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Opening Up: open access publishing, data sharing, and how they can influence your neuroscience career

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No matter how often it might feel like it, science doesn't happen in a bubble – the things we discover aren't worth anything unless they influence other people. Luckily, this ability to reach others with our science is being made ever easier in the digital era. We have already moved far from the traditional model in which scientific findings were only ever presented in subscription-access, print-only journals. Nowadays there are huge opportunities to widen access, not only to complete scientific articles, but also to their underlying raw data, and there is a growing push from funders and other stakeholders to promote such openness. Here, we aim to outline these increasing demands for open access (OA) publishing and data sharing, to describe the routes available for their implementation, and to weigh up the costs and the benefits associated with such scientific openness, especially for early-career researchers.

We don't claim to be exhaustive in our coverage of this large subject, and refer interested readers to the many excellent and comprehensive reviews and opinion pieces written by others and cited in our reference list. But we do aim to bring a neuroscientific, and particularly a young neuroscientists' perspective to the issue, and in this goal we are helped throughout by the responses of our own FENS-Kavli Scholars to a simple questionnaire we gave them in the autumn of 2015. In the spirit of openness – **of course** – this questionnaire and the grouped responses to it are freely available as supplementary data to this article. We're also continuing to collect responses from an online version, found here (<https://fkne.typeform.com/to/Jx4NAq>) and open until a year post-publication, in which **we would** greatly appreciate your participation. With enough additional data, we hope to be in an even stronger position to lobby and advise relevant parties on some of the crucial points we raise below.

Demand: who's expecting me to be open?

There is a prevalent and ever-growing view that publicly-funded research should be accessible to everyone. This is reflected in increasing demands from funding bodies and other relevant parties that neuroscientists be open with both their publications and their data.

Funding bodies pushing Open Science

Funders, in particular, are increasingly requiring scientists to publish OA articles, and to deposit raw research data in public archives as a condition of funding. This is evident by growing efforts in both Europe and the US whereby public funding institutions have adopted open access requirements in their funding schemes (<http://tinyurl.com/j62khsp>). These requirements are sometimes – but not always – enforced strictly. For example, NIH in the U.S. and Wellcome Trust in the U.K. can take extreme measures such as freezing of funds if publications from funded projects are not made OA. For the European Research Council (ERC) and the Research Councils UK (RCUK) on the other hand, while open access of publications is a requirement, no enforcement plan is clearly evident yet.

In Europe, Open Science is the new initiative adopted by the European Commission (<http://tinyurl.com/q7bqkxf>). Commissioner Moedas and Commissioner Oettinger in a joint blog post on June 22, 2015 stated that “Open Science describes the on-going transitions in the way research is performed, researchers collaborate, knowledge is shared, and science is organised. It represents a systemic change in the modus operandi of science and research. It affects the whole research cycle and its stakeholders, enhances science by facilitating more transparency, openness, networking, collaboration, and refocuses science from a 'publish or perish' perspective to a knowledge-sharing perspective.” Towards this goal, the Commission has already initiated several science policy actions, with two large OA pilot initiatives currently operating at the EC level: a) the FP7 post-grant Open Access publishing funds pilot (<http://tinyurl.com/zzq9lur>), where researchers and/or organizations can request funds to cover the open access publication fees for outcomes of a completed FP7 grant, and b) the Open Research Data Pilot (<http://tinyurl.com/jn4deqz>), which “aims to make the research data generated by selected Horizon 2020 projects accessible with as few restrictions as possible, while at the same time protecting sensitive data from inappropriate access.”

Similar initiatives at the National level include the recent announcement (<http://tinyurl.com/q3yzdtv>) of the Dutch National Research Funder NWO that makes Open Access mandatory. In essence, NWO demands that all publications emerging from a 'call for proposals' published by NWO after December 1st 2015 must be immediately accessible to everybody from the moment of publication. According to the announcement, NWO is the first national research council worldwide to take such a step and, importantly, it is supporting this transition to Open Access financially.

