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Perspective

Author-paid publication fees corrupt science and should be abandoned

Thomas J. H. Morgan[1,2,*], **Paul E. Smaldino**[3,4]

[1]Institute of Human Origins, Arizona State University, 777 E University Drive, Tempe, AZ 85287, United States
[2]School of Human Evolution and Social Change, Arizona State University, 900 S Cady Mall, Tempe, AZ 85281, United States
[3]Department of Cognitive and Information Sciences, University of California, 5200 N Lake Road, Merced, CA 95340, United States
[4]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM 87501, United States

*Corresponding author. Institute of Human Origins, Arizona State University, 777 E University Drive, Tempe, AZ 85287, USA. Email: thomas.j.h.morgan@asu.edu

Author-paid publication fees, often associated with so-called "gold" open access journals, lead to the corruption of science by incentivizing the publication of low-quality research and exacerbate inequalities between institutions that are prestigious and well-funded and those that are less so. Pressures to pay article processing fees on the part of funding agencies and university libraries waste research funding and stymie efforts to establish more sustainable publishing systems. We recommend a total abandonment of author-paid publication fees for academic research, the publication of which is typically a public good yet serves to enrich publishers while degrading research outputs. Alternative approaches related to "green" and "diamond" open access are cautiously recommended, as is a refocusing on society-run journals. We encourage the search for alternative models for evaluating and publicizing scientific research, including the formal modelling of competing approaches.

Keywords: Publication Fees; Article Processing Charges; Open Access; Cultural Evolution.

No good deed goes unpunished. —Anon

In 1973, following an OAPEC oil embargo, the US government sought to decrease their oil consumption, in part by raising the minimum standards for fuel efficiency of cars. Perversely, and despite its good intentions, this change would push both consumers and manufacturers towards larger, more dangerous, and *less* fuel-efficient cars (Zipper 2024). The critical factor was an exemption granted to "light trucks." This was intended to avoid adverse effects on industries that relied on large, heavy, and fuel-inefficient vehicles. However, it also meant that after the new standards were introduced, these vehicles became cheaper relative to smaller cars that were subject to more stringent efficiency requirements. They were also more profitable for manufacturers who began to market them heavily as family vehicles. In addition, federal safety requirements only considered the safety of occupants, not other road users, further favoring large, fortress-like vehicles. Today, after 50 years of these policies, SUVs and trucks have grown to constitute more than 80 per cent of new vehicles sold in the USA.

A little over 10 years ago, researchers in the social, behavioral, and medical sciences faced a crisis of their own: the replication crisis, provoked by the discovery that many published results could not be replicated and were, in many cases, wrong. Just like the US government, the scientific community would respond to their crisis with policy reforms Some of these were directly targeted at improving replicability. For instance, preregistration aimed to increase replicability by reducing the scope for researchers to reimagine their work after data was collected. Some journals began emphasizing technical soundness over perceived importance, encouraging the publication of null results and offering a venue for work that previously disappeared into the file drawer. These publications, it was hoped, would offer a natural check to the flashy false-positives that thrived in impact-driven prestigious journals. The urgent need for change also opened the door for reforms more broadly. Open Access (henceforth OA) reforms aimed to benefit the public and underfunded researchers by making publications free to read. They had been building steadily for years, with the first OA declaration dating to 2001 ("Budapest Open Access Initiative, 2001"), but following the upheaval of the replication crisis they went mainstream and more than 20 000 OA journals now exist whose content is freely available to all (see https://doaj.org/). Collectively, all these reforms were intended to put an end to the era of inequitable impact-chasing, false-positives, and unpublished truths. In its place would arise a new culture centred on the equitable and routine publication and open dissemination of unembellished, robust results. Or so it was hoped. In practice, just as with fuel efficiency policy, things did not work out as intended. Rather than solving existing problems, some of these scientific reforms have created new and perhaps worse ones as researchers and publishers converged on unanticipated strategies inadvertently incentivized by these new policies. As we describe below, central to this corruption of science has been pay-as-you-publish "gold" OA publishing. The

remedy is to abandon author-paid OA publishing and seek less harmful alternatives.

1. The economics of publishing

Although the internet has reduced the cost of publishing, it nevertheless takes money to run a journal. Publishers need money to pay for typesetters, proof-readers, and editors. They pay to host digital publications online, and some print physical editions as well. How publishers secure funding creates an incentive structure that affects their publication strategies. Prior to OA, most journals were funded through reader subscriptions, typically paid by institutions, with researchers regularly paying nothing at all to publish. University libraries, for example, would (and still do) negotiate with publishers for access to content. This incentivizes journals to publish content that readers or institutions will pay to access—which, in theory, should correspond to high-quality work. However, no system is perfect, and the replication crisis highlighted that readers' interest in shocking or surprising results increases the false-positive rate because surprising results are disproportionately likely to be incorrect.

