



Doing
creative
research

A good practice
guide for postdocs
in STEM disciplines

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About Vitae

Vitae is supported by Research Councils UK (RCUK) and managed by CRAC: The Careers Development Organisation. Vitae's vision is for the UK to be world class in supporting the personal, professional and career development of researchers.

To achieve our vision we have four aims:

- Building human capital by influencing the development and implementation of effective policy relating to researcher development
- Enhancing higher education provision to train and develop researchers
- Empowering researchers to make an impact in their careers
- Evidencing the impact of professional and career development support for researchers

Vitae's work with higher education institutions

Vitae works with UK higher education institutions (HEIs) to embed professional and career development in the research environment. Vitae plays a major role in innovating, sharing practice and enhancing the capability of the higher education sector to provide world-class professional development and training of researchers. We do this both through national projects and Hub activities.

The programme develops resources for use by trainers and others working with researchers, and provides opportunities for HEIs to share information and practice; develop ideas and approaches; and work collaboratively.

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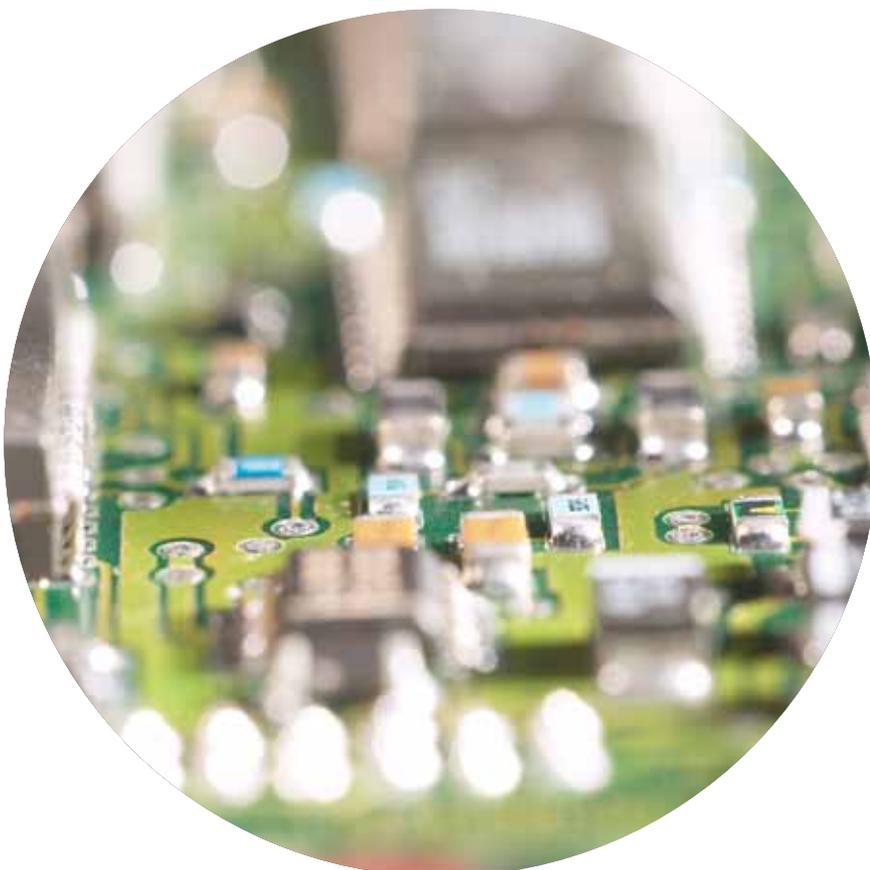
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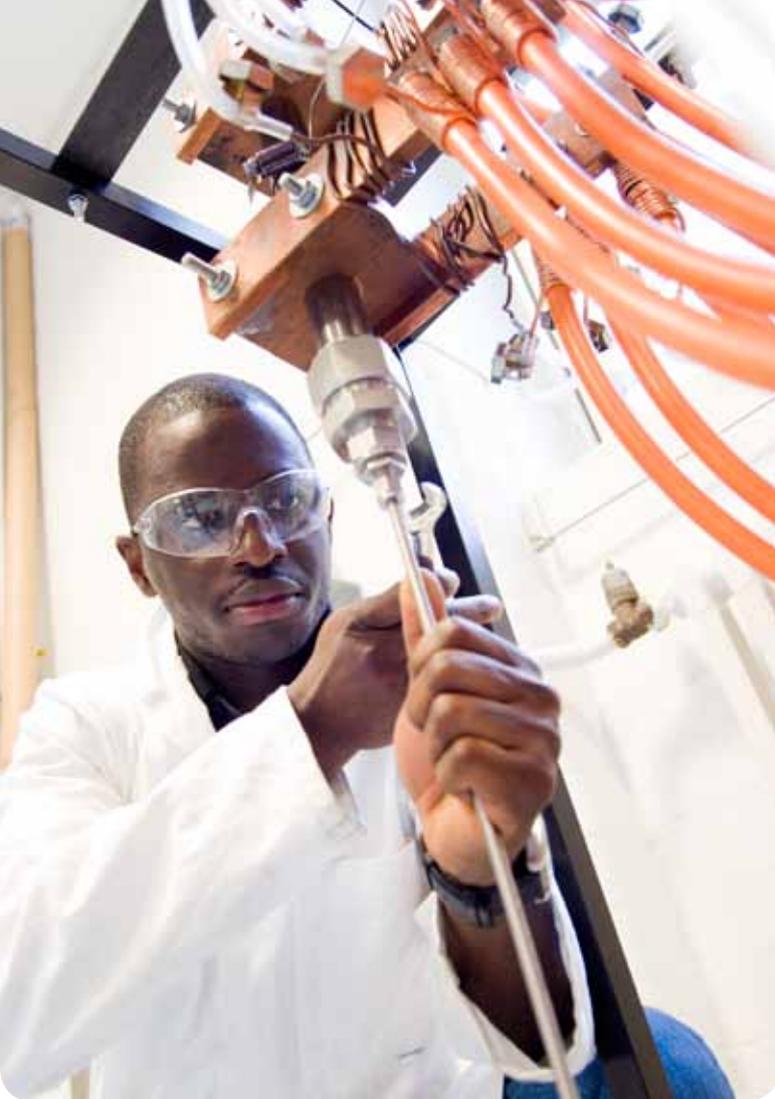
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Introduction

