SCIENTIFIC EXCELLENCE – HOW TO ACHIEVE AND MAINTAIN IT?

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OUTLINE OF THE TALK

1. Significant contributions to science
2. Evaluation of scientific excellence
3. Becoming top-level scientist
   - personal properties
   - environmental/system properties
4. How to stay at the top
   - scientist him/herself
   - environmental properties
5. NORDFORSK: funding and a scientist’s life course
6. Why is the US superior to the EU in science?
7. How to stop brain drain
8. How to develop excellence from a mediocre starting point
9. Scientific process and the origin of new ideas and inventions
   - mind map of scientist
   - nodes
   - origin of new ideas and inventions
   - map-activation level and vector facilitation
   - background factors affecting the mind map
10. How to prepare for an idea, theoretical solution, etc. top performance
SIGNIFICANT CONTRIBUTIONS TO SCIENCE

1. Original findings
2. Theoretical contributions
   - theories
   - interpretations (+ re-)
   - critical reviews of empirical studies
   - classifications / systematizations / ordering
3. Methodological contributions
   - techniques
   - devices
   - their combinations (e.g., TMS + EEG)
   - paradigms
   - signal-analysis methods
EVALUATION OF SCIENTIFIC EXCELLENCE

1. Articles in refereed international journals (one’s contribution to)
   - journal impact factor
2. International books
3. Citations
   - total number of citations
   - citations in a certain time period
   - H-index
4. Peer evaluation
5. Key-note addresses in major scientific congresses

6. Scientific acknowledgements (prizes, honorary doctorates, memberships in scientific academies, major international duties etc.)

7. External grant money obtained

8. Text-book citations and illustrations

9. Leader of centres of excellence in research and major international research consortia

10. Organizer of major international congresses and post-graduate/-doctoral training
LIMITATIONS OF CITATION ANALYSIS

- journals only (in the most accessible forms of citation information)
- depends on the year of publication
- depends on the total number of citations given in the field (extensiveness and publishing traditions of the field)

But very useful when:
- comparisons are made within-field
- number of citations are related to the general level of citation numbers in the field, permitting across-field comparisons
- used as a qualitative measure (content analysis of a sample of citations) also
BECOMING TOP-LEVEL SCIENTIST (NOT ALL NEEDED!)

Personal properties

- inborn talent
- determination (motivation, but directed to science, not just getting to the top): genuine interest, even passion
- ability to feel strong curiosity and inspiration
- ability to experience deep satisfaction in work ("flow") (e.g., "super gear" of writing)
- good education and training (guidance, mentors)
- good health and psychical / physical condition
- good communication / presentation skills
- "strategic eye" and problem sense
• high criteria (with ability to optimize perfectionism, however)
• self-discipline (both in work and rest: avoidance of burnout)
• ability to work hard and to recover
• persistence (to continue and finish)
• frustration tolerance
• ability to minimize distraction (good time management)
• field independence: courage to follow one’s own line and intuition
• self confidence, feeling of worthiness
• fear of failure not easily elicited nor does it act as an inhibiting agent
• personal suitability for group work (e.g., ability of making scientific friendships)
• leadership properties (in group work)
Environmental / system properties

- sufficient funding / sufficient time
- adequate infrastructure and facilities (depending on the field)
- presence of high-level research group (depending on the field)
- presence of critical mass
- presence of feedback circuits
- collaborative links (local, domestic, foreign)
- encouragement, rewards
• supportive human relationships
• effective, early enough recruitment system
  • risk must be accepted
  • evaluation on the basis of time and opportunity a person has had
  • experienced top-science evaluators
• rapidly responding feedback/reward mechanisms (on the basis of citations, publications, prizes
• acknowledgements from elsewhere, and peer evaluation rather than research plans)
• ability to respond strongly and rapidly when top performance is identified (decision of intense, long-time support, and top infrastructure etc.)
• present evaluation procedures need to be reconsidered and dramatically improved (site-visit type of evaluation and evaluator meeting; evaluation comparative)
HOW TO STAY AT THE TOP

Scientist him/herself

• continuous up-dating of knowledge and skills
• active maintenance of psychic and physical condition: rest and recreation (avoidance of burnout)
• strategic planning and the maintenance of focus in research and work life (time management)
• active maintenance of collaborative links at the different levels and scientific friendships
• frustration tolerance and persistence
• ability to educate/train younger scientists
• ability to maintain some of the best students (→ the two-seniors model)
• ability to attract good students and colleagues
• supportive human relations
The system

• rapidly responding feedback/reward mechanisms (on the basis of citations, publications, prizes
• acknowledgements from elsewhere, and peer evaluation rather than research plans)
• ability to continue strong support as long as world-top research performance is maintained (cf. Lasse Virén 1972)
• present evaluation procedures need to be reconsidered and dramatically improved (site-visit type of evaluation and evaluator meeting; evaluation comparative)

THE MAIN PART OF RESEARCH FUNDING SHOULD BE DIVIDED AT THE NATIONAL AND INTERNATIONAL LEVELS RATHER THAN WITHIN THE DIFFERENT UNIVERSITIES (VERY UNFORTUNATE INITIATIVE IN FINLAND)
Funding

Clustering of indicators

High

Level of Excellence

Low

In the making

Established and recognised

Seek money

Networks

Researcher training

NCoE

International publishing

Creative ideas, theses

Success as supervisor

Citations, impact

Keynotes, honorary posts

The Nobel Prize

Patents, products, social innovations

Level of risk

Clusters of instruments

Life course

www.nordforsk.org
WHY IS THE USA SUPERIOR TO THE EU IN SCIENCE?

