THE POLICY SCIENCES CENTER, INC.

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February 27, 2012

Dr. Hunter R. Rawlings III - President
Association of American Universities
1200 New York Ave., NW
Washington, D.C. 20005

Dear Dr. Rawlings:

I write to bring to your attention changes at the National Science Foundation, made during the Republican era, that are coming to light. You and most of your members probably believe (as do most scientists) that NSF grants are decided by the independent, peer-review process. This is incorrect. The Republican-era National Science Board changed the rules so that the independent peer-reviews of scientists at our nation's research universities have been "advisory only." These changes are documented and discussed in the enclosed overview for the American Psychological Association's Ethics Office and legal counsel and Congressional testimony by NSF's Deputy Director.

- NSF appears to have accommodated to Republican-perceived threats that peer-reviewed social science would produce ideas and evidence causing social disruption, political challenge, and supporting liberal activist agendas. The changed rules appear to be partly responsible for the induced stagnation and irrelevance of NSF programs in the social, behavioral, and economic sciences (SBE) on our campuses. The effect has been to curtail the civic role of our research universities.

Suppressing Neuroscience: A Current Example

A current example, discussed in the enclosed background material, is the new neuroscience paradigm. Emerging evidence suggests a **Primate Subordination Syndrome** that curtails motivation, induces endocrine and health changes, and affects other brain functions. The new paradigm suggests unrecognized causes of societal problems in lower status populations (including effects of racism). I attended a meeting with the current NSF Assistant Director-SBE [a holdover appointment by the last Republican-era NSF Director] in which he aggressively rejected the new line of research on the grounds that "the National Science Foundation does not study racism!" His declaration was startling: such NSF policies to circumscribe university research never been disclosed in writing. They are not public knowledge (and they appear to exceed NSF's legitimate authority and role in our system of government). Further evidence has come to light in the case of Dr. David Winter (also discussed in my

letter), one of our most distinguished psychologists: I know him and believe him to be an honest man. The case involves illegal government (apparently, NSF) intimidation of the University of Michigan. The University of Michigan - rather than courageously standing up to bullying (as the President of Harvard did against Senator Joseph McCarthy in the1950s) - capitulated and rather dishonorably pressured its own faculty not to seek data that could reveal racial differences and be cited by activists in public discussions.

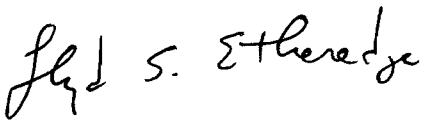
Public Policy: Making the Case for Thinking and Evidence

As background, I enclose a copy of a recent letter to Prof. Sapolsky at Stanford concerning the **Primate Subordination Syndrome**. Also, a review article from **Science** related to this paradigm shift in how we think about problems of social, economic, and political participation, health, and K-12 STEM educational attainment in lower status populations.

- Beyond emphasizing the exciting transformational potential and human benefit of this paradigm shift, may I also draw to your attention that the new paradigm implies the Republican theory of the Nanny/welfare state, and dependency as a cause of these problems, repeated loudly for several decades, may be a painful misinterpretation? [1]

This problem is bigger and more tangled than my foundation project can solve. Thus, I write to bring it to your attention.

Yours truly,



Dr. Lloyd S. Etheredge - Director
Government Learning Project

cc: Presidents Mary Sue Coleman - Chair (Michigan), Scott Cowen - Vice Chair (Tulane), Jared Cohon (Carnegie Mellon), Robert Birgenaeu (Berkeley), Gene Block (UCLA), Ronald Daniels (Johns Hopkins), Amy Gutmann (Pennsylvania), Richard McCormick (Rutgers), Mark Nordenberg (Pittsburgh), Ruth Simmons (Brown), Richard Levin (Yale), Susan Hockfield (MIT)

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[1] You may want to make an independent evaluation of the problem. In this perspective, Republican arguments about "racism" might be a diversion.

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February 13, 2012

Dr. Robert M. Sapolsky
Department of Biology
Stanford University - Gilbert Hall
Stanford, CA 94305-5020

Re: **Primate Subordination Syndrome**

Dear Dr. Sapolsky:

An extension of your research could produce a breakthrough in our thinking about important social problems. I am writing to ask if you might be interested to explore this possibility? I was a Fellow at CASBS in the late 1980s and they have asked if I have new (especially, breakthrough) projects to propose. If you are interested, I would like to meet and explore how a wider project through CASBS might allow us to move rapidly to develop these applications of neuroscience.