This guide has been designed to help postdocs across all STEM disciplines. Whether you are an astrophysicist or an immunologist, a molecular biologist or a pure mathematician, it will contain information that can help you.

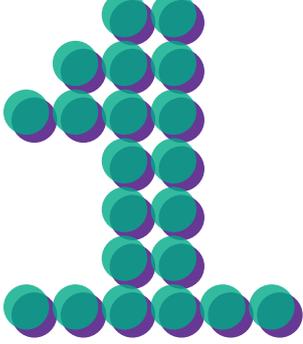
Developing creativity is core to your personal and professional development:

- It enhances the research skills you cultivate during your time as a postdoc
- It's key to innovation: creativity stimulates original ideas, which in turn lead to new discoveries and inventions
- It can help you to stand out: the ability to generate new ideas, processes and products can give you a competitive edge

Therefore, it is vital for you, as a postdoc in the STEM disciplines (science, technology, engineering and mathematics), to develop your creativity as you continue to build your portfolio of research skills.

Despite the centrality of creativity to STEM research, there is very little information available about what it is or how to incorporate it into your day-to-day research. In addition, structural pressures like competition for scarce resources and an increased focus on the economic or social impact of research projects can mean that 'safe', measurable results are prioritised over original ideas and processes.

So, how can you build creativity into your day-to-day routine? The Graduate School and the Postdoc Development Centre at Imperial College London have collaborated on a research project to provide some practical answers to this question. The aim of this guide is to communicate their key findings, providing you with up to date information, tools and techniques to help you make your time as a postdoc a more creative experience.



PART ONE
Creativity

What is creativity?

People tend to associate creativity with the arts, but it is also core to scientific and technological endeavour. So what is creativity?