Open Access policies change these incentives, replacing them with new incentive structures, the specifics of which depend on the form of OA that is adopted. The most typical OA format is "gold" OA in which journals are funded through article processing costs (APCs) paid by researchers upon publication of their work. Other forms exist. For instance, "diamond" OA journals are free to both authors and readers; these are reliant on external donations and volunteers and are therefore typically limited in the scale of both their readership and output. Hybrid journals still rely on subscription fees and so do not mandate APCs, however they allow authors to pay APCs in order to make their articles available to readers without a subscription. A final alternative is author self-archiving, so-called 'green' OA. In this case, authors simply post a copy of their article (often without the journal's official formatting) on a personal website, online repository, or preprint server. Gold is the most common OA policy, and is the focus of our critique.

2. The hidden costs of gold Open Access

Gold OA links journal income to the numbers of papers published, not the number of subscribers. As such, it creates an incentive for journals to publish large volumes of papers, including low-interest papers that do not attract subscriptions, because they generate income regardless. Examination of the fifty most productive journals (thirty-one of which are gold OA, the other nineteen hybrid OA) supports this ("SCImago Journal & Country Rank"): Gold OA journals produce more papers than hybrid journals (an average of 18 613 over 3 years, versus 11 707, $P = .033$), but these papers receive fewer citations (average of 4.9 over 2 years, versus 8.6, $P < .001$). Correspondingly, despite their greater productivity, gold OA journals have lower h-indices than hybrid journals (average of 207 versus 367, $P = .007$).

The publication of low-interest work can be important to preserve important ideas whose time has not yet come—so-called "sleeping beauties" (Ke, Ferrara, and Flammini 2015). But most low-interest papers are not sleeping beauties, and the publication of too many of these has the potential to harm the reputation of prominent journals. To avoid this, many publishers have launched lower-prestige gold OA journals that generate income from less newsworthy publications, while their more prestigious journals remain selective. Indeed, when prestigious journals reject papers, they often offer "transfer" services whereby the submitted manuscript is automatically sent on to a lower-prestige journal owned by the same publisher. The researchers benefit as the time cost of resubmitting the manuscript is reduced, the publisher benefits as they can reject a paper without losing out on the APC. An example is the gold OA journal *Scientific Reports*, published by Springer Nature, which receives transfers from other Nature journals and now publishes more articles per year than any other journal in the world ("SCImago Journal & Country Rank").

As low-prestige gold OA journals have proliferated, they have begun to compete to attract authors. Strategies include increasingly quick and easy routes to publication, as well as invitations to guest edit special issues, in which the invited editors (but not the other contributors) are typically exempt from APCs. This bidding for authors has encouraged researchers to pursue a quantity-over-quality research strategy, further facilitated by the perception that OA publishing is itself a signal of quality and by institutional career incentives that reward the number of publications without assessing their value. As some researchers have decreased the quality of their work, new gold OA journals with lower standards have appeared to provide an outlet. Thus, gold OA combined with quality-agnostic career incentives engenders a coevolutionary process between researchers and publishers in which publishers sacrifice selectivity for volume and researchers sacrifice impact for quantity. This process has been sufficiently rapid that when journals are ranked by papers published per year, eighteen of the top thirty, and *all* of the top five are gold OA ("SCImago Journal & Country Rank").

The negative effects this has on science (and science's public perception) can already be seen in recent cases of mass retractions (Van Noorden 2023), predatory journals and paper mills (Else 2021), and the rise of AI-generated papers (Wong 2024) and peer review (Chawla 2024a). Less dramatically, the increasing volume of publications also undermines human-written peer-review because there are now too many papers to review thoroughly. Even if you have the time, why carefully review a paper that few will read? As a result, low-impact journals are associated with shallower peer-reviews (Severin et al. 2023). The long-term consequence of this erosion of quality controls will be confused literatures and slowed scientific progress. The other big losers in this situation are the funding bodies who must now budget for APCs as authors rarely pay out of pocket. Indeed, funders refusing to cover APCs may be the simplest method to abandon gold OA publishing. But this simply begs the question of what should replace gold OA.