Here is a possible breakthrough that I see:

Neuroscience and a Potential Breakthrough: Connecting the Dots

Your 2005 Science review article, "The Influence of Social Hierarchy on Primate Health," seems to suggest that the brains of humans, and other primates, are hardwired for a similar subordination/ followership syndrome with shared motivational, behavioral, postural, endocrine and (perhaps) stress and health effects. I have been working, as a political scientist and psychologist, from the idea that such power-related effects can be produced by hierarchical psychodramas - i.e., engaged and sustained via the visual cortex:

If so, hierarchical psychodramas might be inducing this syndrome - and keeping it engaged - in susceptible human populations in America. The activation of these brain mechanisms could be an unrecognized explanation of resistant societal problems being expressed in the limitations of self-starting motivation, health effects, more difficult educational attainment, and the reduced social, political and economic participation in lower status populations

The "Nanny Government" v. the Primate Subordination Syndrome

By contrast, as you will recognize, Republican ideologues have, for many decades, argued that the behavioral effects in lower status populations arise from a Nanny government and dependency induced by the misguided generosity of a welfare state. If - instead - the causal mechanisms are lower status and the **Primate Subordination Syndrome** (PSS) (including unrecognized and continuing effects of racism and discrimination), this discovery can activate fresh thinking and rapid learning about how to address these societal problems. A basic set of lectures concerning neuropsychology and several months of gentle imagination and other exercises designed by clinical psychologists and neuroscientists could weaken the hold of these primitive mechanisms and provide breakthroughs to help many people.

Testing a Network of Hypotheses

A range of suggestive hypotheses and predictions might develop this new application of neuroscience research. For example, 1.) strong hierarchical psychodramas involving a personal relationship with a loving God could - for example in the case of a Jewish population - offer immunity from the adverse effects of these secular psychodramas even when members in the group are in lower status positions as defined by their society. And, 2.) I suspect that the inhibitions of self-starting motivation and higher cognitive processes are genuine: thus these induced psychological mechanisms of a Primate Subordination Syndrome may further increase stress and adverse health effects in a highly individualist society, like America, where individuals of lower status have an even greater requirement for self-starting motivation and thinking to cope with their objective circumstances

Also: 3.) At a much earlier stage of my thinking about power relationships, I corresponded with the late Ernest Hilgard about imagination and suggestibility: I recall that he developed an individual-difference theory and scale of imagination and suggestibility that might refine our understanding of the linking role of the visual cortex in the Primate Subordination Syndrome. There also may be correlations with field dependence as a personality trait/cognitive style.

Would you be interested to meet, later this spring, to exchange ideas about how a research program might be organized and the possibility that it could move quickly with an initial location at Stanford and CASBS? I can be contacted in the Washington, DC area at 301-365-5241 or by email at lloyd.etheredge@policyscience.net.

Yours truly,

Lloyd S. Etheredge

Dr. Lloyd S. Etheredge, Director
Government Learning Project

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December 13, 2011

Dr. Linda M. Forrest, Chair
APA Ethics Committee
750 First Ave., NE
Washington, DC 20002-4242

CONFIDENTIAL

Dear Dr. Forrest:

I write, as an APA member, to ask the help of your Committee to investigate and remove unexpected restrictions imposed by the National Science Foundation on studies of racism and the effects of racism. My request also is in support of President Vasquez's Presidential Initiative to accelerate national learning concerning racism and educational disparities.

This letter is based on two data points, my own experience and an earlier case involving the psychologist David Winter at the University of Michigan. If your investigation warrants, I hope that you will recommend a public censure to hold NSF and the National Science Board to account for a history of undisclosed and scientifically illegitimate censorship of research.

Overview

I became aware of NSF's restrictions during a meeting with NSF's Assistant Director for the Social, Behavioral, and Economic (SBE) Sciences. The purpose of the meeting was to brief him about exciting opportunities for rapid learning. One of the promising ideas is the hierarchical psychodrama paradigm emerging from neuroscience and primate studies. There is suggestive evidence that systems of hierarchical status activate unrecognized brain mechanisms in individuals of lower status that inhibit motivation, affect the endocrine system, and may inhibit abstract reasoning. This interdisciplinary paradigm could provide breakthroughs to understand and help to address resistant societal problems of economic, social, and political participation and inhibited K-12 STEM education in affected populations.[1]

Unexpectedly, the NSF Assistant Director interrupted and declared bluntly: "This is the National Science Foundation! The National Science Foundation does not study [the effects of] racism!" I was stunned by the intervention: After the meeting, I immediately wrote a letter to NSF to document the discussion and question the legitimacy of its rule. I also wrote (on March 19, 2011, enclosed) to NSF Director Suresh and Dr. Bowen, Chair of the National Science Board, to ask that their rule be reviewed, disclosed, and withdrawn as part of a mandated Congressional review of NSF's Merit Review system. [NSF provides 55%+ of the funding for social sciences at our universities. NSF appears to have egregiously exceeded its legal authority and national role by undisclosed government rules that change the civic role of our universities and limit our ability for rapid learning about these social problems.]

