Effective Self-Management for Early Career Researchers in the Natural and Life Sciences

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Effective Self-Management for Early Career Researchers in the Natural and Life Sciences

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Early career researchers (ECRs) are faced with a range of competing pressures in academia, making self-management key to building a successful career. The Organization for Human Brain Mapping undertook a group effort to gather helpful advice for ECRs in self-management.

Introduction

Many PhD candidates dream of a research career. This constitutes a rewarding journey in the pursuit of new knowledge, often with meaningful contributions to society. It also represents a largely self-directed career with a high workload but also with great flexibility in time management, similar to owning a business.

However, finding success in today's scientific environment places competing demands on early career researchers (ECRs). We define ECRs as individuals pursuing academic research at the sub-tenure level, regardless of years of experience. At a time when reproducibility is of great concern in science, expectations for research skills in ECRs grow even higher (Poldrack, 2019): they are asked to avoid performing underpowered studies, to replicate their studies, and to maintain high standards of methodological rigor (Poldrack, 2019). Although these developments improve the reliability of scientific findings, they might also negatively affect career-advancing metrics particularly important for ECRs, such as publication count and journal impact factor (a.k.a. prestige; Allen and Mehler,

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2019). Trying to self-navigate under such pressure can be overwhelming, especially given extenuating circumstances that appear during a research career.

This article was created by the Organization for Human Brain Mapping (OHBM) Student and Postdoc Special Interest Group (SP-SIG) and collaborators at different career stages, from Masters students to full professors. Through our own experiences, we found that self-navigating in academia to be particularly daunting and counterintuitive. Access to career guidance varies greatly from institution to institution and even lab to lab; thus, we have compiled information that we find is both useful for self-navigating in academia and broadly applicable. Although our recommendations are largely drawn from personal experience, relevant research studies are cited where possible. A summary of the introduced tools and strategies is given in Supplemental Information.

