It changes the temporal structure of inquiry: brainstorming occurs in real time, feedback becomes instantaneous, and conceptual exploration—traditionally confined to collaborative settings—integrates seamlessly into daily workflow [5]. The model's capacity to retrieve and re-contextualize information from vast textual corpora enables connections that might otherwise remain undiscovered. The dialog is asymmetrical—the model possesses no agency or intent—but it is remarkably adaptive, mirroring the user's phrasing, maintaining context, and elaborating on partially formed ideas. In effect, the model acts as a reflective medium that externalizes reasoning and exposes implicit assumptions [6].

Yet this fluency entails epistemic risks. Coherence can mask uncertainty, and linguistic confidence can foster misplaced trust [13]. The apparent authority of well-formed text may obscure error or bias. If engaged uncritically, such systems risk encouraging intellectual passivity [14]. When used reflexively, however, they function as scaffolds for thought—tools that externalize reasoning without replacing it. The human researcher remains the locus of interpretation and judgment; the model serves as a conversational catalyst that keeps inquiry active [8].

What emerges from this partnership is a new cognitive configuration—part solitary reflection, part dialogical collaboration. It exemplifies hybrid cognition, in which reasoning is distributed across human and artificial agents [15]. Here, the machine contributes to

retrieval and recombination of information, while the human provides interpretation, evaluation, and epistemic control. Scientific thinking becomes dynamic and iterative, unfolding through interaction rather than instruction. The rise of AI in research, therefore, is not merely a story of automation but a rediscovery of dialog as a method of inquiry, where understanding develops through iterative questioning and refinement.

3 | FROM CONVERSATION TO MODELING LOOP

In quantitative biology, computational reasoning has always been iterative and tightly coupled to data. Models are built, tested, refined, and sometimes discarded—a cyclical process central to quantitative inquiry [16]. Traditionally, much of the reasoning shaping these cycles remained implicit or undocumented. What LLMs introduce is a new layer in that loop: a linguistic interface that externalizes reasoning itself. Instead of translating thought into code or equations through specialized syntax, researchers can now express intentions in natural language and receive executable or explanatory responses. The model functions as a linguistic interface between conceptual framing and numerical implementation, allowing researchers to articulate modeling intentions and receive structured computational output.

This shift transforms how modelers engage with uncertainty and abstraction. A systems biologist might ask an AI to propose parameter sets producing oscillations, then explain which feedback terms drive instability. Each exchange refines both the computational setup and its interpretation. The dialog becomes a living record of the modeling process—one that captures the rationale, context, and evolving assumptions that often vanish from published methods. This has direct implications for reproducibility: decisions that would normally be buried in code or tacit expertise become verbally traceable. In this sense, the AI acts as a form of epistemic documentation: a transparent transcript of how models are conceived, questioned, and re-aligned with data.

Classical modeling cycles often end when validation metrics converge; conversational loops continue, generating hypotheses about why a fit succeeded or failed. They make explicit what was previously implicit—how researchers reason between models and observations. This recursive coupling mirrors what philosophers of science describe as circular knowledge production: models shape interpretation, interpretation reshapes modeling choices, and the cycle becomes explicit through language [17]. Dialog is no longer a prelude to analysis; it is part of analysis.

Yet this conversational layer does not dissolve rigor—it repositions it. Responses from an AI can be

interrogated, revised, or traced, making the reasoning process more auditable [18]. Properly integrated into computational pipelines, these exchanges could become part of the provenance metadata that accompanies models and datasets. Such records could complement existing standards for model documentation, including workflow descriptions, parameter histories, and justification of modeling choices. In doing so, conversational AI does not replace the modeling loop of quantitative biology; it renders that loop visible and linguistically documented, enabling continuous revision and scrutiny.

4 | WHEN SCIENCE STARTS TALKING BACK

Scientific ideas rarely emerge fully formed. They evolve—through sketches on a whiteboard, arguments in the lab, or extended correspondence among collaborators. What LLMs add to this process is instant, structured feedback that can be directly linked to analytical or modeling decisions [5, 7]. Instead of waiting for a seminar or a peer review, a researcher can now test a thought the moment it arises.

