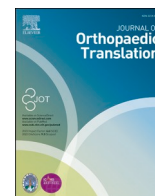


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ChatGPT for scientific writing — The coexistence of opportunities and challenges

Scientific writing is part of academic writing skills and communication skills. These skills develop gradually during our year-after-year studies. With the emergence of artificial intelligence (AI) tools like ChatGPT, the quality and efficiency of scientific writing can be vastly enhanced. ChatGPT speeds up writing, drafts outlines, adds details, and improves writing style. However, many concerns arise naturally regarding ethical issues (e.g. plagiarism, fake data and figures as well as other potential research misconducts), copyright, information safety and accuracy, co-authorship, citation and format, excessive dependence and so forth. However, it is very important that the fear of the latter should not lead to 1) not using it and increasing our effectiveness or 2) prohibiting its use in the academic community. In this editorial, we would like to share our insights and views on its application in scientific writing. As researchers, we need to learn its double-edged sword effects well and prudently embrace this new trend of utilizing ChatGPT to boost the scientific writing process, especially within the framework of law and morality.

1. “ChatGPT, tell me something about yourself.”

“I am ChatGPT, an AI-based large language model (LLM) developed by OpenAI. My primary function is to assist users in generating human-like text based on the prompts and questions I receive. I have been trained on a diverse range of internet text sources to form a broad understanding of language and knowledge. I can help answer questions, provide explanations, assist with writing tasks, engage in conversations, and offer information on various topics. My responses are generated based on patterns and examples in the data I was trained on, but please note that I don't have personal experiences or beliefs. I strive to be beneficial and provide accurate information, but verifying important details from reliable sources is always a good idea. If you have any specific questions or need assistance with something, feel free to ask, and I'll do my best!” As the cutting-edge transformer-based deep generative model, ChatGPT seems to have a clear “self-perception” in its role and mission.

2. ChatGPT, a super student or an ethical educator for academic research?

The well alignment of learning and teaching is crucial for knowledge acquisition and sharing. Each side may not stand alone. As the nature of LLM, ChatGPT is trained on a tokenized corpus for information generation, aiming to assist its users in instant knowledge acquisitions, interactive data interpretations, and multi-disciplinary inspirations, regardless of the barriers of education background and expertise.

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Technically, given the tremendous power of computing hardware in the AI development industry and the continuing created human society information, ChatGPT has excellent potential to be the best ‘student’ ever in terms of its ability to analyze and display information interactively in a very short time. However, as an AI application, its ultimate purpose is to help humankind deal with complicated information sources and give neat answers to specific questions instantly. To some extent, the basic knowledge of ChatGPT is much more than individual humans in general, and we may assume that it can be a good data source for early career researchers. If they plan to explore the boundaries of knowledge and go deeper, will it be possible for them to regard ChatGPT as a supervisor or advisor? The answers are doubtful currently due to the complexity of LLMs themselves. Since these LLMs can curate data and understand information merely from a technical perspective (the language), not the actual scientific meanings behind them. Moreover, good teachers share knowledge and inspire students to think and create. ChatGPT sometimes deprives students of independent thinking opportunities. From these perspectives, ChatGPT is nowhere near good enough. Hence, at this stage, ChatGPT is more likely a mentor who gives us reasonable advice, not a supervisor who can thoroughly guide our academic processing.

3. ChatGPT is an “acceleration pack” for scientific writing

Generally, for scientific writing, ChatGPT can aid in brainstorming research questions, performing literature reviews for abstracting key points in specific fields, identifying gaps or limitations in the literature, processing data for visualizations and interpretations, drawing outlines for drafts, manuscript proofreading, and even responding to the comments and suggestions of editors and reviewers for successful high-quality publications. Although it is fast and effective, it should always be checked. One of the most significant limitations of ChatGPT is that the newer and more innovative the topic, i.e. the less information about the topic is available on the web, the more superficial and inaccurate the AI's suggestions.

4. Concerns of applying ChatGPT in scientific writing

Meanwhile, many concerns about utilizing ChatGPT in scientific writing arise concerning the following aspects. Researchers should be aware of these concerns and use AI tools responsibly, ensuring their work adheres to the ethical standards and guidelines set by their respective fields and journals.

- (1) Ethical issues

Researchers need to utilize ChatGPT ethically, maintaining the integrity of scientific research. One big concern is potential plagiarism and the generation of fake data and figures. ChatGPT contributes significantly to the ease of rewriting existing content from the internet, which may result in plagiarism if not used responsibly. It's inevitable for ChatGPT to plagiarize existing material inadvertently. Besides, AI can be applied to produce non-authentic data and figures for research articles, which significantly hampers research ethics in our academic community. Other ethical concerns like privacy, accountability, and informed consent will arise when using ChatGPT-derived texts in scientific writing.

(2) Copyright

To date, the copyright of texts produced by ChatGPT is controversial and may belong to a complicated and evolving field of law. Copyright protection is generally afforded to "original works of authorship" created by human beings, according to the U.S. Copyright Office. This means that works generated by AI, with negligible human involvement, are not deemed copyrightable under current U.S. law. However, the individual who possesses the AI system or has exclusive rights to it may have ownership of the AI-created content. This is because AI is regarded as a tool for human users, similar to how a painter utilizes a brush. In the UK, there is a distinction where entirely computer-produced works can have copyright protection, but the law still highlights the significance of human authorship.