Take Charge of Your Own Career Development
Follow Your Curiosity and Build Expertise
Curiosity is the primary driver of scientific discovery. However, passion for research might only come with experience built over time; many successful scientists fall in love with what they do only after achieving some level of expertise in the field.
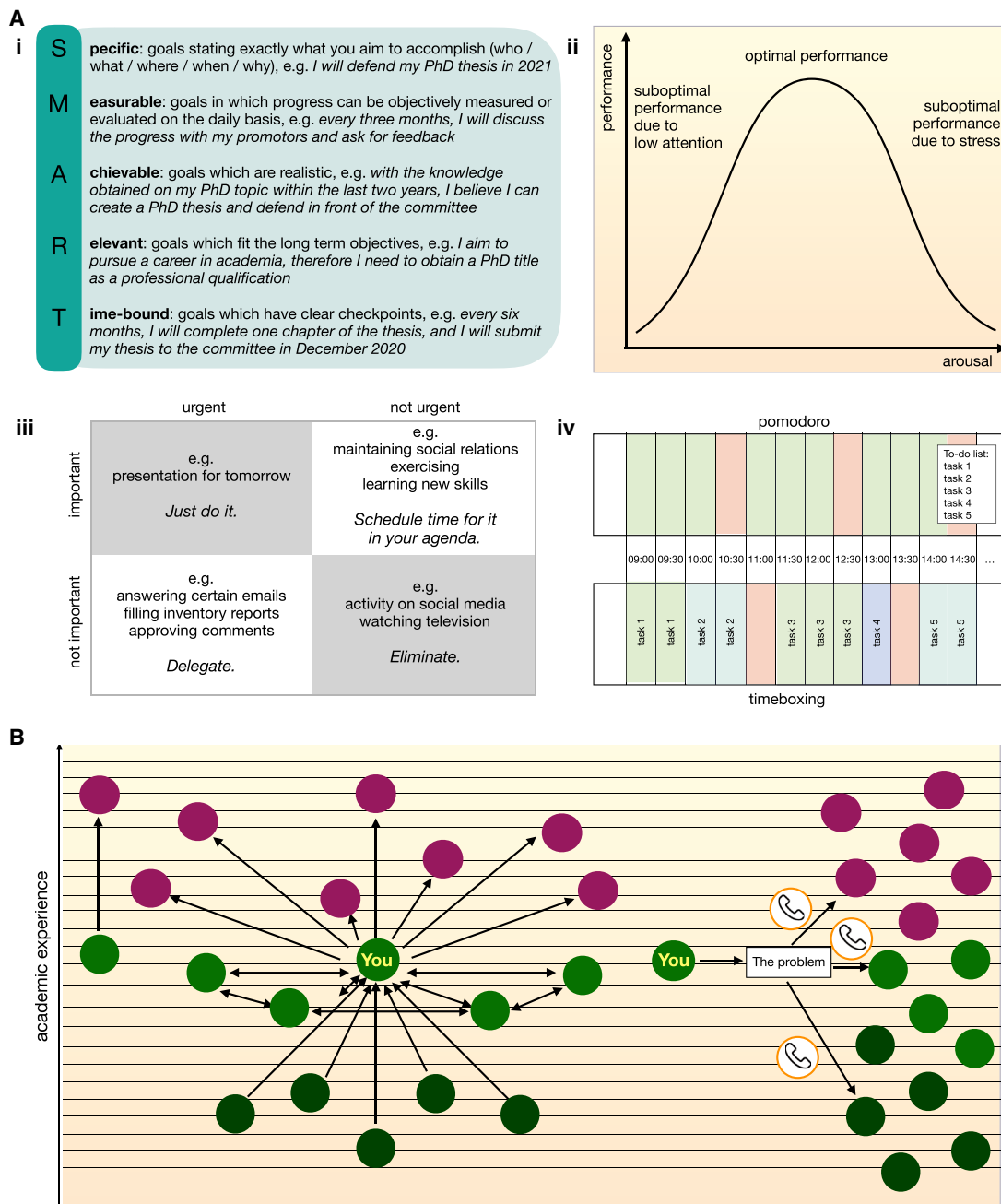
Develop Clear Long-Term Goals
Citing Jim Rohn, "If you don't design your own life plan, chances are you'll fall into someone else's plan." Developing a clear vision and planning small steps toward the ultimate goals is necessary to steer your career. This will also help view small failures and setbacks as lessons and growth opportunities. Usually, only the clearly defined, measurable, and time-bound goals are achieved (Raia, 1965; Figure 1Ai). Moreover, following Yerkes-Dodson law (Figure 1Aii), putting too much pressure on goals can lead to elevated stress, which can result in a cascade of errors, procrastination, and suboptimal performance.

Manage Your Time
Long-term goals can also help you say "no" by choosing tasks that provide delayed gratification over instant but insignificant rewards. Saying "no" is difficult but necessary. Most researchers fall into the trap of temporal discounting, where future time commitments matter less at the time of agreement. One strategy to overcome this issue is to imagine that

A

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S **pecific**: goals stating exactly what you aim to accomplish (who / what / where / when / why), e.g. *I will defend my PhD thesis in 2021*

M **easurable**: goals in which progress can be objectively measured or evaluated on the daily basis, e.g. *every three months, I will discuss the progress with my promotors and ask for feedback*

A **chievable**: goals which are realistic, e.g. *with the knowledge obtained on my PhD topic within the last two years, I believe I can create a PhD thesis and defend in front of the committee*

R **elevant**: goals which fit the long term objectives, e.g. *I aim to pursue a career in academia, therefore I need to obtain a PhD title as a professional qualification*

T **ime-bound**: goals which have clear checkpoints, e.g. *every six months, I will complete one chapter of the thesis, and I will submit my thesis to the committee in December 2020*

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B

Figure 1. Principles of Effective Goal Setting and Time Management and Modern Models of Mentoring
(A) Principles of effective goal setting and time management. (i) The S.M.A.R.T. approach for setting goals (Raia, 1965) with examples. (ii) The Yerkes-Dodson law. There is an optimal level of arousal above which performance decreases due to high stress level. (iii) The Eisenhower chart. The key to long term success is to manage important, but not urgent, tasks. (iv) The "pomodoro" technique and "timeboxing" for planning work time. In the pomodoro technique, tasks are kept in lists and working time is pre-divided into periods of deep work (green) interleaved with breaks (red). In the timeboxing, every task is assigned with a precise time slot.
(B) Models of mentoring. Left: the traditional, hierarchical view. Middle: modern, multilayered model. The mentee becomes the center of their own mentoring network, with multiple mentors at different career stages (magenta), other ECRs at a similar career stage (peer coaching, light green), and more junior mentees (dark green). Right: "lifeline" (or "advisory board") model: a network of mentors at different career stages serving as an advisory board.

the task is due tomorrow—would you still say "yes" on such a tight deadline?

