# Effective self-management for early career researchers in the natural and life sciences

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## Abstract

Early career researchers (ECRs) are faced with a range of competing pressures in academia, making self-management skills key to building a successful career. There are important steps ECRs can take to increase their chances for a successful research career and broaden their career opportunities outside academia. We undertook a group effort within the Organization for Human Brain Mapping Student and Postdoc Special Interest Group to gather advice to help ECRs in self-management. In this article, we covered topics such as taking charge of one's career development by proper goal setting and making one's own opportunities, managing time properly, tips on taking care of oneself and surrounding oneself with positivity, recognizing and addressing bottlenecks in research projects, growing personal network, mentoring and being mentored, and staying vigilant to opportunities outside of science. The essence of this set of guidelines is that, to move forward in academia, one should (1) be self-aware and understand oneself; (2) reach out to people; and (3) keep an open mind to new opportunities.

We believe that more attention should be dedicated to equalising chances for developing careers in academia and beyond.

## Running Title:

Effective self-management for ECRs in natural sciences

## Keywords:

early career researchers, ECRs, self-management, career development, networking, mentoring

## Introduction

Finding success in today's scientific environment places competing demands on early career researchers (ECRs). We define this group as individuals pursuing academic research at the sub-tenure level, regardless of years of experience. ECRs are expected to produce high-quality scientific publications, while rapidly developing a broad skill-set in designing and conducting experiments, scientific writing, computer programming, public speaking, mentoring, and scientific salesmanship. In times when the reproducibility of science is of a great concern, expectations for research skills in ECRs grow even higher (Poldrack, 2019). ECRs are put in a difficult position of needing to publish more than previous generation while simultaneously being held to higher standards of methodological rigor, including better powered studies, pre-registrations, and making all their data and methods openly accessible (Poldrack, 2019). These developments come at a high labor costs that particularly affects ECRs involved in the project (Allen & Mehler, 2019).

Trying to self-navigate this landscape can easily become overwhelming and discouraging, especially given the number of extenuating circumstances which can appear during research career. While changing jobs in industry or during post-PhD academic track may be perceived as a positive sign of initiative for self-development, changing research environments during the PhD programme is often frowned upon. This is especially true when it comes to breaking a PhD contract (Academics Anonymous, 2017). Altogether, developing a career as an ECR can be a formidable challenge.

This article is initiated under the umbrella of the Organization for Human Brain Mapping (OHBM) Student and Postdoc Special Interest Group (further referred to as SP-SIG, www.ohbmtrainees.com). The goal of the SP-SIG is to empower ECRs and provide them with tools and resources that can assist in them developing fulfilling careers in academia and industry (Bielczyk et al., 2018). The purpose of this article is to provide general guidelines that readers can fit to their personal experience. As several career advice-oriented resources for ECRs are available online (Czerniawski, 2017, Santiago-Lopez, 2019, Allen & Mehler, 2019), this article aims to expand on this topic and propose recommendations that ECRs in the natural and life sciences can use to positively influence their career success in academia and beyond. Our recommendations are largely drawn from the personal experiences of the authors as well as strategies they have developed in consultation with their mentors, but where possible relevant research studies are cited.

The advice provided in this article is organised thematically in the sections that follow. The summary of the tools and strategies mentioned throughout the text is given in **Supplementary Material 2**. Lastly, this article was written following guidelines listed in (Frassl et al., 2018, Tennant et al., 2019).

## Take charge of your own career development

### Follow your curiosity and build expertise

Curiosity is the primary driver of scientific discovery (Koestler, 1964, Simon, 1992). However, passion for research usually does not come at the very beginning of the research career: it comes together with the experience and expertise built over a long period of time (Wrzesniewski, McCauley, Rozin, & Schwartz, 1997, Newport, 2012). Many successful scientists start to feel love for what they do only after achieving some level of expertise in the field.

### Set Clear Professional Goals

Citing Jim Rohn, '*If you don't design your own life plan, chances are you'll fall into someone else's plan. And guess what they have planned for you? Not much*' (Investivate, 2017). An effective way to take charge of your own career development is to develop a clear vision of what you want in life and work out a plan consisting of a number of small steps towards these ultimate goals (Sinek, 2011a, Howes, 2012). With this type of long-term perspective, it is easier to view small failures and setbacks as lessons and growth opportunities toward the ultimate goals. For example, a single "failed" project

no longer seems like a significant setback when viewed from the perspective of a 40-year long career. Focusing on how an obstacle could be used to change the approach for future projects could turn a “failed” project into a valuable learning lesson (Sinek, 2011a, Sinek, 2011b, Doerr, 2018). While having long-term goals can improve performance in learning certain skills, e.g. foreign languages (Moeller, Theiler, & Wu, 2012), only those goals that are *clearly defined* are usually achieved (Goerg, 2015, Locke & Latham, 2006; **Fig. 1A**).

Remember that putting too much (time) pressure on the goals can lead to elevated stress, which can result in a cascade of errors, procrastination, and suboptimal performance. This effect is known in psychology as the Yerkes-Dodson law (Yerkes & Dodson, 1908, **Fig. 1B**). Research also suggests that over-planning can have negative impacts on one’s mental health by imposing elevated pressure for success and inducing work-life imbalance (Ordonez, Schweitzer, Galinsky, & Bazerman, 2009, Lipp & Chen, 2019). It is good to keep in mind that given strong education obtained in academia, there are always career opportunities, and a research career is only one of many.

## Manage your time well

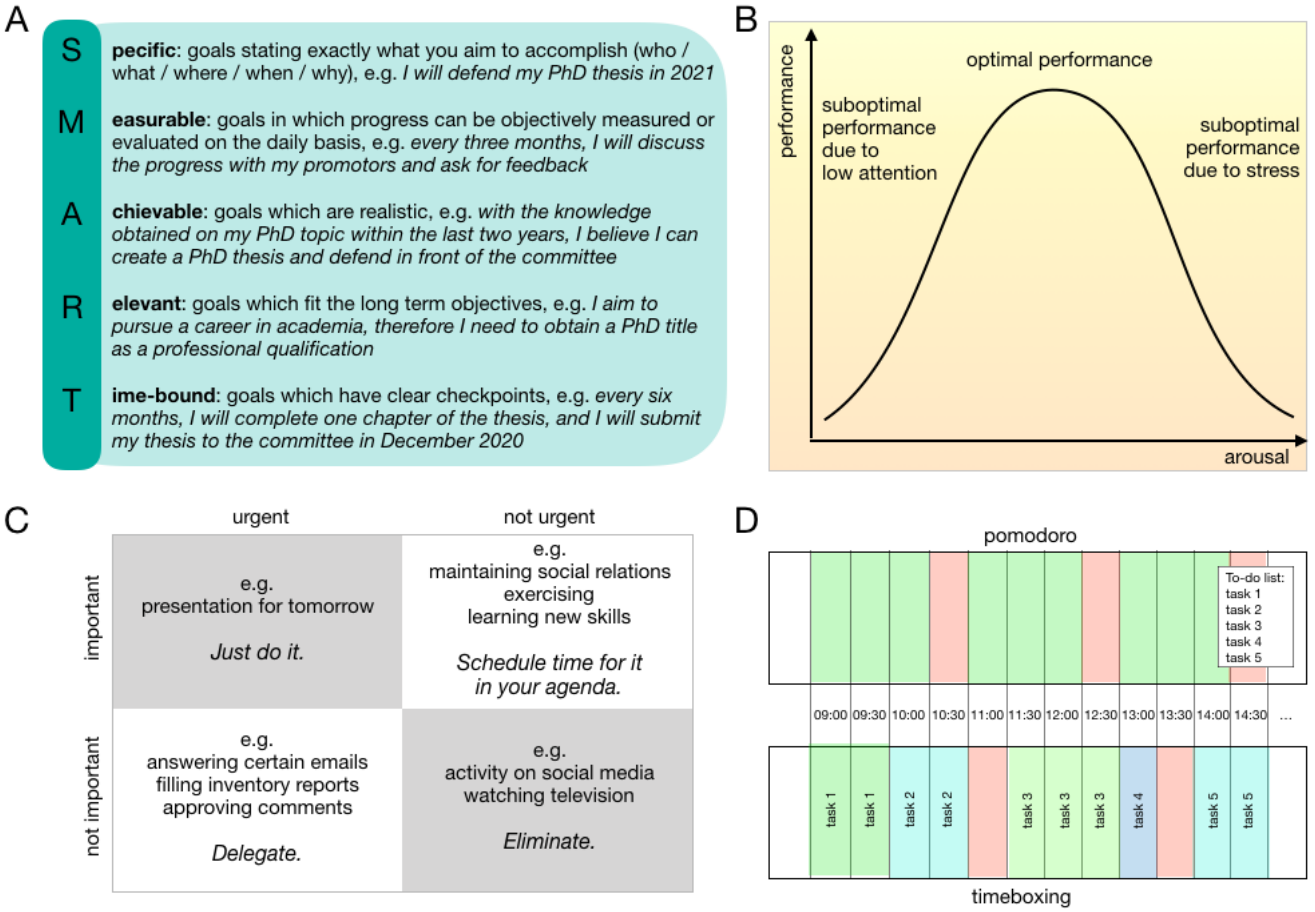


**Figure 1** Several popular concepts in the domain of goal setting and time management. **A:** the S.M.A.R.T approach for setting professional goals (Raia, 1965, Grant, 2012), with examples. The goals should be Specific, Measurable, Achievable, Relevant and Time-bound. **B:** the Yerkes-Dodson law (Yerkes & Dodson, 1908): fulfilling goals requires attention, therefore low arousal leads to suboptimal performance. However, there is an optimal level of arousal over which performance decreases due to high levels of stress. If the goal is unrealistic (e.g., to graduate from a PhD within a year), the time pressure can lead to anxiety and subsequent procrastination. **C:** the Eisenhower chart for managing tasks (Eisenhower, 1954, B. Mackay & Mackay, 2013). Tasks can be divided into urgent versus not urgent tasks, and important versus not important tasks. The key to success in the long term is to properly manage important but not urgent tasks as one needs to actively find time for these tasks in the agenda, **D:** the *pomodoro* technique (Cocirillo, 2011) and *timeboxing* (Pash & Trapani, 2011, Frankton, 2014) for planning working time. In pomodoro technique, tasks are kept in lists and working time is pre-divided into periods of deep work (green) interleaved with breaks (red). In timeboxing technique, every task is given a precise slot; working on a given task precisely within the given frame is more important than completing the task. It is possible to combine these two techniques by setting regular time boxes for tasks and for the breaks between tasks.