3. Can diamond, green, or hybrid Open Access help?

Given the various forms of OA available, the easiest solution may be to switch from Gold to a less corrupting alternative. However, identifying such an alternative is far from easy. Hybrid OA journals make use of APCs and so, to the extent that their funding comes from APCs, they are subject to the same incentives as gold OA journals. Moreover, within hybrid journals, publishing OA produces a citation boost and

so reduces the relative prominence of work by underfunded researchers, with this penalty being exacerbated by the larger APCs at the most prestigious journals (Brembs 2018; Sobchuk 2023). This suggests that hybrid OA policies will do little to help.

A recent alternative is the replacement of author-paid APCs at gold OA journals with institutional agreements with publishers to waive APCs for their employees (e.g. "Transformative Agreements with Cambridge"). By replacing the *pay-as-you-publish* model with a *pay-in-order-to-publish* model, these agreements may be an improvement on gold OA. However, attention needs to be given to the new incentives they create. For instance, to incentivize quality research, institutions should avoid reaching such agreements with low quality journals. However, both publishers (seeking to maximize income) and researchers (seeking non-selective venues to maximize publication rates) may desire the opposite. In addition, such institutional policies do not typically benefit researchers from underfunded institutions, who must continue to pay APCs. Finally, such agreements burden research funders and university libraries with huge costs that could otherwise go towards establishing less expensive alternatives.

Diamond and green OA publishing do not involve APCs and so are not affected by the incentives that APCs create. This also means they guarantee access to both readers and authors regardless of their funding. As such they may be a viable solution to the problems discussed above. Nonetheless, these journals face logistical concerns. Diamond OA journals are financially insecure and can struggle to scale up to the size of widely read journals without switching to gold OA policies. Green OA policies are similarly reliant on outside funding for preprint servers, while individual hosting is unreliable and not standardized. A solution to these issues is for funding bodies to switch from supporting gold OA, by mandating OA publication and providing funds for APCs, to funding green and/or diamond initiatives directly. For instance, the not-for-profit Open Library of Humanities (openlibhums.org) receives funding from libraries and other institutions which it uses to support diamond OA journals (Abizadeh 2024). Meanwhile, the Japanese government is spending ¥10 billion to create and maintain green OA repositories (Chawla 2024b). The potential long-term success of green and diamond OA can be seen in organizations such as the arXiv, a repository which has been consistently maintained since 1991; SciELO, a program supporting OA research communication in central and south America since 1997; AJOL, founded in 1998, which indexes research output from Africa, including 180 000 OA articles; Redalyc, an OA indexing system founded in 2003 that started in Ibero-America but now offers its service globally; and PubMed Central, an OA repository that hosts all NIH funded research published since 2009. Moreover, in the fields in which posting preprints has been normative for many years—including physics, computer science, and economics—journals still play an important role for vetting and curation while preprints guarantee access. Should such repositories become widespread, they may ultimately free journals from the burden of hosting content, enabling them to focus on the critical work of peer review, as with so-called "overlay" journals (Räsänen 2019). Thus, with suitable institutional and governmental support, green and diamond OA journals may realize the potential of the OA movement.

4. Future directions

Science is a complex process. Its success requires policies that incentivize researchers and journals to behave in ways that maximize its societal benefit. Such policies must strike a balance between the quality and quantity of work produced while avoiding unanticipated negative consequences. Too much emphasis on quality delays discoveries by trapping researchers in endless planning, proposals, and revisions. Moreover, where quality is hard to identify, it can inadvertently catapult misleading results to prominence while the truth languishes in obscurity. Nonetheless, too little emphasis on quantity buries genuine discoveries under masses of uninteresting and contradictory publications. Indeed, although the non-publication of data (the "file-drawer effect") is generally seen as bad, encouraging the publication of null results can foster the mass publication of underpowered studies, which may be worse (Tiokhin, Yan and Morgan 2021). From this viewpoint, gold OA policies have harmed science by overly favouring quantity at the expense of quality. In hindsight, reliance on reader subscriptions is a powerful incentive for journals to robustly check the quality of the work they publish, and, in turn, for scientists to conduct high-quality work in the first place (provided that community norms also ensure high-quality peer review). This reveals reader subscription fees to be valuable safeguards to the scientific process, replaceable only by comparable indicators of reader interest or publication quality. Nonetheless, we should not look back with rose-tinted glasses (Houghton 2022). Prior to OA reforms, the acquisition of a vast number of journals by a handful of commercial publishers created monopolies that enabled publishers to charge exorbitant reader fees, driving up private profit margins with public money (Larivière, Haustein and Mongeon 2015; Buranyi 2017). Our criticisms of gold OA are thus not a suggestion to uncritically revert to prior practices. But neither do the problems with subscription fees excuse the harm done by well-meant gold OA reforms. Indeed, switching from subscriptions to APCs posed no problem for publisher profits, with APCs exceeding more than $1B between 2015 and 2018 (Butler et al. 2023), and no doubt being even higher today. Instead, we should learn from the past as well as the present, and design incentive systems that meet our goals whether or not the mechanisms themselves carry the label of progress.