According to Dwight D. Eisenhower, activities can be divided along two dimen-sions: important/not important and ur-gent/not urgent (Figure 1Aiii). Although important/urgent tasks are prioritized, proper management of important/non-ur-gent tasks (related to your long-term pro-fessional development, health, building bonds, etc.) are the real key to success. Furthermore, following Parkinson's law,

the more time you allocate to a given task, the more time the task will take. Practice delegating tasks that you do not need to do by yourself and consider implementing productivity strategies, such as the "pomodoro" (free applications available, e.g., Time Out and Stretchly) or the "timeboxing" technique (Figure 1Aiv).

Take Care of Yourself
Exercise
Exercising 2 to 3 times a week reduces the chances of depression, anger, stress, and anxiety disorders. For example, walk or bike between home and work or perform simple yoga stretches during the day. Group exercise sessions are also effective in controlling stress and improving mood.

Discover Your Optimal Work Style
When are you the most productive or most creative during the day? What is your preferred sleep schedule? What type of diet makes you feel the most energized? What makes you procrastinate? Knowing your optimal work style can help you achieve work-life balance.

Seek Help
If your mood stays low for a prolonged period, you might benefit from therapy or counselling. Although seeking professional help was often stigmatized in the past, it is increasingly being appreciated. Treat your mind as you would your body: take good care of your mental health and go in for professional check-ups. Typically, academic institutions offer mental health services to their employees. Additionally, there are associations dedicated to this cause, e.g., Academic Mental Health Collective.

Join Communities
Research suggests that among doctoral students and academics aged 18 to 34, isolation was the biggest contributor to reported mental health problems (Shaw, 2014). There are highly inclusive online associations open to ECRs that focus on career and personal development, such as the community of eLife Ambassadors.

Discern Criticism
Although (self-)criticism is a part of the daily research routine, it is helpful to distinguish a critique of your work from criticism of you. Constructive criticism provides an opportunity for improvement. If criticism is destructive or personal, it is best not to react immediately but instead

to take a step back and understand the true motives underlying the criticism.

Clarify Your Rights on Work-Family Balance
Either now or in the future, you will likely have caretaking responsibilities (children, partners, family members, etc.). In that case, ask a mentor or colleague you trust for support. Find out about your rights to statutory leave. Additionally, most employers have policies to grant additional leave and/or benefits above what is legally mandated: courses on work-family balance, a contract extension for caretakers, childcare support, and support groups for parents in research. You should also look for grants and fellowships that provide support for the continuation of your research during leave or upon return after a career break (check: "Scientist and parent" series at eLife).

Make sure that you and your Principal Investigator (PI) have similar expectations about work-life balance (e.g., consider options such as part-time employment) and have up-front discussions about your availability (or lack thereof) outside your normal work schedule.

Write a CV of Failures
Success rates for publishing in high impact journals and obtaining grants can be 10% or lower, making academia very competitive. It is easy to get a false impression of chronic underachievement in such conditions.

In 2010, Dr. Melanie Stefan proposed writing a "CV of failures," where only rejections and failures are documented (Stefan, 2010). Reading CVs of failures written by established researchers can be helpful, as it demonstrates that failure is an integral part of science and should not be taken personally (Cheplygina, 2018). Documenting rejections can also be beneficial as an index of productivity and source of self-motivation: once you create a CV of failures, every action will add to either your official CV or the "shadow CV."

Plan Out Your Projects
You might find that your research project has bottlenecks that can delay its completion. You can increase the chances of successful completion by careful planning and teamwork. Online scheduling tools, such as Slack or Trello, can

help keep the team on track. If bottlenecks appear, you should ask yourself: "Can we decompose this problem into smaller and manageable chunks? Who is a useful contact to address each of these subproblems?" Communicate the bottlenecks clearly to your superiors as soon as they arrive. Be your own advocate—if you don't ask for what you need, no one will know you need it.