Saying ‘no’ is difficult for most researchers, but necessary. Temporal discounting is a problem here: future time commitments seem to matter less when agreeing to them in the moment. One strategy to overcome this issue is to imagine that you had to do it for tomorrow - would you still say ‘yes’ on such a tight deadline? To make this choice easier, you can also establish personal rules for when to say ‘yes’ and ‘no’ (for some guidelines, see Rojas, 2016, Mackay, 2017). Having long-term goals can help you decide which tasks provide delayed gratification rather than instant but insignificant rewards.

According to Dwight D. Eisenhower (Eisenhower, 1954, B. Mackay & Mackay, 2013, **Fig. 1C**), activities can be divided along two dimensions: important/not important and urgent/not urgent. While important and urgent tasks are prioritised, proper management of the important and non-urgent tasks is the real key to success as they require commitment and careful scheduling – otherwise the urgent tasks will always win your attention. Learn to delegate tasks that don’t need to be done by you. As you become busier, this skill will become only more important.

Furthermore, following Parkinson’s law (Parkinson, 1955), the more time you allocate for a given task, the more time the task will take you. To complete projects in a timely manner and maintain focus throughout the day, consider implementing productivity strategies such as the *pomodoro* (Cocirillo, 2011; free applications implementing pomodoro are available, e.g. Time Out and Stretchly) or *timeboxing* technique (Pash & Trapani, 2011, Frankton, 2014). These techniques (**Fig. 1D**) can be combined with the *getting things done* approach (Allen, 2002): moving planned tasks out of the mind by recording them, and focusing attention on taking action.

## Take care of yourself

Take care of yourself

Mental health problems in academia are very common (Academic, 2014, Bernstein, 2015, Evans, Bira, Gastelum, Weiss, & Vanderford, 2018, Levecque, Anseel, De Beuckelaer, Van der Heyden, & Gisle, 2017, Barreira, Basilico, & Bolotnyy, 2018, Nöbauer, 2012). It is essential to be self-aware of your well-being, and keep proper balance in your life. Keeping social contacts outside academia, caring about mental health and physical well-being need persistence (Petersen, Riccaboni, Stanley, & Pammolli, 2012). Below, you can find some suggestions for every day personal care:

Exercise at least three times a week. Many studies showed that exercising between two and three times a week reduces the chances for depression, stress, anxiety disorders and anger (Hassmén, Koivula, & Uutela, 2000). This does not need to be an excursion to the gym; you can walk a distance between your home and office at a faster pace than usual or make simple yoga moves in the morning. However, group exercise has been proven to be more effective in helping people control their stress and improve their mood (Yorks, Frothingham, & Schuenke, 2017).

Discover your optimal working style. When are you the most productive or most creative within a given day? What is your best sleep schedule? What type of diet makes you feel the most energized? What makes you procrastinate (Donald, 2018)? Knowing your optimal working style can help you in catching work-life balance.

Break the cycle of negative thought and manage stress. If for a prolonged period your mood stays low, you may benefit from therapy or counselling. Seeking professional help is too often stigmatized. Instead it should be viewed as a healthy approach that can have a positive impact on your career success and quality of life. Treat your mental health as you would treat your body: take good care of it, and go in for professional check-ups whenever you feel it would be helpful. Typically, academic institutions offer mental health services to their employees. Find information about these opportunities early, and keep it at hand and use it whenever it is needed. There are also associations dedicated to helping early career researchers in maintaining mental health, such as Academic Mental Health Collective (AMHC, https://amhcollective.com/about-the-amhc/).

Develop ways of managing criticism. Criticism and self-criticism are a part of daily research routine. Try to always discern between critics towards your work and critics towards yourself, and do not take it personally. If the criticism constructive, take it as advice, and be grateful for it. You might even practice saying 'Thank you' for constructive criticism, as hard as it may be. If the criticism is destructive, or about your personal character, don't react. Take a step back and try to understand the true motives underlying the criticism, and move on from there.

### Take care of your family

Either now or in the future, you will likely have caretaking responsibilities (children, partners, family members, etc.). A parent or family member may get seriously ill and need your help. Perhaps you or your partner get(s) pregnant, and you have to raise a child in addition to your career. These life-events are normal and bring a richness to life, and also can help you find a balance between work and life.

Ask a mentor or colleague you trust for support. Find out about your rights to statutory leave, whether for maternity, paternity, adoption or dependent caring. In addition to your statutory rights, most employers have policies that entitle you to additional leave and benefits above what is legally mandated. Many employers now have special programmes, such as courses on work-family balance, contract extension for caretakers, childcare support, and support groups for parents that enable them to combine career and kids, e.g. extra time when taking care of sick family members etc. Look around for others in similar situation, see and ask how they handle it. Look out for awards, grants and fellowships that provide support for the continuation of your research while you are away with caretaking responsibilities, or those that encourage a return to science after a career break. It can be reassuring and useful to read about how other scientists have managed their careers alongside caring responsibilities (Payne, 2018, *'Scientist and parent'* series at *eLife*, https://elifesciences.org/collections/29e48019/scientist-and-parent).

Furthermore, it is good to make sure that you and your PI have similar expectations about work-life balance. Consider options such as part-time work, and make realistic goals. Sometimes it is helpful to plan work only in core hours and not in the evening or weekends and learn to turn your phone off. If you notice that your boss or co-workers are crossing lines and demanding more from your private life than you are willing to give, communicate this clearly.

## Find a positive circle of influence

Working in academia can lead to feelings of loneliness and isolation (Sibai, Figueiredo, & Ferreira, 2019). Importantly, recent data suggested that, among doctoral students and academics aged 18-34, isolation associated with careers in academia was the biggest contributor to reported mental health problems (Shaw, 2014). This has prompted global efforts to develop strategies that enhance the ECR experience by encouraging engagement of ECRs in their research environments (Belkhir et al., 2018). There are also highly inclusive online associations open to ECRs focused on career- and personal development, such as the community of eLife Ambassadors (https://elifesciences.org/inside-elife/a946c355/elife-community-ambassadors-243-volunteers-join-the-programme-in-2019). You can consider applying to join such a community.

There is a popular saying in science: *We're all smart. Distinguish yourself by being kind.* This is a good piece of professional development advice in general, both in science and beyond. Developing kindness and gratitude does not require any unique talent, and can make you a linchpin in your workplace (Godin, 2011).

## Start writing your CV of failures

Success rates in publishing in high impact journals and obtaining grants can be around 10% or lower, making academia very competitive and rejection rates high. The daily life in academia does not feel any more successful, as in most research projects, it needs multiple failed attempts before any discovery or improvement can be seen. For these reasons, it is easy to get a false impression of an overall professional, chronic underachievement (Gelman, 2016).

In 2010, Dr. Melanie Stefan proposed writing a CV of failures, where only rejections and failures were documented (Stefan, 2010). Reading CVs of failures written by established researchers can be helpful to ECRs, as it demonstrates that failure is an integral part of science and should not be taken personally. Thankfully, it is becoming increasingly popular for established PIs to divulge their CV of failures to the public (e.g. Haushofer, 2016, Voytek, 2018, 'How I fail' series, Cheplygina, 2018, 'Growing up in failure' series, http://www.cns.nyu.edu/events/growingupinscience/unofficial.html).

Documenting rejections in a CV of failures can also be beneficial to ECRs as it serves as an index of productivity and a source of motivation. Once you start writing your CV of failures, every action will add to your CV: either the official CV or the 'failure CV'. You can also learn from your mistakes (Clark & Sousa, 2015). This does not only help you to learn from your own failures, but also allows others to benefit from these experiences. Furthermore, sharing failures decreases the malicious envy of others (Huang, Buell, Huang, Brooks, & Hall, 2018), which can otherwise negatively affect interpersonal communication and productivity.

## Plan out your projects

You may find that your research project has certain bottlenecks or difficulties which can hamper its successful completion. You can increase these chances by careful planning, gathering a good team, and flexibly changing the strategy throughout the process. Online scheduling tools, such as Trello, can help to keep the team on track. If any bottlenecks appear, you should clearly communicate this issue to other members of your team. You can ask yourself: can we solve this problem within the current team? Can we decompose this problem into smaller and manageable chunks? Who is a useful contact person to address each one of these subproblems? Remember that time is an asset that cannot be reclaimed, and you will save yourself a lot of time by identifying potential bottlenecks upfront. The more comprehensive advice on how to minimise risks during your research project, is given in **Supplementary Material 1**.

Also, developing side projects can help in stress management, especially if your main project is burdened with serious bottlenecks. Think about your research activities as an investment portfolio: you want it to be diversified enough that the failure of one project will not tank your entire career. When you present your idea for risk diversification to your supervisors, treat it like a business pitch: it is often helpful to have a general project plan written out so that your superiors can see that your project planning is worthwhile and well-thought out.

## Grow your network

### Fill a niche and become the 'go-to' person

Work to develop at least one skill which will allow you to stand out in your research community and to become a 'go-to' person. This is a key element of personal branding in academia. Your niche can be almost anything: a detailed knowledge of a particular model or experimental tool, high fluency in a certain programming language, a talent to create good graphics, a knack for teaching or organising communities, or an ability to write particular types of texts (e.g. essays or motivational letters). It is important to discover early on what your strengths are and find the right channels to communicate

them to your research field in order to build personal branding around that skillset. For instance, you can occasionally offer help within your field of expertise to your colleagues while having lunch together, or announce it to your research circles through social media. Good news spreads fast: your colleagues will remember about your willingness to help, and spread the word whenever they hear about someone searching for this particular expertise.

Also, hone your reputation as a ‘go-to’ person by communicating with collaborators in a timely manner. We live in a culture of sharing, yet it is often the case that researchers take weeks or even months to reply to an email. Instead, consider allocating time in your daily schedule to respond to emails and inquiries. Doing so can eliminate these distractions during the work day and ensure that they do not detract from dedicated research time.

### Join Twitter

Twitter is a popular tool for networking in academia. Twitter allows you to disseminate and advertise your own work (e.g., preprints, conference appearances), get first-hand information (e.g. open calls for travel grants and special issues in research journals in your field), have a voice in your community, ask for opinions, and get a clearer picture of how daily life in academia looks like from more experienced researchers. Currently, it is also often the case that open, online, massive collaborative projects begin on Twitter – therefore, you might engage in interesting side projects this way (Tennant et al., 2019). Also, you can find out about new funding resources and opportunities (Evans & Cvitanovic, 2018) through Twitter (for examples, see @nihfunding, @nihgrants, @nsf, and @ibrosecretariat).

