Correspondence

AI doesn't model human language

Artificial intelligence (AI) is being used to develop large language models (LLMs) with considerable success. But they should not be seen as being models of how human language works and is acquired.

First, LLMs are probabilistic models of externalized language data, whereas human language is truly generative: it yields an unbounded number of hierarchically structured expressions (M. B. A. Everaert *et al. Trends Cogn. Sci.* **19**, 729–743; 2015). Second, language acquisition in infants does not depend on massive amounts of input data, but includes knowledge of language's generative nature. Therefore, children can acquire any language rapidly with minimal linguistic input (C. Yang *et al. Neurosci. Biobehav. Rev.* **81**, 103–119; 2017). Third, LLMs can produce 'impossible' languages, not generated by the principles governing all known human languages, just as well as (if not better than) natural language output, and cannot distinguish between them (A. Moro *et al. Cortex* **167**, 82–85; 2023).

LLMs are a useful technology, good at reproducing strands of information derived from training data, but they do not model the structure of human language, let alone encompass its creative nature.

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Migratory fish need global swimways

A report by the Convention on the Conservation of Migratory Species of Wild Animals makes for grim reading on migratory fishes (see go.nature.com/3v8pdv2). Among the 37 species with sufficient data, populations have declined by an average of 90% since 1970. Migratory fishes have key ecological roles, and their decline undermines Indigenous cultures, food security and biodiversity conservation.

No more than 37% of rivers longer than 1,000 kilometres remain free-flowing over their entire length (G. Grill *et al. Nature* **569**, 215–221; 2019). Obstructing more migration routes will condemn important species to complete destruction. Governments must act now by designating 'global swimways' (T. A. Worthington *et al. Front. Ecol. Environ.* **20**, 573–580; 2022).

Many rivers cross national boundaries, so protecting and restoring swimways will require regional collaborations. This will be key to achieving future targets to reduce freshwater biodiversity loss, combat climate change and improve food and water security. Global swimways are essential for both river ecosystems and those who depend on them.

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Language matters in addressing vaccine hesitancy

Your Comment article on cervical cancer (*Nature* **626**, 30–32; 2024) suggests that, in some cultures, infection with human papillomavirus (HPV) tends to be associated with promiscuity, not disease, and that culturally sensitive communication is key to addressing vaccine hesitancy.

Other factors can also be at play. In Hong Kong, the HPV vaccine is commonly labelled the cervical cancer vaccine, hindering the promotion of gender-neutral vaccination programmes that can reduce the incidence of other cancers and diseases, too (T. H. Cheung *et al. Hum. Vacc. Immunother.* **19**, 2184605; 2023).

Normative associations vary between cultures and languages. When tackling vaccination hesitancy in multilingual societies, it is helpful to strategically adopt the language that creates more positive associations. Bilingual speakers in Hong Kong, for instance, were more willing to get vaccinated against COVID-19 when information was presented in English, rather than Chinese, because they associate more trust with the former (J. Geipel *et al. Sci. Rep.* **12**, 253; 2022).

Furthermore, health messages that cater to normative social influences are more effective in cultures that display a higher willingness to adhere to their norms, such as China and Japan (J. Shi *et al. Soc. Sci. Med.* **340**, 116431; 2024). Elsewhere, health authorities might highlight norm adherence or use other strategies to influence the population.

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There's more to meaningful science than just outputs

Your News feature advises scientists on how to maximize the impact of their research by translating its results to applications that make a tangible difference (see *Nature* https://doi.org/mk5t; 2024). But there are other ways in which a scientific career can be meaningful.

First, even if the applications are unclear, creating knowledge is valuable for the understanding it produces of how disparate facts connect – itself a source of awe and wonder.

Second, scientists have a unique social role in guiding informed decision-making. Curating relevant facts, even if gappy and uncertain, is impossible without making value judgements; there is no simple 'follow the science'. But in a democracy, a scientist cannot insert their own value judgements into work that might affect the lives of people who do not share their thoughts. Getting this balance right is enormously hard, and should be a matter of professional pride.

Third is keeping the candle of science burning through economic and geopolitical upheavals. This depends on trust between generations of researchers: we accept nurture and inspiration from our teachers, and we pass those on to our students. As the moral reality around us changes, we are challenged to make science more inclusive and respectful of people and the planet.

Producing impactful outputs is a familiar demand, but it does not define, nor exhaust, meaning.

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