Furthermore, consider developing side projects if your main project is burdened with bottlenecks outside your control. Think about your research activities as an investment portfolio: it should 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: professional, worthwhile, and well thought out. Refer to Supplemental Information for comprehensive advice on minimizing risk in research projects.

Grow Your Network
Become the "Go-To" Person
Develop a core competence that will allow you to stand out in your research community and develop a personal brand around it. Your niche can be anything: from proficiency in using a particular experimental tool to talent in community management. You can promote your skill by offering to help (e.g., through Twitter). Good news spreads fast; your colleagues will remember your willingness to help and spread the word whenever they hear about someone searching for this particular expertise.

Join Twitter
Twitter allows you to disseminate your work, get first-hand information (e.g., open calls for travel grants), have a voice in your community, and ask for opinions (Cheplygina et al., 2020). It is also common for online collaborative projects to begin on Twitter, engaging you in interesting side projects (Tennant et al., 2019). Funding opportunities can also be found on Twitter (e.g., @nihfunding, @nihgrants, @nsf, @ibrosecretariat). However, Twitter should be used responsibly, as it can become time-consuming and addictive.

Build Online Visibility
Aim to gradually increase your visibility online. Keep your LinkedIn and Google Scholar profiles updated and linked to all your online outlets. You can also set up a

personal website—even if you do not have an established research portfolio yet, you can post a blog or updates on your career activities (e.g., CV and/or failure CV). You can also search for yourself on Google and review the search results. If you see records you don't want to be associated with, you can contact Google support to remove this information from search results or contact the administrators of the website that features unwanted content.

Post Preprints

Consider posting preprints of your article and encouraging the research community to comment before submission to peer-reviewed journals. Articles preceded by a preprint are usually better cited than original submissions (Serghiou and Ioannidis, 2018), and the amount of online attention highly correlates with the impact factor of the eventual accepted journal. There are also certain downsides to preprints, e.g., not gaining enough online attention might discourage high-impact journal publication. However, posting preprints promotes your commitment to open science, which will be rewarded in the long run.

Give More Presentations

It might be difficult and daunting to talk at a major conference at the beginning of your research career. Start by giving seminars at your own research institute and student conferences. You can also propose to be a guest online speaker in lab meetings to a junior professor you met at a conference. More talks bring more invitations, and practice makes perfect.

Join Hackathons

Hackathons are themed sprint-like events where participants conduct group research projects over a period of a few hours to a few days. Hackathons will allow you to develop: (1) leadership skills, by converting and delegating parts of your project into Hackathon projects or proposing small standalone projects; (2) research and networking skills, by joining other projects and building collaborations; and (3) writing skills, by authoring project proposals and brief proceedings publications. You may find a list of exemplary science-themed Hackathons in Supplemental Information.

Share Your Ideas with Others

Blogs are a great tool to share your ideas and opinions. To start, you can consider writing guest posts for established blogs in your field. For example, the OHBM Student and Postdoc SIG leads a blog dedicated to ECRs and is always open to featuring materials proposed by their readers.

You might also volunteer to review other researchers' manuscripts and grants. For example, you can join ECR-dedicated grant reviewing programs, e.g., Early Career Reviewer Programme at NIH.

Supporting Open Science by sharing your work as an open-source resource can also strengthen your research and networking skills. GitHub is a good place to start as it hosts code for many open-source tools and facilitates not only collaborations but also interactions with code developers. Sharing research tools and promoting them on Q&A, sites such as NeuroStars, can also increase networking opportunities and improve your work, as others might find issues or potential enhancements that were previously overlooked.

Mentoring Is Key

A common misunderstanding is that mentorship is just another aspect of day-to-day interactions with your supervisor (Figure 1B, left). Creating a *network* of mentors can be more beneficial for providing diverse advice in different situations (Figure 1B, middle). A "lifeline" model of mentoring (Figure 1B, right), where you develop a mentoring environment of multiple helpful researchers whom you can call as a lifeline, is also recommended.

