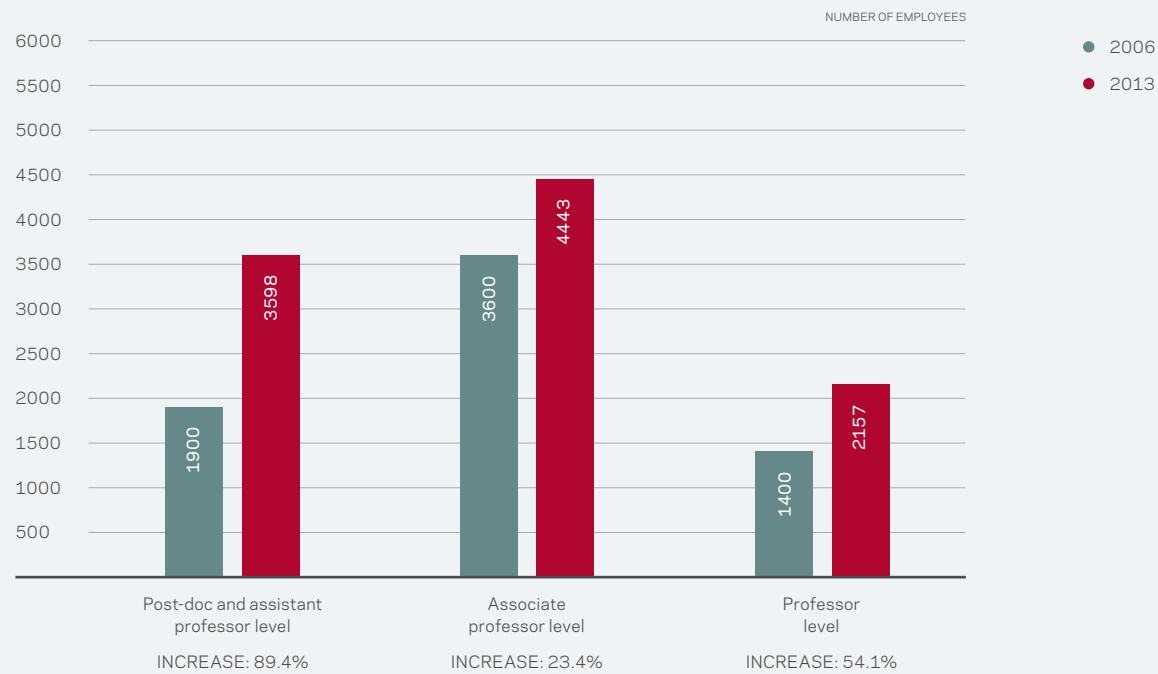


THE DANISH NATIONAL RESEARCH FOUNDATION THE POST-DOC CHALLENGE



THE POST-DOC CHALLENGE

FIGURE 1
EMPLOYEES AT DANISH UNIVERSITIES



Post-docs represent a massive talent pool that produces outstanding research, transfers expertise between laboratories, and promotes internationalization. They make breakthrough discoveries, and consequently, their work benefits their respective fields of research immensely. They also greatly benefit the more established researchers with whom and for whom they work.

At present, there is a growing mismatch between the number of permanent academic positions and the number of scientists applying for them, since the latter group is increasing globally. In Denmark, the number of people who entered Ph.D. training doubled over the years 2006-2010, and subsequently, the number of employees at the level of post-doc/assistant professor likewise nearly doubled in the period 2006 to 2013.

At the same time, and on a global scale, the number of permanent positions in academia in terms of associate professors and full professors has not increased at the same pace.

This has created the “post-doc challenge,” a global problem of disequilibrium between the supply of researchers and the number of permanent positions available in academia.

During 2014/2015 the DNRF chair, board members, and director addressed this challenging situation for post-docs at the annual follow-up meetings with the DNRF Centers of Excellence by talking to approximately 300 post-docs. Moreover, the DNRF conducted a written survey of 253 post-docs affiliated with DNRF Centers of Excellence between 2007 and 2014.

This little folder presents the DNRF’s preliminary results and its reflections on the post-doc challenge. It is a complex, difficult, and sensitive subject to address, a subject with inherent dilemmas and no easy solutions. Of course, the DNRF cannot solve this internationally acknowledged plight, but we can hopefully contribute our observations and participate in the ongoing debate.

International science is competitive – as it should be. Meritocracy is known to produce the best results, and we would never question that. Alas, there are damaging downsides to the very competitive research system, as debated lately internationally.

The goal should be to organize research more wisely so that, in the future, the organization improves life for individuals without damaging the pursuit of the best research. It is a delicate balance, and there are no straightforward solutions.

