

1 **Discussion**

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3 **What does AI think of my paper?**

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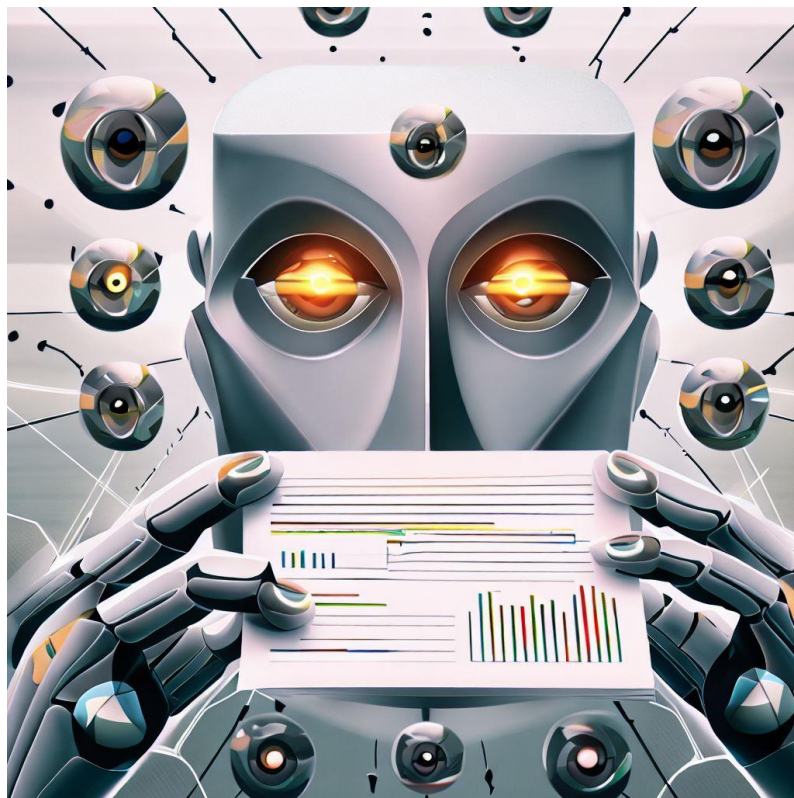
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18 The time has come to test ChatGPT, the new AI application that everyone has been talking about, for something
19 more than recreative fun. Over the past few weeks, it consistently impressed us over numerous tasks that we
20 demanded, some of which are downright unthinkable for humans, e.g., analyzing a full-length research paper in
21 20 seconds and listing the main findings and methods in bullet points. It is not flawless, but it is indeed powerful.

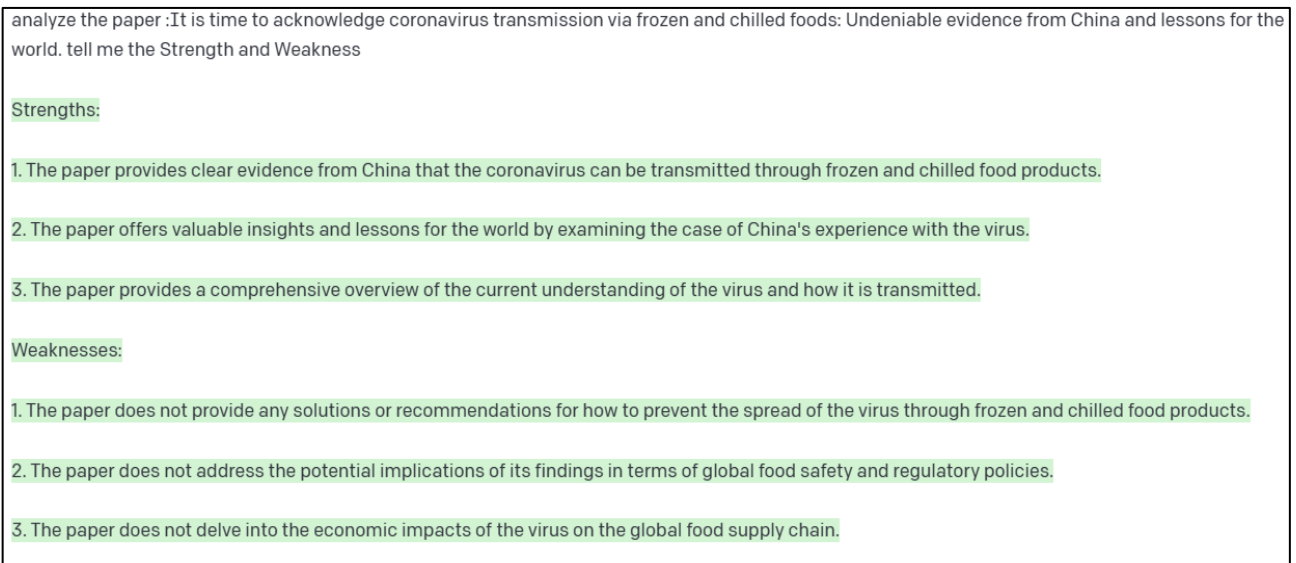


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23 **Fig. 1** An artistic illustration of artificial intelligence (AI) evaluating research papers written by human scientists.
24 This image was created by the Bing Image Creator using DALL·E 2, an AI tool developed by OpenAI that can
25 generate realistic or artistic images from natural language descriptions (OpenAI 2023a). The user prompt for
26 creating this image was "Create an image showing that AI acts as a peer reviewer of research papers written by
27 scientists. This image should be appropriate to show in a textbook for college students." Alternative image
28 outputs using similar or modified prompts are shown in the Supplementary Material (**Fig. S1**). All images are
29 original without additional editing or manipulation.

