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PERSPECTIVE

The Innovation Nutrition

Beyond technology: Scientific taste and judgment in nutritional science

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Nutritional science is entering an era of unprecedented technological possibilities. Artificial intelligence, multi-omics, and precision nutrition are expanding our ability to generate and integrate information, but not necessarily our ability to understand what matters. In this Perspective, I reflect on the qualities that define a great nutritional scientist in this changing landscape, drawing on experiences accumulated throughout my career in clinical and nutritional research.I argue that scientific taste, understood as the ability to recognize important questions, choose methods that serve them, and distinguish meaningful findings from statistical or biological signals, is becoming increasingly important. I discuss the challenges of moving from association to causation, determining whether precision nutrition genuinely improves health, and interpreting increasingly complex data and artificial intelligence. Scientific progress also requires intellectual humility, learning from failure, and communicating uncertainty responsibly.Finally, I reflect on scientific leadership and mentorship as essential contributions to the future of our discipline. The most enduring legacy of a scientist may not be the number of publications or the sophistication of the tools used, but the people helped to become independent scientists and the questions they are encouraged to pursue.Technology can increase the power of science. Scientific taste determines where that power should be directed.

What makes a great nutritional scientist today, in this era of artificial intelligence, multi-omics, and precision nutrition?

INTRODUCTION

As our tools become more powerful, scientific judgment becomes even more important.

Nutritional science is entering a period in which our capacity to generate and integrate information is expanding faster than our ability to interpret it, creating new challenges for scientific judgment. We can now measure more than we ever could; the challenge is knowing what matters. Genomics, metabolomics, microbiome profiling, digital phenotyping, artificial intelligence, and increasingly large datasets are providing unprecedented opportunities to investigate how diet influences human health. These developments are changing the scale and nature of the questions we can ask. Yet greater analytical power does not necessarily translate into better science. The ability to identify which questions matter, which methods are appropriate, and which findings deserve to influence practice may become as important as the ability to generate new data.

I have witnessed several technological transitions during my scientific career and sometimes I still remember them with some emotion, and I still remember some of them with a sense of nostalgia. I remember, for example, when one of the first computers arrived at my faculty in Reus. At the time, it



represented an entirely new way of working, and none of us could foresee the extent to which such tools would transform research. Since then, computers have been followed by the internet, high-throughput molecular technologies, large international databases, and now artificial intelligence. What has remained remarkably constant, however, is the need for scientific judgment: deciding what is worth asking, what evidence is sufficiently robust to be trusted, and what knowledge is important enough to change how we understand or improve human health.

I would describe this capacity as ***scientific taste***: ***the ability to recognize an important question before it becomes fashionable, distinguish signal from noise, select an appropriate method, and identify findings likely to remain meaningful beyond the dataset in which they were generated***. It is difficult to quantify and develops through experience, critical discussion, and intellectual curiosity. It also grows through perseverance, collaboration, and a willingness to learn from failure.

ASKING THE RIGHT QUESTION

My early experiences in clinical nutrition shaped the way I think about scientific questions. During my training in Lyon and Paris, I saw how nutritional interventions could be central to the treatment of children with severe digestive diseases. Those years also taught me that important nutritional questions require multiple perspectives: clinical medicine, physiology, metabolism, epidemiology, and public health.

When I returned to Spain, nutrition was still far from being considered a strategic scientific discipline. I nevertheless believed that understanding how food influences health would become a challenge of modern medicine.

This experience also taught me that ***great scientists do not simply follow important questions; sometimes they recognize them before others do***. Recognizing an important question often requires the courage to move beyond established routines and to take a calculated risk when the opportunity is scientifically meaningful.

Today, when thousands of biological variables can be measured simultaneously and artificial intelligence can explore complex relationships rapidly, the temptation is to let available technology determine the scientific question.

We should resist this.

A sophisticated method does not make a question important. A statistically significant association is not necessarily clinically meaningful. A predictive biomarker is not necessarily causal. A complex molecular signature is not automatically useful simply because it is biologically interesting.

WHEN MORE DATA DO NOT NECESSARILY MEAN MORE KNOWLEDGE

Nutrition poses unusually difficult measurement challenges. Dietary exposures are multidimensional, correlated, dynamic, and strongly influenced by social and behavioral context. Self-reported dietary assessment is subject to measurement error, whereas biomarkers can provide complementary information but require appropriate validation and statistical treatment.[1,2]

Large datasets increase statistical power, but also the number of possible associations. Multi-omics generates hypotheses at an unprecedented scale, while AI can detect patterns that may be difficult for an individual investigator to identify.