Post-docs experience publication pressure, career uncertainty, relatively poor pay, and frequent mobility requirements that coincide with the years of starting a family. Although opinions among key stakeholders vary, this can be viewed as an unavoidable side-effect of the quest for the very best research. But for all those in the research field, it is a warning signal if the competitive struggle has negative consequences for science:

- Do low success rates in the research funding system due to increased competition induce conservative thinking?
- Do burdensome publishing requirements put pressure on post-docs to rush into print, cut corners, and exaggerate findings?
- Do we have an increasing problem with published results that cannot be replicated?
- Is the consequence of the above a loss of public trust in research results and scientists?
- Are present hiring structures a hindrance to securing talent?
- Is our research system structured in a way that favors guaranteed results over potentially groundbreaking ideas?

WHY DOES THE DNRF CARE ABOUT POST-DOCS?

Building and retaining research talent is a critical issue for the DNRF because it is a crucial part of its overarching mission to advance excellent research.

Post-docs are highly valuable staff members, and the scientific results that benefit society as a whole rest to a high degree on their efforts. We know from several studies that most scientific breakthroughs arise from younger researchers' ideas and work.¹ Post-docs break new ground, they take the necessary risks to advance science, they invent innovative technology transfer, and they increase the internationalization of science.

For these reasons, post-docs constitute a continuous focal point for the DNRF. The foundation highly values post-docs, and a large part of DNRF grants goes into funding post-docs. Further, the Danish Council for Independent Research (DFF) funds approximately 300 post-docs annually, and the analysis *Evaluering af postdocfinansering i Det Frie Forskningsråd* concludes that post-docs funded by DFF out-perform the control group on key parameters, which confirms DFF's role as a key player in securing and supporting the best talents for Danish research.²

The DNRF together with other public and private foundations supporting post-docs are thereby involved, and we should take responsibility. Instead of increasing the pressure on the bottleneck, the DNRF encourages its centers to think about scientific mid-careers in new ways. The DNRF cannot solve the issue alone, but we will try to contribute to national and international solutions.

It is important to us that the challenges for post-docs are being debated internationally and that dignified, sustainable solutions are found that can be systematically implemented to get the best out of this huge talent pool for the benefit of our society and the individual post-doc. And we must do this without compromising the pursuit of the best research.

Hypercompetition: Consequences for science

Research is and should be competitive. However, the substantial increase in the number of Ph.D.s and post-docs in Denmark and internationally over the past 15 years has created an unsustainable, hypercompetitive system that can discourage even the most outstanding young researcher.

The damaging downsides of the low success rates for grant applications and permanent positions can cause a diminution in creative thinking and risk-taking. In other words, the current system may foster a tendency to go for guaranteed results rather than potentially groundbreaking ideas.³ Furthermore, excessive competition can promote academic dishonesty, including exaggeration of findings, optimistic data presentation, and a lack of reproducibility.⁴

Hypercompetition is a general problem in science, not an issue limited to post-docs. It is a serious problem if the research system has developed into a structure that might shape a less risk-taking, less creative mindset in younger researchers, a mindset that will follow them throughout their careers.

This goes directly against the DNRF's core values of supporting the unforeseeable cutting-edge research that contributes to delivering tomorrow's breakthrough, carried out in a way that maintains the integrity of both the research and the researcher.

¹ M. Packalen & J. Bhattacharya, Age and the trying out of new ideas, Preprint at <http://doi.org./z87> 2015

² Evaluering af postdocfinansering i Det Frie Forskningsråd, Styrelsen for Forskning og Innovation 2012

³ Alberts B, Kirschner MW, Tilghman S, et al.: Rescuing US biomedical research from its systemic flaws. Proc Natl Acad Sci USA. 2014

⁴ Lang JM: Cheating Lessons: Learning From Academic Dishonesty. Cambridge, Massachusetts: Harvard University Press. 2013

THE POST-DOC PARADOX

During meetings with approximately 300 post-docs at the DNRF Centers of Excellence, a recurring, somewhat paradoxical issue emerged: at least 90% of the post-docs at the DNRF Centers of Excellence want to stay in academia, preferably in permanent positions, despite knowing that the statistics are against them – in some fields only 10% get tenure. Although they know their endeavor to find a permanent position requires them to be absolutely top level, many post-docs find themselves to be unqualified for jobs outside academia.

This perception seems paradoxical. Are academic positions really so different from other jobs? Can most post-docs be eligible for permanent positions in the fiercely competitive environment at universities and, at the same time, unqualified for jobs outside academia? Are the shutters between academia and the outside world too tight? Or could it be that the reality of being a post-doc is too far from the definition of one?