There are online resources that can assist mentees and mentors in making the mentoring process run smoothly. For example, the Early Faculty Online Training program at Stanford University offers information for mentees and mentors to develop a mentorship skill-set useful for researchers at many career stages. There is also an open initiative to increase the diversity in the biomedical research workforce from the National Research Mentoring Network (NRMN).

Join or Create a Peer Coaching Program

Peer mentoring is a particular form of mentorship, in which mentors and mentees at similar career stages cooperate in pairs. In this scheme, mentors and mentees usually self-manage their relationship.

A recently popularized form of peer mentoring is a coaching group, which consists of researchers at similar career stages who support each other during a series of in-person meetings and are typically assisted by a trained facilitator. Peer coaching groups efficiently complement traditional mentoring. If there is no peer coaching group available at your institute, consider creating one with your fellow ECRs.

An alternative option is joining an online mentoring program. In such a program, mentees are paired with mentors who might be geographically distant. For example, the OHBM offers an International Online Mentoring Program (Bielczyk et al., 2019) in which mentors are coupled with mentees on the basis of years of experience in active research and mutual expectations. Other examples include programs from the Institute of Electrical and Electronics Engineers, where mentees can apply for a particular mentor or 1000 Girls, 1000 Futures dedicated to women in Science, Technology, Engineering, and Mathematics (STEM), which offers two hours of mentoring per month for a period of one year.

Conclusion

Although many of the authors of this manuscript work in neuroscience and psychology, we believe that the points discussed here apply for a broader ECR community. Although the demands of academia seem to be ever increasing, self-management of your career can increase your confidence and sense of control. There are also career options beyond academia, which might suit you better. In Supplemental Information, we give additional advice to researchers considering a career switch to industry, and we list exemplary professions in which academic experience is an asset. For more information about post-PhD career tracks, you can reach out to the Corresponding Author, Dr. Bielczyk (Bielczyk, 2019).

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Supplemental Information

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for Early Career Researchers

in the Natural and Life Sciences

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Part 1 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 organization that provides international grants for Research Fellowships, 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
Peer coach programmes	*Donders Institute, Nijmegen*	A peer coaching program
	Institute of Electrical and Electronics Engineers (IEEE)	An online mentoring program that allows mentees to apply for a particular mentor
Developing mentorship skills	*Early Faculty Online Training program*	A program 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 enter or transition into industry careers
		Bigger pharmaceutical or biotechnology companies (e.g., Roche)	Companies that offer full PhD and Postdoc programs, which can allow one to gain both research career advancement and gain industry experience at the same time
	Science-themed hackathons	*Brainhack*	An international organization that coordinates multiple international hackathons focused on neuroscience- and network research
		HackOverflow	A world-renowned hackathon in computer science organized by the Stanford Women in Computer Science association
		McGill Physics Hackathon	A world-renowned hackathon in computational physics organized at McGill University in Montreal, Canada
		Odyssey Hackathon	The biggest blockchain hackathon in the world where blockchain meets science, organized in Groningen, the Netherlands
		Eduhack	A hackathon focused on building solutions for today's education problems

Part 2 Tips to avoid common pitfalls in science

A Good planning and experimental design

Do a robust literature review. Look out for contradictory results and null findings to build the best prior to 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, www.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.

B Mitigating risk and robust logistics

Quality checks. Always check your data quality during data collection to allow identification and correction of problems and to enable mitigation strategies during 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 the 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 spanning a major upgrade as it may introduce biases. If you cannot avoid this, ensure that you model this potential confounding factor in your analysis, or employ a case/control design with case/control pairs collected close in time on the same equipment. 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.

C 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 underestimating the time required for different phases.

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

D Closing out and publishing work

Pre-plan your analysis. Deciding on how to analyze the data before collection is essential to avoid close-out issues.

Mind P-hacking. Do not analyze and re-analyze data until you find a 'significant' result.

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 backups in mind.

E Robust career planning

Diversity. Do not rely on only one project; have multiple streams at different stages to smooth out your career progress.

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 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 only 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. 1B**).