Creativity is understood and described in many ways depending on the context. In STEM research environments, creativity is usually defined as:

- The development of ideas and products that are original and useful
- The examination and/or combination of existing facts, ideas and theories in original and useful ways

STEM researchers use creativity to develop and explore new problems and re-examine, re-articulate or solve existing ones in novel ways.

Deciding what is and isn't creative is not straightforward in practice. For example, who chooses whether an idea is useful, or who it might be useful to? How can we know that an idea, invention or discovery might not be useful in future? These questions illustrate the fact that creativity is a nebulous concept, and any definition (including ours) is context sensitive.

Despite being tricky to pin down, it's often argued that 'you know creativity when you see it'. The box below outlines the behaviours demonstrated by postdocs who are developing and using creativity in their research.

» HOW TO SPOT A CREATIVE RESEARCHER



The Research Development Framework (RDF) shows how creativity relates to the development of excellent researchers by outlining the behaviours of creative researchers.

Behaviour of a creative researcher:

- » Develops new ways of working; has novel ideas and realises their potential
- » Identifies new trends; creates new opportunities Develops convincing and persuasive arguments to defend research
- » Takes intellectual risks; challenges the status quo

These behaviours are manifest in different ways, depending on the stage you are currently at in your research career.

Details can be found at:
www.vitae.ac.uk/rdf

Who is creative?

Until recently, creativity was seen as a rare talent which a person either possessed or they didn't. Creative scientists were identified by their contributions, which were thought to be exceptionally novel and significant, and people tried to discover the characteristics that set creative scientists apart from others.

Today, it is widely understood that every researcher has the potential to develop and use creativity, although an individual's skills, knowledge and abilities will influence the ways in which their creativity is expressed.

In the world of science and technology, creativity is no longer simply a matter of individual geniuses making paradigm exploding discoveries. It also encompasses the types of creativity that can lead to everyday breakthroughs and recognises the enormous potential for creativity in collaborative enterprise.

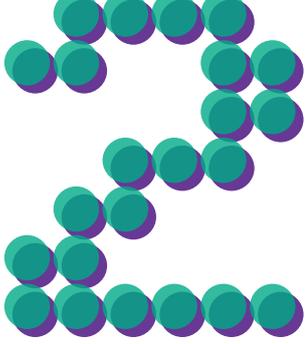
Whilst 'Eureka!' moments still occur, it's rarely an individual person or a single breakthrough that pioneers development. Our knowledge is more often enhanced by the incremental progress that comes about through collectively reconfiguring problems and situations.

Creativity and your research environment

As our understanding of creativity develops, so does our appreciation that an individual's skills, talents and knowledge are not the only factors that influence their ability to think and work creatively. The physical, social and intellectual environments in which we work are also significant to our levels of creativity.

This means that as a postdoc, your ability to develop and use creativity is influenced by a combination of individual and environmental factors. Some of these factors can stimulate creativity. Others can inhibit it.

Part three of this guide concentrates on the environmental factors that have been found to be significant in stimulating the creativity of postdoc researchers working across the STEM disciplines. It provides practical guidance on how you can change your research environment to make it a more creativity-friendly place to work.



PART TWO Are science and creativity compatible?

Is it possible for a microbiologist, a theoretical physicist, or a chemical engineer to research creatively? And if it's possible, is it practical? These are valid questions, but the answer to each of them is: ABSOLUTELY! Here's why.

Creativity and research processes

Creativity can be used at every significant stage of the research process, as well as in day-to-day research activities. Creativity can be particularly helpful in:

- Generating original ideas
- Designing research methodologies and choosing methods
- Constructing experiments
- Analysing data
- Disseminating findings

What do postdocs think about creativity?

Research often requires methodical preparation, repetitive data collection and rigorous analysis, delivered within strict budgets and tight time-frames. It is understandable then, that some researchers wonder where being creative fits into the picture.

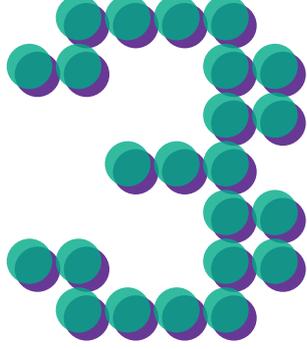
Their postdoc experiences seem to provide little scope for imagination or innovation, novelty or originality. Nor do they leap out as golden opportunities to exercise creative freedom, imagine, build or try out completely new and untested ideas.