1. Investments (including tax-free donations)
   - e.g., in 2006, Harvard got 460M€ as private donations and its funds 23 billion euros (6650 students) - Oxford: no donations; funds 5.4 billion euros (11200 students)

2. Top universities provide prerequisites for science (e.g., professor/student ratio; specialization of professor possible)

3. Competition between universities (very little state regulation) very heavy
   - can buy the best staff
4. Best students from all over the world (brain drain for Europe and elsewhere)
5. High incentives → deep gradients
6. No age, etc. discrimination
7. Generous grant system
8. U.S.-dominated scientific journals
9. Language advantage
10. Norm to work very hard
HOW TO STOP BRAIN DRAIN

• return support
• post-doc funding system
• long-term and permanent research positions
• salary increase (more competitive in comparison with alternatives)
• high incentives → deep gradients
HOW TO DEVELOP EXCELLENCE FROM A MEDIocre STARTING POINT

• recruit a top-level expert from elsewhere
• increase funding to an appropriate level
• send young promising students to leading departments and labs elsewhere (with return commitment, however)
• create a progress-evaluation system (explicit)
• create a feedback/reward system (explicit)
MIND MAP OF SCIENTIST

OWN FIELD

ADJACENT FIELD

---- SUBLIMINAL SEM. ACTIVATION
— ONGOING WORK, RECENT READING, CONGRESS ETC. (activation)
ZOOM IN --- NODE STRUCTURE FOR SCHIZOPHRENIA

GENETICS
- GEN. DET.
- GEN. DET.
- GEN. DET.

ENVIRONMENT
- FAMILY
- SCHOOL AND STUDIES

BIPOLAR DISEASE

FRONTAL CHANGE

HG VOL. LOSS

AUDIT. HALLUC.

MMN

COGN. + FUNCT. DECLINE

DRUGS

HOSPITALIZATION

AUTISM SPECTRUM
- AS-PERGER

GROUP

MRI
MIND MAP OF A SCIENTIST

• consists of field-specific and related information in latent but well-organized form
• develops as a function of different cognitive events (reading, scientific discussions etc.)
• nodes selectively activated and differentiated as a function of suitable stimulation
• activation/excitability state of each node is enhanced by its previous activations and decays with time
NODES

- central units of scientific information
- consist of field-specific and related information in latent but well-organized form
- correspond to major concepts, issues, or research subfields
- develop as a function of different cognitive events (reading, scientific discussions etc.)
- self-organized into a net structure according to inter-node semantic distances (modified by further information)
• nodes selectively activated and differentiated as a function of suitable stimulation
• have micro structures representing more detailed information (e.g., classifications, determinants, indices, scientists and groups involved)
• activation/excitability state of each node is enhanced by its previous activations and decays with time
• become progressively more differentiated:
  - with the progress of the research field (if the scientist can follow developments)
  - with the progress of the research work of the scientist him/herself
  - with new relevant information (e.g., reading, discussions, congresses)
  - during writing process
• connected with each other also through a network of specific subliminal associations (potential ideas; may also be activated in the form of intuitions)
ORIGIN OF IDEAS

• Often a novel association or an analogy applied to a novel context: e.g., activation of some of the existing subliminal associations (often preceded by an intuition)

Prerequisites and triggering events for activation of subliminal (or new) associations

1. Field activation high (specific and general)
2. The emergence of new related, or potentially related, nodes
3. Reorganization in the mind map triggered by a new, or deeper, way of understanding the problem
4. Specific key stimulation (comment, reading, discussion, colloquia, congresses, scientific visits)
5. Development of search attractors
   - created by emerging questions in mind or indirectly by regions of activation
   - incoming stimuli are automatically related to search attractors
   - may activate subliminal associations and create connections to nodes all over the map
BACKGROUND FACTORS AFFECTING MIND-MAP ACTIVATION LEVEL AND FACILITATION (besides flow of time)

• health and well-being
• stressors
• distraction
• fatigue and sleepiness
• drugs (alcohol, nicotine etc.)
TYPICAL PROFESSOR WORK LIFE (DISTRACTION)

MAP ACTIVATION

PRODUCTIVE PERIOD
- READING
- TRYING TO WRITE
- "WARM-UP"

OTHER DUTY WARM-UP

TIME

- ANALOGY TO PAPER MACHINE
HOW TO PREPARE FOR AN IDEA, THEORETICAL SOLUTION ETC.

• elaborate the problem or question as far as possible (the 1st step toward solution)
• consider what might be needed
• secure that you have all components at hand (e.g., modular information should be acquired and activated before the start)
• secure an uninterrupted period of time (duties away beforehand)
• secure the availability of important feedback sources during the process
• decide on deadlines (midway etc.) but on a realistic basis
• decide on the reward system beforehand
• thereafter, raise the relevant-part map activation at a rapid rate as high as possible (here avoid any breaks if you can)
• try to choose the most useful search attractors (“regions of interest”)
• maximize chances of encountering a key stimulus while the relevant map activation is at top
• work very hard, however avoiding exhaustion

HIGH (RELEVANT) MAP ACTIVATION + KEY STIMULUS → IDEA