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Recommendations of the French Academy of Sciences for a practical application of the principles of open science

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Open Science Working Group of the Academy of Sciences

Contents

Executive Summary

The opening up of science, i.e., the free provision to all readers of the results of research, articles and associated data, as well as protocols, software, programs, laboratory notebooks, etc., and their free reuse under Creative Commons-type licenses, aims to give the scientific publication system an ethical and transparent momentum, of international scope.

Despite the enthusiasm generated by this laudable movement, obstacles to its free accessibility remain, due to the very functioning of the evaluation of research actors, and threats exist at the international level, particularly regarding sensitive biological data.

Researchers, individually or through learned societies and academies, are key players in taking charge of this important transition towards greater accessibility, by being both drivers of the evolution of the methods of evaluation of research results and by maintaining close contact with information and documentation professionals.

It is on the occasion of the formulation of the second National Plan for Open Science and while it will host in 2022 the OSEC22 (Open Science European Conference) within the framework of the French Presidency of the European Union, that the Academy of Sciences wishes to reaffirm its support for national and international initiatives that promote ethically acceptable open science. Thus, this report proposes to draw up an inventory of the current modalities of scientific publishing and intends to promote the many appropriate ways to follow for its evolution.

Recommandations for a practical application of the principles of open science

Introduction

The opening up of science should be understood as the free and open availability of research outputs, articles and associated data, as well as protocols, software, licenses/patents, laboratory notebooks, etc. to all readers and their free reuse under Creative Commons-type licenses[1].

This practice thus aims to give the scientific publication system an ethical and transparent momentum and it is currently experiencing growing interest and rapid progress. This is to be welcomed, while remaining vigilant about possible abuses. In particular, this rise in support for open science represents for some commercial publishers a perfect opportunity to increase their profits and, by the same token, increase the costs of scientific dissemination, thus undermining the ethics of science and the proper functioning of research.

Researchers, individually or through learned societies and academies, are key players in taking charge of this ethically important transition to greater accessibility, both by driving changes in the way research outputs are evaluated and by maintaining close contact with information and documentation professionals.

It is with this in mind that in 2012, at a congress of the American Society for Cell Biology, publishers, researchers, and specialists in scientific information decided together to write a charter of good practices in scientific evaluation. They drew up, with discernment and rigor, a list of 18 recommendations - now referred to by the acronym DORA[2] (for *San Francisco Declaration On Research Assessment*) - calling on all research actors to improve the quality of their evaluation and to put an end to its misuse.

Today, on the occasion of the formulation of the second National Plan for Open Science[3] and while it will host in 2022 the OSEC22 conference (OpenScience European Conference)[4] within the framework of the French Presidency of the European Union, the Academy of Sciences, which has repeatedly expressed itself on the issue of open science[5], wishes to reaffirm its support for national and international initiatives that work towards ethically acceptable open science. Thus, this report, nearly ten years after the writing of the DORA declaration, draws up an inventory of scientific publishing and intends to promote the best ways to follow for its evolution.

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[1] : *https://creativecommons.org/about/cclicenses/*

[2] : *https://sfdora.org/read/*

[3] : *https://www.enseignementsup-recherche.gouv.fr/fr/le-plan-national-pour-la-science-ouverte-2021-2024-vers-une-generalisation-de-la-science-ouverte-en-48525*

[4] : *https://www.ouvrirlascience.fr/les-journees-europeennes-de-la-science-ouverte-osec/*

[5] : See for example: (i) Individual evaluation of researchers and teacher-researchers in exact and experimental sciences *https://www.academie-sciences.fr/pdf/rapport/rapport080709.pdf* ; (ii) The proper use of bibliometrics for the individual evaluation of researchers: *https://www.academie-sciences.fr/fr/Rapports-ouvrages-avis-et-recommandations-de-l-Academie/du-bon-usage-de-la-bibliometrie-pour-l-evaluation-individuelle-des-chercheurs.html* ; (iii) The new challenges of scientific publishing: *https://www.academie-sciences.fr/fr/Rapports-ouvrages-avis-et-recommandations-de-l-Academie/nouveaux-enjeux-edition-scientifique.html* ; (iv) Declaration on Good Practices in the Evaluation of Researchers and Research Programs by Three National Academies - Academy of Sciences, Leopoldina et Royal Society : *https://www.academie-sciences.fr/fr/Rapports-ouvrages-avis-et-recommandations-de-l-Academie/declaration-sur-les-bonnes-pratiques-en-matiere-d-evaluation-des-chercheurs.html*