Creativity can also be seen as 'airy fairy' and being creative as exercising a freedom which appears to contradict or threaten the discipline and control integral to much STEM research.

On the other hand, creativity is increasingly being seen as a skill that can help you make the most of your postdoc, both personally and professionally. It can help you:

- Develop your intellectual curiosity and sense of adventure
- Push the frontiers of knowledge – both your own knowledge and the wider corpus of knowledge in your subject area

For researchers who appreciate the centrality of creativity to their work, carrying out postdoc research isn't just about working on someone else's project. It's an opportunity to generate exciting new ideas.

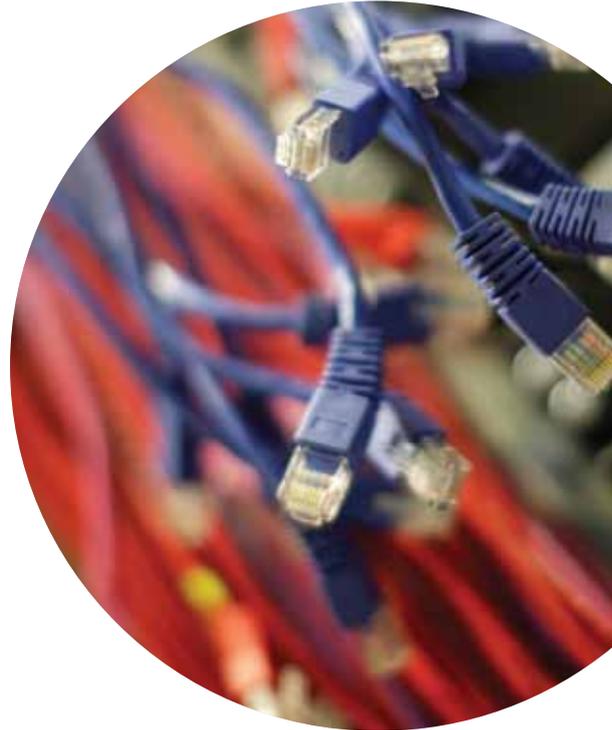


PART THREE Good practice for creative researchers

We spoke with postdocs and their principal investigators (PIs) about what they felt helped, or hindered, their creativity at work. Three aspects of the academic research environment stood out as having a significant impact on creativity, regardless of the STEM discipline in which postdocs worked. These are:

- The wider research culture to which postdocs belong
- The level and quality of communication postdocs have with colleagues
- The amount of time and space postdocs have to be creative

These aren't the only things that can impact on creativity, but they are all things that you, as a postdoc researcher, can change. From our findings, we have developed three 'key principles' which are designed to help you positively influence your research environment.





... Principle one: Help build a positive research culture

Your research environment consists of the physical space where you work every day (your office or lab) and the people you work alongside. Your research culture can be thought of as ‘how things are usually done’ by people in this context. For postdocs working in STEM disciplines, creativity is most likely to flourish in research cultures that balance support and freedom.

What is a supportive research environment?

IT'S STRUCTURED

Doing creative research means having the time and space to think of – and try out – new ideas. Whilst this requires the freedom to make some independent decisions, such as when to pursue an interesting finding, it's also important to feel that you're exercising this freedom within a structured environment. Environments where project objectives, timetables and deadlines are clearly communicated can be particularly productive for creative research.

IT'S SAFE

Doing creative research requires the confidence to try things out, take risks and make mistakes. It also requires the confidence to ask questions and voice ideas. This means working in a culture where ‘silly’ questions are positively welcomed and nobody is afraid of being ridiculed for sharing an idea. As an expert in your field, it's likely that your contribution is valid and even if it doesn't work, it could be the catalyst for an idea that does.

IT'S COMMUNICATIVE

Communicating your ideas is a shortcut to creativity, but it needn't be a formal collaboration. Just chatting with colleagues can generate new ideas which they can help you explore, critique and refine. This will enhance both your individual creativity and the scope for creative collaboration.

What is a free research environment?