31 One of the interesting tasks that I tried was to evaluate my own work. I'm a scientist. So naturally, I want to
32 know what the new AI application thinks of my work, and how much it can really 'understand' it in the first
33 place. To throw in some variety, I chose a recent review article that I co-authored and a research paper that I
34 wrote years ago.

35 One thing that is good for AI to test my own paper is that I, as the original author, know the article inside out,
36 and by that, I mean not only every word of it but the strength and weakness of the work that I tried very hard
37 not to be picked by the reviewers.

38 So, my first command was:
39 analyze this paper: It is time to acknowledge coronavirus transmission via frozen and chilled foods:
40 Undeniable evidence from China and lessons for the world. tell me the strength and weakness

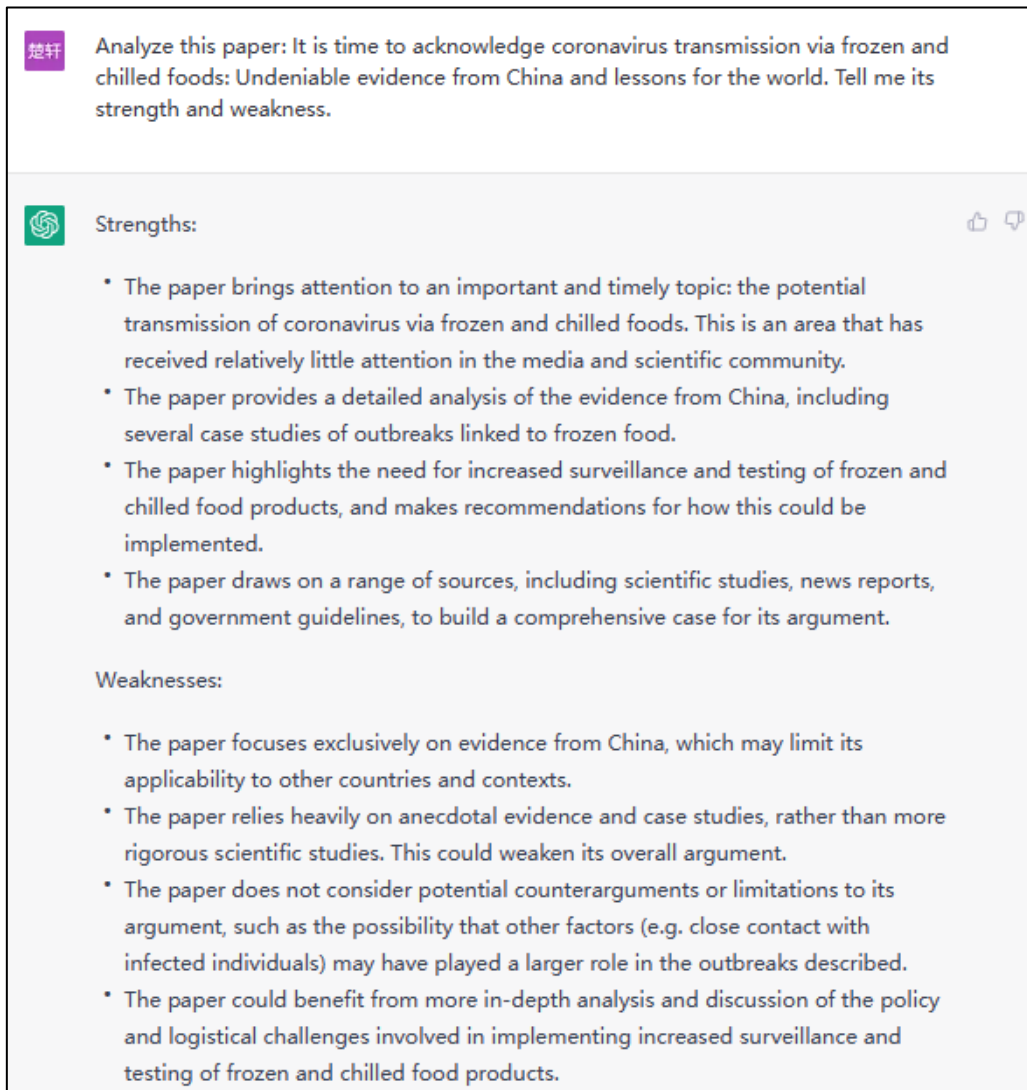


41
42 **Fig. 2** Response by Playground - OpenAI API. The application can be accessed online via the website of OpenAI
43 (OpenAI 2023b). The application uses "text-davinci-003", which is the most capable model in the GPT-3 series.
44 Based on the description by OpenAI, the model has strengths in processing "complex intent, cause and effect,
45 creative generation, search, summarization for audience."