The state of play

While it has never been easier to share research results through digital tools, open access to scientific publications is not receiving the boost it deserves. According to the French barometer of open science[6], 56% of publications published in 2019 were open in 2020, with great disparities between disciplines: on the one hand, mathematics, fundamental biology, physics, and astronomy perform well[7], while engineering science struggles to open up. It is also worrying to note that, compared to other European countries, France does not play the leading role it should in open access to publications[8], given its many poles of research excellence. Thus, while more than 52% of British and Swiss publications are freely accessible for the period 2009 -2018, France and Germany are lagging far behind with open access percentages of only 41.8% and 40.4% respectively[9, 10].

This delay can be explained by two main obstacles: on the one hand, the costs charged by some publishers to provide open access for a publication, and on the other hand, the preference still expressed by many researchers to publish in closed journals when they are considered to be very prestigious.

For the first point, it is important to note that the increase in the costs of disseminating science coincided with a major privatization of the dissemination of scientific knowledge, which was initially carried out by learned societies and gradually passed, over the last century, into the hands of commercial publishers. In 2018, four houses of edition alone accounted for 52% of the scientific publishing market, achieving, according to their financial reports, profit margins close to 40%, particularly in the publications branch. This has led to an absurd situation in which the cost of subscriptions has continued to rise over the past two decades, while at the same time the adaptation of researchers to publishing tools has increased considerably, making the task of publishers even easier. The move to open access has even worsened the situation, with journal publishers setting up hybrid subscription packages with a supplement per article or APC (Article Processing Charge) required for free publication on the publisher's website, resulting in double payment, by readers and authors. Thus, journals considered prestigious - and therefore very popular with researchers - go so far as to require APCs of € 10,000; it is shocking that these open publication costs reduce the budgets allocated to research, even though the publication work largely rests on the shoulders of the researchers themselves.

At the same time, the imperatives dictated by the recognition of research work and its authors can hinder accessibility, despite the willingness of researchers themselves to participate in this ethical movement. Indeed, as a recent Couperin study on the publication and open access practices of French researchers in 2019 showed, "researchers are *generally* in favor of open access and understand the *major stakes*», *but* one of their main concerns in the choice of the place of publication remains the search for recognition by their peers[11]. Thus, it is the habits of the community of evaluators, largely intertwined with that of researchers, that must evolve. A

[6] : *https://www.enseignementsup-recherche.gouv.fr/fr/barometre-francais-de-la-science-ouverte-2020-47519*

[7] : Their open access rates vary respectively between 75% and 64%. See footnote 5

[8] : *https://www.hceres.fr/sites/default/files/media/downloads/mesurer_taux_acces_ouvert_publications_points_ost_2020_01.pdf*

[9] : *https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science/open-science-monitor_en*

[10] : Great Britain has bet a lot on the Gold way, vide below, following the report Finch (*https://www.researchinfonet.org/finch/*)

[11] : *https://www.couperin.org/site-content/261-a-laune/%201407-resultats-de-l-enquete-sur-les-pratiques-de-publication-et-d-acces-ouvertdes-%20chercheurs-francais*

questioning of evaluation in all its forms is necessary. Evaluation, when based on the use of metrics, often gives excessive and undue weight to prestigious journals with closed access or very expensive open access. However, it is an evaluation focused on the quality and originality of the article that will encourage open access and, by the same token, reduce the budgets often unjustifiably committed to scientific publication.

Finally, it should be remembered that an open science is not limited to articles alone but also concerns the material underlying publications, such as data. Among the latter, genomic and epidemiological data are now a subject of strategic and even geopolitical importance, for which the greatest vigilance must be exercised on the international scene.

Recommendations for a wider and more responsible opening

1. Improve the publication system for research results and promote "biblio-diversity"

When authors wish to commit to open publication or when it is required by research funding bodies, such as cOAlition-S members[12], several means guaranteeing visibility requirements for all are available in the current system and constitute a true "biblio-diversity" which should be encouraged.