IT GIVES YOU AUTONOMY

Making the transition from PhD to postdoc should involve developing greater autonomy as a researcher. A comfortable degree of autonomy gives you space to manage your own workload and to allocate time and resources to areas of your research you think are important, whilst still having access to your PI when you feel you need feedback, guidance or advice.

IT'S INFORMAL

Working in a relaxed and informal environment can really boost your creativity by giving you time to focus on what matters – your research – rather than having to worry about office politics. Informal working cultures prioritise quality (what you achieve) over quantity (the number of hours that you spend in the lab or at your desk). They also facilitate open and informal relations between departmental staff, postdocs and students. Finally, they feel democratic. So every member of the department is approachable, and everyone's ideas are valued.

IT ENCOURAGES INTELLECTUAL ADVENTUROUSNESS

The amount of creativity you bring to your research will be influenced by the amount of support you receive from your PI to follow interesting leads, try things out and test original new ideas. In order to do these things, you need to take some calculated risks – when to pursue a new or interesting piece of data, how long to deviate from your original timetable, what types of resources to invest. You also need to accept that sometimes you'll make mistakes and sometimes you will fail. Working in an environment where you're actively encouraged to try things out can help you develop the confidence to work creatively.

“Everyone is insecure, and to be creative you’ve got to fail...a lot. You’ve got to have stupid ideas that would never work and then you’ve got to figure out why. If you feel that you’re in an environment where you can fail and it’s not going to be the end of the world, then you will learn and progress”.

Postdoc, Natural Sciences

How can I make my research culture more positive?

Your experience of the research culture where you work is likely to be strongly influenced by your PI. They will certainly influence the balance of support and freedom that you have at work, and can also impact on the level and types of communication you share with your colleagues whilst at work. Finally, PIs often play a role in encouraging or discouraging your sense of intellectual adventure by influencing the amount of time and space you have to try out creative ideas.

While it’s normal to feel as if you have a very limited control over how your PI chooses to project manage, you are not powerless. Here are some positive changes you can make to improve your experience of the research environment where you work:

- » **Evaluate:** Look again at each of the factors that contribute to a positive working culture. Think about how your lab or office balances structure and freedom; if it’s structured, safe and communicative and if you are encouraged to be autonomous and adventurous.
- » **Ask:** Is there anything here that I would like to change?
- » **Act:** There are several courses of action you can take to effect change:

DISCUSS IT WITH YOUR PI

Your PI should, if possible, be the first person you speak with if you feel that the balance of support and freedom in your lab or office isn’t working for you. They may not be aware that more structured support, or greater freedom in your day-to-day work could really benefit you and your research. Be specific about the changes you would like to make – asking for help to become a better researcher should encourage your PI to look for ways to facilitate it.

TALK WITH YOUR COLLEAGUES

Sharing your experiences with other postdocs can be useful and instructive. As well as being reassured that many of these issues are common to postdocs in and outside of your group and department, you might pick up some useful tips from colleagues who have already taken steps to change their research environment.

INVESTIGATE THE RESOURCES AVAILABLE AT YOUR INSTITUTION

Find out what support your institution offers to postdocs. Does your contract make provisions for your professional development? Are there any training courses aimed at early career researchers that might be useful to you? Is there a member of staff in HR or the staff development department who specialises in supporting postdocs? You might be surprised at the resources available to you.

MAKE SURE THAT POSTDOCS ARE REPRESENTED IN YOUR DEPARTMENT AND FACULTY

As a postdoc, you are no longer a student. Nor are you a permanent member of academic staff. Being in this in between position sometimes means that the needs and concerns of postdocs are overlooked. One way to combat this is to make sure that you are adequately represented at departmental level. Do you have a departmental rep that you can take your ideas and concerns to? Are you, as a postdoc, represented at committee and departmental meetings? The best way to find these things out is to attend departmental meetings, find out what’s going on in your department and share this information with your fellow postdocs. If you feel you require better representation, think about who you might speak with to make this happen. If you’re already part of a positive research culture, the tips below can help you to sustain and enhance it. If, on the other hand, your group isn’t that communicative, you might feel that there is very little you can do to change it. In fact, there are some simple things you can do to make a difference.