What is a post-doc?

According to the National Science Foundation, “A postdoctoral scholar is an individual who has received a doctoral degree and is engaged in a temporary and defined period of mentored advanced training to enhance the professional skills and research independence needed to pursue his or her chosen career path.”

The article *Shaping the Future of Research: A Perspective from Junior Scientists* notes that many post-docs (in U.S. biomedical research) feel they are unaware of what jobs they are training for, let alone what skills those jobs require.¹ This is an observation the DNRF recognizes from meetings with DNRF-affiliated post-docs in all fields, especially when talking about jobs outside universities but, to a certain extent, about jobs at universities as well.

From what the DNRF has learned at its meetings with post-docs, the “mentored advanced training” is at best an iffy description and not systematically carried out. This does not correspond to the research system’s broadly declared goal to nourish and develop talent.

The post-doc proletariat

It is a further “post-doc paradox” that we have this massive talent pool, and at the same time, we are not systematically developing individual talent. This could partly be because the increasing number of post-docs has created a kind of post-doc proletariat – those who have had many post-doc positions and are less successful in research.

¹ Gary S. McDowell et al.: Shaping the Future of Research: A Perspective from Junior Scientists notes that many post-docs, F1000Research 2014

THE DNRF POST-DOC SURVEY 2015

The DNRF conducted a survey among 365 people who were post-docs in the period 2007-2014 at the DNRF's Centers of Excellence. The respondents came from 20 Centers of Excellence opened in the period from 2001 up to 2011 (in total, 57 centers opened during this period). The selected centers are representative with regard to scientific areas and host institutions. Out of the 365 recipients of the survey, 253 responded to the questionnaire (69% response rate).

FIGURE 2
DISTRIBUTION OF CITIZENSHIP
AMONG POST-DOCS

Distribution of citizenship among post-docs at Centers of Excellence. Citizens from 45 different countries are represented with Denmark accounting for 35%.

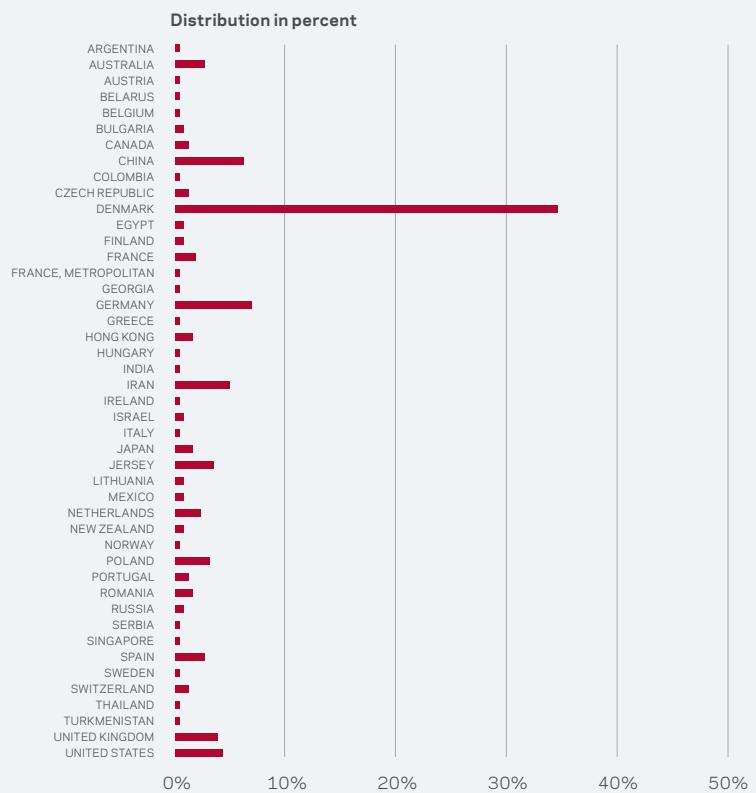


FIGURE 3
DISTRIBUTION OF CURRENT COUNTRY
OF RESIDENCE

Distribution of current country of residence for post-docs starting at a Center of Excellence in 2011 or before. Approximately 50% of these post-docs are still in Denmark. A significant number of foreign post-docs stay in Denmark.