The different publication systems to be promoted and encouraged

- Let us first recall the existence of a perfectly acceptable model, called the **diamond model**, which does not generate any cost either for authors or for readers and which has been adopted for the "*Comptes Rendus de l'Académie des sciences*"[13] since January 1, 2020, or for the Peer Community Journal (Peer Community In, PCI)[14]. However, this model requires sustainable funding, which implies a reorientation of funds previously devoted to subscriptions, as well as providing substantial savings. In general, the diamond model is not without problems, especially for the publication of articles from countries that do not contribute to the financing of the journal.
- Similarly, the so-called **freemium** or **platinum model** - adopted, by Open Edition journals in Social and Human Sciences - does not generate any cost either for authors or for readers who wish to have access to plain text, but offers additional paid services associated with a real added value provided by the publisher, such as downloading an interactive PDF.
- More and more renowned publishers also want to embark on the path of open access and publish their journals in a fully accessible form. It is the **Gold model**, also known as the **golden way**, which remains above all a financial strategy: publishers who engage in this path pass on the costs to the authors themselves, who are asked to pay a publication fee (APC) for the dissemination of their articles. These costs are often unrelated to the reality of the added value provided by the publisher, and only related to the prestige of the journal. Some subscription journals also offer authors the option of paying an APC to

[12] : *https://www.coalition-s.org/*

[13] : *https://www.academie-sciences.fr/fr/Transmettre-les-connaissances/comptes-rendus-de-l-academie-des-sciences-numerisees-sur-le-site-de-la-bibliotheque-nationale-de-france.html*

[14] : *https://peercommunityin.org/*

publish their articles: this so-called hybrid model allows the publisher to charge twice for its services, once by the subscription to the journal and once by the APC. This is why more and more learned societies, research funders and decision-makers are condemning the hybrid model and demanding that APCs be capped at around €1500 per article. This rule should be required by funding bodies and agencies[15, 16].

In response to this escalation of open access prices, one solution adopted by many European countries is to negotiate so-called transformation agreements between consortia and publishers. These agreements combine budgets for readers and open access budgets (APCs) for a global sum that takes into account the number of articles that can be published in open access per year in the publisher's various journals. These agreements aim, within a defined period of time, to move from subscriptions for readers to mixed subscriptions combining fees for readers and for publication in open access, which requires very tough negotiations with publishers. If these conditions are not met, the transition from the reader-pays model to the author-pays model will not lead to savings, quite the contrary.

The Academy of Sciences therefore hopes that, like many of our European neighbours, clear choices followed by action will be quickly made so that the subscription formulas imposed by publishers (Big Deals) are not replaced by equally restrictive APC formulas. It should be noted that the Directory of Open Access Journals (DOAJ)[17] also provides information on open access journals (APC tariffs, copyright policy, etc.).

- Researchers may wish to publish in a subscription journal only for reasons of recognition. In this case, the validated search results must still be freely accessible in an open archive: this is called the Green way, with usually an embargo of 6 months before opening on the publisher's site.

  However, an alternative to the immediate open access of validated information can be proposed, with an important condition. The author of the article must not assign his rights to the publisher, and it is the principle of copyright conservation for the manuscript reviewed by the referees and accepted for publication (or AAM, for Author Accepted Manuscript) that is requested. This is the case for the ANR[18], the ERC[19] and certain foundations such as the Wellcome Trust. The AAM can be put on a server without embargo and the non-assignment of rights could thus lead to a questioning of the law "*Loi pour une République Numérique*" of 2016[20]. It should be noted that some major publishers of learned societies, such as the American Physical Society (APS), allow articles to be posted online on institutional servers as soon as they are published. The Sherpa Romeo platform[21] compiles the various editorial policies on this subject.

  Any scientist, any citizen reader, must also know that the Green way frequently allows free access to the content of an article even when the published article is only available

[15] : *https://www.coalition-s.org/why-hybrid-journals-do-not-lead-to-full-and-immediate-open-access/*

[16] : This is particularly what the Max Planck Institute library advocates, based on the cost per item in the subscription model.

[17] : *https://doaj.org/*

[18] : *https://anr.fr/fr/actualites-de-lanr/details/news/science-ouverte-lanr-prepare-la-mise-en-oeuvre-de-la-strategie-de-non-cession-des-droits-initiee-p/*

[19] : *https://erc.europa.eu/news-events/magazine/open-science-editorial-erc-scientific-council*

[20] : *https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000033202746/*

[21] : *https://v2.sherpa.ac.uk/romeo/about.html*

on the publisher's website by subscription. To do this, it is sufficient to download onto one's favorite search engine the Unpaywall[22] or Click&Read[23] applications that allow instant retrieval of the content of research articles, freely and legally, or with an automatic request for them to the authors. The Academy of Sciences supports such initiatives and practices.