Of course, Twitter should be used responsibly, as Twitter notifications can induce the same dopamine loop as gambling (Haynes, 2018) and tweeting can consume considerable amount of time. One solution to this could be applying time-management tools as mentioned in section *Manage your time well*.

### Build online visibility

Aim to gradually increase your visibility online. Keep your LinkedIn and ResearchGate profiles updated. Link your Twitter / LinkedIn / ResearchGate profiles to each other. You can also set up a personal website. Even if you have not yet established a thick research portfolio, a personal website can be supplied with blog posts or updates on your career activities, as well as any recognitions and awards you have received, and not only with a publication list. You might also check the Google records appearing when you search for yourself. There might be some records which you do not wish to appear in the search engine anymore. If this is sensitive information, you can directly contact Google support to remove this information from Google search results. Otherwise, you will need to contact administrators of the website which features unwanted content (https://support.google.com/websearch/troubleshooter/3111061).

### Post Preprints

Consider posting preprints of your work (Bourne, Polka, Vale, & Kiley, 2017) and encouraging the research community to comment on your work before you submit it to a peer-reviewed journal. There is a strong trend in posting preprints across the natural and life sciences (Lin, 2018). Post-preprint submissions to peer-reviewed journals are usually more highly cited than original submissions (Serghiou & Ioannidis, 2018), and the amount of online attention (e.g. a number of mentions on Twitter, a number of readers’ comments posted on the preprint server) the preprint receives highly correlates with the impact factor of the eventual target journal (Learn, 2019). Posting a preprint allows for collecting and implementing feedback from the community before submission for peer review, and the visibility of the work is increased (Mudrak, 2018). Some researchers also choose to expose their work by posting preprints but do not go for the traditional, long peer-review process (this can be useful especially when researchers with expired contracts move to industry). There are also certain

downsides to preprints, e.g., if your preprint does not gain enough attention, it might discourage publication in high-impact journals (Enago Academy, 2018). However, commitment to open science should eventually be highly valued with consequent academic career benefits.

### Try to give more talks

At the beginning of the research career, it is often hard to land a talk at a major conference in your field. Do not underestimate the significance of giving small seminar presentations at your own research institute and at student conferences. You can also schedule online talks through online platforms such as Skype. You can, for instance, propose a guest online lab talk to a junior professor you met at a conference. With more talks, more invitations will come, and you will build new bonds this way. Also, practice makes perfect.

### Join Hackathons

Hackathons are themed sprint-like events in which groups of participants conduct research projects over a period of a few hours to a few days. Hackathons are becoming popular across multiple fieldsFor instance, in neuroimaging research, the Brainhack organization (www.brainhack.org, Craddock et al., 2016) coordinates dozens of hackathons dedicated to brain research all around the world. Hackathons are also popular in other fields such as computer science (e.g., http://web.stanford.edu/group/wics/hackoverflow/spr2018/), physics (e.g., http://www.physics.mcgill.ca/hackathon2017/ https://www.beds.ac.uk/cst/hackathon) and education (e.g., http://educationhack.nl/). You can benefit from Hackathons in multiple ways:

- developing leadership skills by converting a part of your main project into a Hackathon project and delegating it, or proposing a small standalone project
- developing research and networking skills by joining another project in your area of interest in order to learn from others and to obtain new collaborations
- developing writing skills by authoring a brief proceedings publication

## Share your ideas with others

Blogs are a good way to share your ideas and points of view. You might consider writing guest posts for established blogs in your field as a start. For example, OHBM Student and Postdoc Special Interest Group is always open to feature materials proposed by readers of their blog (www.ohbmtrainees.com/sig-blog/).

Giving back to the community by volunteering to review other researchers' manuscripts and grants, and taking on roles in professional societies, is also incredibly rewarding. You can, for instance, join one of the dedicated grant reviewing programmes for ECRs, e.g. Early Career Reviewer (ECR) Programme (https://public.csr.nih.gov/ForReviewers/BecomeAReviewer/ECR) at NIH.

Lastly, supporting the Open Science movement by sharing your work as an open-source resource with the public and interacting with the users and readers can also strengthen your research and soft skills, and help you gain more contacts. GitHub (www.github.com) is a good place to get started, as it hosts codes for many open-source tools and facilitates not only collaboration, but interaction with code developers and maintainers. Researchers can directly contribute code or other materials via pull-requests (PRs) or improve existing code by performing tests and providing feedback via issues. Sharing research tools and promoting them on Question & Answer sites, such as NeuroStars (neurostars.org), can also increase networking opportunities and improve your craft, as others may find issues or potential enhancements that were previously overlooked.

## Mentoring is key

Career-wise, it is important to learn from the examples of others. Otherwise, you can only get your lessons by trial and error, and you will always get outcompeted by those who have good advisors around them, making good mentors crucial for ECRs (Curtin, Malley, & Stewart, 2016).

A common misunderstanding is that mentorship is just another aspect of day-to-day interactions with your supervisor. It is unlikely that a single mentor, such as a supervisor, can provide the full suite of guidance and perspectives required throughout a research career. Creating a network of mentors can be beneficial to providing diverse advice in different situations. Bear in mind that research systematically shows that there is no common way of becoming successful in academia and career trajectories vary greatly (Sinatra et al., 2016, Clauset, Larremore, & Sinatra, 2017, Way, Morgan, Clauset, & Larremore, 2017, Bielczyk, 2018). Therefore, unlike the traditional mentor-protege model (**Fig. 2A**), you should aim for creating a network of mentors at different career stages rather than relying on advice from one particular person (**Fig. 2B**). A 'lifeline' or 'advisory board' model of mentoring is also recommended (**Fig. 2C**). It means developing a mentoring environment consisting of multiple researchers at different career stages, and consulting every encountered issue on an individual basis with a few mentors who are most likely to be well informed in that particular area. It is also a good idea to reach out to external mentors from outside your institution, especially if their expertise is different from yours, as having exposure to experts from other disciplines has long-lasting benefits (Liénard, Achakulvisut, Acuna, & David, 2018).

### Join or create a peer coaching programme

*Peer mentoring* is a particular form of mentorship, in which mentors and mentees at similar career stages cooperate in pairs for a period of time. In such a mentoring scheme, mentors and mentees usually self-manage their relationship, including scheduling, and can discuss any aspect of their careers or personal lives. Peer mentoring is possible in person or with use of online conference tools, e.g. Skype (Payne, 2018) or online platforms such as Slack. Peer mentoring has a long-term positive influence on mentees' well being (Leidenfrost, Strassnig, Schütz, Carbon, & Schabmann, 2014, Fox & Stevenson, 2007).

A recently popularized form of peer mentoring is a *coaching group*. A coaching group is a group consisting of researchers at a similar career stage, who support each other during a series of meetings in person (e.g., a peer coaching programme at the Donders Institute, Nijmegen, the Netherlands http://www.ru.nl/donders/peercoaching). Such meetings are typically assisted by a trained session moderator or a facilitator. Research studies demonstrated that such peer coaching group activities can efficiently complement traditional mentoring (Williams, Thakore, & McGee, 2016). If there is no peer coaching group available at your institution, you might consider creating one with your fellow ECRs.

An alternative option is joining an *online mentoring programme* (Payne, 2018). In such programmes, mentees are offered mentorship from more experienced researchers who might be geographically distant. For example, the OHBM offers an International Online Mentoring Programme (Bielczyk & Veldsman et al., 2018) in which mentors are coupled with mentees on the basis of years of experience in active research and mutual expectations. Another example of an online mentoring programme is run by the Institute of Electrical and Electronics Engineers (IEEE, https://www.ieee.org/membership/mentoring.html). This programme allows mentees to apply for a particular mentor. *1000 Girls, 1000 Futures* (https://www.nyas.org/programs/global-stem-alliance/1000-girls-1000-futures/) is an online mentoring programme dedicated to women in STEM, which offers two hours of mentoring per month for a period of one year.

### Learn how to mentor and be mentored

Mentoring is a complex interaction (Straus, Johnson, Marquez, & Feldman, 2013): the mentor can also become the mentee and they learn from each other. There are a wide variety of online resources that can assist both mentees and mentors in making the process run more smoothly. For example, this Early Faculty Online Training programme offers a range of training information for mentors to develop their mentorship skill-set, and can be useful for scientists at many stages of their career: https://ctsc.health.unm.edu/apps/brep/. Stanford University has compiled a range of resources and written materials providing additional training for mentees and mentors alike (https://biosciences.stanford.edu/current-students/advising-and-mentoring/how-to-get-the-mentoring-you-need/). It is also good to visit the websites of the National Research Mentoring Network (https://nrmnet.net/), which is an open initiative aiming to increase the diversity in biomedical research workforce.

In order to have a fruitful mentoring relationship as a mentee, prepare for the meeting with your mentor by thinking about your personal needs for advice, summarise the progress since your last meeting and prepare a set of questions (Iversen, Eady, & Wessely, 2014). You may also consider explicitly formulating written mutual expectations for the mentor-mentee relationship (Masters & Kreeger, 2017).

