BREAKTHROUGH RESEARCH: FUNDING OF HIGH-RISK RESEARCH AT THE ACADEMY OF FINLAND

Maunu Häyrynen 8 June 2007
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The term *high-risk research funding* has been hitherto used at the Academy of Finland to refer to funding for research that takes on extraordinary challenges and that promises significant, far-reaching results, but that also carries a high risk of failure. Rather than emphasising this aspect of risks and the possibility of failure, I prefer here to use the expression ***breakthrough research*** to refer to scientific research that may be regarded as scientifically innovative, that involves pronounced uncertainties and that has the potential for broad and far-reaching impacts (parallel concepts: frontier research; transformative research; high potential research).

Perceived *risk* is the subjective probability of an undesired state (Holton 2004). It is very difficult to find any objective criteria for the probability of achieving the objectives set for a research project; at least basic research is quite simply an inherently uncertain exercise. The subjective risks of research can be viewed and assessed from different perspectives, which means that they may be perceived differently by the researcher, reviewer, funding organisation and science community.

Novelty and originality are regarded as key values of science (Merton 1962; Popper 1992). Breakthrough research at the cutting edge of science or humanities stimulates and promotes the scientific evolution and guarantees the diversity that lies at its very foundation (Ziman 2000 & 1994). However, novelty and originality cannot be the sole scientific criteria for research; they are constrained by other scientific norms and established research traditions. It is thought that the intense competition for research funding leads to a situation where the most ambitious applications are rejected in peer reviewing precisely on grounds of their perceived risks (Becher 1989; Bourdieu 1988). Applicants may therefore be persuaded to take a more cautious approach, which translates into scientifically less innovative research (Elzinga 1997; Gulbrandsen 2000).

Funding models for breakthrough research

Internationally, funding organisations in the United States (National Science Board and Foundation: AC/GPA 2006 & 2005; NSB 2007; NSF 2006), the UK (Research Councils UK: RCUK 2006; HM Treasury 2006), Canada (Natural Sciences and Engineering Research Council: NSERC 2006 & 2002) and the European Union (ERC 2006 & 2007) are among those that have devoted special attention to breakthrough research. They have taken different approaches to the subject and opened different kinds of funding programmes for such ventures. The NSF has provided targeted research funding (*Special Grants for Exploratory Research*) for themes of acute interest, but also looked more broadly into different ways of funding high-risk or transformative research. The NSF funding model makes a distinction between encouraging general scientific innovativeness in basic research on the one hand, and sponsoring a selected number of scientifically innovative, risky and potentially rewarding projects on the other. Research Councils UK has suggested general science policy means for supporting high potential, high impact research, while the NSERC and other funding bodies have targeted funding for scientifically innovative research in specific areas.

All in all, the studied research funding bodies appear to have the following alternative operational approaches to breakthrough research:

Allocation: Breakthrough research is encouraged by the allocation of targeted or general programme funding to research issues of special current interest or to strategic priority areas. (NSF, NSERC, RCUK.)

Separate-lane system. Breakthrough research is processed separately from other research funding, applying a separate set of criteria that favours scientific innovation and tolerates risks (NSF).

Rewards system. Breakthrough research, including the projects that have failed to deliver, is given better recognition as a scientific merit and as a factor of scientific quality (RCUK).

Mainstreaming. The criteria for research funding are modified across the board so that they favour scientific innovativeness and are more tolerant of risks (ERC, RCUK).

Elements from all these four models have featured in the internal discussions that have been going on at the Academy. Prompted by an international evaluation commenting on its peer reviewing practice (Gibbons et al. 2004), the Academy management commissioned an internal audit that was to put the spotlight on practices of "high-risk research funding". The audit was based on interviews with Academy management and Board members. The funding model that received the most support was that of strategic allocation, whereas a working group on funding instruments took a different stance (*Tutkimusrahoitusinstrumenttien kehittäminen* 2005). The group recommended the mainstreaming option, to be complemented by the allocation of research funding. The comments by the working group on interdisciplinary research led by Professor Henrik Bruun (Bruun et al. 2005) with respect to the problems and opportunities of interdisciplinary research are largely applicable to breakthrough research as well.

An inquiry into breakthrough research at the Academy

In early 2006, I was commissioned by the Academy management to conduct an inquiry into breakthrough research, its characteristics, funding situation and funding criteria. This inquiry has involved discussions with senior management at the Academy, heads of Research Units and other key personnel. Furthermore, I held a round of discussions at all Research Units and Research Councils and reviewed the processing of applications for general research grants in 2005 together with the respective Research Councils in selected fields of research.