Within our own group of 20 young **neuroscientists** working in Europe, **55% (n = 11)** have received funding from institutions that insist on open access publications. However, the funds dedicated to such publications were only available to **25% (n = 5)** of the scholars. Although the sample size of our own little survey is admittedly very small, these results indicate that while Open Access is largely promoted via funding agencies, it is not yet fully financially supported.

Overall, the current demands of Funding bodies for Open Access of research outcomes are highly variable. This tends to be far stricter for Open Access to publications rather than for data sharing at the moment, largely because data sharing requires the development of appropriate digital infrastructures and management protocols which are currently underway. However, it is becoming more and more apparent that Open Access and Data sharing, or 'Open Science' is a rapidly approaching reality and that everyone involved should be prepared for the inevitable.

Other stakeholders pushing Open Science

In addition to funding bodies and organizations, pressure for Open Access comes from **other** sources. The Max Planck Society has been actively advocating Open Access since 2003 (<http://tinyurl.com/htjoz37>), with the publication of the 'Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities.' Ever since, it has been holding annual conferences to increase awareness and propose measures towards Open Access. In Canada, McGill University's Montreal Neurological Institute (MNI) has recently embraced openness on an unprecedented institutional scale – on a voluntary basis, its researchers are making all results and data freely available at the time of publication, and are foregoing patent applications. What's more, in the hope that this approach will go viral, they're requiring their collaborators to sign up to the same principles (<http://tinyurl.com/z7lu4do>).

There are also a number of collective organisations promoting scientific openness. These include Voice of Researchers (VoR; <http://voice.euraxess.org>), a network formed in 2012 that takes an active role in shaping the European Research Area. The League of European Research Universities (LERU; <http://www.leru.org>), a prominent advocate for the promotion of basic research at European universities, is also a strong supporter of Open Access. In October 2015, LERU issued a statement entitled "Christmas is over. Research Funding should go to research, not to publishers!" (<http://tinyurl.com/jhlqqkk>), proposing a new business model in favour of Open Access. Specifically, 'LERU wants universities, which pay for subscriptions, to be able to use their current spending level to 'offset' subscriptions against payment for **article processing charges (APCs)** for journal articles in hybrid journals. As part of any agreement, publishers should permit all papers published by university researchers taking up the deal to be made open access for no extra charge.' And ERCIM, the European Research Consortium for Informatics and Mathematics (<http://www.ercim.eu>), has recently published a report entitled 'BOM@ERCIM — Towards an open access policy for ERCIM'. This document provides a basis for better communication between research organisations about dissemination of research results and OA. It also gives a strong set of recommendations that could be implemented step-by-step by all ERCIM members and other interested parties.

Importantly, **in addition to** public institutions, private enterprises have also joined the quest for Open Access and Data sharing. The Allen Institute in the U.S. has adopted an openness attitude from the beginning (e.g. via the open access to its brain atlases) and has recently joined the effort to generate the necessary protocols and digital infrastructure that would allow large scale data sharing. The neuroscience community in particular is a major driving force in this effort, primarily due to the funding invested and the massive amounts of data generated as part of the two large neuroscience initiatives: the Brain Initiative in the U.S. and the Human Brain Project in Europe.

With respect to data sharing, several journals and commercial repositories are also pushing open data forward. For example PLOS journals now require open data associated with their publications as detailed in their blog from Feb 2014. (<http://tinyurl.com/hpmp6xm>). They 'strongly encourage deposition in subject area repositories...where those exist, and in unstructured repositories...where there is no appropriate subject-domain repository.'

In line with these positions, our own group also managed to agree on something: 100% of the FKNE scholars (**n = 20**) believe that Open Access to both data and publications is good for neuroscience. With everyone pulling in the same direction, and with openness becoming an increasingly common requirement for scientific endeavour, the natural next question is 'how do I do it?'

Supply: where can I share?