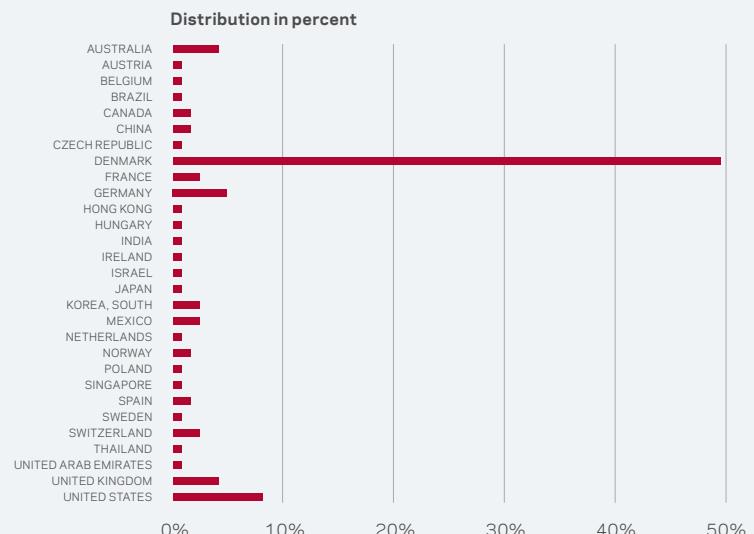


FIGURE 4
LEVELS OF SATISFACTION WITH AFFILIATION
AT CENTER OF EXCELLENCE

- Very satisfied
- Fairly satisfied
- Fairly unsatisfied
- Very unsatisfied

88% state that they were very satisfied or fairly satisfied with their overall experience at the Center of Excellence. In particular, the levels of satisfaction with regard to scientific/intellectual environment are very impressive. The only major exception is satisfaction in relation to job security/stability.

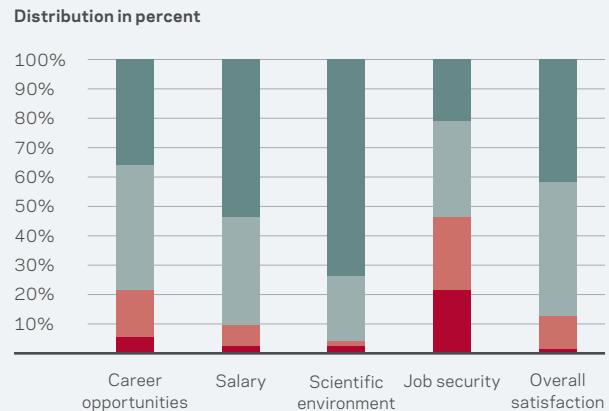


FIGURE 5
CURRENT SECTOR OF EMPLOYMENT AMONG
ALL RESPONDENTS

- Employed in university or other institute of higher education
- Employed in other sectors

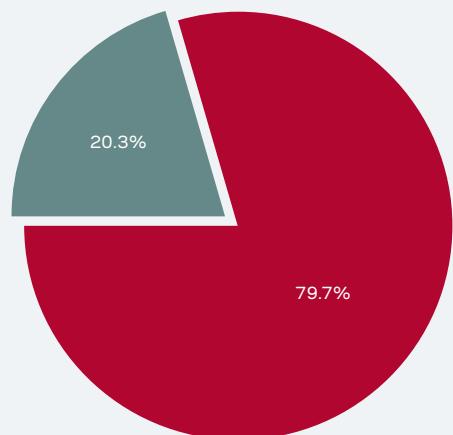


FIGURE 6
EXPOSURE TO MENTORING ACTIVITIES

- Not exposed to mentoring initiatives with people from outside academia during post-doc at Center of Excellence
- Exposed to mentoring initiatives with people from outside academia during post-doc at Center of Excellence

Few respondents have been exposed to mentoring activities with people from outside academia during their affiliation with the Center of Excellence.

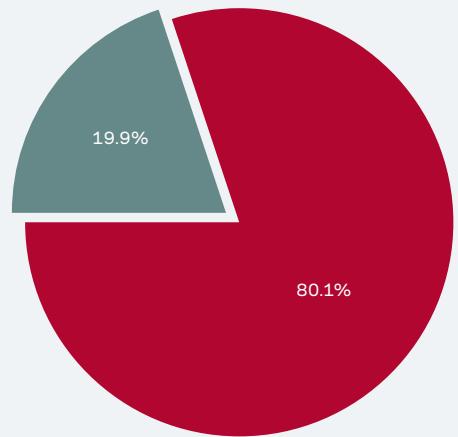


FIGURE 7
YEAR OF PH.D. DEGREE COMPARED
TO CURRENT SECTOR

- Employed in university or other institute of higher education
- Employed in other sectors

In the first 6 years after obtaining the Ph.D. degree, the candidates tend to stay in academia, and even after 8 years, a mere 40% are employed outside.