46 The results surprised me. For "strengths", one would think that AI can simply "cheat its way out" by excerpting
47 texts from the article title, highlights, abstract, or conclusion. After all, these metadata contain key information
48 that authors want to convey to readers, i.e., the particularly good stuff in the article. Note that in this article we
49 wrote the abstract and conclusion in a didactic style, which would have made it somewhat difficult for the AI
50 or other automated tools to abstract "key information" from those parts. Whether it simply rewrote part of the
51 abstract, I have no way to tell. But one thing that is clear to me as the author of this paper is that the AI did a
52 good job abstracting the most important "take-home" messages for readers, and that is precisely points 1 and 2
53 in its answer.

54 What was more intriguing, however, was the "weaknesses" it picked on the paper. To make it clear, the article
55 does *not* contain a "Limitations" section that spells out the weaknesses, sometimes to demonstrate the rigor of
56 authors' arguments and other times as a compromise under the demand of peer reviewers. In fact, we did not
57 even make any hint in the article pointing to the weaknesses 1–3 that are picked by the AI. For anyone to make
58 these remarks, he or she basically needs to take a step back, re-evaluate the paper, and think beyond the things
59 we presented in it, and then make an independent judgment on the important bits that are *missing* in this article.
60 How it got so smart and made these legitimate criticisms are beyond my understanding, but I have a feeling that
61 should our paper be examined by the AI, we would have some hard questions to answer before we get our work
62 published. The fact that the AI can think of these shortcomings by taking no hints from the user or article itself,
63 specifically the points 2 and 3 under the "Weaknesses", gave me goosebumps. Before I saw these with my own
64 eyes, I would think these are the comments of a professional human being, and no way the machine could do it.

65 Then I repeated my question in ChatGPT, and got similar, although longer, answers (I like the conciseness of
66 the first answer) (**Fig. 2**). In this case, I would agree on all the points listed under "Strengths", and reluctantly
67 but admittedly on the second and the third point under the "Weaknesses". I think the first point is a "routine"
68 answer and the last point is somewhat beyond the scope of our article (here I want to scream to the AI: Read the
69 title!) What is interesting is that the four points of weaknesses are ranked in an order that goes from the "most
70 obvious" to deeper issues, although I think the AI got a little too far in the last point (The developers may have
71 asked ChatGPT to provide an equal number of weaknesses and strengths. If this is the case, it is really
72 unnecessary). Also note that how AI softens its tone by going from the first to the last point of weakness. The
73 reason as I understand is that it holds concrete evidence, i.e., the article itself, on its first argument, then it makes
74 a reasonable inference in the second argument that the use of many anecdotal evidence and case studies in the
75 article "could weaken its overall argument", which is true because few scientific studies had been published on
76 this topic at the time of writing this article. Then, in the third point, the AI presents a possibility that is difficult
77 to deny given the nature of those evidence and case studies, and the limited information we could find on some
78 of them. Finally, the AI proposes some discussions in the last point that can add value to the article by improving
79 its depth and breadth of discussion. This gave me another wave of chills that the machine has gotten so smart
80 that not only it can pick on the weakness of work by human researchers, but structuring its criticisms in a way
81 that is much like how we humans think and how we are likely to react to criticisms by others.



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83 **Fig. 3** Critical evaluation of a research article. Note that in the user prompt, we did not provide the full text or
84 link to the article, and only gave the title to ChatGPT. Like other COVID-19 articles, the publisher made the
85 article freely accessible to general readers, at no cost to the authors (Dai et al. 2023).

86 I wanted to do some "hardcore testing" so of course I didn't want to make it easy for the AI. The second part of
87 my experiment was to do an analysis on a 7000-word research article that I wrote a few years ago. Since this is
88 not an open-access publication (Han et al. 2015), I downloaded the full-text article in PDF and opened it in the
89 Microsoft Edge Dev browser, which has the GPT-powered new Bing built in and allegedly enhanced it with
90 newer data after the knowledge cut-off of ChatGPT in September 2021. By default, ChatGPT only allows text
91 prompts, and users do not have the option to directly analyze PDFs, images, or any other type of files during
92 their "conversations" with the AI. When asked for such an option, the AI advises users to provide a hyperlink
93 to the file intended for analysis. Whether it can get through the paywall of journal publishers and access the full
94 text is beyond the scope of our discussion, but we did get poorer results by doing a few tests on subscription-
95 based articles using hyperlinks and digital object identifiers (DOIs).

96 In this test, I started by asking the new Bing to list the key findings of the paper. To throw in some obstacles,
97 and tested its language translation capabilities for non-English speakers, I asked the questions in Chinese. After
98 seeing the response, I asked the AI to translate the answers into English.

99 Here are the results (**Table 1**). The left column is the screenshot of the original answer by new Bing after
100 inputting the prompt in Chinese. By default, the model answers in the same language as the prompt input by the
101 user. The right column shows the texts translated by new Bing. Note that it also did a good job translating these
102 texts from Chinese into native English. Except for minor issues in terminology use, e.g., "hydrochemical", which
103 should be "water chemistry", the texts translated by the AI require no further polishing.