Open access publication

OA publication is widely available, particularly since the government and funder mandates mentioned above have come into effect. However, the world of OA publishing can still be quite confusing, with different grades of openness available. To help clarify things a little, we spoke to Phill Jones, head of publisher Outreach Digital Science and a "chef" on the Scholarly Kitchen blog (<http://scholarlykitchen.sspnet.org>). He told us that, traditionally, authors signed over the copyright of their publication to the journal, which charged subscription fees to access their publications. This is still the case in many journals, but because of OA requirements most of these journals now allow 'self-archiving', which means that the final accepted peer-reviewed version of the article, but not the publisher's nifty pdf version, can be uploaded to a repository such as PubMed Central or institutional websites after an embargo period. The embargo period is typically 6-12 months, meaning that only people with subscriptions or those willing to pay the fee to buy the individual article can read the paper during this initial period after publication. This self-archiving method is often referred to as 'green' OA publishing.

A level up from green is 'gold' OA which allows immediate access to the published final version on the journal website. Often gold OA is paid for by the author through high publication fees, **in** the order of several thousand **euros**. Even within gold OA, there are grades of openness defined by the copyright license. The most open publishing copyright commonly used by journals is the Creative Commons Attribution license (cc-by), which permits anyone to read, distribute, or reuse the article as long as the original source is properly cited. Still OA but slightly less so are articles published under non-commercial (NC) and non-derivative (ND) cc-by copyright which do allow free access to the final published article but do not permit commercial use of the article (NC) or derivative re-use like text mining or data mining (ND) (for more information about the confusing area of licences, see <http://creativecommons.org/licenses>). Most purely OA journals, such as eLife, Frontiers and the PLoS journals publish with the cc-by license.

To make matters more confusing, many journals (such as Nature, PNAS, and EJM) now have a hybrid model where most of their articles are not OA or can be green OA after the embargo period, but authors have the option of paying extra to make their papers immediately accessible with gold OA.

This can be particularly infuriating to universities and other institutions because they are effectively paying twice for access to articles, once through subscription fees and again by paying for gold OA.

OA type	What	Where
green	Accepted manuscript (Usually NOT the final publisher pdf)	<ul style="list-style-type: none"> - institutional repository - free digital repositories (e.g. PubMed Central) - some journals make articles available after embargo period on their websites
gold	Final published version	<ul style="list-style-type: none"> - journal website - generally wherever else you want to share it

Table 1. Routes for OA publishing.

So now we know a bit about what OA is, but is it important for us as early-mid career neuroscientists? Within the admittedly small sample size of the FKNE, **100% (n = 20)** of the scholars agreed that OA **publishing** is good for neuroscience. However, only **52% (n = 183/354)** of our collective **PI-authored** papers are currently freely available online. When asked ‘How important are open access options in your choice of journal for your lab’s primary research publications?’ only one scholar responded with the choice ‘it means everything to me’. The most common choice (**40%; n = 8**) was ‘it enters my thoughts briefly and then I go back to checking impact factors’, while a close second (**35%; n = 7**) responded ‘it definitely plays a role in the decision-making process’ and **20% (n = 4)** thought ‘it really doesn’t matter’.

For neuroscientists, the most important thing to keep in mind about OA publishing is whether you are complying with your funder’s requirements. So before deciding which journal to publish in, it’s important to make sure that if your funder requires gold OA, that is an option in your journal of choice. Some funders, such as the Wellcome Trust and RCUK in the UK, provide funds directly to universities as ‘block grants’ to pay the OA fees (see below). Sometimes, your institutional librarians know about these opportunities and can help you pay for OA fees. Many funders require green OA, in which case it is your responsibility to make sure the final accepted version of the article (not the publisher’s pdf) is shared online. This can be done through public repositories like PubMed Central, ResearchGate or OpenAIRE (see Table 2), or often through institutional repositories. Again librarians can often help with this process and inform you whether your institution has any particular rules.