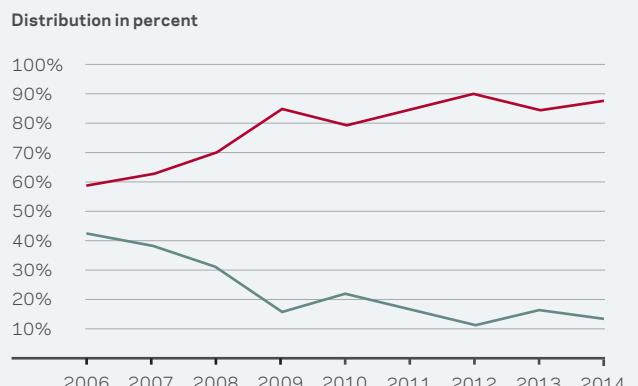


FIGURE 8
CURRENT POSITION FOR THOSE EMPLOYED IN UNIVERSITIES OR OTHER INSTITUTES OF HIGHER EDUCATION COMPARED TO YEAR OF PH.D. DEGREE

- Ph.D. degree awarded in 2006 or before
- Ph.D. degree awarded in 2007-2010
- Ph.D. degree awarded in 2011-2014

The longer respondents have held a Ph.D.-degree the more likely it is that they have senior positions in universities. However, among the respondents having received the Ph.D.-degree in 2006 or before 39 % are still post-docs or assist. professors.

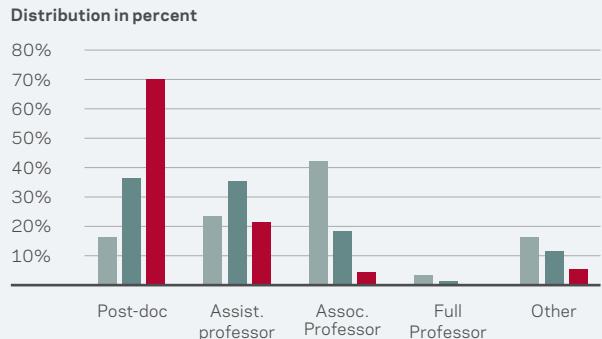


FIGURE 9
MOTIVES FOR TAKING CURRENT POSITION

- Very important
- Fairly important
- Fairly unimportant
- Very unimportant

Motives for taking current position for respondents both employed and not employed in universities or other institutes of higher education. It is remarkable how similar the motives are for the two groups.

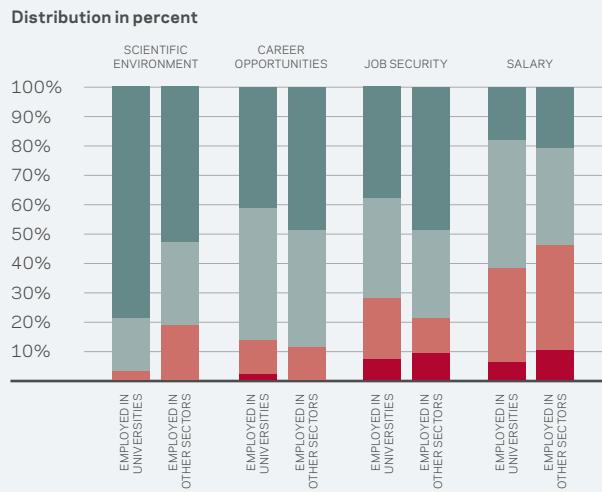
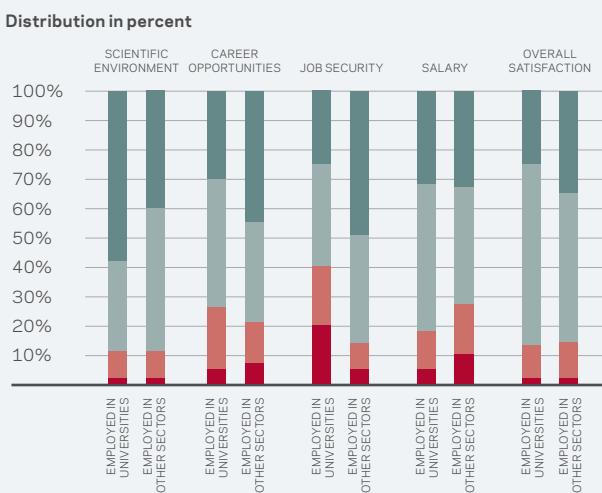


FIGURE 10
LEVELS OF SATISFACTION WITH CURRENT POSITION

- Very satisfied
- Fairly satisfied
- Fairly unsatisfied
- Very unsatisfied

Levels of satisfaction with current position for respondents both employed and not employed in universities or other institutes of higher education. The two groups have very similar levels of satisfaction, except for job security.