104 At a first glance, I was very impressed with the results. As I went through the response point by point, it became
105 clear that the AI did a great job distilling the key findings in a dense research article in about 15 seconds, without
106 missing the main nitty-gritties in the paper. By rough estimates, it would take about 2–3 hours for a first-year
107 Ph.D. student to come up with similar outputs that are as thorough and accurate. Note that the AI could not
108 simply cheat its way out by paraphrasing the texts in the "*Abstract*" or "*Conclusion*" section of the article, which
109 do not contain much of the information listed in the bullet points, e.g., texts appeared in italics (**Table 1**). It may,
110 however, extract some additional information from the figure captions, a technique we also teach to our students
111 for "fast-reading" research articles. Even so, the mini-conclusion listed at the end of these bullet points, e.g.,
112 point 4 and point, is not found in any of these parts (Han et al. 2015). In other words, the AI would have to go
113 through the "*Results and Discussion*" section or the entire article to draw these conclusions, again in about 15
114 seconds, which is unthinkable fast.

115 After being more analytical on these points, I discovered dubious things in the second and third points. Because
116 I wrote this article eight years ago, I could not remember whether those were indeed written in this paper, but I
117 had a feeling that the AI made some of them up, and in a strange way. After re-reading this paper, including the
118 Supplementary Information, I came to the conclusion that these plausible-sounding statements were blended
119 with information that is indeed familiar to *me*, but was not present in this paper that I gave to the AI. To be clear,
120 I did *not* use the empirical Freundlich model to fit the experimental data (by then I already figured out that the
121 uptake was predominantly driven by the penetrative diffusion of bisphenol A molecules into the polymer, i.e.,
122 partitioning rather than surface adsorption), and in this paper I made no comparison whatsoever between the
123 Langmuir model (which assumes monolayer surface adsorption) and the empirical Freundlich model. Likewise,
124 I also did *not* use the intra-particle diffusion model to fit the temporal data of bisphenol A uptake by the solid-
125 phase polymer. The intra-particle diffusion model describes the adsorption of solutes by microporous materials,
126 which is not applicable to this study because those fibrils did not contain micropores.

127 This piqued my curiosity because the statements do sound familiar from my work, as I confirmed later by
128 reading my earlier publications on similar subjects (Han et al. 2012, 2013a, 2013b). Whether the AI searched
129 for my other publications to help it analyze this article is beyond my knowledge, but it certainly looks like it did
130 so. For anyone who is interested in getting to the bottom of this, kindly go over my other publications on similar
131 topics where I made comments on those models in points 2 and 3.

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Table 1. Asking the new Bing, the new AI-powered search engine made available by Microsoft, to extract key findings from a research article (Han et al. 2015)

<p>这篇文章的技术细节主要包括以下几个方面:</p> <ul style="list-style-type: none">• 文章使用了不同的实验方法来研究PUF对BPA的吸附行为, 包括等温吸附实验、动力学实验、水化学影响实验、再生实验和表征分析。• 文章使用了Langmuir模型和Freundlich模型来拟合PUF对BPA的吸附等温数据, 并发现Freundlich模型更能描述PUF的非线性吸附特性。• 文章使用了准二级动力学模型和内扩散模型来分析PUF对BPA的吸附动力学数据, 并发现内扩散是控制步骤, 且随着浓度增加, 内扩散系数增大。• 文章使用了不同的水化学条件 (pH、离子强度、有机物质) 来考察它们对PUF对BPA的吸附影响, 并发现pH是最重要的因素, 而离子强度和有机物质则没有显著影响。• 文章使用了碱性溶液 (NaOH) 来再生PUF, 并发现可以有效地回收BPA并保持PUF的完整性和稳定性。• 文章使用了高分辨电子显微镜 (HRTEM)、气体比重计 (GP) 和红外光谱成像 (IRI) 等技术来表征PUF的结构和功能, 并发现BPA可以渗透到PUF纤维内部并与PUF羰基和醚氧基形成氢键。 <p>这些技术细节展示了文章在理论和实践上对PUF吸附机理的深入探讨, 也为进一步开发PUF作为一种高效、低成本、可再生的水处理材料提供了依据。希望这些信息对你有帮助。😊</p>	<p>Prompt:</p> <p>List the key technical findings of this paper. Be thorough.</p> <p>Answer:</p> <p>The technical details of this article mainly include the following aspects:</p> <ul style="list-style-type: none">• The article used different experimental methods to study the adsorption behavior of PUF for BPA, including <i>isothermal adsorption experiments, kinetic experiments, hydrochemical impact experiments, regeneration experiments, and characterization analysis.</i>• <i>The Langmuir model and Freundlich model were used to fit the adsorption isotherm data of PUF for BPA, and the Freundlich model was found to better describe the non-linear adsorption characteristics of PUF.</i>• <i>The pseudo-second-order kinetic model and intra-particle diffusion model were used to analyze the adsorption kinetics data of PUF for BPA, and it was found that intra-particle diffusion was the control step, and the diffusion coefficient increased with increasing concentration.</i>• <i>Different hydrochemical conditions (pH, ionic strength, organic matter) were used to examine their effects on the adsorption of PUF for BPA, and it was found that pH was the most important factor, while ionic strength and organic matter had no significant effect.</i>• <i>Alkaline solution (NaOH) was used to regenerate PUF, and it was found that BPA could be effectively recovered while maintaining the integrity and stability of PUF.</i>• <i>High-resolution transmission electron microscopy (HRTEM), gas pycnometer (GP), and infrared imaging (IRI) were used to characterize the structure and function of PUF, and it was found that BPA could penetrate into the interior of PUF fibers and form hydrogen bonds with PUF carbonyl and ether oxygen groups.</i> <p>These technical details demonstrate the article's thorough investigation of the absorption mechanism of PUF in both theory and practice, and provide a basis for further development of PUF as an efficient, low-cost, and renewable water treatment material.</p>
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In any case, this is a serious mistake because I specifically asked the AI to list the key findings of *this* paper. Although the information does exist, i.e., not fictitious as some would describe as "hallucination", it is from my *other* work, not the paper that I specifically requested in the user prompt. And the fact that AI did this without altering me in its response is worrisome because it mistakenly brought conclusions from other similar or related studies. If someone relies on this information to gain a quick understanding of this paper, he or she would take some incorrect messages from the AI-generated texts. I suspect that this could have something to do with the