Principle two: Communicate

Communication is vital to creativity, so it makes a big difference if you work in an open and communicative environment where you feel free to share ideas with your colleagues. This is one of the most important attributes of a positive research culture.

Two modes of communication have been shown to be particularly significant in stimulating creativity amongst postdocs: these are informal and formal communication.

If you're already part of a positive research culture, these tips can help you to sustain and enhance it. If, on the other hand, your group isn't that communicative, you might feel that there is very little you can do to change it. In fact, there are some simple things you can do to make a difference.

Informal communication

THIS CAN TAKE PLACE:

- » **At work:** Having a coffee, planning or taking an impromptu lunch or even just chatting in your workspace with other members of your research group
- » **Away from work:** Socialising with other postdocs during a planned evening out, playing for – or supporting – a departmental sports team you've joined or created, or attending an away day with members of your group or department

THE BENEFITS:

Whilst talking with your colleagues might not feel very productive, you are actually cultivating an invaluable resource – one which will help you throughout your postdoc (and beyond).

- » Taking time to get to know the people you work with helps you build social and professional networks. It's hardly surprising that working in an environment where people invest time in communicating informally with each other has been shown to help counter feelings of isolation and loneliness.

- » Chatting with colleagues is good for your research too: It provides time and space to share important information about what's going on in your field, such as new journal articles or upcoming conferences.
- » Your colleagues also provide a vital sounding board you can use to generate, explore and critique new ideas. Bouncing ideas can also help you to clarify and refine them, enhancing your capacity for thinking creatively and speeding up your working processes.
- » Talking through ideas in an informal environment can be exactly what you need to stimulate your creativity. That's why researchers often say that their best ideas are generated when they're socialising in the park, at a cafe or pub, rather than when they are hard at work in the lab or office.



“My idea of creativity is of reaching out to the science around you and then making connections and pulling things together”.

Postdoc, Natural Sciences

Formal communication

THIS CAN TAKE PLACE:

- » **In your research group or department:** When you have productive meetings or brainstorming sessions
- » **At faculty or university level:** When you attend seminars, talks or other activities outside of your department or your immediate field of research
- » **Beyond your university:** When you interact with other researchers from outside your university at conferences and other professional events

THE BENEFITS:

Most research groups organise periodic meetings. These meetings can take the form of progress report sessions, discussion groups or seminars, but all represent some form of structured, formal communication. But not all of these are constructive.

CONSTRUCTIVE FORMAL COMMUNICATION IS:

- » **Open:** It takes place in an environment where everyone feels safe to share their ideas, ask questions, discuss problems and elicit help and advice
- » **Safe:** It creates a space where people are encouraged to feel that there are no silly questions or stupid comments, just ideas

- » **Democratic:** Where knowledge is exchanged horizontally across all participants rather than being dispensed by senior group members
- » **Supportive and encouraging:** Where every member of the group can give and receive constructive critique without fear of rebuke or ridicule
- » **Intellectually adventurous:** Where all group members are encouraged to think big

If you don't feel that the formal communication in your group or department is as constructive as it could be, there are lots of practical things you can do to change that. You'll find that many PIs will be receptive to new ideas if you market them in the right way!

In a climate of tight budgets and deadlines, interrupting your research to attend a conference or even take a lunch can feel like a luxury you can't afford – or worse, like a waste of precious time. In fact, the opposite is true; communicating is integral to your work as a creative researcher. It helps build and sustain networks vital to your personal and professional development; facilitates information sharing and most importantly, provides a forum for you to shape, test and bounce your creative ideas.

“I think you need people around you to be creative because every so often you get really stuck... you can go and have a cup of tea and just talk through ‘any idea why this isn’t working’ or ‘any idea how to analyse this better’, and even if they don’t actually know the answer, because obviously your project’s very specific, they might have an idea that you can feed in and then that allows you to continue”.

Postdoc, Engineering

How can I make my research culture more communicative?