CONCLUSION OF SURVEY

- WHAT IS IT LIKE TO BE A POST-DOC AT A DNRF CENTER OF EXCELLENCE?

Generally, the CoE-affiliated post-docs find their jobs very satisfying. The centers are international hubs that attract talent from all over the world, and it seems that affiliation with the highly recognized DNRF centers leads to careers with a high degree of satisfaction with regard to scientific environment, salary, and career opportunities.

The vast majority of the 2015 generation of post-docs want to stay in academia, as stated at the site visits, and many of them feel they are unqualified for other jobs. The survey confirms this observation, as it shows that approximately half of the respondents answered that they consider the possibilities of getting jobs outside universities to be unlikely or very unlikely. Interestingly, the social scientists are the group with the highest degree of very likely or likely answers, and the humanities is the group with the lowest confidence about getting jobs outside academia.

Another interesting aspect revealed by the survey is that the level of satisfaction with respect to scientific environment, salary, and career opportunities is similar between those employed in universities and other institutes of higher education and those who work in other sectors. This is surprising considering that 90% of the 2015 post-docs are very eager to stay employed at universities, often with the argument that the scientific environment is highly stimulating there.

Unfortunately, the post-docs' career paths, job satisfaction, exposure to mentoring, and so forth are not being followed in Denmark, so we cannot know whether the CoE-affiliated post-docs are doing better than the average post-doc. CoE-affiliated post-docs are doing well, but we cannot get around the fact that more and more post-docs will have to find employment outside universities.



The development of original ideas that can potentially lead to scientific breakthroughs takes time – time for thinking, reading, and talking to peers. The support of highly skilled staff scientists who run the advanced labs and costly equipment could prove to be a strength that complements the scientists in a surprisingly efficient way.

POST-DOC DILEMMAS - "SUPER-DOCS" TO THE RESCUE?

Addressing “the post-doc challenge” raises a number of dilemmas. On the one hand, the high productivity of the large pool of young researchers in today’s post-doc system benefits the research field as a whole. On the other hand, the unsustainably low ratio of post-docs who will get the desired permanent positions may turn the large talent pool into a research proletariat, which is ethically questionable.

Then again, can we treat post-docs better or differently? Is such a large talent pool not necessary if we want to pick only the best? Maybe so. But we still need to



ask two questions: are we getting a good return on the massive investment involved in choosing a very few younger researchers who go on to permanent positions? And how do we get the best out of the remaining candidates?

We also need to ask ourselves whether we are confident that the current post-doc system ensures that the most talented researchers stay in research. What if those who stay and endure the publication pressure, career uncertainty, relatively poor pay, and frequent mobility requirements are the ones we just can't get rid of?

It should also be considered whether we generally should offer longer post-doc positions. It could well be that the post-docs who spend the longest consecutive periods in the same institution are those who do the most excellent research. On the other hand, what if the ones hired for relatively long periods turn out not to have the necessary talent after all?

Should we instead make a dramatic cut in the number of post-doc positions? New Zealand has tried this approach with discouraging results: the cut in numbers drained the country of its best Ph.D.s. The best ones went overseas for post-doc positions, and thus, the post-docs who used to fill the labs were replaced with less experienced researchers, creating extra work for the principal investigators in terms of management and mentoring.¹

Staff scientists - The “super-doc” position

One recurring suggestion to alleviate the challenges of the post-doc system is the creation of staff scientist positions. These would be adequately paid, permanent positions for talented post-docs who choose not to pursue PI positions.

Creating these positions implies a cut in post-doc positions and associate professorships. Over the past year, this suggestion and other ideas have been discussed at follow-up meetings, center leader meetings, and DNRF board and strategy meetings.

The results of the deliberations are presented on the following pages as comments and suggestions for change toward a sustainable and yet competitive research system. The comments and suggestions are divided into the different levels of the research funding system at which they are directed.

¹ Kendall Powell: The future of the post-doc: Nature News and Comment, April 2015

DIRECTED TO THE RESEARCH COMMUNITY AT LARGE

The Global Research Council

The challenges posed by the substantial increase in the number of post-docs need to be addressed globally. Addressing the challenges of the post-doc system and facilitating the implementation of change are obvious tasks for the Global Research Council (GRC). In the spring of 2015 at the GRC's annual meeting, the DNRF chair, Professor Liselotte Højgaard, raised the issue and found that the global research community agreed that the post-doc challenge needs to be addressed and remedied. But everyone acknowledged that there are no easy solutions. The DNRF has encouraged the GRC to initiate discussions of the definition of the post-doc position and communicate discipline-specific definitions to the research community at large to promote a common understanding of the position.