Being even more open – data sharing

Beyond sharing the final version of published articles, sharing raw data is another important aspect of open science. Data sharing has been particularly successful in some areas with standardized data outputs such as genomics (Choudhury *et al.*, 2014). For instance, the International Nucleotide Sequence Database Collaboration (<http://www.insdc.org>) combines worldwide genetic sequence data including the European Nucleotide Archive, the US NIH GenBank, and the DNA DataBank of

Japan. In neuroscience, the Psychiatric Genomics Consortium (<http://www.med.unc.edu/pgc/>) has freely available genetic data from over 900,000 people with psychiatric disorders and controls. The Human Connectome Project (HCP; <http://www.humanconnectomeproject.org>) is another successful neuroscience data sharing initiative that collects and shares MR imaging, cognitive, and demographic data on 1,200 healthy volunteers to define variation in brain wiring (Van Essen *et al.*, 2013). PubMed shows over 1000 hits for this project indicating its utility to the field. There are also many other general or specialised repositories for brain imaging data, where sharing appears to be particularly well resourced (Eickhoff *et al.*, 2016; Table 2). In addition, the Collaborative Research in Computational Neuroscience (CRCNS; <https://crcns.org>) data sharing repository is a joint effort of the National Science Foundation (NSF), the National Institutes of Health (NIH), the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung; BMBF), the French National Research Agency (Agence Nationale de la Recherche; ANR) and the United States-Israel Binational Science Foundation (BSF) that supports the sharing of experimental data from various brain regions, analysis tools and simulations.

Another incredibly useful neuroscience data sharing initiative comes from the Allen Institute for Brain Science, which freely provides multiple large datasets in the form of brain atlases highlighting development, connectivity, and cell types in several species (<http://brain-map.org>). According to Terri Gilbert at the Allen Institute, they have more than 45,000 visits to their brain maps every month, around 150 citations per year of the mouse atlases, and 25 citations per year each of the connectivity and human atlases.

Digital reconstructions of neurons are another example of successful data sharing in neuroscience. Digitized neuron traces are shared on NeuroMorpho.org (Parekh & Ascoli, 2013; Ascoli, 2015), and the Allen Institute is working on the BigNeuron project to provide a resource for automated neuronal reconstructions from imaging data (Peng *et al.*, 2015). With respect to sharing of computational models of neurons and circuits, ModelDB is the largest open repository at the moment (<https://senselab.med.yale.edu/modeldb>). For electrophysiological recordings, the Carmen portal (<http://www.carmen.org.uk>) provides an open repository as well as analysis tools, and the Neurodata Without Borders (NWB; <http://nwb.org>; Teeters *et al.*, 2015) project continues to develop a common data format for ease of sharing.

In addition to these large initiatives sharing standardized data sets, there are options for sharing any type of data. There are unstructured repositories such as Dryad, FigShare and Zenodo, and many institutions provide their own repositories for their researchers' data. Data sharing should also be greatly facilitated by the EU's OpenAIRE initiative (<https://www.openaire.eu>). OpenAIRE is a network of Open Access repositories, archives and journals that support Open Access policies. It goes beyond the traditional publications aggregator by interconnecting entities related to scholarly communication (publications, research data, funding, people, organizations, data sources) allowing users to navigate alongside a rich information space graph and provides a wide range of services, from deposition to statistics. At the time of writing, OpenAIRE provided access to 13,333,818 publications and 16,735 datasets from 6,081 data sources. These involved 98,410 projects and 18,351 organizations!

These repositories, amongst others, are summarised in Table 2. This can be used as a first stop for choosing a sharing route, but is not by any means exhaustive. For the full picture of your data

sharing options we recommend the Neuroscience Information Framework (<http://www.neuinfo.org>), a comprehensive ‘database of neuroscience databases’ set up by the NIH’s Blueprint for Neuroscience Research.