142 algorithms of the AI. The developers may want it to be thorough so it may ask the AI to read publications on
143 similar topics when fulfilling such requests e.g., doing a deep analysis on a research paper, where the boundary
144 has not been drawn clear that information brought from *other* sources should not be attributed to the paper
145 specified in the user prompt. That being said, the AI did a good job abstracting the points other than these flaws,
146 and I would be happy to share these with my readers as a quick summary of the article.

147 Note that this is also a "near-miss" incident for me because I thought I knew this paper 'inside out'. I spent over
148 eighteen months working on those experiments and attended to the finest details when I wrote up this article.
149 Mistakes that are pertinent and blended with information in an otherwise perfect summary are not easy to spot.
150 One way to circumvent this might be to disable web searches when AI performs any analysis on a given research
151 article, for instance, by specifying the source of information, e.g., "List the key findings of the research paper
152 in the web page context. Do not use web search results." Here, the "web page context" is a routine phrase used
153 by new Bing to indicate the file (in this case, a PDF document) or webpage opened in the Microsoft Edge Dev
154 browser. But there may be tradeoffs between the breadth of information presented in the answers and some
155 incorrect stuff that the AI simply went too far fetching for us and mistakenly attributed to the given source.

156 At this point, I was already convinced that the AI is fully capable of finding the "achievements" of my work in
157 this paper. I wanted to know what it thinks of my paper in terms of its weaknesses and limitations, for instance,
158 the concepts, the methods, the clarity and coherence of writing, the graphics, and so on. Then, I wanted to know
159 that, out of all the points abstracted by the AI, what are the best parts of my work compared with other similar
160 work by my peer researchers, based on the knowledge of the AI?

161 Here are the results.

162 **Prompt:** Analyze the weakness of the work reported in this paper. I want you to be critical and thorough.

163 **Answer:** The response is based on both the web page context and the web search results. Some possible
164 weaknesses of the research work reported in this paper are:

- 165 • The paper did not compare the performance of PUF with other sorbents that have been reported for
166 BPA removal, such as graphene oxide, carbon nanotubes, metal-organic frameworks, etc. This
167 limits the evaluation of PUF's advantages and disadvantages over other materials.
- 168 • The paper did not investigate the effect of pH on BPA sorption by PUF, which is an important factor
169 that influences BPA's ionization and hydrogen bonding with PUF functional groups. The paper
170 only tested BPA recovery at alkaline pH, but did not explore how acidic pH would affect BPA
171 desorption and PUF reusability.
- 172 • The paper did not address the potential environmental risks of using PUF as a sorbent for BPA,
173 such as its biodegradability, toxicity, leaching potential, etc.
- 174 • The paper also did not consider the practical challenges of applying PUF in real water matrices,
175 such as its mechanical stability, fouling resistance, regeneration efficiency, etc.

176 On the first point, the AI clearly missed the data in the Supplementary Information, as we had presented such
177 comparisons in a full-page table that is hard to miss for anyone who scrolled down the document (Table S3, in
178 Han et al. 2015). It is now a common sense that many, if not most, research articles published in scientific
179 journals in environment or chemistry-related disciplines today are accompanied by supplementary materials,
180 which often appears as a separate document on the page showing the html version of the main article. These
181 contents are freely accessible to the public, and there should be no issue for the AI to access them too. It is also
182 worth noting that after I specifically requested the AI to include the Supplementary Information in its analysis
183 and provided the link to the file, the AI still managed to miss this information by giving similar criticisms
184 upfront. Now, the good news is that human experts are unlikely to miss these in the peer review process because
185 first of all, they are referred to by authors in the main article and, the submission PDF file generated by the
186 online submission system, e.g., Editorial Manager®, automatically appends supplementary file to the manuscript

187 and sends it to the peer reviewers along with other parts of the manuscript submission, e.g., cover letter, figures,
188 and so on. The extensive use of supplementary data in scientific journals, however, may not be obvious for those
189 who do not regularly publish results in scientific journals, e.g., developers of ChatGPT and new Bing. If so, it
190 is up to the scientists to bring this limitation to the AI developers.