A common understanding of which skills a post-doc should acquire during the post-doc period would make it more feasible to implement the necessary framework to alleviate the challenges of the present system, e.g., by implementing systematic and focused mentoring.

The GRC should also lead initiatives to share experiences with staff scientists and to spread best practice examples, with a strong focus on maximizing the potential for wide-ranging scientific discovery and minimizing the loss of talented younger researchers in order to develop a global model for a division between post-docs and staff scientists.

Change the culture

Careers outside academia are still referred to as "alternative careers," and more often than not, the term "alternative" is not positive. Reasons for this could be the perception that those who leave academia are the ones who couldn't cut it. Another reason could be that research environments tend to become somewhat self-absorbed, which is understandable because they are preoccupied with competing for funds, publication pressure, administrative burdens, and competition from other research groups all over the world, and they are passionate about their specialized fields. It is often the case that these high-level curiosity driven science environments become the gold standard for younger researchers' career choices, when realistically their horizons could and should be much broader.

A change of culture could be brought about by abandoning terms like "alternative careers" or "non-academic careers" and instead call the careers what they are: careers in cultural, innovative, advisory, financial, and industrial positions. Another way to change the culture could be to systematically introduce younger researchers to role models with careers outside academia, a kind of non-academic mentoring alongside systematic academic mentoring. Only 20% of the post-docs in our survey have received such career advice. The first jump from the safe haven of a university to a job in another sector is the most difficult one, and mentors could do a lot to ease this difficulty. The research community at large can raise awareness of the importance of systematic mentoring, but the responsibility to implement it lies with the institutions responsible for talent development, e.g., universities.

DIRECTED TO UNIVERSITIES

Mobility requirements

The mobility requirements for post-docs in many cases often imply that they live as international nomads. It is worth remembering that although the international dimension is important when it comes to science and that young researchers gain a lot of experience from working in different research groups, these factors are not necessarily prerequisites for doing great research. Universities could consider offering more flexibility with respect to post-docs going abroad for extended periods. The funding bodies could offer more come-home grants to the most talented scientists, which will help with embedment.

Clear career paths

The disequilibrium between supply and demand makes the post-doc position an uncertain career path by definition. However, there are a number of things universities can do. First, the question of whether post-docs are going to stay in academia should be settled at an early stage. Second, many post-docs should be appointed for longer periods for a number of reasons. One reason is that the publication process is slow, and by the time the post-doc grant expires, the papers resulting from the research might not have been published yet, and thus the post-doc cannot cite the publication in the next grant proposal. Another reason for longer post-doc positions is that the post-docs should have time to teach because teaching promotes career opportunities.

Finding the time to do actual research, teach, publish papers, go abroad, and write grant proposals all within a one-year position is not likely to foster original and creative research, and DNRF center leaders have reported on post-docs who experience severe mental pressure in their positions.

The answer could be fewer and longer post-doc positions. This structural change could perhaps take the form of categorizing researchers into staff scientists and post-docs eligible for PI careers.

Mentoring

Mentoring is the buzzword of talent development in research. Yet when it comes to post-docs, it is surprisingly unclear what mentoring is, how mentoring should be implemented, and what the post-doc should gain from it. More often than not, post-doc mentoring is completely non-systematic.

Mentoring could be divided into scientific mentoring and career mentoring, including role models from industry and other job markets outside academia. Mentoring could also facilitate a link between academic and other types of jobs, making the transition more obvious and thereby broadening the post-doc's career horizons.

What can the individual PI do?

A number of DNRF center leaders have already launched initiatives for sharing experience between current post-docs and former post-docs who now have careers in cultural, innovative, advisory, and financial positions or research positions in industry. This is a very simple, concrete, and highly effective way to create closer ties between universities and the outside job market, and the potential of this approach could easily be expanded. These meetings help to open the post-docs' eyes to how their skills are attractive outside academia, and how the combination of strong basic knowledge, curiosity, and specialization can create value in industry.

DIRECTED TO POTENTIAL EMPLOYERS OUTSIDE ACADEMIA

As mentioned in the “Mentoring” paragraph in the previous section, mentoring facilitated by universities could include role models from other relevant sectors. This group could consist of former post-docs who have chosen to continue their careers in other sectors or potential employers from these sectors.

For mentoring to work as a way to break down the barriers to shifting from university careers to careers in the cultural, advisory, financial, or industrial sectors, potential employers outside universities must actively take part in various networking activities and career discussions with post-docs who are currently employed at universities.