Type a question, get an answer, ask again. Each exchange reshapes the problem. The conversation does not end—it loops. The scientist's question becomes the seed for the next response, which in turn sparks a new question. This recursive rhythm sustains cognitive momentum. In quantitative workflows, this often translates into faster refinement of model assumptions, parameter choices, or analytical strategies. Even when the model's answers are incomplete or imprecise, they perform a heuristic function: they generate candidate explanations, alternative formulations, or analytical directions that can later be evaluated empirically. Dialog itself becomes an experimental instrument, allowing researchers to “think out loud” in an environment that provides structured feedback. Empirical evidence supports this intuition. When researchers were tasked with generating hypotheses with and without AI assistance, the AI-supported ideas were rated as more novel, though sometimes less feasible [10]. This suggests that LLMs expand the exploratory space of reasoning while leaving feasibility assessment and selection to human judgment. They invite scientists to pursue fragile or incomplete intuitions that might otherwise be dismissed as premature [19].

The implications extend beyond individual creativity. As reasoning becomes conversational, knowledge circulates through new channels. However, this openness introduces new epistemic tensions. When algorithms participate in knowledge formation, questions of authorship, verification, and accountability become increasingly complex [13].

At a deeper level, this recursive dynamic exposes a feature of scientific reasoning that is usually hidden: the continual adjustment between interpretation and modeling decisions. Dialog with AI makes this interpretive work visible, rendering the reasoning process observable, revisable, and open to meta-cognitive reflection. The shift from iteration to conversation thus marks not merely a technological development, but a transformation in epistemic practice: discovery increasingly emerges through interaction, where understanding evolves through continuous dialog alongside, rather than replacing, discrete experimental events [1].

5 | THE ACCESSIBLE MIND: WHO GETS TO SPEAK SCIENCE?

When analysis can be conducted through ordinary language, the boundaries of scientific participation expand. What was once limited to those fluent in programming or embedded within well-resourced institutions can now, in principle, be accessed by a far broader range of researchers, including those without advanced computational training [20]. Tasks that previously required scripting analyses, configuring software pipelines, or accessing dedicated bioinformatics support can now be initiated through dialog. For researchers in underfunded institutions or regions with limited resources, this transition represents a tangible step toward greater epistemic equity in global science [19].

Yet this same shift redefines what it means to be scientifically literate. As technical barriers decline, linguistic precision becomes the new epistemic threshold. The capacity to formulate effective questions, to interpret probabilistic answers critically, and to detect when fluent language conceals error or bias now determines the quality of reasoning. In a context where AI can execute analytical procedures autonomously, the human contribution centers on understanding—the ability to reason clearly, read critically, and construct questions that elicit meaning rather than merely retrieve information.

This transition has major implications for scientific education. The next generation of researchers will need to cultivate interpretive as well as computational skills. Teaching statistical interpretation, scientific writing, and critical reading thus becomes central—not peripheral—to training, as these skills govern how researchers evaluate and integrate AI-generated analyses.

Language models also function as linguistic and cultural bridges. A researcher can query in Spanish about a paper written in Standard Chinese and receive a coherent contextual synthesis. In this sense, scientific dialog becomes multilingual by default, lowering linguistic barriers that have historically limited participation and slowed the circulation of methods and results [1].

However, the promise of democratization remains contingent. Access depends on digital infrastructure, licensing regimes, and critical engagement [3]. Moreover, while the models appear neutral, they reproduce the biases embedded in their training data: overrepresentation of English-language and Western scientific discourse, underrepresentation of regional or minority scholarship, and epistemic blind spots in non-dominant traditions [13, 21]. In practice, this can skew literature summaries, marginalize region-specific disease research, or bias model recommendations toward dominant methodological traditions. Without deliberate correction, these asymmetries risk transforming “inclusive AI” into a new mechanism of exclusion—amplifying existing hierarchies under the guise of universality.

The outcome will depend on design and governance. Open, transparent, and multilingual models could form part of a shared conversational infrastructure that supports more equitable participation in scientific reasoning and method development. Conversely, proprietary systems restricted by paywalls or licensing constraints risk entrenching epistemic inequality.