On the basis of my discussions it was clear that the problems surrounding breakthrough research were recognised, but there was an obvious need for greater conceptual clarity. Basic research was seen as an inherently risky exercise, but because of the overwhelming number of unfinanced proposals in respect to those financed (the 2005 ratio being 90%/10% of total applied funding), it was widely acknowledged that scientifically innovative projects involving risks could easily be sidelined. Since breakthrough research was seen as a problem primarily associated with basic research, there was a reluctance to target funding on grounds of strategic priorities or practical applicability. Opinions were divided on whether potential breakthrough research should be expected of young and inexperienced researchers or more senior scholars venturing into new areas. As far as funding was concerned, the scales usually tipped in favour of ordinary project funding, i.e. funding that is applied for through regular channels and granted for normal periods (up to 4 years in general research grants) and that does not involve extra reporting or monitoring measures. A separate instrument for funding breakthrough research was not deemed necessary, instead the broad

consensus preferred allocation or simply additional guidelines for reviewers in connection with normal rounds of evaluation.

Working closely with Council presenting officials, I reviewed the 2005 applications process of general research grants in order to identify projects that in the fields concerned might represent scientifically innovative approaches involving high risks. This review seemed to reveal potential breakthrough research in virtually all fields of research both amongst projects that had been funded and those that had been turned down. The overall number of proposals identified as potential breakthrough projects was comparatively small (20, n=209), and in some individual cases identification was unclear. However, a tenth of all proposals and a fifth of the projects receiving funding could be identified as breakthrough research using the "triple criteria" adopted from NSF (*innovation – risk –reward* in combination). Of identified breakthrough research proposals about half were funded, their likelihood to receive funding thus being much higher than that of an average proposal. Breakthrough research was funded in five of the eight fields under study.

The examination focused on two fields of research from each Council as follows:

- Biosciences and Environment: **biosciences/multidisciplinary** and Biosciences and Environment/Culture and Society **social and environmental research** (8+22)
- Health Research: **pharmacy** and **public health** (22+11)
- Culture and Society: **linguistics** and **media studies** (8+7)
- Natural Sciences and Engineering: **physics** and **information technology** (34+52)

The ratings for proposals identified as potential research projects were on a 1 to 5 scale within the range of 3–5 (average 4.0), the figures for those funded were within 4–5 (average 4.4). The total number of potential research proposals that were not funded was eleven, and their ratings ranged between 3–5 (average 3.6). Both scientific innovativeness and risks occurred differently in the specific context of each discipline. No breakthrough potential was detected among applications that received low ratings.

Funded potential breakthrough proposals stood out as high-quality research projects that were characterised by high scientific ambitions and conscious risk-taking to achieve them. On the basis of reviewer statements the applicants were more or less established, published and internationally recognised scholars, the applications were clear and well structured and the research environments and arrangements for researcher training of a high standard. The risks identified had to do with the challenging subject matters as such, method and data issues, the management of multidisciplinarity, the practical division of labour and management and/or difficulties with the practical application of the results.

Unfunded potential breakthrough proposals were a more heterogeneous group. While the reviewers took note of the special interest value of these applications, the research plans suffered from technical problems or methods and data shortcomings. The overall quality of applications was good and the applicants were considered competent. There was more variation in terms of the applicants' scientific merits, international contacts and arrangements for postgraduate training. Various kinds of specific risks were also involved.

The proportion of y*oung researchers* was not particularly salient among the applicants with potential breakthrough proposals. *Multidisciplinary* and *interdisciplinary* projects as well as projects within traditional disciplines featured among both funded and unfunded projects. There were no more than a couple of *applied* research projects, but a greater number of projects offering

potential for applications. There was a notable scarcity of *women* among potential breakthrough proposals.

Conclusions

The Board of the Academy ended up supporting breakthrough research by mainstreaming. However, for potential breakthrough proposals to receive due attention in the Academy's applications review and funding system further discussion about their role within different disciplines and different forms of funding will be needed. It is impossible to reliably predict whether a research project will lead to a major scientific breakthrough either on the basis of a research plan or on the basis of the field of research concerned. Thus the support of breakthrough research should not be confined to the strategic areas highlighted by foresight exercises and bibliometrics. Indeed the funding of breakthrough research is first and foremost based on *guaranteeing the diversity of research*, only realisable by relaxing the excessively tight reviewing criteria. This also requires a preparedness to endure a probable increase in the rate of failures.