This is already happening in some sectors, e.g., finance, medicine and technology, not necessarily on an institutional level, but rather on a smaller scale from person to person. Similar models could be used in other sectors as well.

“Although the large number of post-docs being trained currently poses a challenge to the academic community, we have to remember that they represent a vital brain-gain to society. Research leaders together with other stakeholders now have to focus more on career development for young scientists and expose them to the multitude of exciting jobs they are qualified for everywhere in our society to benefit from this opportunity.”

- Professor Søren-Peter Olesen, Director DNRF

DIRECTED TO THE INDIVIDUAL POST-DOC

Take charge

Changing the post-doc system at the levels of the global research community, universities, and legislature should go hand in hand with individual post-docs taking responsibility for their own careers.

When the odds of getting a permanent position in academia are one in ten, the individual post-doc should actively pursue opportunities outside academia. Post-docs should be aware of their own situations and ask for relevant mentoring. They should broaden their career horizon and look openly for inspiration as to how their talents can be used outside academia.

In other words, post-docs should actively address their career options and work to change the system they are part of – and the research system should listen to their advice. They know what they are talking about.

DIRECTED TO THE LEGISLATURE

Society should have a sound return on the large investment it makes in post-docs. These exceptional, highly skilled people should add value to both the academic and the other private and public sectors through their expertise in research, development, and leadership. This has historically been the case. The challenge is to continue this at a time when there has been a substantial increase in the number of post-docs.

Career tracking

An important starting point for the legislative system would be to start to systematically analyze the career paths of post-docs. Danish science policy has intensely focused on Ph.D.s; however, the DNRF would recommend that post-docs be analyzed carefully across time and institutions. It would be beneficial to know where post-docs go after a post-doctoral contract at a Danish institution expires. Do they continue in academia? Do they leave the country? Have they been exposed to the private Danish labor market?

Balanced funding system

Additionally, it is important that the legislative system strive to achieve a balance between funding instruments for researchers at various levels of their careers. The DNRF believes it is of key importance for the Danish system that grants be available for promising younger researchers. For the outstanding post-docs, these grants should be the stepping-stones to permanent or tenure track positions.

Stable financial framework

The DNRF believes that establishing clear and well-defined career paths is the responsibility of the research institutions. Nonetheless, the legislative system can support the institutions by ensuring a stable, long-term financial framework that makes it possible for the institutions to invest in career development in areas where there is a particular talent or need.

Global labor market

Finally, post-docs operate in a global labor market with high demands on mobility. This can have negative consequences at a personal level, e.g., in relation to starting a family and securing pensions across borders. The legislative system should continuously engage in easing the negative consequences of mobility, e.g., through the development of a common European Research Area, wherein European researchers cooperate across academic and national borders. The free movement of knowledge, people, and technology is the key to maximizing scientific discovery and minimizing the loss of talent.

NEXT STEPS FOR THE DNRF

Post-docs at the DNRF Centers of Excellence are very satisfied with the scientific environment, and they are doing well in their chosen careers. They contribute immensely to their respective research areas and society as a whole with their knowledge, international networking, and transfer of technology. They also contribute to a general "Bildung" of the public by their participation in a wide variety of outreach activities. In these ways, post-docs are the backbone of the DNRF Centers of Excellence.

The DNRF does not recommend dramatically cutting the number of post-docs, but instead, the foundation encourages a much more systematic development of their talent with mentoring initiatives, including networking activities with the cultural, advisory, financial, and industrial sectors. The DNRF also encourages the post-docs early in their careers to actively pursue career opportunities in various job markets.

The DNRF will follow career trajectories of the CoE-affiliated post-docs, and work at improving the way we collect data on this subject in order to learn more about the challenges and to be able to contribute to improving the situation based on our information.

The foundation will also encourage the DNRF center leaders to enter into annual career discussions with the post-docs, to care about post-docs' future positions, to initiate various networking activities with potential future post-doc employers, and to establish closer ties between potential job markets and university employees.

The DNRF will follow the situation and continue to engage with the post-docs, with our CoE leaders, and with Danish and key international stakeholders. The DNRF will also strive to improve the situation through dialogue. It will do all of these things with the aim of strengthening research and, at the same time, improving the future for bright young people.



Prof. Liselotte Højgaard, Chair,
and Prof. Søren-Peter Olesen, Director



Danish National Research Foundation
Holbergsgade 14, 1
DK-1057 Copenhagen K

T +45 3318 1954
F +45 3315 0626
E dg@dg.dk

www.dg.dk