Data format	Repository	Website
Article file	PubMed Central	http://www.ncbi.nlm.nih.gov/pmc
	ResearchGate	https://www.researchgate.net
	OpenAIRE	https://www.openaire.eu
All data formats	figshare	https://figshare.com
	Dryad	http://datadryad.org
	Zenodo	http://zenodo.org
	Synapse	https://www.synapse.org/#
Genetic data	INSDC	http://www.insdc.org
	PGC	https://www.med.unc.edu/pgc
	GenomeRNAi	http://www.genomernai.org
Imaging data	HCP	http://www.humanconnectomeproject.org
	OpenfMRI	https://openfmri.org
	COINS	http://coins.mrn.org
	NITRC	https://www.nitrc.org
Electrophysiological recordings	CRCNS	https://crcns.org
	Carmen	http://www.carmen.org.uk
	Neuroelectro	http://www.neuroelectro.org
Morphological reconstructions	Neuromorpho	http://neuromorpho.org
	BigNeuron	http://alleninstitute.org/bigneuron
Computational models	ModelDB	https://senselab.med.yale.edu/modeldb

Table 2. Popular data sharing repositories.

However, even with so many opportunities available to share and exploit neuroscience data, their use is pretty low amongst our Network: 35% of us (**n = 7**) have not shared any data openly yet, and only 45% of us (**n = 9**) have ever used shared data to benefit our own research. However, there are examples within the network of sharing several types of data, including sequences, behaviour, electrophysiological data, morphological data, and computational models.

One key question remains concerning the sharing of neuroscience data: what exactly should be shared? In other words, what is the ‘minimum data unit’ that is useful for sharing with other scientists? This clearly has huge implications, on the one hand for the work that our fellow scientists are able to perform with the data we have generated, and on the other for the amount of time and effort required to get our data in sharable form (see below). But there’s little agreement as to the most useful balance to be found here. Amongst the FKNE Scholars, 50% (**n = 10**) thought that defining the minimum data unit was ‘hard to say, and depends on the type of data’, while the remaining votes were split evenly between ‘all raw data that contributed to a single publication’ (20%; **n = 4**) and ‘all raw data represented in the figures of a single publication’ (25%; **n = 5**). Defining the standard in the field will be a crucial step to advance data sharing in neuroscience in the near future.

Motivation: what's in it for me?

Being open with articles and data is therefore becoming increasingly demanded of neuroscientists, and the options for fulfilling these demands are growing and growing. But what are the benefits, and the potential drawbacks, of openness in modern neuroscience? How can it influence your career, especially if you're just establishing your own lab?

Many people think the answer to both these questions is 'not much'. Asking our Network revealed very little expectation that open access publications or data sharing would impact on the careers of young neuroscientists. Only 35 % of us (**n = 7**) agreed that 'publishing open access articles is important for the career development of early-stage neuroscientists'. And while asking for 'good reasons to share your data openly' revealed some very noble motives amongst our group – the top answers were 'It's good for science' (n = 18) and 'It's the right thing to do' (n = 12) – only 6 of us thought that 'It benefits my career'. However, there *are* some clear and demonstrable benefits to being open with your science.

Benefits of being open with your science

Perhaps the negative perception of **the career impact of openness** is because so few of these benefits are '**direct**' – where publishing open access articles or sharing data are rewarded in their own right. But direct benefits do exist, even if they are only permissive. For example, funding bodies such as the NIH and the Wellcome Trust now insist that their researchers publish their findings in OA format (see above), and can prevent future applications from those who do not comply. In other words, publishing OA articles brings the benefit of being eligible for future grant applications. **While** these eligibility criteria are not currently so strict for other funding bodies, many, including the ERC and RCUK, are known to be reviewing policy in this area. For data sharing, the guidelines and requirements are currently nowhere near as strict as those for OA publishing (see above). However, many grant applications now require researchers to list their plans for data sharing, and in today's ultra-competitive environment this is, at the very least, an area where a lack of detail or poor motives could pull a project just under the 'fundable' bar. Moreover, in the EC's 2014 public consultation on Science 2.0: Science in Transition (<http://tinyurl.com/hh7fegv>) 85% of respondents (48% 'totally agree', 37% 'partially agree') believed open science activities 'should be taken into account for researchers' career progression'.