But detecting a pattern does not establish that the pattern is real, causal, reproducible, or clinically relevant.

A scientist who knows how to run a machine-learning algorithm is technologically competent. ***A scientist who knows whether the algorithm should be used, what assumptions it requires, and how much confidence should be placed in its output is exercising scientific judgment***.

This is why I do not see the future of nutritional science as a transition from traditional epidemiology towards artificial intelligence or multi-omics. Rather, I see an opportunity to integrate approaches according to the scientific question.

FROM ASSOCIATION TO CAUSATION

Causal thinking remains central to nutritional science.

This lesson became particularly clear during the development of PREDIMED. Observational studies had suggested that the Mediterranean diet was associated with cardiovascular health, but the crucial question was whether this association reflected a causal effect. The PREDIMED randomized trial provided experimental evidence that a Mediterranean diet supplemented with extra-virgin olive oil or nuts reduced major cardiovascular events among adults at high cardiovascular risk.[3]

The importance of PREDIMED was not simply its magnitude, but that a clinically meaningful question was addressed with a design capable of strengthening causal inference. As coordinator of PREDIMED-Plus, I learned that meaningful science depends not only on technology, but also on rigorous methods, collaboration, and a clear commitment to improving health. The PREDIMED-Plus experience further reinforced the importance of integrating dietary intervention, physical activity, behavioral strategies, and advanced biological measurements while keeping the central scientific question clearly defined.[4]

When randomized trials are unavailable, the target-trial framework can help to formulate observational analyses around a clearly specified causal question, including eligibility, treatment, time zero, follow-up, and outcomes.[5] Such approaches clarify the question but do not remove observational assumptions.

Scientific taste therefore involves knowing not only which method is sophisticated, but which method is appropriate.

PRECISION NUTRITION: PRECISION REQUIRES EVIDENCE

Precision nutrition is perhaps the clearest example of the tension between technological possibility and scientific maturity.

PREDICT-1 demonstrated substantial inter-individual variability in postprandial glucose, insulin, and triglyceride responses to identical meals and identified person-specific characteristics, including the gut microbiome, that contributed to some of this variability.[6] These findings provided an important biological rationale for personalized nutrition.

But biological plausibility is not the same as clinical effectiveness.

The key question is whether acting on individual differences produced better health outcomes than appropriate general dietary advice.

Recent randomized evidence illustrates why this distinction matters. An 18-week personalized nutrition intervention incorporating individual postprandial responses, microbiome characteristics, and health history produced beneficial cardiometabolic effects compared with general dietary advice.[7] However, another randomized trial found no additional benefit of a precision nutrition-based diet over a conventional diet for glycemic variability or HbA1c.[8]

These findings illustrate the evolving evidence base in precision nutrition. Precision nutrition should complement rather than replace population-based nutrition.[9] ***A great nutritional scientist must determine when precision adds value rather than complexity.***

ARTIFICIAL INTELLIGENCE WILL INCREASE THE NEED FOR SCIENTIFIC JUDGMENT

Artificial intelligence may transform dietary assessment, data integration, prediction, and personalized recommendations. Its applications in precision nutrition are expanding, although important challenges remain regarding validation, generalizability, interpretability, representativeness, and equity.[10]

I suspect that the most important future skill will therefore not be the ability to use AI. Machines will increasingly make that easier.***The more important skill will be the ability to judge the output of AI scientifically***.

Is the dataset appropriate? Is the model externally validated? Does it work in populations that differ from the training population? Could systematic biases be amplified? Does better prediction actually improve clinical decisions?

As machines become more capable of generating hypotheses and predictions, the comparative advantage of the human scientist may shift towards interpretation and judgment.

SCIENTIFIC TASTE REQUIRES INTELLECTUAL HUMILITY

Scientific taste requires humility.

A great scientist must recognize when an attractive finding may be a false-positive result, when a plausible biological mechanism does not establish causation, and when an apparently important association has limited clinical relevance.

Nutrition is particularly vulnerable to overinterpretation because scientific findings can rapidly enter public discourse and influence individual behavior, clinical advice, and policy.

We therefore need scientists who can communicate uncertainty without creating distrust or fear. The objective is to make conclusions proportionate to the strength of the evidence.