Part 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 to increase your chances in the job recruitment process (Bielczyk, 2019). However, one should not ignore opportunities beyond the professorial route, as many PhD holders find fulfilling careers in other domains. As mentioned in the Introduction, the demographics in academia are rapidly changing, with the percentage of researchers staying in academia decreasing. Although higher education remains a large sector 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. Similarly, about 65% of PhD holders enter a postdoc in the US, as opposed to only 30% in the UK. Changing course from academia to another profession is a professional development opportunity, and should not be considered a failure. 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.

So, where to start? You can consider doing an internship in a private company during your research contract. For example, an initiative that helps PhD candidates in the Netherlands to get internships is the Professional PhD Program (PPP) by the PhD Network Netherlands (PNN, https://www.hetpnn.nl/en/2013/05/06/ppp/). Their program 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 that 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 upcoming vacancies at their workplace. You can also join post-degree training programs to ease the transition into industry and get a grasp of how working in certain industries looks like in practice (e.g., workshops 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. Examples of such transferable skills are mediation, negotiation, communication, organization, scheduling, management, mentoring, coaching, journalism. While long experience in academia might hamper your chances of landing a good position in industry in some circumstances, all of these skills can make you competitive on the open job market.

You also need to realize that recruiters in industry speak a language of business and management rather than a language of science, so 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 that 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 program and getting an overview of what we should improve on for further career development. Another example is Gallup StrengthsFinder (https://www.gallupstrengthscenter.com/home/en-us/strengthsfinder), a commercial program to explore five main personal strengths.

If you do decide to apply for a position in industry, there are online services dedicated to helping you adjust your CV to industry standards and to find your first job, 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. 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.

While holding a PhD can sometimes mean that you are overqualified for a specific 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. There are also companies (e.g., *Roche*), which offer full PhD and Postdoc programs so that you can both advance your research career and gain industry experience at the same time. In **Supplementary Material, Part 4**, we list exemplary professions in which a PhD title is typically an asset rather than a liability.

What should you do if you do not have a clear idea 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 some may 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. 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.

Part 4 A list of potential careers in industry to consider for holders of a PhD in the natural and life sciences

Below, we list ideas for career options outside academia for PhD graduates.

Data Analyst/Data Scientist

Data scientists are experts in data analysis. They collect, visualize and analyze large amounts of data. 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 and have relevant experience, you could become a senior data analyst and 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 reproducible science using these 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.

Working on research infrastructure

You can search for employment at organizations 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.

(Freelance) Scientific Consultant

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

Grant advisor/Project acquisition

Conducting research most often depends on grants. Many organizations (including universities and research institutes) and private companies employ professionals to advise others on available grants and aid with grant applications. Furthermore, private companies are 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 the 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 throughout their PhDs; however, becoming a software developer often requires additional training.

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 organizations, large hospitals, and other research organizations. Day-to-day work could entail gathering, analyzing, 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 take care of lab equipment and all of the organizational tasks to support the ongoing research. The lab manager is a function you can get in an academic institution as well as in industry.

Medical Science Liaison

Medical Science Liaisons (MSLs) are excellent communicators who liaise between clinicians and researchers. They must be able to tailor complicated information to their target audience clearly and concisely, as they help ensure health-related products are utilized effectively. They can be found in the pharmaceutical, biotechnology, medical device, and other health-care industries or

contract research organizations. 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 analyze the key advantages/disadvantages of the company's technologies/products and ideas 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 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 the production of journal articles after they are accepted for publication. Scientific editors work for specific journals and must be excellent at the 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 summarizing 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 infrastructures 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 specialized 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 specialized in the sector of the market closest to your former PhD topic.

Entrepreneur

PhDs often have entrepreneurial talents, 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, technical or community college or high school level. It is often the case that to pursue a career in education, you will need to get 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, to become a freelancer, you need to register your business in the local Chamber of Commerce as a sole trader and manage your 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:

(1) https://cheekyscientist.com/top-10-list-of-alternative-careers-for-phd-science-graduates/
(2) http://curiousaboutscience.net/phd-job-options/
(3) Bielczyk (2019). The landscape of post-PhD career tracks. Amazon Digital Services, ISBN: 1675579660.