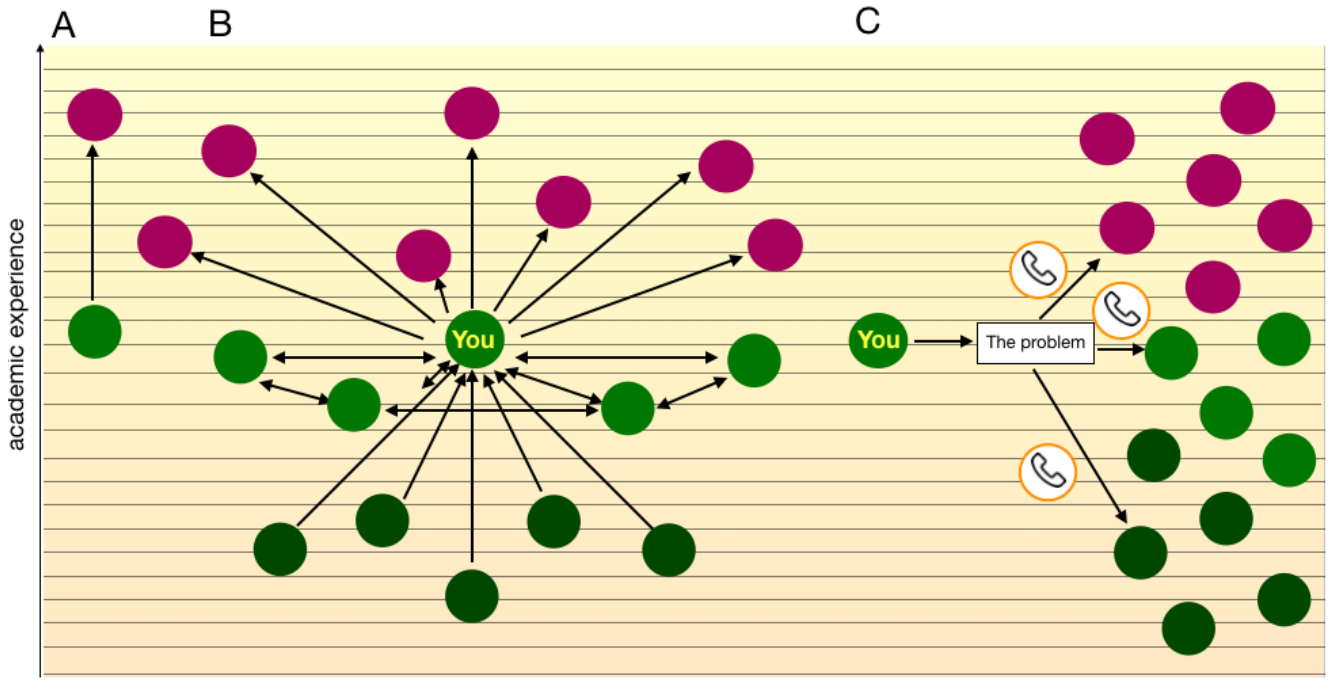


**Figure 2** Models of mentoring. **A:** the traditional view at the mentor-protege relationship. It is a strictly hierarchical relationship; the mentee follows the mentor's advice and builds a career under the mentor's direct supervision. **B:** the modern, multilayered model of mentoring. In this model, the mentee becomes a centre of their own little 'galaxy'. Firstly, the mentee reaches out to multiple mentors at different career stages (magenta). Secondly, the mentee peer-coaches other ECRs at similar career stage (light green). Thirdly, the mentee mentors more junior ECRs (dark green). **C:** 'lifeline' or 'advisory board' model of mentoring, in which a network of mentors at different career stages is used as a form of an advisory board: for each encountered problem, a few mentors are most likely to give a proper advice on this particular problem.

## Conclusion

While many of us that initiated this work come from cognitive/computational neuroscience and psychology research backgrounds, we believe that the key points discussed here apply for a broader range of ECRs in the natural life sciences. Career building always needs patience and persistence (Sinek, 2016), overcoming the imposter syndrome and developing a self-confidence. And sometimes, it turns out that there are other options beyond academia, which will suits you better. In

**Supplementary Material 3**, we give additional advice to researchers considering a career switch. In **Supplementary Material 4**, we list exemplary professions in which a PhD title is typically an asset rather than a liability.

## Acknowledgments

We would like to thank the **Organization for Human Brain Mapping** for encouragement and support with this project. We cordially thank to **Daniele Marinazzo**, **Brielle Stark** and **František Vaša** for commenting on the early version of the manuscript. We would also like to thank to all the Twitter users who helped us in spreading the news about our project to the larger research community and helped us in assembling a vibrant and productive Google group to discuss this content.

## Author contributions

NB drafted the initial version of the manuscript.
AA, AP B, CC, MG, AH, LM H, KI, DK, DL, MM M, AN and MV joined the project as the members of the working group, added more content and edited the manuscript in multiple rounds of internal revision.
CA, VC, CB, KB, RB, VC, KF, AK, CL, DM, RP, PR, TS, SG S, LU, DV, SV, CW, PW, JY and XZ joined the project and contributed using online tools: Google group and Google docs.
AB, EE, HF and SN edited the final manuscript.

## REFERENCES

Academics Anonymous. (2017, June 1). I landed my dream PhD – and it turned into a nightmare. Retrieved from https://www.theguardian.com/higher-education-network/2017/jan/06/i-landed-my-dream-phd-and-it-turned-into-a-nightmare

Academic Positions. (2018, September 21). The 7 Essential Transferable Skills All PhDs Have. Retrieved from https://academicpositions.com/career-advice/the-7-essential-transferable-skills-all-phds-have

Angel-Ferrero, M. (2016, April 3). Why PhDs are potential entrepreneurs? Retrieved from https://medium.com/@miss.startup/why-phds-are-potential-entrepreneurs-df3dec2c544c

Academic, A. (2014, March 1). There is a culture of acceptance around mental health issues in academia. *The Guardian*. Retrieved from https://web.archive.org/web/20181109070542/https://www.theguardian.com/higher-education-network/blog/2014/mar/01/mental-health-issue-phd-research-university

Allen, D. (2002). *Getting Things Done: The Art of Stress-Free Productivity*. London: Penguin Books Ltd.

Allen, C. P. G., & Mehler, D. M. (2019). Open Science challenges, benefits and tips in early career and beyond. *PLOS Biology*, *7*(5), e3000246. https://doi.org/10.1371/journal.pbio.3000246

Auriol, L., Misu, M., & Freeman, R. (2013). *Careers of Doctorate Holders: Analysis of Labour Market and Mobility Indicators*. Retrieved from OECD Publishing website: https://doi.org/

10.1787/5k43nxgs289w-en

Barreira, P., Basilico, M., & Bolotnyy, V. (2018). *Graduate Student Mental Health: Lessons from American Economics Departments*.

Belkhir, M., Brouard, M., Brunk, K. H., Dalmoro, M., Ferreira, M. C., Figueiredo, B., … Smith, A. N. (2018). Isolation in Globalizing Academic Fields: A Collaborative Autoethnography of Early Career Researchers. *Academy of Management Learning & Education*. https://doi.org/10.5465/amle.2017.0329

Bernstein, R. (2015, May 13). Depression afflicts almost half of STEM graduate students at UC Berkeley. Retrieved December 29, 2018, from Science | AAAS website: https://www.sciencemag.org/careers/2015/05/depression-afflicts-almost-half-stem-graduate-students-uc-berkeley

Bielczyk, N. (2018, August 9). On the variability in career paths - interview with Dr Aaron Clauset. Retrieved from https://web.archive.org/save/https://www.ohbmtrainees.com/sig-blog/2018/8/9/on-the-variability-in-career-paths

Bielczyk*, N., Veldsman*, M., Ando, A., Caldinelli, C., Makary, M., Nikolaidis, A., … Badhwar, A. (2018). Mentoring early career researchers: Lessons from the Organization for Human Brain Mapping International Mentoring Programme. *European Journal of Neuroscience*.

Boehning Lab. (2014, March 14). Working Class Scientist. Retrieved from https://boehninglab.wordpress.com/2014/03/14/working-class-scientist/

Bourne, P. E., Polka, J. K., Vale, R. D., & Kiley, R. (2017). Ten simple rules to consider regarding preprint submission. *PLoS Computational Biology*, *13*(5). https://doi.org/10.1371/journal.pcbi.1005473

Boice, R. (2000). *Advice for New Faculty Members*. Allyn and Bacon.

Cheplygina, V. (2018). How I fail. Retrieved from http://web.archive.org/web/20180817170504/http://veronikach.com/how-i-fail/

Clark, A., & Sousa, B. (2015, April 11). Academics: you are going to fail, so learn how to do it better. Retrieved from https://www.theguardian.com/higher-education-network/2015/nov/04/academics-you-are-going-to-fail-so-learn-how-to-do-it-better

Clauset, A., Larremore, D. B., & Sinatra, R. (2017). Data-driven predictions in the science of science. *Science*, *355*(6324), 477–480. https://doi.org/10.1126/science.aal4217

Cocirillo, F. (2011). Do more and have fun with time management. Retrieved from http://

web.archive.org/web/20181203212738/https://francescocirillo.com/pages/pomodoro-technique

Covey, S. (2013). *The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change*. Simon & Schuster.

Craddock, C. R., Margulies, D. S., Bellec, P., Nichols, N. B., Alcauter, S., Barrios, F. A., … Xu, T. (2016). Brainhack: a collaborative workshop for the open neuroscience community. *GigaScience*, *5*, 16. https://doi.org/10.1186/s13742-016-0121-x

Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life*. New York, NY, US: Basic Books.

Curtin, N., Malley, J., & Stewart, A. J. (2016). Mentoring the Next Generation of Faculty: Supporting Academic Career Aspirations Among Doctoral Students. *Research in Higher Education*, *57*(6), 714–738. https://doi.org/10.1007/s11162-015-9403-x

Czerniawski, G. (2017, October 16). Early Career Researchers - 20 tips for career development. Retrieved from http://web.archive.org/web/20180303120510/https://www.bera.ac.uk/blog/early-career-researchers-20-tips-for-career-development

Daily Mail Reporter. (2017, May 22). *Forget being a nurse or doctor, three quarters of today's children would rather be YouTubers and vloggers*. Retrieved from http://web.archive.org/web/20181104164313/https://www.dailymail.co.uk/news/article-4532266/75-cent-children-want-YouTubers-vloggers.html

De Jonge Akademie. (2019, January 29). *De roze bril van wetenschapsminister Van Engelshoven*. Retrieved from https://www.nrc.nl/nieuws/2019/02/03/de-roze-bril-van-wetenschapsminister-van-engelshoven-a3652717

Doerr, J. (2018). *Why the secret to success is setting the right goals*. Retrieved from https://web.archive.org/web/20181206080715/https://www.ted.com/talks/john_doerr_why_the_secret_to_success_is_setting_the_right_goals

Dolgin, E. (2017, November 13). Young scientists flail in sink or swim system. Retrieved from https://www.natureindex.com/news-blog/young-scientists-flail-in-sink-or-swim-system

Donald, A. (2018, November 11). The Lure of Procrastination. Retrieved from http://web.archive.org/web/20181208114054/http://occamstypewriter.org/athenedonald/2018/11/11/the-lure-of-procrastination/

Doring, M. (2018, September 17). Here's Why Tony Robbins Should Definitely Not Be Your Guru.