Scientific integrity also requires the willingness to change one's mind. The scientist's loyalty should be to the evidence rather than to their own hypothesis.

Failure, rejection, and unexpected results are not necessarily signs that a scientific career is going wrong. They can reveal weaknesses in our assumptions, redirect a project, and sometimes open a better scientific path. The essential response is to understand what happened, learn from it, and continue with greater clarity.

SCIENTIFIC LEADERSHIP IS ABOUT BUILDING COMMUNITIES

My career has also convinced me that scientific excellence is rarely an individual achievement.

One aspect of which I am particularly proud is having contributed to the development of an internationally recognized nutrition research community in Reus, Spain. Scientific excellence is not determined by geography. It is determined by vision, perseverance, collaboration, infrastructure, and the ability to bring talented people together around meaningful questions.

International collaboration was essential to this process, broadening perspectives, challenging assumptions, and enabling questions that no single group could have answered.

A great scientific leader creates the conditions in which other people can generate relevant knowledge. This also means building genuine networks, helping colleagues succeed, and knowing when to accept responsibility and when to say no so that important work can be done well.

THE ULTIMATE LEGACY IS PEOPLE

At this stage of my career, I increasingly believe that the most enduring scientific contribution is people.

I have often thought of mentorship as, in some ways, similar to parenthood, while recognizing that the two relationships are fundamentally different. Every parent hopes that their children will grow into independent adults and find their own path in life. I have always felt the same about doctoral students and postdoctoral researchers. My objective was never to create followers. It was to help create scientists who would eventually become better than me.

Seeing former students become independent scientists, lead research groups, and develop their own scientific identities is among the most satisfying experiences of an academic career.

Their success is not my competition. It's my legacy.

Scientific taste also means thinking beyond one's own career: which questions can we help the next generation ask, and which scientific values can we pass on?

Mentorship is one of the most important ways in which these values, and scientific taste itself, can be developed.

A good mentor should not simply teach methods or transmit their own scientific preferences, but help younger researchers learn how to frame questions, challenge assumptions, evaluate evidence, and recognize which questions are worth pursuing. This also requires giving them the freedom to explore ideas and perspectives that differ from their mentor's own. Scientific judgment develops through everyday practice: discussing why a question matters, questioning whether a method is appropriate, interpreting unexpected results, and learning to distinguish what is interesting from what is genuinely important. In this sense, ***mentorship is not about creating scientists who think like their mentors, but about helping them develop the judgment and independence to think for themselves.***

LOOKING FORWARD

As I approach the stage of my career when retirement naturally becomes part of the conversation, I find myself reflecting not only on what I have accomplished, but also on unanswered questions, new collaborations, and new scientific possibilities. Academic careers evolve, and making room for the next generation is an essential part of the life of an institution. At the same time, I believe that scientific curiosity and the desire to contribute can continue beyond formal institutional roles. Several projects that now excite me build on questions that emerged decades ago, although the technologies available to address them would have been difficult to imagine then.

Perhaps this is the simplest definition of a scientist: ***someone whose curiosity retires later than they do.***

We will need scientists who can ask meaningful questions, recognize the limits of the data, distinguish prediction from causation, integrate complementary forms of evidence, and understand when precision genuinely improves health.

We will also need leaders who help others become independent, critical, and generous scientists. ***The future of science belongs not to those who hold on to their positions, but to those who help others find their own path***.

CONCLUSION

The first computer that arrived at my faculty in Reus marked the beginning of a technological transformation that has continued throughout my career. Artificial intelligence may represent another comparable transition.

But technology should never define scientific progress.

The great nutritional scientist is not necessarily the scientist with the largest dataset, the most sophisticated algorithm, or the highest number of publications. Rather, it is the scientist who combines curiosity with rigor, innovation with judgment, ambition with humility, and scientific excellence with a commitment to people.

Above all, we need scientists with scientific taste: the ability to recognize an important question before it becomes fashionable; choose the method because it serves the question; distinguish statistical interest from scientific importance; and enable others to discover.

The tools will continue to change. The questions will continue to evolve as well.

But the essential tasks of the nutritional scientist will remain remarkably constant: ***to decide what matters, to establish what is true, and to use knowledge to improve human health***.

Technology can increase the power of science. Scientific taste determines where that power should be directed.

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ETHICAL STATEMENT AND PATIENT CONSENT

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