- » Get to know people. Make a point of talking to some of the people you don’t know very well in your department.
- » Get out of the lab or office for tea, coffee, lunch or after work catch ups with colleagues.
- » Organise an away day, or just an ‘away lunch’ where you can spend time socially with your group or members of your department. Invite as many people as you like!
- » Be persistent. If you’re organising events in a department where people aren’t used to socialising, it might take a while to get people on board. But with a little perseverance, you can make it happen. Don’t forget to enlist willing helpers.
- » Try brainstorming techniques with your research group to spark creative ideas, share knowledge and promote discussion. Bouncing ideas between colleagues in an environment where everyone feels safe to ‘think out loud’ can help generate really creative solutions to tricky problems.
- » Change the way you communicate in group meetings.
 - Make group meetings about sharing success not simply reporting, housekeeping and troubleshooting
 - Introduce some democratic working principles to change the dynamic of team meetings. For example, suggest rotating the chair at meetings. This helps establish the principle that everyone can contribute ideas on an equal footing, regardless of their position.
- » Become part of a wider research community. Look for inspiration outside of your work environment by attending lectures, seminars and conferences. These events don’t need to be in your immediate field. If they look interesting, or you know the speaker is really good, you will likely come away feeling inspired. You might meet some interesting people too.
- » Organise a postdoc poster day or symposium to share information about who is researching what. You could extend the invitation to members of your department, the faculty or even your university. These events help build networks and provide scope for potential future collaborations. You might be surprised at who you meet, what they do and how you can pool valuable knowledge, ideas and resources.





... Principle three: Make time and space for creativity

Working as a postdoc in today's results driven research environment isn't straightforward. Pressure to help win funding, complete projects to deadline and on budget and then publish the results in high ranking journals can leave you feeling that there is very little room for creativity.

But despite these pressures (or, perhaps, because of them) it is increasingly important that you allocate time and space for creative research. Pursuing interesting findings that emerge from data analysis; learning by playing, trying things out and making mistakes (then figuring out how to fix them) are all creative processes that can enhance and sustain your motivation and lead to exciting and unanticipated findings.

Time and space to think

Having time and space to think – either to focus on particular issues or just to let ideas gently develop in the back of your mind – is important for your creativity. Whilst you can dedicate time and space to processing ideas in your lab or office, thinking over problems and issues outside of your usual workspace can also be helpful in generating creative ideas.

Time and space to learn by experimentation

Having room to find out how things work by actually trying them out yourself, playing around with them and making (lots of) mistakes is also vital to your creativity as a researcher. Achieving this is easier if you are able to build time and space to explore ideas into your schedule. You will also need to draw on your sense of intellectual adventure and your confidence as an autonomous researcher to spend some of your time experimenting with ideas or solutions that might not generate anticipated results. This is an unavoidable aspect of creative research, but need not be viewed as a negative outcome. Trying things out is a valuable learning process, and discovering where your experiment went wrong can be as instructive as getting it right.

“I love going to the school and watching the kids... it’s the look on their face when you’re teaching them something and suddenly they understand it and it all makes sense and the whole world is right again and it’s great”.

Postdoc, Natural Sciences

Time and space to pursue interesting and unexpected leads

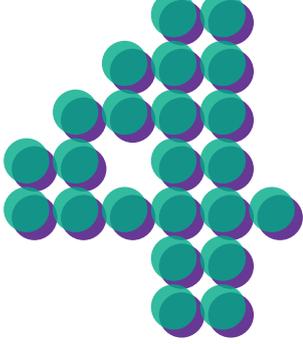
Researching creatively involves being attentive to interesting and unexpected findings which can emerge during experimentation or data analysis. These might be easy to overlook, particularly if they do not relate directly to the project that you are working on. But try not to feel absolutely constrained by your project brief – you may find that your PI is keen to pursue unanticipated outcomes.

How can I create more time and space to be creative?

Your PI is likely to influence the amount of time and space you are able to dedicate to doing creative research. If they are intellectually adventurous and tend to pursue interesting new findings and ideas, they are likely to see this as a fundamental part of the research process, and encourage you to do the same. If you are working in a group which is more process and results driven, then making time and space for creative research is less likely to be a consistent feature of your research processes. Regardless, there are some things that you can do make time and space for creative research.