This being said, most senior neuroscientists we asked who sit on grant boards or hiring committees told us that an applicant's prevalence of OA publications, or their data sharing achievements, almost never currently factor into the process of making career-defining award decisions. Indeed, few of the FENS-Kavli Scholars have ever been asked for OA publication information (35 %; **n = 7**), or information on data sharing contributions (20 %; **n = 4**) 'as part of a grant application, job interview, appraisal or other career-influencing process.' Part of the problem here is a recognised lack of quantification for scientific openness. With the field of altmetrics currently working feverishly on the best ways to reflect scientific productivity and impact in our era of electronic publishing and

social media, it may well be that in a few years' time young neuroscientists are being awarded grants and positions based at least partly on their articles' or datasets' download statistics, or something far more imaginative and informative. Giorgio Ascoli puts this well in his excellent recent article discussing the successes and challenges of the neuronal morphology database NeuroMorpho.org:

'Researchers who can demonstrate not only high productivity of their own labs but also the facilitative influence of their data on other labs are well positioned to gain a decisive advantage over similarly productive competitors who choose not to share their data with peers.' (Ascoli, 2015)

In the meantime, however, we have to make do with the '**indirect**' benefits of scientific openness. Luckily, these are considerable:

- 1) There are, for example, **wider benefits** of OA publications and data sharing for the global neuroscience community, with broad agreement (including unanimously within our Network, see above) that openness is 'good for neuroscience'. Having open access to publications, and especially their associated raw data, is very clearly a powerful force to prevent unnecessary duplication, to guard against fraud, to bolster the validity and reproducibility of findings (Iqbal *et al.*, 2016), to allow efficient data re-analysis and re-use, and to advance neuroscience education (Ascoli, 2015). But even if you're not feeling community-spirited, there are still benefits to being open with your science...
- 2) Across a huge swathe of the scientific, funder, publisher and lobbyist communities, there's no doubt that **open access is *The Way Forward***. Funding bodies and employers are going to become increasingly insistent that candidates have a proven record in OA publication and data sharing (see above), and that they continue to operate in as open a manner as possible. With this in mind, neuroscientists, and especially young neuroscientists with their whole careers ahead of them, can benefit hugely from getting a jump **start** on the system. Openness is coming, so be ready!
- 3) More immediately, there's great potential for openness, particularly data sharing, to **improve your science**. Much as experimental design can be greatly improved by considering how you'll analyse your data before collecting any, project planning can be hugely assisted by considering how you'll eventually share your data. Tim Hubbard, Professor of Bioinformatics at KCL, told us: 'If you think about organising your data for sharing, it'll help with your own analysis.'
- 4) Finally, and maybe most importantly for the careers of young neuroscientists, being open can considerably boost your work's **citation count**. An influential comparison of open access vs non-open access articles published in the same journal found significantly higher citations for the OA papers (Eysenbach, 2006), although it should be noted that these data include, but do not specifically apply to, neuroscience, and alternative explanations for these findings have been suggested (Craig *et al.*, 2007). There's also good evidence that papers with open data receive more citations (Piwowar *et al.*, 2007; Piwowar & Vision, 2013). In addition, there are growing opportunities to create, and receive citations for, additional publications that solely describe open datasets (Ascoli, 2015). And these benefits are not just numeric – the reuse of your data should be taken as a strong indicator that your original study was well performed, interesting, important **and clearly influencing the field**.

Costs of being open with your science

The combination of these direct and indirect benefits makes a pretty compelling case for scientific openness. However, there are also potential **costs** that need to be considered before you decide to publish OA or openly share your research data.