- Possibilities of open access also exist in the subscription system.

  As an example, the pilot project launched in 2020 by Annual Reviews (Subscribe to Open, S2O[24]) consists of opening, without embargo, all the content of the journal under subscription and keeping it open during the current year, not only to all subscribers but also to non-subscribers, provided that the former undertake to keep their subscription to ensure economic viability. It is a good model, based on the esteem that the scientific community has for a journal and on mutual respect between authors-readers and publishers. This open access formula based on esteem and trust has been extended to 74 journals as of March 2021, mainly journals of fundamental and applied mathematics. In France in particular, this model of open access to publications has just been set up by the publisher EDPSciences with the journals of the Society of Applied and Industrial Mathematics. In addition, the cOAlition-S2 recognizes and supports the S2O model as complying with the requirements of Plan S[25, 26].

- Parallel models of publication

  The opening up of science goes beyond the simple adaptation of the subscription system or its economic model; other means of disseminating science deserve serious attention. First of all, making manuscripts available before evaluation - on dedicated servers such as arXiv, BioRxiv, MedRxiv, ChemRxiv, (etc.) - is an interesting approach. However, this practice requires that the stage of publication be clearly identified so as not to risk confusing the "e-manuscript submitted before any evaluation" with the latest version accepted for publication (AAM). It will also be necessary to carefully select the serious platforms likely to accommodate this type of deposit of manuscripts (directories exist in this regard, such as ROAR or OpenDOAR, as well as endorsement procedures). The possibilities are therefore to be examined on a case-by-case basis and it is necessary to be vigilant about open access platforms for which there is no serious filter.

  The second scheme may concern models in which the scientific content of "e-manuscripts" on free servers is validated by peers, according to the Peer Community In (PCI) model[27] which should be extended to as many scientific disciplines as possible. This system guarantees a classic scientific peer review and open access, without necessarily going through publication in a journal.

  Another initiative of the same type as the previous one has emerged in the fields of mathematics and computer science. These are the epi-journals[28] in which editorial

[22] : *https://openaccessbutton.org/*
[23] : *https://clickandread.inist.fr/*
[24] : *https://subscribetoopencommunity.org/*
[25] : *https://www.coalition-s.org/about/*
[26] : *https://www.coalition-s.org/plan-s-principes-et-mise-%20en-oeuvre/*
[27] : See footnote 14.
[28] : *https://www.episciences.org/*

committees organize the evaluation of pre-prints submitted to institutional platforms. The epi-journals can be considered as an overlay added to the open archives: they bring a real added value by applying the scientific guarantee of an editorial board to each validated article.

To encourage a change in behaviour that could promote open access, it is essential that publications in these epi-journals or in the PCI mode mentioned above are valued at least as much, if not more, than publications in current journals considered as prestigious.

There is a tool developed by cOAlition-S, the Journal Checker Tool[29], which allows researchers to know clearly and quickly whether the journal in which they wish to publish is in line with the open access policy of the organization that funds their research, when it is aligned with the Plan S. The French Academy of Sciences, as well as funding bodies in France, should encourage its use.

The crucial issue of access to research data

According to the established formula, data should be as open as possible and as closed as necessary. All material associated with publications must be open and data must be deposited in trusted, sustainable repositories that adhere to the principles developed by Wilkinson *et al.* (2016)[30], i.e., to make them findable, accessible, interoperable, and reusable (FAIR). This is particularly the case for the databases maintained by the INSDC (for International Nucleotide Sequence Database Collaboration)[31] concerning genomic data. The reproducibility and reliability of scientific practices and the duty to share the knowledge acquired at the time of publication are at stake. These good practices are currently seriously threatened by the recent and growing authorization of some scientific journals, including prestigious ones, to publish articles without genomic data necessarily being deposited in INSDC-type databases. Even more serious, the integration of genomic sequence data into the Nagoya Protocol, which is unfortunately on track, means that some countries will be able to restrict access to sequences of living organisms harvested on their soil. This is a very strong threat to science, not only to its accessibility but also to its reliability and reproducibility.

2. Reconsider and value evaluation in a necessarily international context

The validation of research results is inseparable from peer review.

Evaluation is inherent in the normal activity of any researcher and is part of his mission. This activity is fundamental and far from trivial, especially since it requires a lot of time and effort and can be very beneficial both for the scientific community and for the evaluator.