Retrieved from http://web.archive.org/web/20181208143317/https://www.headstuff.org/topical/science/heres-tony-robbins-definitely-not-guru/

Dunbar, K., & Fugelsang, J. (2005). Causal Thinking in Science: How Scientists and Students Interpret the Unexpected. In M. Gorman, R. Tweney, D. Gooding, & A. Kincannon (Eds.), *Scientific and Technological Thinking* (pp. 57–79). Erlbaum.

Eisenhower, D. W. (1954, August 19). *Address at the Second Assembly of the World Council of Churches*. Retrieved from https://web.archive.org/web/20150402111315/http://www.presidency.ucsb.edu/ws/?pid=9991

Enago Academy. (2018). *Preprints: Does Publishing Research Early Have a Downside?* Retrieved from http://web.archive.org/web/20181208132648/https://www.enago.com/academy/preprints-publishing-research-early-downside/

Evans, M. C., & Cvitanovic, C. (2018). An introduction to achieving policy impact for early career researchers. *Palgrave Communications*, *4*(1), 88. https://doi.org/10.1057/s41599-018-0144-2

Evans, T. M., Bira, L., Gastelum, J. B., Weiss, L. T., & Vanderford, N. L. (2018). Evidence for a mental health crisis in graduate education. *Nature Biotechnology*, *36*, 282–284. https://doi.org/10.1038/nbt.4089

Ferriss, T. (2007). *The 4-Hour Workweek: Escape 9-5, Live Anywhere, and Join the New Rich*. Crown Publishing Group.

Fiske, P. (2016). For your information. *Nature*, *538*, 417–418. https://doi.org/10.1038/nj7625-417a

Frankton, J. (2014, April 4). 40 Ways To Stop Procrastinating. Why Am I Lazy? Retrieved from http://web.archive.org/web/https://whyamilazy.com/40-super-effective-ways-to-stop-procrastinating/

Frassl, M. A., Hamilton, D. P., Denfeld, B. A., Eyto, E. de, Hampton, S. E., Keller, P. S., … Catalán, N. (2018). Ten simple rules for collaboratively writing a multi-authored paper. *PLOS Computational Biology*, *14*(11), e1006508. https://doi.org/10.1371/journal.pcbi.1006508

Gelman, A. (2016, August 6). Scientists aren't superheroes – failure is a valid result. Retrieved from https://www.theguardian.com/higher-education-network/2016/jun/08/scientists-arent-superheroes-failure-is-a-valid-result

Gill, M. J., Roulet, T. J., & Kerridge, S. P. (2018). Mentoring for mental health: A mixed-method study of the benefits of formal mentoring programmes in the English police force. *Journal of Vocational Behavior*, *108*, 201–213. https://doi.org/10.1016/j.jvb.2018.08.005

Godin, S. (2011). *Linchpin: Are You Indispensable?* (1 edition). New York: Portfolio.

Goerg, S. J. (2015). Goal setting and worker motivation. *IZA World of Labor*. https://doi.org/10.15185/izawol.178

Gramlich, P., & Bodewits, K. (2016, November 30). Return to academia: The price I'm willing to pay. Retrieved from https://web.archive.org/web/20180419170031/http://blogs.nature.com:80/naturejobs/2016/11/30/return-to-academia-the-price-im-willing-to-pay

Grant, A. M. (2012). An integrated model of goal-focused coaching: An evidence-based framework for teaching and practice. *International Coaching Psychology Review*, *7*(2), 146–165.

Griffiths, H. (2016, September 16). Am I a PhD ECR? What is an Early Career Researcher? Retrieved from blog.jobs.ac.uk: Great jobs for bright people website: https://web.archive.org/web/20181208104530/https://blog.jobs.ac.uk/all-things-research/phd-ecr/

Grinstein, A., & Treister, R. (2018). The unhappy postdoc: a survey based study. *F1000Research*, *6*. https://doi.org/10.12688/f1000research.12538.2

Hankel, I. (2019). Why earning a PhD is an advantage in today's industry job market. *Nature*. https://doi.org/10.1038/d41586-019-00097-x

Hassmén, P., Koivula, N., & Uutela, A. (2000). Physical Exercise and Psychological Well-Being: A Population Study in Finland. *Preventive Medicine*, *30*(1), 17–25. https://doi.org/10.1006/pmed.1999.0597

Haushofer, J. (2016, April 1). *CV of Failures*. Retrieved from http://web.archive.org/web/20181111114202/https://www.princeton.edu/~joha/Johannes_Haushofer_CV_of_Failures.pdf

Haynes, T. (2018, January 5). Dopamine, Smartphones & You: A battle for your time. Retrieved from http://sitn.hms.harvard.edu/flash/2018/dopamine-smartphones-battle-time/

Head, M. L., Holman, L., Lanfear, R., Kahn, A. T., & Jennions, M. D. (2015). The Extent and Consequences of P-Hacking in Science. *PLOS Biology*, *13*(3), e1002106. https://doi.org/10.1371/journal.pbio.1002106

Howes, L. (2012, July 6). Why Thinking Small Is The Secret To Big Success. *Forbes*. Retrieved from https://web.archive.org/web/20181129124143/https://www.forbes.com/sites/lewishowes/2012/07/06/why-thinking-small-is-the-secret-to-big-success/

Huang, K., Buell, R. W., Huang, L., Brooks, A. W., & Hall, B. (2018). *Mitigating Malicious Envy: Why Successful Individuals Should Reveal Their Failures*. Retrieved from https://web.archive.org/web/20190219023624/https://www.hbs.edu/faculty/Publication%20Files/18-080_56688b05-34cd-47ef-adeb-aa7050b93452.pdf

Humphrey, C. (2017, January 24). Discover the 20+ transferable skills that make PhDs totally employable. Retrieved from Jobs on Toast website: http://jobsontoast.com/the-20-skills-that-make-you-totally-employable/

Humphries, M. (2018, July 20). Academia Is the Alternative Career Path. Retrieved from https://medium.com/@drmdhumphries/academia-is-the-alternative-career-path-106c89fc3412

Investivate. (2017, May 13). 60 Jim Rohn Motivational Quotes About Success and Life. Retrieved from http://web.archive.org/web/https://www.investivate.com/jim-rohn-inspirational-quotes/

Iversen, A. C., Eady, N. A., & Wessely, S. C. (2014). The role of mentoring in academic career progression: a cross-sectional survey of the Academy of Medical Sciences mentoring scheme. *Journal of the Royal Society of Medicine*, *107*(8), 308–317. https://doi.org/10.1177/0141076814530685

Kerr, N. L. (1998). HARKing: hypothesizing after the results are known. *Personality and Social Psychology Review: An Official Journal of the Society for Personality and Social Psychology, Inc*, *2*(3), 196–217. https://doi.org/10.1207/s15327957pspr0203_4

Koestler, A. (1964). *The Act of Creation*. New York: Penguin Books.

Krogerus, M., & Tschäppeler, R. (2011). *The Decision Book: Fifty Models for Strategic Thinking*. Profile Books.

Kruger, P. (2018). Why it is not a ‘failure’ to leave academia. *Nature*, *560*, 7716. https://doi.org/10.1038/d41586-018-05838-y

Kupferschmidt, K. (2018, September 19). More and more scientists are preregistering their studies. Should you? Retrieved June 9, 2019, from Science | AAAS website: https://www.sciencemag.org/news/2018/09/more-and-more-scientists-are-preregistering-their-studies-should-you

Learn, J. R. (2019). What bioRxiv’s first 30,000 preprints reveal about biologists. *Nature*. https://doi.org/10.1038/d41586-019-00199-6

Leidenfrost, B., Strassnig, B., Schütz, M., Carbon, C.-C., & Schabmann, A. (2014). The Impact of Peer Mentoring on Mentee Academic Performance: Is Any Mentoring Style Better than No Mentoring at All? *International Journal of Teaching and Learning in Higher Education*, *26*(1), 102–111.

Levecque, K., Anseel, F., De Beuckelaer, A., Van der Heyden, J., & Gisle, L. (2017). Work organization and mental health problems in PhD students. *Research Policy*, *46*(4), 868–879.

https://doi.org/10.1016/j.respol.2017.02.008

Liénard, J. F., Achakulvisut, T., Acuna, D. E., & David, S. V. (2018). Intellectual synthesis in mentorship determines success in academic careers. *Nature Communications*, *9*(1), 4840. https://doi.org/10.1038/s41467-018-07034-y

Lin, J. (2018, May 31). Preprints growth rate ten times higher than journal articles. Retrieved from http://web.archive.org/web/20180921194346/https://www.crossref.org/blog/preprints-growth-rate-ten-times-higher-than-journal-articles/

Lipp, I., & Chen, J. (2019, January 11). Can you have it all? A story about work-life balance in academia. Retrieved from https://www.ohbmbrainmappingblog.com/blog/can-you-have-it-all-a-story-about-work-life-balance-in-academia

Locke, E. A., & Latham, G. P. (2006). New Directions in Goal-Setting Theory. *Current Directions in Psychological Science*, *15*(5), 265–268. https://doi.org/10.1111/j.1467-8721.2006.00449.x

Mackay, B., & Mackay, K. (2013, October 23). The Eisenhower Decision Matrix: How to Distinguish Between Urgent and Important Tasks and Make Real Progress in Your Life. Retrieved from https://web.archive.org/web/20181208042913/https://www.artofmanliness.com/articles/eisenhower-decision-matrix/

Mackay, K. (2017, February 13). Before you say Yes: 3 questions to ask yourself (And I'm not talking about marriage!). Retrieved from http://web.archive.org/web/20181208104623/https://blog.jobs.ac.uk/career-advice/before-you-say-yes/

Mackin, E. (2017, January 18). Talking About Failing in the Academy. Retrieved from http://www.elliemackin.net/blog/talking-about-failing-in-the-academy

Marketdata. (2017). *The Market for Self-Improvement Products & Services (12th Edition)*.