- 1) **Time.** This is a crucial consideration. Not so much for OA publishing, which takes minimal extra time and effort amongst our Scholars – 80% of us (**n = 16**) estimate that securing OA for occupies less than half a day of additional work – but certainly for data sharing. By far the most popular response when we asked the FKNE Scholars to list good reasons *not* to share data openly was ‘It’s too much work’ (n = 14). The work involved consists largely of preparing the data to be shared – cleaning up, collating, annotating and providing metadata for files (Ascoli, 2015). This can be a considerable effort. We asked our Network ‘If you had to make all of the raw data from your last publication ready for open access sharing, including uploading each individual file with metadata to make it understandable to others, how long do you think it would take you?’, and the mean answer was *9 days*. For any lab publishing a few papers annually this soon represents a significant workload. Indeed, concerns about the additional demands of open science for young researchers were raised in the EC’s 2014 public consultation on Science 2.0: Science in Transition (<http://tinyurl.com/hh7fegv>): ‘the mandatory inclusion of Open science activities into career progression could constitute an additional stress factor to the already high workload of junior scientists (e.g. Young Academy Europe)’. (p16)

It is clear that many data repositories appreciate this issue, and are making it as easy as possible for authors to deposit with them. However, not all forms of neuroscience data have dedicated easy-deposit repositories, or come in readily-shared formats, although movements such as Neurodata Without Borders (see Table 2) for electrophysiological recordings are working to address this. This is an obvious place for funders and others with a vested interest, to invest money to widen the uptake of open data sharing. Even with current sharing options, though, there is an argument that sharing your data can save you time in the long-run, by allowing you easy access to well-archived and maintained datasets (Ascoli, 2015). And, of course, time issues are intimately tied up with finances – if you can get funding for someone to share your data for you, it ceases to be an issue...

- 2) **Money.** Sure, ‘time is money’. But money is also money, and the financial costs of scientific openness can be significant, especially for OA publishing. Even amongst a relatively well-funded group of young researchers, only 25% of the FKNE Scholars (**n = 5**) have access to specific funds for OA publishing, where individual **APCs** usually run in the thousands of **euros**. At present, those without such dedicated resources need to make very careful decisions about whether additional OA costs, offset by all the direct and indirect benefits of OA publishing outlined above, are worth the investment of scarce funding resources. There are calls for this situation to improve, given that OA in the highest impact journals is simply unaffordable – an APC of ~30,000 **euro**, for example, to make Nature full OA (Van Noorden, 2013)! The business model that is envisioned by the EC, according to Jean-Claude Burgelman, head of the C2 Unit of DG Research and responsible for Open Science, is initially

to put a cap on the OA fee that would be an eligible expense for EU funding. In the longer term, publishers would recoup lost income by charging a small, pay-per-download fee for each publication, similar to how Apple **operates** i-Tunes. Introducing any charge to view the results of publicly-funded science, no matter how small, negates the fundamental principal behind OA, however, so we watch with interest to see how this might be resolved.

Data sharing can also involve considerable financial cost, especially in the human resources necessary for data preparation. To cover these costs, many funding bodies allow specific data sharing funds to be written into grant proposals, and many more (most notably the ERC) are currently considering this possibility. So, where at all possible, our advice to young neuroscientists is to take the time to detail their data-sharing plans in grant applications, and to cost them **appropriately**. Prof Tim Hubbard's view here is that, in general, funders look more favourably upon people looking to tap into good existing resources, rather than people proposing to spend lots more money creating additional, duplicate repositories. So use **those repositories indicated** in Table 2 and other resources to find an appropriate home for your data, and make sure you get the funding you need to put them there.