In particular, some reports can bring to the original work a significant amount of additional scientific information. This is a practice that would be very interesting to develop with, for example, encouragement of the evaluator to write, in the margins of the original article, a short text to place the article in a broader scientific context. Similarly, the communication of exchanges between reviewers and authors of a manuscript, under the control of the publisher and guaranteeing the anonymity of the evaluators, would increase the quality and objectivity of the review process.

[29] : *https://journalcheckertool.org/*
[30] : *https://www.nature.com/articles/sdata201618.pdf*
[31] : *http://www.insdc.org*

In a context of increasing health and environmental crises, the evaluation of published work requires the widest possible access to the raw data (including negative data, protocols, metadata, algorithms, etc.) in order to ensure their validation and possible replication. Access to data must therefore be free and sustainable. It is important to remember here that the personnel in charge of the maintenance of data depositories and specialized databases are entitled to the same recognition as any other contributor to scientific knowledge.

Evaluation, a bottleneck for open science?

As highlighted by the Couperin survey[32], the evolution of scientific evaluation practices is a prerequisite for the opening up of research data in a way that is more respectful of the public funding committed to it. Evaluation plays a fundamental role in the career of scientist and the publication of a researcher's work is an important part of his activity, not least because it represents the means to be recognized by his peers at the national and international level. There is a consensus to publish openly with free access, but on condition that it does not jeopardize the chances of recruitment or funding. Publication is the preferred medium for peer review, but it should not be the only one, as the Academy of Sciences has already indicated[33].

With the increase in the number of researchers and the inflation in the number of their publications, it is tempting for evaluation bodies to rely on the simple counting of articles or citations that bibliometric databases make possible. Even if the Academy of Sciences has often expressed itself on the limits of bibliometrics[34], it seems useful to recall once again that bibliometric indicators are only a means to communicate quantitative information and not to reflect the quality and originality of an article. These last two points, which are eminently relevant for a pertinent evaluation, are only accessible through a qualitative assessment.

The Academy of Sciences recommends that the documents to be evaluated include, in addition to the list of publications, a text explaining the impact of the work accomplished and the contribution to the scientific community over a given period, on the understanding that the extent of this period strongly depends on the practices of each scientific field. In addition, the evaluation should focus as much on the open access to publications as on the prestige of the journals. Furthermore, in order to avoid any personal interest, any evaluation must have an international character with financial means in line with its objectives.

Finally, as the Academy of Sciences has often pointed out in its statements, it is essential that the evaluation is not limited to publications alone and that it takes into account the diversity of research outputs, i.e., patents under license, the creation of start-ups or discoveries that have led to a prototype or a clinical trial[35].

Necessary training in evaluation and scientific integrity during graduate studies.

Good practices in ethics, integrity and dissemination of research results should be known to all students involved in research[36]. The Academy of Sciences supports the introduction of teaching modules on these subjects in all doctoral schools to train doctoral students and newly

[32] : *https://hal-cea.archives-ouvertes.fr/cea-02450324v2/document*
[33] : *https://www.academie-sciences.fr/pdf/rapport/rapport080709.pdf.*
[34] : *https://www.academie-sciences.fr/pdf/rapport/avis170111.pdf*
[35] : See footnote 17.
[36] : *https://cache.media.enseignementsup-recherche.gouv.fr/file/Actus/84/2/Rapport_Corvol_29-06-2016_601842.pdf*

recruited staff. Several French universities[37] have already set an example and these initiatives should be widely known[38].

Training young people in the evaluation of articles is an essential tool for their own research as well as for the writing up of their work. It will also relieve the work of senior evaluators, who must not become professional evaluators at the expense of their own investment in active scientific research.

Open science: an international practice.

Advances in research are the result of constant exchanges between colleagues from all countries. Each country is unique in its approach to open science. At the strategic level, international consultation of universities and research organizations on this important subject is necessary (as is beginning to be the case) and France must strengthen its exchanges with the international community to give more weight to the position of academics in negotiations with major publishers. In particular, it is important to study the practices of foreign universities that have been pioneers in open science policies and their implementation, such as Utrecht in the Netherlands or University College London in the UK.

Conclusion

In recent decades, advances in digital technology have opened the possibility of making research results accessible not only to all professionals who have contributed to them, but also to any reader curious about scientific knowledge. Despite this removal of the technological bottleneck, the opening up of science still faces multiple challenges to guarantee the scientific integrity and reproducibility of research.

Multiple publishing channels are developing today and tend to increase the visibility of research results while offering the same, if not better, validation guarantees than traditional channels.