More broadly, rather than simply adopting new policies (which inherently favours policies congruent with existing power structures), we strongly encourage further formal modeling of the scientific process to identify beneficial changes (O'Connor 2023). Game theory and evolutionary modeling are particularly suitable because they allow for multiple parties (authors, reviewers, editors, and publishers) to dynamically respond to each other's actions and allow researchers to identify evolutionarily stable strategies. This approach could provide critical vetting for proposals such as "Plan U," which advocates for the public release of pre-prints prior to peer review (Sever, Eisen, and Inglis 2019; Dalmia and Coates 2024), because the widespread adoption of such policies is likely to cause a change in researchers' publication strategies. Taking an evolutionary approach to author behavior also highlights the futility of asking researchers to make ethical choices despite them being in a system that incentivizes against such choices (e.g. Logan 2017). Instead, we must identify

Table 1. Summary of our assessment of different proposals.

Policy	Recommendation	Notes
Gold OA	Abandon	Incentivizes the mass production and publication of low-quality science, corrupting the scientific process.
Institutional APC waivers	Treat with caution	Unlikely to reward high-quality journals over low-quality journals. Likely unavailable to researchers at underfunded institutions.
Hybrid OA	Abandon	Likely subject to the same incentives as Gold OA.
Green/Diamond OA	Recommend with reservations	They plausibly create good incentives but may struggle to be sustained without external support.
Society journals	Recommend with reservations	Appropriate policies are unclear in detail. Societies need safeguards against corruption and abuse.
Formal theory of journal policies	Recommend	Must consider dynamic strategies of authors, reviewers, editors and publishers.

how to change the system such that rational, self-interested actors will make the desired choices anyway. Existing work taking this approach has anticipated some of the problems discussed above. For instance, it was predicted that expediting the review process and encouraging the publication of novel null results, both of which gold OA supports, would decrease reliability, increase retractions and increase the peer review burden (McElreath and Smaldino 2015; Tiokhin et al. 2021; Tiokhin, Yan, and Morgan 2021). Other work anticipated the sorts of coevolutionary dynamics between authors and publishers we highlight in this paper (Smaldino and McElreath 2016). Critically, these methods can be used to assess policies *before* their implementation, thereby reducing the chances of unforeseen consequences. Recent modelling work on modified lotteries for grant funding illustrates how this can be done (Avin 2019; Gross and Bergstrom 2019; Smaldino, Turner, and Kallens 2019).

Beyond alternative forms of OA, a proposal we suggest for further evaluation is a re-emphasis on society journals. The proliferation of society-less OA journals means that too often researchers publish in, review for, and serve as editors for journals they are not invested in. A renewed emphasis on society journals may remedy this. With fewer alternative journals bidding for work, editors and reviewers may be more able to demand major improvements or extensions to submitted work, though this would have to be balanced by the need for diverse outlets. Journals could even require a history of thorough reviews as a prerequisite for submitting one's own work, thereby incentivizing high-quality reviews and fairly distributing the peer-review burden. Societies may also be well positioned to develop holistic assessments of research productivity that go beyond mere enumeration of journal articles and account for the diverse ways in which individuals contribute to research and scholarship, easing the pressure to maximize publication rates which has overburdened quality assurance mechanisms (Alperin et al. 2019). The existing set of society journals is likely to be insufficient to cover the wide range of current research, which is increasingly at the interstices of traditional disciplinary boundaries. However, emphasizing the connections researchers have to their communities is likely to improve the monitoring of standards (Ostrom 1990), provided that those communities avoid becoming overly disconnected from others who can provide critical input (Smaldino and O'Connor 2022).

Bearing in mind the unintended consequences of well-intentioned policy changes, from fuel efficiency to gold OA, we encourage readers to be cautious in their evaluation of our suggestions (see Table 1). Green and Diamond OA may not be sustainable in the long term; seemingly useful quality metrics may simply distort publishing in other ways; society journals may be vulnerable to corruption and abuse. Rather than adopting new policies that feel good and hoping for the best, proposals (including our own) should be examined through careful consideration, including formal modeling of the scientific process, to make sure they advance our goals. Where theory identifies policies that are likely to be successful, they can be further tested in experimental journals before being adopted wholesale. This sort of vetting is critical to avoid policy blunders; there is too much at stake to proceed blindly.

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