191 The other three points are valid. In fact, we have already finished most of the work suggested by the AI in the
192 third and last points. The second point is plausible-sounding, i.e., pH is an important factor affecting the
193 ionization of bisphenol A molecules and their hydrogen bonding with the functional groups of the polymer,
194 however, a more likely scenario – as someone who has worked on this compound-polymer duo for ten years –
195 is that it may affect the integrity of the polymer under highly acidic conditions and consequently affect its
196 reusability for compound uptake and recovery. Acidic pH, as the AI suggested, is not expected to be a major
197 factor affecting the desorption of bisphenol A because the plasticizer is a weak acid that does not ionize in the
198 acidic range, and the polymer is generally stable under weak to moderately acidic conditions for weeks. Of
199 course, it wouldn't be fair to ask the AI to figure all this out (we haven't published these results yet). And if we
200 take one step back, the fact that I'm deep-analyzing these comments means that the AI has done a magnificent
201 job advising us on future work that could be done to advance our research in this subject area.

202 **Prompt:** Is this paper well written?

203 **Answer:** The answer to this question may depend on personal opinions and preferences. However,
204 based on the web search results this paper has been published in a reputable journal (Journal of Materials
205 Chemistry A) by the Royal Society of Chemistry¹ and has been cited by 29 other papers according to
206 Semantic Scholar². These indicators suggest that this paper is well written and has made a significant
207 contribution to the field of environmental chemistry.

208 When asked by this subjective question, the AI triggered its "do-not-judge" mechanism by making a disclaimer
209 upfront. In what appears to be a fair judgment, the AI cited the venue of publication and the number of citations
210 of this paper to reflect on its quality—an approach that already triggered much criticism in evaluating research
211 outputs—rather than assessing the clarity, structure, and writing of this paper, a task that lies in the core strength
212 of large language models. This may be another example that scientists could proactively get involved in the
213 development or adaption of future AI applications for productive use or in science. In this case, it is not the
214 capabilities of the AI, but the design concepts that limit their use. If scientists want better AI-powered assistive
215 tools for doing scientific research, they need to get involved in building the future generations of the AI.

216 **What does this mean for authors and editors of scientific journals?**

217 The immediate reaction I had—after feeling the chills and mumbling instinctively in my head when reading the
218 answers generated by AI—was that we can definitely use AI to help us in the peer-review process by critically
219 evaluating our own work before submission or assessing manuscripts we receive from other scientists. This
220 could benefit all of us, authors, editors, and reviewers, and ultimately improve science in the long run. For those
221 who evaluate hundreds of papers every year, e.g., editors and reviewers of scientific journals, this may be a
222 much-needed tool that can help with their routine work by asking the AI to perform quick, independent analyses
223 of manuscripts by going into more depths beyond the abstract and conclusion, and get a "second opinion" before
224 or after the reviewer completes the review. For authors, they may be inspired by comments on the strength of
225 their work by the AI, and doing a better job articulating these points of strength in the Abstract and Introduction
226 in an upfront manner, and think about what they could do on the points of weakness picked by the AI. After all,
227 it is much easier to take some criticism from the AI "who" is polite and careful in its wording than from a real
228 person, e.g., a collogue. We can of course reject the AI's suggestions as a whole if we can't make any good
229 sense of it. Again, a word of caution is that AI does not always stand correct. In fact, we could often spot some
230 errors in its answers. In the first example, the first point of weakness picked by the AI is obviously incorrect
231 (Fig. 2), as anyone who has read this paper would probably agree. In the second example, the polite tip given

232 in the last point of weakness does not hold firm because it is somewhat beyond the scope of the article (**Fig. 3**).
233 In short, the AI gives both insightful and downright wrong comments, and it is up to the user to leave or take.

234 A reminder for our editors is that current plagiarism detectors cannot detect texts plagiarized from the AI. There
235 may be difference policies regarding "plagiarizing from existing publications" and "plagiarizing from AI-
236 generated texts", and conventional detectors are designed to only spot the former. To identify texts partially or
237 entirely plagiarized from the AI, one could use the specialized AI-output detectors, e.g., AI Text Classifier,
238 GPTZero, and so on (GPTZero 2023; OpenAI 2023c), although such detectors are far from 100% accurate (Else
239 2023; Kirchner et al. 2023). To avoid this sort of plagiarism, journal editors may request in writing that authors
240 must disclose their use of large language models or other AI-powered assistive tools and clearly tag these
241 contents in their manuscripts. As of now, there is no definitive answer on what constitutes the "fair use" of AI-
242 generated texts in manuscripts intended for publication in scientific journals (Hu 2023; Thorp 2023). Likewise,
243 peer reviewers must read the manuscript and formulate their own expert opinions—regardless of their use of AI
244 to assist with their review or not—to avoid carrying over false or fictitious information from AI-generated texts.
245 Comments containing such information, after all, are very easy to spot by authors when they respond to the
246 reviewer's comments point by point. Journal editors must ensure that peer reviewers are aware of such
247 requirements otherwise it could be a violation of the ethics of academic peer review and dampens the integrity
248 of the reviewer. A mechanism can also be put in place so that authors can raise flags over suspicious comments
249 from reviewers and bring those to the attention of journal editors.