The accessibility of science must be seen in the context of an evolution in the evaluation of research; this indispensable and demanding activity must be carried out by peers and be better valued and recognised. Moreover, as research progress often depends on close and strong international cooperation, it is on this scale that a solution must be found for evaluation practices.

It is also essential for the reliability and usefulness of research that the data (including genomic data) on which scientific articles are based must be deposited in open databases such as those of the INSDC.

The second National Plan for Open Science aims to ensure that France has 100% of publications in open access by 2030. Let us hope that the deployment of existing and future ethically acceptable publishing channels can help shorten this period.

[37] : Examples include the universities of Lorraine, Nantes, Bordeaux, Strasbourg and Paris-Saclay.

[38] : *https://www.ouvrirlascience.fr/former-a-la-science-ouverte-tout-au-long-de-la-these/*

Appendix

Workgroup composition

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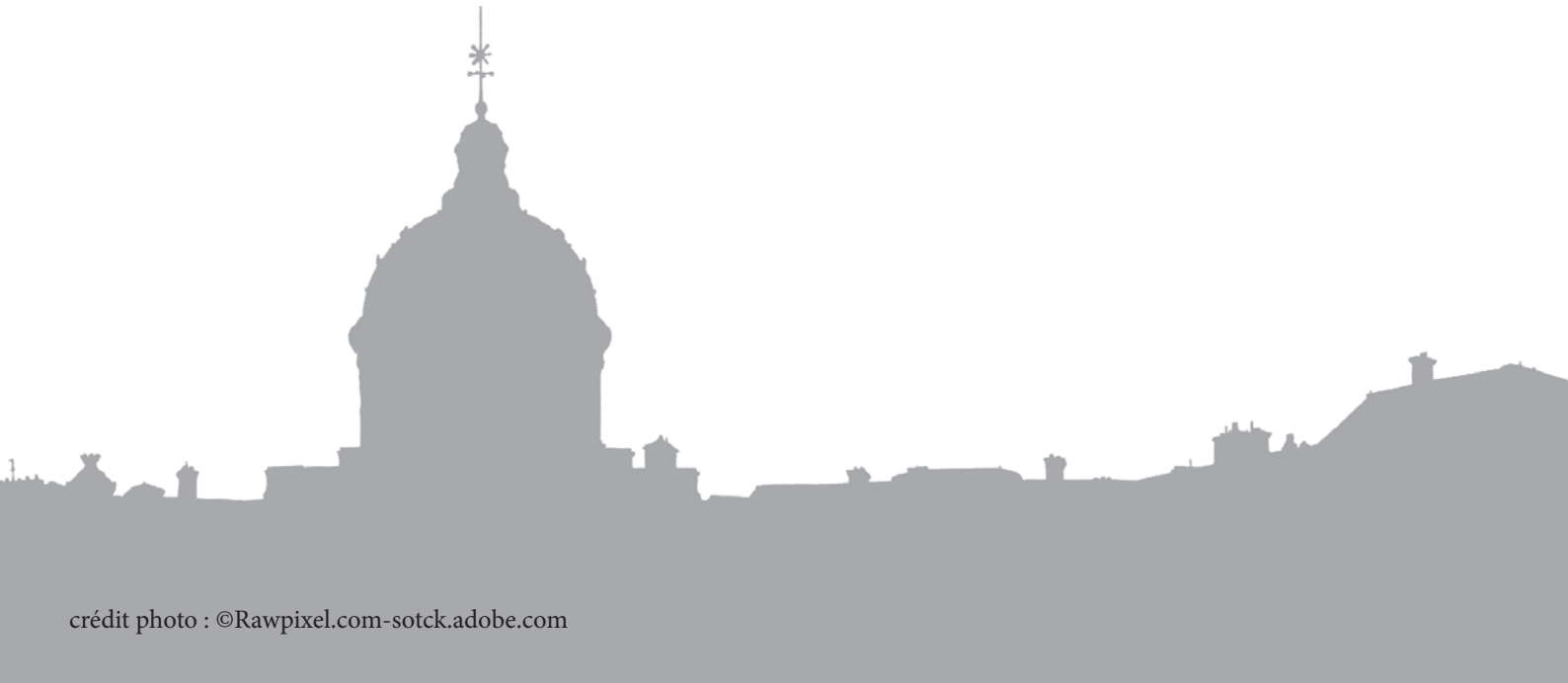

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