NEGOTIATE TIME AND SPACE FOR CREATIVITY

- » Take the time to go for a walk in your local park, or in another setting you find inspiring. Exercise in the gym or the pool. This change of activity can help stimulate creative ideas.
- » It’s a good idea to always keep a notebook and pencil handy, so that you can jot ideas down when they arise – wherever you happen to be!
- » Try to manage your workload effectively. Keeping on top of a reasonable workload will demonstrate both your commitment to the project and your ability to manage your time effectively. Both of these will help convince your PI that spending more time pursuing new ideas is going to be beneficial, rather than detrimental, to their project.
- » Talk with your PI about the amount of time and space you currently have to work on creative ideas. If you feel it’s insufficient (or non-existent), try to negotiate more. You start by asking for time to try out an exciting new idea or approach.
- » Stay on the lookout for creative directions. If you find something new and potentially exciting which you think is worth pursuing, ask for support in doing this. Sometimes the potential rewards – exiting and unexpected research findings – are worth the calculated risk of deviating from budget and deadline. Always discuss what you learn from this type of work with your PI, regardless of the results.
- » Make it a policy to share the exciting parts of your research with your PI as well as the frustrating or problematic aspects. This is particularly important if your PI is process driven.



PART FOUR Developing and sustaining your personal creativity

Section three focussed on what you can do to enhance your research environment to make it more creativity-friendly. This section complements that with some tips and techniques you can use to enhance and sustain your personal creativity.

“Just be patient. I don’t think you have a choice there, it’s work that has to be done and I try to motivate myself by just saying ‘all right you will take a break after this’... or try to break the days into interesting and less interesting things so that I don’t have one boring procedure to do for the whole day”.

PhD, Medicine

Try to do research you find interesting

An underlying interest in your subject and a belief in its value can really boost your motivation. Not only does this impact on your creativity on good days, it can also help sustain you on those days when nothing goes according to plan.

Share your passion

Try communicating your science to a non-academic audience. You might find that talking about science to an enthusiastic audience boosts your own enthusiasm.

Manage your expectations

Any postdoc will tell you how wonderful it feels when things go well and how frustrated you can feel when they don’t. Being a creative STEM researcher means finding ways of dealing with this ebb and flow. Here are some tips:

- » Perfect is the enemy of good! Think about how you can develop strategies to combat perfectionism. This will help boost productivity and minimise frustration.
- » Look for strategies for getting through the boring bits (and there will be boring bits).

Conclusion

Achieving balance

This guide has described some things you, as a postdoc, can do to make your research a more creative process. Whilst your power to influence your environment may not be as great as you would like, it is worth remembering that even small changes can make a big difference, especially if you are able to involve your peers.

Every academic department, lab and research centre is different. Each constitutes a unique research environment, with its own individual culture. Some aspects of this culture will help you be creative. Others will make it more difficult. Your experience of research environments will also be influenced by the qualities and abilities you, as an individual, bring to your research. These, in turn, are likely to change over the course of your postdoc contract(s), as you learn new skills and techniques, grow in confidence, adopt more responsibility and attain greater independence as a researcher.

Because of this, there is no algorithm for doing consistently creative research. Making space for creativity is itself a creative task, one that is often achieved by striking a balance – sometimes known as a creative tension – between too little of a given factor and too much. The freedom to pursue ideas needs to be balanced by the structure of reasonable project targets and deadlines. Similarly, having unlimited time and space to try out new ideas would soon become as unproductive as working with insufficient resources.

In carrying out the research for this publication, time and again we observed that people who worked in creative environments were more likely to be motivated, enjoy their work, be invested in it, get on with their colleagues and feel good about their results than those who didn't. Therefore, it is worth assessing from time to time how effectively your research environment is supporting you in your drive to be a creative researcher. The evidence suggests that even simple adjustments could greatly improve your research experience, increasing your job satisfaction and enhancing your reputation and employability as a creative researcher.



Other good practice guides are available in this series:

Doing creative research

A good practice guide for postgraduate researchers in STEM disciplines

Encouraging creativity in PhD and postdoc researchers

A guide for supervisors and principal investigators

These resources may also be downloaded from:

www.vitae.ac.uk/database-of-resources