Martin, K. C. (2017). Tips for Young Scientists on the Junior Faculty/Independent Investigator Job Search. *Neuron*, *93*(4), 731–736. https://doi.org/10.1016/j.neuron.2017.02.012

Masters, K. S., & Kreeger, P. K. (2017). Ten simple rules for developing a mentor–mentee expectations document. *PLoS Computational Biology*, *13*(9), e1005709. https://doi.org/10.1371/journal.pcbi.1005709

Mather-L'Huillier, N. (n.d.). Non-academic Careers for PhD Holders. Retrieved from https://www.findaphd.com/advice/doing/phd-non-academic-careers.aspx

Milojević, S., Radicchi, F., & Walsh, J. P. (2018). Changing demographics of scientific careers: The rise of the temporary workforce. *Proceedings of the National Academy of Sciences*, *115*(50),

12616–12623. https://doi.org/10.1073/pnas.1800478115

Moeller, A. J., Theiler, J. M., & Wu, C. (2012). Goal Setting and Student Achievement: A Longitudinal Study. *The Modern Language Journal*, *96*(2), 153–169. https://doi.org/10.1111/j.1540-4781.2011.01231.x

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., … Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693–2698. https://doi.org/10.1073/pnas.1010076108

Mudrak, B. (2018). What are Preprints, and How Do They Benefit Authors? Retrieved from http://web.archive.org/web/20181208132128/https://www.aje.com/en/arc/benefits-of-preprints-for-researchers/

Newport, C. (2012). *So Good They Can't Ignore You*. Grand Central Publishing, Hachette Book Group.

Newport, C. (2016). *Deep Work: Rules for Focused Success in a Distracted World*. Grand Central Publishing.

Nöbauer, H. (2012). Affective landscapes in academia: emotional labour, vulnerability, and uncertainty in late-modern academic work. *International Journal of Work Organisation and Emotion*, *5*(2), 132–144. https://doi.org/10.1504/IJWOE.2012.049517

Ong, S. A. (2013, October 1). How Your Circle of Friends Influence Who You Become. Retrieved from http://web.archive.org/web/20180408092159/http://www.simonalexanderong.com:80/2013/10/how-your-circle-of-friends-influence-who-you-become

Ordonez, L. D., Schweitzer, M. E., Galinsky, A. E., & Bazerman, M. H. (2009). *Goals Gone Wild: The Systematic Side Effects of Over-Prescribing Goal Setting*. Retrieved from http://web.archive.org/web/http://hbswk.hbs.edu/item/goals-gone-wild-the-systematic-side-effects-of-over-prescribing-goal-setting

Orzel, C. (2017). *A Little Luck Is Essential For Success In Science*. Retrieved from https://web.archive.org/web/20170415193258/https://www.forbes.com/sites/chadorzel/2017/04/10/a-little-luck-is-essential-for-success-in-science/#5bc9ea6551a3

Otremba, J. (2016, June 30). Finding your tribe: How the people around you influence you. Retrieved from http://web.archive.org/web/20181209114802/https://www.janiceotremba.com/finding-your-tribe-how-the-people-around-you-influence-you/

Parkinson, C. N. (1955, November 19). *Parkinson's Law*. Retrieved from http://web.archive.org/web/https://www.economist.com/news/1955/11/19/parkinsons-law

Pash, A., & Trapani, G. (2011). *Lifehacker: The guide to working smarter, faster, and better*. Indianapolis: Ind: Wiley.

Payne, D. (2018). The pros and cons of mentoring by Skype. *Nature*. https://doi.org/10.1038/d41586-018-05794-7

Payne, D. (2018). Juggling research and family life: honest reflections from scientist dads. *Nature*, *563*, 725. https://doi.org/10.1038/d41586-018-07511-w

Petersen, A. M., Riccaboni, M., Stanley, H. E., & Pammolli, F. (2012). Persistence and uncertainty in the academic career. *Proceedings of the National Academy of Sciences*, *109*(14), 5213–5218. https://doi.org/10.1073/pnas.1121429109

Poldrack, R. A. (2019). The Costs of Reproducibility. *Neuron*, *101*(1), 11–14. https://doi.org/10.1016/j.neuron.2018.11.030

Poulton, R., Moffitt, T. E., & Silva, P. A. (2015). The Dunedin Multidisciplinary Health and Development Study: overview of the first 40 years, with an eye to the future. *Social Psychiatry and Psychiatric Epidemiology*, *50*(5), 679–693. https://doi.org/10.1007/s00127-015-1048-8

Powell, K. (2016). Young, talented and fed-up: scientists tell their stories. *Nature*, *538*, 446–449. https://doi.org/10.1038/538446a

Powell, K. (2018). How to sail smoothly from academia to industry. *Nature*, *555*, 549. https://doi.org/10.1038/d41586-018-03306-1

Raia, A. P. (1965). Goal Setting and Self-Control: An Empirical Study. *Journal of Management Studies*, *2*(1), 34–53. https://doi.org/10.1111/j.1467-6486.1965.tb00564.x

Reese, H. W. (2011). The learning-by-doing principle. *Behavioral Development Bulletin*, *17*(1), 1–19. https://doi.org/10.1037/h0100597

Robbins, T. (1992). *Awaken the Giant Within: How to Take Immediate Control of Your Mental, Emotional, Physical and Financial Destiny!* Simon & Schuster.

Rojas, F. (2016, January 13). When to say yes and no in academia. Retrieved from https://web.archive.org/web/20171110175440/https://orgtheory.wordpress.com/2016/01/13/when-to-say-yes-and-no-in-academia/

Santiago-Lopez, A. (2019). Six project-management tips for your PhD. *Nature*. https://doi.org/10.1038/d41586-018-07860-6

SAS. (2018). What is a Data Scientist? Who they are, what they do and why you want to be one. Retrieved from http://web.archive.org/web/20181208022428/https://www.sas.com/en_us/insights/analytics/what-is-a-data-scientist.html

Schillebeeckx, M., Maricque, B., & Lewis, C. (2013). The missing piece to changing the university culture. *Nature Biotechnology*, *31*, 938–941. https://doi.org/10.1038/nbt.2706

Scholtens, S., Anbeek, P., Böhmer, J., Brullemans-Spansier, M., Marije van der Geest, M., Jetten, M., … van Gelder, C. (2019). *Life sciences data steward function matrix*. https://doi.org/10.5281/zenodo.2561723

Serghiou, S., & Ioannidis, J. P. A. (2018). Altmetric Scores, Citations, and Publication of Studies Posted as Preprints. *JAMA*, *319*(4), 402–404. https://doi.org/10.1001/jama.2017.21168

Shaw, C. (2014, August 5). Overworked and isolated - work pressure fuels mental illness in academia. *The Guardian*. Retrieved from https://www.theguardian.com/higher-education-network/blog/2014/may/08/work-pressure-fuels-academic-mental-illness-guardian-study-health

Sibai, O., Figueiredo, B., & Ferreira, M. C. (2019, November 29). Overworked and isolated: the rising epidemic of loneliness in academia. Retrieved from http://theconversation.com/overworked-and-isolated-the-rising-epidemic-of-loneliness-in-academia-110009

Silvia, P. J. (2007). *How to Write a Lot: A Practical Guide to Productive Academic Writing*. Washington DC: American Psychological Association.

Simon, H. (1992). *The cat that curiosity couldn't kill*. Pittsburgh, PA: Department of Psychology, Carnegie Mellon University.

Sinatra, R., Wang, D., Deville, P., Song, C., & Barabási, A.-L. (2016). Quantifying the evolution of individual scientific impact. *Science*, *354*(6312), aaf5239. https://doi.org/10.1126/science.aaf5239

Sinek, S. (2011a). *How Setting Unrealistic Goals Can Serve the Greater Good*. Retrieved from https://web.archive.org/web/20181208104442/https://www.youtube.com/watch?v=seHJMJ-_6dA

Sinek, S. (2011b). *Start with Why: How Great Leaders Inspire Everyone to Take Action*. Penguin Books Ltd.

Sinek, S. (2016). *Simon Sinek on Millennials in the Workplace*. Retrieved from http://web.archive.org/web/20181127043456/https://www.youtube.com/watch?v=hER0Qp6QJNU&t=59s

Soapbox Science. (2012). PhDelta: The Road Less Travelled - From PhD to Software Development.

Retrieved from http://web.archive.org/web/20180321083009/http://blogs.nature.com:80/soapboxscience/2012/08/17/phdelta-the-road-less-travelled-from-phd-to-software-development

Stefan, M. (2010). A CV of failures. *Nature*, *468*(7322), 467–467. https://doi.org/10.1038/nj7322-467a

Stefan, M. (2013, May 9). Ice Cream Day. Retrieved from http://web.archive.org/web/20150828193736/http://lifeandlearning.me:80/2013/05/09/ice-cream-day/

Straus, S. E., Johnson, M. O., Marquez, C., & Feldman, M. D. (2013). Characteristics of successful and failed mentoring relationships: a qualitative study across two academic health centers. *Academic Medicine: Journal of the Association of American Medical Colleges*, *88*(1), 82–89. https://doi.org/10.1097/ACM.0b013e31827647a0

Stulberg, B. (2017, June 6). The Power of the People Around You: Self-improvement has a lot to do with whom you surround yourself. Retrieved from http://web.archive.org/web/20181209114550/https://medium.com/the-mission/the-power-of-the-people-around-you-c01ed098551c

Tennant, J., Bielczyk, N., Cheplygina, V., Hartgerink, C., Havemann, J., Masuzzo, P., & Steiner, T. (2019). Ten simple rules for researchers collaborating on Massively Open Online Papers (MOOPs). *Under Review*.

The Guardian (2014, March 1). https://web.archive.org/web/20181109070542/https://www.theguardian.com/higher-education-network/blog/2014/mar/01/mental-health-issue-phd-research-university

Tong, C. W., Ahmad, T., Brittain, E. L., Bunch, T. J., Damp, J. B., Dardas, T., … Freeman, A. M. (2014). Challenges Facing Early Career Academic Cardiologists. *Journal of the American College of Cardiology*, *63*(21), 2199–2208. https://doi.org/10.1016/j.jacc.2014.03.011

Tracy, B. (2001). *Eat That Frog!: 21 Great Ways to Stop Procrastinating and Get More Done in Less Time*. Berrett-Koehler Publishers.

Voytek, B. (2018). *CV*. Retrieved from http://web.archive.org/web/20181109210656/http://voyteklab.com/wp-content/uploads/voytek_cv.pdf

Wapnick, E. (2016). *Why some of us don't have one true calling*. Retrieved from https://web.archive.org/web/20181205101618/https://www.ted.com/talks/emilie_wapnick_why_some_of_us_don_t_have_one_true_calling?language=en

Wapnick, E. (2017). *How to Be Everything: A Guide for Those Who (Still) Don't Know What They*

*Want to Be When They Grow Up*. HarperOne.