In short, conversational AI broadens access but raises the cognitive bar for understanding. The scientist of the near future may write fewer lines of code—but must ask sharper, more critical questions—because the quality of inquiry will increasingly hinge on how well those questions are formulated.

6 | WHERE IDEAS CROSS BORDERS

If accessibility changes who can do science, creativity changes what kind of science can be imagined. LLMs are not merely accelerators of analysis; they are catalysts that reshape the cognitive landscape in which ideas emerge [10]. In quantitative biology, this often manifests as the ability to link mechanistic models, statistical patterns, and conceptual frameworks that originate in distinct research traditions. By enabling researchers to traverse disciplines through dialog, they reintroduce fluidity into an intellectual system increasingly structured by specialization, funding silos, and metric-driven evaluation [19].

Scientific creativity has always relied on analogy—the capacity to detect patterns that link distinct domains of inquiry [22]. Yet disciplinary segmentation has narrowed the range of such analogical reasoning: a neuroscientist rarely reads economics, and an engineer may never consult philosophy. Because LLMs are trained on language that spans fields, genres, and conceptual traditions, they can surface latent resonances that would otherwise remain inaccessible. A molecular biologist asking how cells coordinate under stress might receive an analogy drawn from collective behavior in ecology or information theory in network

science. While these analogies can sometimes be inaccurate, they frequently reflect shared descriptive structures across disciplines—terms, metaphors, and conceptual schemas that recur in scientific discourse. In this sense, the model functions as an agent of analogy, retrieving forgotten conceptual bridges between separate epistemic traditions [1].

Such cross-domain associations make dialog with AI inherently generative. When a researcher asks, “Is there something like this in another system?”, the model’s associative reasoning expands the map of possible connections. This process reintroduces serendipity into a research culture that has become heavily optimized and risk-averse.

Creativity also resides in expression. To articulate an idea clearly often means to understand it more deeply. Here too, LLMs act as rhetorical collaborators—proposing alternative framings, metaphors, and analogies that help researchers reimagine their own findings. A biologist might prompt, “Explain this mechanism as if it were architecture,” and discover parallels in structure, stability, or hierarchy. These exercises may appear playful, yet they are cognitively substantive: metaphors operate as instruments of conceptual discovery. Empirical work in design and engineering similarly suggests that conversational AI expands the range and originality of proposed solutions [8].

The scientist remains the author of insight, but the dialog sustains creative momentum. The act of discovery becomes distributed—a recursive process in which human intention and algorithmic suggestion co-evolve. However, this collaborative creativity also introduces new ethical and epistemic questions. When an idea arises from such an interaction, where does authorship reside? Is the model a co-author, a tool, or a catalyst? The practical answer may be less important than the intellectual posture it requires: one of responsible play—the ability to speculate freely while maintaining critical rigor [7].

The generative conversation is therefore both opportunity and test. Creativity becomes partially distributed, emerging from interactions between human reasoning, disciplinary knowledge, and algorithmic association. In this light, AI does not invent on our behalf; it reactivates our capacity to invent. It restores conversation as the central mechanism of creative inquiry, reconnecting disciplines and highlighting that, in many areas of quantitative research, conceptual advances begin as tentative questions rather than finalized models.

7 | THE FRAGILE DIALOG

Every transformation in how humans think and communicate introduces new forms of fragility. The rise of AI-driven dialog in science is no exception. The same

systems that make reasoning more fluid also generate subtle distortions in how knowledge is produced, validated, and shared. To realize their potential, these vulnerabilities must be addressed directly—not as technical flaws to be patched, but as structural tensions inherent to a new cognitive ecology [7].

LLMs are extraordinarily fluent, and that fluency can deceive. They generate plausible text rather than verified truth and their linguistic coherence can effectively mask uncertainty. In science—where authority is often conveyed through polished language—this performative confidence poses a risk. Fabricated citations, elided ambiguity, or stylistic precision can give an illusion of rigor that even experts may hesitate to challenge. The danger lies not only in misinformation but in the erosion of epistemic vigilance: the tendency to treat fluency as evidence [10].