There is a key drawback, however, in awarding openness costs within individual grants. Publications, and associated post-publication data deposits, very often occur after the termination of the grant that funded them, and in many cases this means that funds are no longer eligible for OA publication or data-sharing costs. In the case of OA publishing this problem can be solved with the award of 'block grants' to individual institutions, who then use the money to fund OA across their funded staff even if articles are published long after the grant funds ran out. This is common practice through RCUK and the Charity Open Access Fund (COAF) in the UK, and Alex Saxon, Associate Director of Policy and Analysis at RCUK, tells us that this works well, especially amongst early-career researchers. Hopefully the FP7 post-grant Open Access publishing funds pilot (see above) will prove similarly successful at a European level, resulting in a wider adoption of the approach in future, and a potential extension to apply to the costs of open data sharing as well.

- 3) Lack of support for **learned societies**. Unfortunately, not all funders have the financial resources to be able to support full OA of publications or research data. An OA model for many would mean a significant loss of subscription revenue for societies that perform unique and important roles in the scientific community – this very journal is no exception! Subscription revenues prove **very** hard to replace with other sources of income (<http://tinyurl.com/hof55xj>) and very few society journals have been able to make the transition to full OA. Some have launched parallel OA publishing routes (e.g. the Society for Neuroscience's eNeuro journal), and time will tell whether these are successful. However, it is important to consider the impact on societies when choosing where to send your next paper – maybe OA isn't everything in this one key case. To quote a recent report from the Initiative for Science in Europe Open Access Working Group: 'In general, learned societies have as goals the wide and barrier-free distribution of scientific knowledge; the sustainability of the scientific enterprise; and the contributions that the learned societies make to the advancement of scientists and the development of the careers of individual scientists. Attaining these goals while restructuring a major source of income for such activities will certainly require some trade-offs'. (<http://tinyurl.com/hof55xj>)

- 4) Effects on your **network**. Even if you've decided that being open with your science is in your best interests, other important people may not necessarily share that opinion. For example, for young PIs there is certainly a risk that **senior colleagues** – the kind of people who sit on grant boards and hiring panels – may see efforts towards openness as time that could be spent more productively elsewhere (Gewin, 2016). However, there's no doubt that anyone thinking this way is out of step with the prevailing attitudes of most funders and publishers (see above), and these kind of opinions are likely to grow increasingly rare in coming years. Anyway, the additional positive impacts of being open with your research will almost certainly outweigh any old-fashioned negative attitudes. More crucial might be wariness on the part of your existing or future **collaborators**. These people can be absolutely vital in the early stages of your independent research career, but might not necessarily be convinced of the value of sharing the data you produce together. Most important here is to make sure that the plans for your collaborative data and your joint publications are discussed, agreed and documented as early as possible.

- 5) Competing needs for **privacy**. This is a special concern for data sharing, where 'Open data is not an unqualified public good' (Alex Saxon, RCUK). In terms of retaining credit for primary research findings, any issues surrounding the open availability of data and the potential to be scooped in their use disappear if the bulk of the sharing happens post-publication. Ethical issues are more pressing, but really apply only to studies with human data, where concerns over the public release of personal data are understandably strong. However, safeguards and guidelines are similarly sturdy in this area (e.g. <http://tinyurl.com/grn54oz> ; <http://tinyurl.com/ot8eqw4>) and it goes without saying that these should be followed rigorously in all cases. A final consideration is intellectual property, where open sharing of data could potentially impact on commercial interests. In these cases, parties who have funded the research usually have clear advice on data use. RCUK, for instance, strongly advise that collaboration agreements are set up in the early stages of project, and explicitly cover the governance of access to data. They also err in favour of openness: 'Research Councils expect commercial partners not to restrict publication of research results unless arrangements to do so have been previously agreed with the funders.' (<http://tinyurl.com/ot8eqw4>). The main lesson here is: read the small print!

Conclusions

Despite some very real potential costs that should always be taken into consideration, it is clear that there are manifest and multiple benefits to being scientifically open, both with your publications and with your raw data. None of these benefits apply exclusively to young researchers, but today's changing landscape will certainly have a greater impact on those with the longest careers ahead of them. Openness is undoubtedly the future, so be part of it now – it'll help you, and it'll help us all to produce some fantastic neuroscience!

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