Review practices

Scientific excellence and innovativeness are listed among the Academy's current criteria for reviewing applications, and applicants are specifically encouraged to take risks. The mainstreaming principle would, at a bare minimum, require the inclusion of potential breakthrough proposals under the criterion of scientific excellence and innovativeness by adding the element of risk. To ensure the effectivity of such a change, further guidelines will need to be developed for reviewers.

The review process is based upon the application's *adequate scientific quality*, which is assessed in terms of the applicant's qualifications, the clarity of the research plan, appropriate research environments and networks of contacts. However, the goal of ensuring diversity requires that the criteria for breakthrough research allow for greater flexibility with respect to the researcher's track record and the details of the research plan, and they should not give exclusive precedence to top-level research environments or priority areas of research.

The main emphasis in the assessment of proposed research projects should be placed upon the *exceptional scientific innovativeness of the research plan* and *conscious risk-taking* as assessed against the background of the relevant discipline or field of research. The model applied in the review process should guarantee that expertise in specific fields of research as well as multidisciplinary expertise is put to the best possible use as breakthrough research may represent either traditional disciplines and/or interdisciplinary research. The applicability of *portfolio management methods* (Gustafsson & Salo 2005) for purposes of balancing breakthrough research with other research policy issues is a possibility that warrants closer investigation.

Funding model

Given the Academy's commitment to increase funding for breakthrough research, an option for its operationalisation would be through *Council allocation of general research grants*. That would not tie down excessive resources and would allow for some flexibility in project identification and funding. Based on the experiences gained, it might then be possible to consider other funding models as well. In addition, it would be necessary to look into the viability of the internationally adopted funding models for breakthrough research. The funding made available for potential research projects should be long-term, comprehensive funding.

In *other forms of funding*, it might as well be possible to put added weight to breakthrough research and risk-taking. In the context of thematic research programmes this could mean supporting risk-taking in general or in specifically identified problem areas; in the case of postdoctoral researcher's

projects and Academy Research Fellows, encouraging junior researchers to take greater risks; and at Centres of Excellence, dedicating additional funding towards risky research topics.

Monitoring

New forms of project reporting and monitoring should be developed for projects that are funded as breakthrough research, since the progress and results of these projects may well be expected to have wider interest both from the point of view of research in general and the Academy's operation. Breakthrough research could serve as a testing ground for Academy-client interactivity, another area of development at the Academy. Failed projects that have received funding should be accepted as results and the reasons for these failures should be analysed in the same way as successful scientific breakthroughs. Ex-post assessments can only be conducted after a sufficient time lag, several years after completion of the project.

Communications

Apart from the availability of funding, the aptitude of researchers to take risks also depends on their career prospects and on the general climate of attitudes. In its communications the Academy should be prepared both to give exposure to scientific breakthroughs and to justify its decisions for funding projects that turn out to be failures. The Academy can encourage researchers to submit plans for high-risk breakthrough research in their applications not only by providing funding, but also by taking a public stance in favour of risk-taking in research and by reducing the stigma of failure.

1 MODERATE ENCOURAGEMENT

STRENGTHS	OPPORTUNITIES
- No new tasks for personnel - Established review practices - Based on current expertise	- Funding can be made available for viable projects with breakthrough potential - Minor Academy investment provides high-visibility encouragement for risk-taking by researchers
- No improvement necessarily achieved in the identification of breakthrough research - Funding for breakthrough research may be overtaken by other priorities	- Reform remains cosmetic - Finnish research loses diversity and capacity for regeneration
WEAKNESSES	THREATS

2 RADICAL RISK-TAKING

STRENGTHS	OPPORTUNITIES
- Separate assessment makes for easier identification and risk management of breakthrough research - New kinds of review practices are created - Unprejudiced funding for breakthrough research allows for their effective implementation	- Academy provides extensive and visible funding for scientifically innovative projects that lead to scientific breakthroughs - Academy generally assumes a more supportive stance towards scientific innovativeness and risk-taking - Researchers show more aptitude for risk-taking in their applications
- No unambiguous criteria exist for breakthrough research - Separate review and monitoring process is laborious & expensive, increases sporadic funding - Funding for breakthrough may attract weak applications	- Increased proportion of failures among funded projects - Increased criticism against Academy funding decisions - In spite of the investment researchers do not put forward proposals with breakthrough potential
WEAKNESSES	THREATS

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