A deeper threat, however, lies in habituation. Conversational ease can dull the skepticism on which science depends. When complex questions yield instant, confident answers, reflection itself risks being outsourced. Psychologists refer to this as cognitive offloading—delegating mental effort to an external system [14]. Yet here, the offloading concerns reasoning, not memory. The issue is not computational capacity but the gradual normalization of unverified reasoning within analytical workflows.

Avoiding this outcome requires a new scientific literacy—one that is not computational but dialogical. Researchers and students must learn to interrogate models as they would colleagues: to ask where claims originate, what evidence supports them, and what assumptions remain hidden [15]. Pedagogy must therefore evolve from learning to compute toward learning to converse critically. The scientist of the future will need to integrate linguistic competence with methodological rigor, ensuring that conversational inputs remain grounded in data and reproducible analyses.

These shifts also complicate established norms of attribution and responsibility. As AI becomes a partner in reasoning, long-standing norms of authorship and accountability grow less certain. Meanwhile, inequities in access may deepen: wealthier institutions capable of licensing advanced models will amplify their advantage, while resource-poor contexts risk exclusion from this emerging conversational infrastructure [20]. What appears as democratization could easily reproduce hierarchy.

A responsible framework for AI-assisted research must therefore be both technical and cultural. Transparency about model use, explicit disclosure of AI involvement, ethical training for researchers, and public investment in open, multilingual systems are essential. The goal is not to constrain dialog but to preserve its integrity—to ensure that human-machine conversation remains a medium for understanding, not persuasion. One practical response to these risks is to treat dialog

itself as part of the scientific record. In quantitative biology, reproducibility depends on documenting how models are designed, parameterized, and interpreted. Conversational AI can extend that transparency by embedding a dialogical audit trail within computational workflows—storing prompts, model suggestions, and subsequent revisions alongside the data and code they helped produce. These records would reveal the interpretive steps that shape model outcomes, exposing biases or misframings before they harden into results. Much as version control systems track code evolution, conversational logs could function analogously to version control for interpretation—tracking why modeling decisions were made, what alternatives were considered, and how conclusions emerged. Incorporating this “epistemic provenance” into metadata and repositories would transform AI-assisted dialog from an opaque exchange into a traceable component of the modeling process, aligning it with the open-science standards already familiar in the field.

The fragility of AI-mediated dialog does not negate its promise; it defines the conditions under which that promise can mature. Every new medium of thought distorts even as it reveals. The task of science is to navigate this duality consciously. If researchers engage artificial interlocutors with critical awareness and humility, dialog itself may evolve into an ethical framework—a mode of reasoning that remains computational yet distinctly human.

8 | CONCLUSION: TOWARD A MORE HUMAN SCIENCE?

To converse with AI is to participate in an experiment in co-thinking. Its success depends on maintaining symmetry without equivalence—a partnership in which the human remains the ethical and epistemic anchor. The future of scientific dialog rests on three principles: transparency, critical literacy, and humility. Transparency keeps the origins of ideas visible and the role of AI explicit. Critical literacy safeguards against the illusion of machine authority. Humility reminds us that dialog, even when technologically mediated, remains an ethical act—a practice of listening as much as speaking.

The rise of LLMs signals a phase shift in scientific reasoning: one defined less by automation than by conversation. Discovery now extends beyond commanding tools to collaborating with them. A single dialog can traverse literature review, hypothesis formation, and conceptual synthesis—transforming inquiry from a linear sequence into a recursive exchange between intuition and computation. For quantitative biology, this shift has practical consequences: model development, parameter exploration, and conceptual framing increasingly occur through iterative linguistic interaction rather than isolated coding stages.

This transition does not diminish rigor; it reframes it. LLMs expand the horizon of reasoning, offering scope, recall, and linguistic agility, while judgment and interpretation remain human.

If approached with care and reflexivity, this partnership could inaugurate a more reflective and participatory scientific practice—one in which technology becomes an extension of our interpretive and creative capacities rather than their replacement. In this plural dialog between human and artificial minds, knowledge regains its oldest form: conversation. And through that, science may reinforce one of its enduring strengths: the collaborative refinement of ideas through shared inquiry.

AUTHOR CONTRIBUTIONS

Anna Viktorovna Gavrilova: Conceptualization; writing—original draft. **Carlo Galli:** Conceptualization; writing—review and editing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

No data were generated for the present work and thus no data are available.