Warner, J. (2017, January 23). “CVs of Failure” Don’t Tell the Whole Story. Retrieved from https://www.insidehighered.com/blogs/just-visiting/cvs-failure-dont-tell-whole-story

Way, S. F., Morgan, A. C., Clauset, A., & Larremore, D. B. (2017). The misleading narrative of the canonical faculty productivity trajectory. *Proceedings of the National Academy of Sciences*, *114*(44), E9216–E9223. https://doi.org/10.1073/pnas.1702121114

Williams, S. N., Thakore, B. K., & McGee, R. (2016). Coaching to Augment Mentoring to Achieve Faculty Diversity: A Randomized Controlled Trial. *Academic Medicine: Journal of the Association of American Medical Colleges*, *91*(8), 1128–1135. https://doi.org/10.1097/ACM.0000000000001026

Woolston, C. (2017). Workplace habits: Full-time is full enough. *Nature*, *546*, 175–177. https://doi.org/10.1038/nj7656-175a

Woolston, C. (2018a). Seven steps to boost your research career in 2019. *Nature*, *564*, 449. https://doi.org/10.1038/d41586-018-07807-x

Woolston, C. (2018b). Why a postdoc might not advance your career. *Nature*, *565*, 125. https://doi.org/10.1038/d41586-018-07652-y

Wrzesniewski, A., McCauley, C., Rozin, P., & Schwartz, B. (1997). Jobs, careers, and callings: People’s relations to their work. *Journal of Research in Personality*, *31*(1), 21–33. https://doi.org/10.1006/jrpe.1997.2162

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology*, *18*(5), 459–482. https://doi.org/10.1002/cne.920180503

Yorks, D. M., Frothingham, C. A., & Schuenke, M. D. (2017). Effects of Group Fitness Classes on Stress and Quality of Life of Medical Students. *The Journal of the American Osteopathic Association*, *117*(11), e17–e25. https://doi.org/10.7556/jaoa.2017.140

# SUPPLEMENTARY MATERIALS

## Supplementary Material 1: Tips to avoid common pitfalls in successful science

### 1 Good planning and experimental design

**Do a robust literature review.** Look out for contradictory results and null findings to build the best prior on the outcome of your experiment.

**Keep up to date.** Look at experimental designs from recent literature to avoid using outdated or flawed practices or data acquisitions.

**Do not reinvent the wheel.** Use validated and publicly available analysis tools wherever possible.

**Pilot analysis.** Use a small sample, publicly available data, or in silico generated data, to test analysis pipelines and iron out issues before data collection begins.

**Pre-register your study.** Pre-registration means specifying, in as much detail as possible, the planning for a study, i.e. the research hypothesis, the number of subjects and power estimation, description of experimental stimuli, procedures, measures, plan for data analysis etc. This planning should be posted in a time-stamped, locked file in an online repository which can then be accessed by editors and reviewers of academic journals (e.g. in the Open Science Framework, OSF.io).

**Impact and novelty.** Plan for null results. Publish replications. Use preprint servers. If the work is risky or unlikely to generate highly novel results, consider pre-registration and registered reports.

### 2 Mitigating risk and robust logistics

**Quality checks.** Always check your data quality during data collection in order to prevent further problems with results interpretation.

**Data access.** Relying on collaborators or other institutions for data can be efficient, but don't invest time and energy into data collection until you are sure you will have access to it.

**Ethics/regulatory approval**. Before the project starts, check whether there is an ethics approval in place or if you need to write one. Later in the process, keep an eye on expiry dates. Ask colleagues about time required for approvals, plan for delays and amendments.

**Equipment.** Ask operators for maintenance schedules on any equipment you will use. Make sure the equipment is well maintained. Avoid collecting data during maintenance windows. Avoid collecting data before and after upgrades as it may introduce biases. If you cannot avoid the equipment downtime, ensure you model this potential confounding factor in your analysis, and in case/control designs collected from both cohorts before and after. Use phantoms or calibration data before and after all equipment modifications in any longitudinal study.

**Expertise.** When planning your experiment, go through all phases of data collection, analysis and interpretation and ensure that you have access to all the required expertise.

### 3 Tracking and monitoring progress

**Support staff**. If you train Research Assistants or students, keep a close eye on their data collection, especially early on. Request progress reports and supervise whenever possible to ensure protocols have been communicated correctly.

**Pilot analysis.** Run analysis on the first few data points acquired to identify mistakes early on.

**Plan and compare.** Write down milestones and assign dates to them. Compare actual progress with planned progress regularly to identify where you might be over - or under- estimating the time required for different phases.

**Be honest**. Reflect on your abilities, successes and failures. Undertake further training or find collaborators with required expertise to address your weaknesses as you progress.

### 4 Closing out and publishing work

**Pre-plan your analysis.** Deciding on how to analyse the data before collection is essential to avoiding close-out issues.

**Mind P-hacking.** Do not analyse and re-analyse data until you find a 'significant' result (Head, Holman, Lanfear, Kahn, & Jennions, 2015).
**Involve collaborators early.** Send working manuscripts to collaborators early for advice and input. Involve your co-authors in the writing process as much as you can, and as early on as you can.
**Venues.** Make a list of suitable publication journals at the design stage of your project. Have back-ups in mind.

### 5 Robust career planning

**Diversity.** Do not rely on only one project, having multiple streams at different stages to smooth out your career success.
**Redundancy.** Plan for failure. Assume projects will not complete on time or may be halted indefinitely. Collaborate with others and ensure a flow of publications and outputs from multiple sources.
**Funding.** Funding cycles are typically 6-12 months, so plan ahead for acquiring funds. Make use of publicly available datasets wherever possible.
**Employment.** Do not wait for the end of your thesis to apply for postdoc positions and attend conferences in your last 6-12 months to shop around and advertise yourself. Building a good network early in your training will increase your chances of securing sequential postdocs. Diversify skills wherever possible.
**Supervision**. Choose your supervisor wisely. Do not be overly reliant on their time; most are busy, some are neglectful. Develop a broad and diverse network of mentors and collaborators to avoid being solely reliant on your supervisor (see: **Fig. 2**).

## Supplementary Material 2: A summary of online resources for ECRs

**Table 1** A list of online resources for ECRs

| Category | Name | Remarks |
|---|---|---|
| Grant opportunities | *International Brain Research Organization (IBRO)* | An organisation that provides international grants for Research Fellowship, travel grants in brain research |
| Time management | *Time Out* | A break time reminder app that gently reminds you to take a break on a regular basis |
| | *Stretchly* | A break time reminder app that reminds you to take breaks when working with computers |
| Grow network | *Twitter* | A social platform that allows you to disseminate and advertise your own work, get first-hand information, and have a voice in your community |
| Open peer review | *biorxiv* | A preprint server for biology |
| | *psyarxiv* | A free preprint service for the psychological sciences |
| | *F1000Research* | A preprint server that publishes all your findings including null results, data notes and more |

| | | |
|---|---|---|
| | *Peeriodicals* | A lightweight virtual journal with you as the Editor-in-chief, giving you complete freedom in setting editorial policy to select the most interesting and useful manuscripts for your readers |
| Joining Hackathons | *Brainhack organization* | A unique conference that convenes researchers from across the globe and a myriad of disciplines to work together on innovative projects related to neuroscience |
| Sharing ideas | *GitHub* | Online service to share your work |
| | *ResearchGate* | Online service to make your work visible |
| Peer coach programmes | *Donders Institute, Nijmegen* | A peer coaching programme |
| | *Institute of Electrical and Electronics Engineers (IEEE)* | An online mentoring programme that allows mentees to apply for a particular mentor |
| Developing mentorship skills | *Early Faculty Online Training program* | A programme that offers a range of training information for mentors to develop their mentorship skill-sets |
| | *Stanford Biosciences* | A range of resources and written materials providing additional training for mentees and mentors |
| Career | *LinkedIn* | A social network specifically designed for career and business professionals to connect |
| | *Cheeky Scientist association* | The world's largest PhD-only job search training platform specifically for helping PhDs transition into industry careers |
| | *Bigger pharmaceutical or biotechnology companies (e.g., Roche)* | Companies that offer full PhD and Postdoc programmes, which can allow one to gain both research career advancement and gain industry experience at the same time |

## Supplementary Material 3: Advice for researchers who are considering a career switch

If you aim for a tenure track position in academia, there are multiple steps you may take in order to increase your chances in the job recruitment process (Martin, 2017). However, if at some point in your career, you desire to try something else other than academic research, do not be afraid to do that. As mentioned in the Introduction, the demographics in academia are rapidly changing, with the percentage of researchers staying in academia decreasing (Milojević, Radicchi, & Walsh, 2018). Although the higher education sector is one of the largest sectors of employment for doctoral graduates, a significant proportion of PhDs and postdocs will not pursue a career in academia. The exact numbers vary depending on the country and while the vast majority of doctorate holders in

Poland and Portugal work in higher education, this is only true for one third of them in the Netherlands, Belgium and Denmark (Auriol, Misu & Freeman, 2013). Therefore, in fact not industry but academia is often the alternative career path in these countries (Humphries, 2018)[1]. Changing course from academia to another profession is a professional development opportunity, and should not be considered a failure (Kruger, 2018). Also, a decision to try a position in industry is not a definite decision to leave academia, as there are also multiple success stories of transitioning back (Gramlich & Bodewits, 2016).

So, where to start? You can consider doing an internship in a private company during your research contract. In example, an initiative that helps PhD candidates in the Netherlands to get internships is the Professional PhD Programme (PPP) by the PhD Network Netherlands (PNN, https://www.hetpnn.nl/en/2013/05/06/ppp/). Their programme offers PhD candidates the possibility to do a short-term paid internship during their PhD at one of several companies, such as banks or funding agencies. Projects like PPP provide a low-threshold opportunity for PhD candidates to get an impression of the world outside the lab and educate companies which are often not aware of all the transferable skills that academics have acquired in their scientific education.
It is recommended to start actively looking for opportunities at least a few months before your current contract expires as finding a suitable industry position takes time. The best method at the early stage may be to tap into your professional network of colleagues who work outside of academia as they might inform you about the incoming vacancies at their workplace. You can also join post-degree training programmes to ease the transition into industry and get a grasp of how working in certain industries looks like in practice (e.g. bootcamps in data science are a popular way of training academics and preparing them to take industry positions, https://www.insightdatascience.com/).

One way to increase your general employability, both in academia and beyond, is developing your transferable skills. In fact, spending a few years in academia gives a broad spectrum of transferable skills (Mather-L'Huillier, n.d., Academic Positions, 2018, Humphrey, 2017). Examples of such transferable skills are mediation, negotiation, communication, organisation, scheduling, management, mentoring, coaching, journalism. While long experience in academia might hamper your chances of landing a good position in industry in certain circumstances (Woolston, 2018b), all of these skills can make you competitive on the open job market (Woolston, 2018a).