One should keep in mind that these interpretations can vary by jurisdiction and are subject to change as new cases are brought to court and legislation evolves to keep up with technological breakthroughs. For the most current and detailed information, it's advisable to consult legal experts or the latest guidelines from the relevant copyright offices. The current academic view is that AI is a tool and that authorship belongs to those who use and control the content of ChatGPT. But similarly, the author and not the AI is responsible for the authenticity and content of the material.

(3) Can it completely replace human expertise, critical thinking, and analysis?

So far, the answer is "no". The content generated by ChatGPT cannot reach the level of top scientists who own truly specialized human expertise. Also, it is incapable of critical thinking and complex and logical analysis like human beings currently. Our users still need to review and edit the content generated by ChatGPT to ensure it aligns with the research objectives and meets the standards of scientific writing.

(4) Is it possible to provide information with high-level accuracy?

The content produced by ChatGPT may have the potential risk of bias and errors. An AI tool is only as good as the data it is trained on. If the training data is biased or contains errors, the AI-generated content may also reflect these issues. At present, it cannot always produce accurate or reliable content, as it may directly copy or paraphrase from existing sources, make factual errors, or generate nonsensical or irrelevant text.

(5) Excessive dependence on ChatGPT

The excessive reliance on ChatGPT in scientific writing may result in the potential of "learning losses". It is for sure that it can effectively help us process a lot of information. Meanwhile, relying on AI for writing too much can gradually harm our independent thinking ability and writing skills. It deprives these opportunities and duties of thinking and writing for users. Finally, the above capability and skill may not be practiced and improved. Thus, we should pay much attention to this issue.

(6) Shall we co-author with an AI tool when publishing scientific papers?

The co-authorship of ChatGPT is controversial. In academia, some scientists already added ChatGPT as one co-author of their publications, while the majority still remain cautious about this issue. According to current discussions in the scientific publishing industry, giant publishers such as Springer Nature, Science, and Cell Press consistently agree that ChatGPT is still on its way to becoming a mature technology that may boost the prosperity of the scientific community and cannot be listed as one of the authors in the manuscripts [1–3]. AI models cannot meet the requirements for authorship because they cannot take responsibility for submitted work, assert the presence or absence of conflicts of interest, or manage copyright and license agreements.

(7) Accurate citation and format matter in scientific writing

Accurate citation and formatting are crucial for our scientific writing but cannot be achieved by the current version of ChatGPT. The expressions generated by ChatGPT may not always follow the specific guidelines, formats, or conventions of the target journal or publication. The references are usually cited casually and incorrectly [4], which obviously does not meet the requirements of high-quality scientific papers.

(8) Are the sounds from scientific publishers about ChatGPT encouraging us to use it for transparent science?

It's crucial for authors to disclose the utilization of AI tools in their papers to ensure transparency and enable readers to notice the biases and limitations of ChatGPT-generated content. For the attitudes of scientific publishers, at the very beginning, the giant publishers objected to allowing authors to use it in their publications. However, now they seem more open to AI tools [5–7]; for example, the *Science* family of journals has changed their policy on the adoption of ChatGPT in assisting scientific writing and providing clear guidelines, especially when authors use these tools more appropriately and the content meets the publication standards.

5. How to use ChatGPT properly in scientific writing?

Considering the concerns and tremendous benefits of applying ChatGPT in scientific writing, the editorial office would like to do our part to build consensus and launch an initiative. Researchers are encouraged to use AI tools in scientific writing with caution. Here is some advice for the proper application of ChatGPT in scientific writing.

- (1) First, the authors should understand the application scenario and boundaries of applying ChatGPT in scientific writing. It should be within the framework of law and morality. Namely, authors should avoid bringing some ethical concerns, including plagiarism, producing fake data and figures, privacy breaches, accountability, and violation of informed consent.
- (2) Disclose the use of AI in creating content to ensure transparency.
- (3) List ChatGPT in the optimized position. Please list it in the section of Methods & Materials or acknowledgement with specific version information, instead of a co-author. It is just an AI tool to assist us in processing information.
- (4) The users are responsible for verifying the sources, facts, and logic of the content generated by ChatGPT to ensure it is valid and credible. Evaluate this content carefully before being applied to academic outputs.
- (5) Be cautious of the citation and format issues produced by ChatGPT. Authors should check and guarantee the accuracy of citations and format in their manuscripts. Also, users must adhere

to the chosen outlet's requirements and expectations for publishing the scientific paper.

- (6) For some beginners in the academic journey, please do not rely on the tool too much and too frequently. Individuals lacking basic training in hands-on data acquisition, analysis, and manuscript drafting should learn to think independently and practice their writing skills continuously. But for senior researchers, ChatGPT can help them accelerate the massive labor work in preparing manuscripts and free their productivity because they already have adequate training.
- (7) ChatGPT should only be used with extreme caution and care for innovative, cutting-edge new research.

In conclusion, ChatGPT can be an “acceleration pack” for scientific writing despite the coexistence of opportunities and challenges. But it should be used with caution and discretion. It should be regarded as a supplement, not a substitute, for the human intelligence, creativity, and skills essential for producing a high-quality scientific paper. The entire academic community, including universities, institutions, and journals, should work together to establish guidelines and standards for using ChatGPT responsibly in scientific writing.

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