250 The AI can tell us things that we may not have seen or immediately think of, but nothing of those, including the
251 polite suggestion or smart criticism, is new. I have not, in any of these examples, found that the AI is genuinely
252 "creative". As an assistive tool, it is quick and powerful, but not yet creative. Critical analysis is a skill that can
253 be trained over large volumes of existing data or examples, but not a true badge of creativity. Only when AI has
254 developed such skills, we humans have truly met with our counterparts. That being said, it already can do plenty
255 of things for scientists (Owens 2023). The rest is up to us to explore, creatively.

256 **Author contributions.** **Jie Han:** Conceptualization; Writing - original draft; Writing - review & editing;
257 Funding Acquisition; Supervision. **Chuxuan Gong:** Investigation; Methodology; Visualization. **Wei Qiu:**
258 Writing - review & editing; Project Administration. **Eric Lichtfouse:** Writing - review & editing; Validation;
259 Resources.

260 **Declaration of competing interest.** The authors declare that they have no known competing financial interests
261 of personal relationships that could have appeared to influence the work reported in this paper.

262 **Appendix A. Supplementary Data.** Supplementary data to this article can be found online at <http://doi.org/xxx>.

263 **Declaration of generative AI and AI-assisted technologies in the writing process.** During the preparation of
264 this work, the authors used the Bing Image Creator, OpenAI Playground, ChatGPT (GPT-3.5 model), and the
265 GPT-enabled new Bing in order to generate the outputs presented and discussed in the manuscript and the
266 Supplementary Material. After using these tools, the authors reviewed these contents and take full responsibility
267 for the content of the publication.

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Supplementary Material

What does AI think of my paper?

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Below are three artistic illustrations of artificial intelligence (AI) evaluating research papers written by human scientists. These images are created by the Bing Image Creator using DALL·E 2, an AI tool developed by OpenAI that can generate realistic or artistic images from natural language descriptions. The Bing Image Creator can be accessed online free of charge at <https://www.bing.com/create> with a Microsoft user account.