You also need to realize that recruiters in industry speak a language of business and management rather than a language of science, therefore you need to *translate* your resume to this other language before applying for a job in industry. If you have a hard time defining your core or transferable skills, there are multiple online tools which can assist you. For instance, Transferable Skills Assessment (https://www.unl.edu/careers/documents/miscellaneous/TransferableSkillsAssessment.xlsx) is a free online tool for identifying competencies obtained during the PhD programme and getting an overview of what we should improve on for the further career development. Another example is Gallup StrengthsFinder (https://www.gallupstrengthscenter.com/home/en-us/strengthsfinder), a commercial programme to explore five main personal strengths.

If you decide to apply for a position in industry, there are online services dedicated to help you adjust your CV to industry standards and find your first job in industry, e.g. the Cheeky Scientist association (https://cheekyscientist.com/). It is also essential to prepare for a job interview by getting familiar with the working culture of the company you are applying for (Fiske, 2016). For most large companies, you can find some information and testimonials online. You can also research the working conditions within the company through online services such as Glassdoor.

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[1] This depends on the country, e.g. the percentage of all PhD holders entering a Postdoc amounts to 65% in the US as opposed to only 30% in the UK

While holding a PhD can sometimes mean that you are overqualified for the job, for the most part holding a PhD is a valuable asset. For example, large companies with strong Research & Development departments (e.g., Google or Amazon) and IT startups often welcome candidates with a PhD as they are innovative and independent (Hankel, 2019). There are also companies (e.g., Roche), which offer full PhD and Postdoc programmes, so that you can have both research career advance and gain industry experience at the same time. In **Supplementary Material 4**, we list exemplary professions in which a PhD title is typically an asset rather than a liability.

What to do if you do not have a clear plan of which profession to go for next? If you are looking for ideas for your new career path, it could be worth considering the popular belief *'whatever you are naturally drawn to when you are procrastinating is what you should do for a living'*. Think about how you are spending your time and reflect on what you are passionate about; many ECRs have never held positions outside of academia and have yet to discover their natural talents. Furthermore, the job market is very dynamic; along with the development of internet services and social media, new professions are continuously being created. For example, ten years ago, professions such as a YouTuber or a vlogger did not exist, while now, these are the dream jobs for over 50% of children in the United Kingdom (Daily Mail Reporter, 2017). Similarly, new trends in science including science journalism and communication between research teams and industry are rapidly developing. As Steve Jobs famously said, 'stay hungry, stay foolish' - and, you never know when the time will come to connect all the dots.

## Supplementary Material 4: A list of potential alternative careers to consider for holders of a PhD title in natural and life sciences

Below, we list a number of ideas for alternative career options after your PhD.

### Data Analyst/Data Scientist

Data scientists are experts in data analysis. They collect, visualise and analyse large amounts of data (SAS, 2018). Data scientists are typically trained in math, statistics, computer science, information science, finance or economics. Data scientists must have high technical and analytical skills, and should be adept at using a variety of statistical programming languages such as R, SAS or Python. Data scientists often use complex analytical techniques, such as machine learning and deep learning. They can freelance through online platforms such as Upwork or find jobs in IT and business-related fields. If you hold a PhD title, you can apply for senior data analyst positions, which partially resemble research life in the sense that you will supervise junior data analysts.

### Data steward

The amount of (digital) data has increased enormously over the past years and the pressure for good data management and open and reproducibly science using this data creates the need for new data professionals. These data professionals are also often called data stewards and they combine different sets of skills related to research data management, processing and analysis (Scholtens et al., 2019).

### Working on research infrastructure

You can search for employment at organisations providing tools and infrastructure for research such as data centers or service providers like ORCID, DataCite or Crossref.

### Consultant

There are many different consulting firms (McKinsey and Boston Consulting Group being some of the well known ones) looking for highly educated professionals. As a consultant you provide professional

advice to individuals or companies. As an employee of a consultancy company, you would need to re-qualify and learn about the products and services offered by the company.

(Freelancing) Scientific Consultant

You can also choose to become an external scientific consultant, who is hired as a freelancer by companies in order to solve specific issues. This is an especially interesting option if during your scientific career you have mastered a certain technique (i.e. engineering around a certain type of highly specialistic machines) which is now a crucial element of larger projects in large companies. There is a high demand for such external consultants, especially in pharmaceutical industry and in engineering.

Grant advisor/Project acquisition

Conducting research most often depends on grants. Many organisations (including universities and research institutes) and private companies employ professionals to advise others on available grants and aid with grant applications. Furthermore, there are private companies offering commercial grant consultancy.

Publisher

Consider applying your knowledge about publishing and reviewing scientific articles by working for a publisher. There are over 2,000 for-profit publishers on the market, but most large scientific societies also lead their own, non-profit journals.

Software Developer

Software developers build, design, and test software for consumers. They should have high technical expertise to write, test, and maintain code, strong analytical skills and be capable of long periods of extreme concentration. They can work in a variety of industries and are currently in high demand. PhD candidates in natural and life sciences often need to write and run scripts over the course of their PhDs, however, becoming a software developer often requires some amount of additional training. To read more about the experience of a PhD who transitioned to software development, see (Soapbox Science, 2012).

Research Scientist

Research scientists set up and conduct projects and experiments in a specific scientific area in R&D departments of private companies, much like they would in an academic institution. They can work in a wide range of areas, including industry (i.e., tech companies, pharmaceutical producers etc.), government laboratories, environmental organisations, large hospitals, and other specialist research organisations. Day-to-day work could entail gathering, analysing, and interpreting data, as well as designing projects and putting together research proposals. Research scientists should have strong written and verbal communication skills, as they may be expected to work in diverse teams and liaise with other staff.

Lab manager

As a lab manager you help to keep the lab running, you may care for the equipment of research participants and all of the organisational tasks to support the ongoing research.

Medical Science Liaison

Medical Science Liaisons (MSLs) are excellent communicators who liaise between physicians, clinicians and researchers. They must be able to tailor complicated information to their target audience in a clear and concise way, as they help ensure health-related products are utilised effectively. They can be found in the pharmaceutical, biotechnology, medical device, and other health-care industries or contract research organisations. Since science communication is a compulsory

competence to obtain such a position, it may be helpful for those interested in MSL positions to use social media, such as tweeting and blogging, as a platform to market themselves and practice writing for a non-scientific audience.

### Market Research Analyst

A market research analyst's primary role is to conduct research to analyse the key advantages / disadvantages of the company's technologies/products and ideas in order to assess their commercial value. Market research analysts often work in innovation-based sectors: biotechnology, electronics, and IT (although market research analyst roles exist in most industries). They must have excellent oral and written communication skills and strong analytical thinking with a knack for business.

### Healthcare Information Technology Specialist

Health IT specialists manage technical aspects of handling patient health data. They may support or build electronic health record systems, be involved in data analytics and be a part of interdisciplinary teams to facilitate improved healthcare outcomes. Health IT specialists must have basic knowledge of the Microsoft Office software, as well as medical terminology, database management and document imaging software.

### Scientific Editor

The role of a scientific editor is to ensure that the peer review process of a journal is fair and efficient, and to carry out production of journal articles after they are accepted for publication. Scientific editors work for specific journals and must be excellent at critical reading of scientific literature, including literature in unfamiliar topics. Scientific editors must also be strong writers able to work under time pressure, as they may be asked to write news pieces or blog posts summarising newly published papers.

### Science Communication Officer

The role of a Science Communication Officer is to communicate recent scientific output of an institution such as a research institute, to the general public by releasing press notes, blogging and social media activity. Science communication officers create the content in collaboration with the authors of the scientific work. This job is a form of journalism, which additionally requires an understanding of science and technology, as well as having strong communication skills.

### Science Policy Analyst

The role of a Science Policy Analyst is to use their research experience to interpret how policy affects scientists. Every federal agency hires multiple PhDs working in policy. Almost all universities also have government-relations offices that employ policy analysts.

### Project Leader in public institutions or large corporations

Public institutions such as the Ministry of Education usually have separate units dedicated to creating infrastructure around science, such as developing new directions in science education, working on behalf of gender and ethnicity diversity, or building open-source databases or computing clouds. As multitasking and communicative individuals, PhDs can also excel as Project Managers in the more general corporate culture.

### Business Developer

Business development requires a profound understanding of the relevant market sector: a degree in business management might not be sufficient to help a highly specialised project survive on the free

market. Therefore, if you have a general interest in developing projects, you can become competitive on the market by gaining additional competence in business management and finding a job as a business developer specialised in the sector of the market close to your former PhD topic.

## Entrepreneur

PhDs often present entrepreneurial talents (Angel-Ferrero, 2016), as the skills of a PhD candidate are not unlike those of successful founders, with resourcefulness, intrinsic motivation, independence, project management, commitment and passion being a few of the leading traits. Most PhD students are exceptionally good at thorough market research (i.e. the literature review). This might be more tailored towards understanding competitors rather than customers, but many skills are transferable. Whilst salesmanship is not natural to many, all academics need to learn it through writing grants, cover letters to journals, presenting scientific work, etc. Many PhDs also involve building Intellectual Property, i.e. patentable solutions. That kind of experience will put you well above a Bachelor of Business or similar in terms of running a start-up.

## Academic / High school teacher

If teaching students was your favorite part of a PhD, you might consider pursuing a further career in teaching, either at the university or in high school education. It is often the case that in order to pursue a career in education, you will need to get an additional training in pedagogics after your PhD. For instance in the US, all high school teachers must obtain edTPA qualification (https://www.edtpa.com/).

## Freelance Writer / Content Writer / Copywriter

If writing is your favorite part of the daily research practice, you might consider freelance writing. This job allows you to choose the scope of topics and select your preferred forms of text from a broad range of possibilities: from blog posts, through essays and articles, to white papers and grant proposals. Typically, in order to become a freelancer, you need to register your business in the local Chamber of Commerce as a sole trader and manage your own finances (pay taxes for yourself, choose a pension fund etc.). It can be a good employment option if you are strong in self-management, you are fond of flexible working hours and you are prepared to negotiate your hourly rates with clients.

For more ideas, please check: https://cheekyscientist.com/top-10-list-of-alternative-careers-for-phd-science-graduates/
http://curiousaboutscience.net/phd-job-options/