REFERENCES

- [1] Zhang Y, Khan SA, Mahmud A, Yang H, Lavin A, Levin M, et al. Exploring the role of large language models in the scientific method: from hypothesis to discovery. *npj Artificial Intelligence*. 2025;1(1):14.
- [2] Knuuttila T. Modelling and representing: an artefactual approach to model-based representation. *Stud Hist Philos Sci*. 2011;42(2):262–71.
- [3] Branda F, Cicciozzi M, Scarpa F. Artificial intelligence in scientific research: challenges, opportunities and the imperative of a human-centric synergy. *J Informetr*. 2025;19(4):101727.
- [4] Latour B. *Science in action: how to follow scientists and engineers through society x*. Harvard University Press; 1987.
- [5] Mishra T, Sutanto E, Rossanti R, Pant N, Ashraf A, Raut A, et al. Use of large language models as artificial intelligence tools in academic research and publishing among global clinical researchers. *Sci Rep*. 2024;14(1):31672.
- [6] Shao E, Wang Y, Qian Y, Pan Z, Liu H, Wang D. SciSciGPT: advancing Human-AI collaboration in the science of science. 2025. Preprint at arXiv:2504.05559.
- [7] Binz M, Alaniz S, Roskies A, Aczel B, Bergstrom CT, Allen C, et al. How should the advancement of large language models affect the practice of science? *Proc Natl Acad Sci U S A*. 2025; 122(5):e2401227121.
- [8] Almarie B, Teixeira PEP, Pacheco-Barrios K, Rossetti CA, Fregni F. Editorial - the use of large language models in science: opportunities and challenges. *Principles and Practice of Clinical Research Journal*. 2023;9(1):1–4.
- [9] Hernández-Orallo J. Enhancement and assessment in the AI age: an extended mind perspective. *J Pac Rim Psychol*. 2025; 19:18344909241309376.
- [10] Doshi AR, Hauser OP. Generative AI enhances individual creativity but reduces the collective diversity of novel content. *Sci Adv*. 2024;10(28):5290.
- [11] Liu Z, Liu K, Zhu Y, Lei X, Yang Z, Zhang Z, et al. AIGS: generating science from AI-Powered automated falsification. 2024. Preprint at arXiv: 2411.11910.
- [12] Memmert L, Tavanapour N. Towards human-AI-collaboration in brainstorming: empirical insights into the perception of working with a generative AI. 2023.
- [13] Hila A. The epistemological consequences of large language models: rethinking collective intelligence and institutional knowledge. *AI Soc*. 2025:1–19.
- [14] Gerlich M. AI tools in society: impacts on cognitive offloading and the future of critical thinking. *Societies*. 2025;15(1):6.
- [15] Bewersdorff A, Hartmann C, Hornberger M, Seßler K, Bannert M, Kasneci E, et al. Taking the next step with generative artificial intelligence: the transformative role of multimodal large language models in science education. *Learn Individ Differ*. 2024;118: 102601.
- [16] Changiz T, Yousefy A, Fakhari M. Research utilization process model: a cyclical, spiral, and developmental process to provide conclusive research knowledge in health professions education. *Med J Islam Repub Iran*. 2020;34:79.
- [17] Dounas-Frazer DR, Lewandowski HJ. The modelling framework for experimental physics: description, development, and applications. *Eur J Phys*. 2018;39(6):064005.
- [18] Treude C, Kula RG. Interacting with ai reasoning models: harnessing "thoughts" for ai-driven software engineering. 2025. Preprint at arXiv: 250300483.
- [19] Chiarello F, Giordano V, Spada I, Barandoni S, Fantoni G. Future applications of generative large language models: a data-driven case study on ChatGPT. *Technovation*. 2024:133.
- [20] Gujar V. Edge of innovation: technology democratization. *Int J Sci Res*. 2025:411–3.
- [21] Benjamin R. Race after technology. In: *Social theory Re-Wired*. Routledge; 2023. p. 405–15.
- [22] Nersessian NJ. The cognitive work of metaphor and analogy in scientific practice. *Philosophical Inquiries*. 2015;3:133–56.

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