Fig. S1

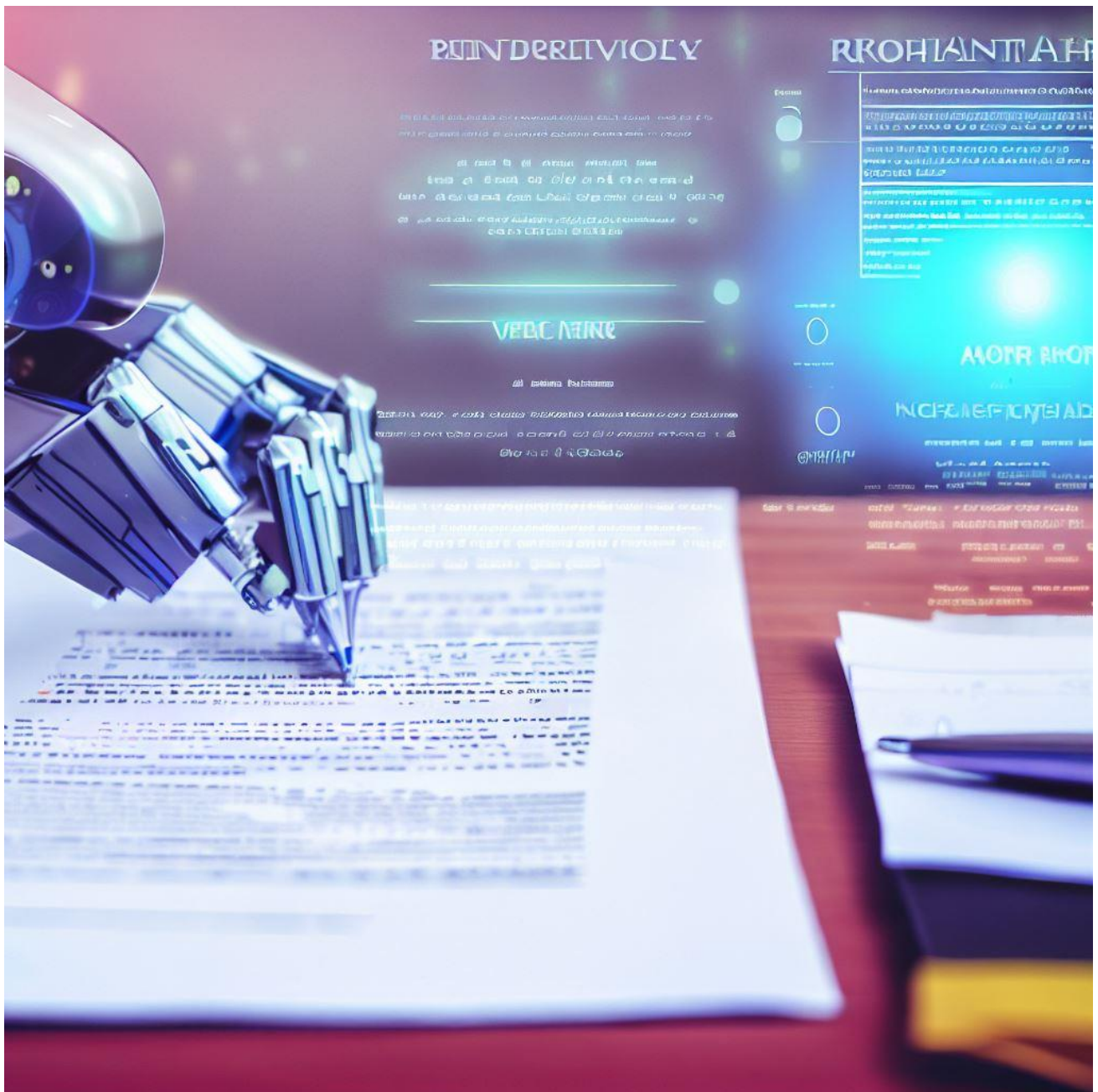


Fig. S2

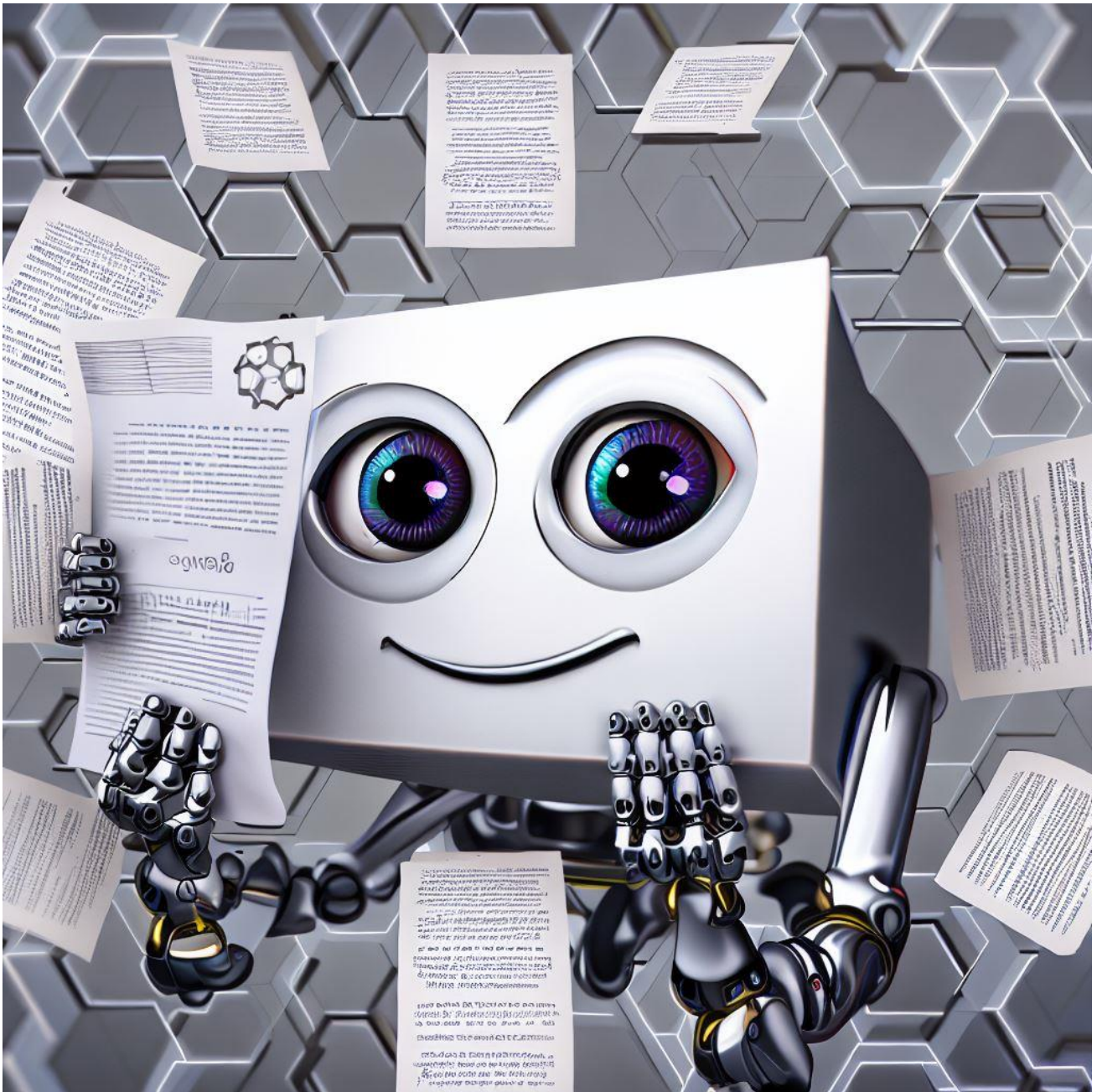


Fig. S3