NSF's New Powers

In its recent Congressional testimony NSF did not discuss or withdraw its rule. However testimony by NSF's Deputy Director, Cora Marrett's (enclosed), confirmed that NSF's traditional system of peer-review has been replaced by a new management framework that gives decision making authority for all grants and initiatives to herself and her subordinates and that treats external, peer reviews as "advisory only": *"[I]n contrast to a number of other funding bodies, the external reviewers do not make binding recommendations that the program officer is obliged to follow . . . NSF has chosen to give the program officer the responsibility for making funding recommendations . . ." (p. 3)*

The Bush-era National Science Board reconstituted Program Officers and NSF's senior officials with the authority, and accountability, for the contours and results of their national research "portfolios." In addition to rejecting proposals that do not fit with their visions, they may make competitive and final rankings by their definitions of societal benefit, scientific innovation, geographic equity, and other criteria.[2] Dr. Marrett's discussion also locates the policy and final grant decision rules and processes by herself and her subordinates within the protection of NSF's self-created rules of administrative secrecy - although she claims (somewhat disingenuously) that "NSF is continuously striving to maintain and improve the . . . transparency of the process." (p. 1).

Establishing the Battle Lines

Dr. Marrett's testimony has clarified national misperceptions, established the boundaries of what she will not discuss, and the battle lines. Before her disclosures most scientists probably trusted that NSF decisions were determined by scientific merit and a peer-review process that is guaranteed by a network of safeguards and above reproach. Dr.Marrett's disclosures put the ball into APA's court: There is no longer a "right" to peer-reviewed outcomes. Thus, if psychologists want: 1.) to study racism and the effects of racism, or test the new predictions of the hierarchical psychodrama paradigm;

and/or 2.) to have government scientific restrictions imposed only after full public disclosure and democratic decision making that allows vigorous debate, APA will have to fight for our rights.

The issues are both legal and ethical: NSF must operate in a way that is legitimate and ethical in the eyes of the scientific community. When NSF does not honor the ethical sensibility of scientists, NSF must change.

- I am stunned by these policies and rules:[3] 1.) Since Runnymede the common law guarantee of peer reviewed juries has been defined by the right to an independent judgment that excludes the political process and a government's officials and their appointees; 2.) The study of racism and the effects of discrimination have been a legitimate scientific concern of psychologists since The Authoritarian Personality and the social science that informed the 1954 Supreme Court decision in Brown v. Board of Education; 3.) NSF is not being responsive to what psychologists want to study and contributions they want to make. APA Presidents have supported this kind of research as Presidential Initiatives: Dr. Vasquez has made it an APA Presidential Initiative (discussed in her message on the APA Website) to address the "grand challenge" of "racism and educational disparities." [4]

Next Steps: Furthering the Process of Disclosure and Policy Change?

I hope that your Committee can help to achieve full disclosure and informed consent. NSF - including psychologists on the National Science Board and NSF advisory committees and employed by NSF - has an obligation to make a full, candid, and specific disclosure of its rules so that scientists, as scientists and citizens, can criticize these rules and restrictions on our profession and the civic role of universities. And have a well-informed basis to pursue our rights to change hateful policies. In your investigation, I hope that you can secure full disclosure about why NSF is imposing these rules? For example:

1.) A friend of mine, a clinical psychologist, opposes studies of racism and its effects on therapeutic and policy grounds. She believes that such studies encourage a psychology of victimhood. Is this NSF's justification?[5]

2.) Another possible explanation is the "culture war" by core Republican zealots to defund the Left and neutralize campus activism and any social science that could be socially disruptive or politically challenging. [Some NSF accommodations appear to have begun in the Reagan years, when projects in the spirit of the late Donald Campbell, for rapid national learning to test Republican ideological assumptions and their economic policies as experiments, were derailed at NSF.] Is NSF - although it is supposed to be an independent agency - rationalizing a lack of political courage and merely deciding,

as a bureaucracy, to restrict psychological research to avoid battles that it does not want to have?

3.) A third possibility is that the NSF rule is a legacy from an earlier era. President Nixon's domestic policy adviser, Daniel Patrick Moynihan, famously recommended "benign neglect" about racism. Did this create NSF's policy? If so, it is overdue for review because this restrictive policy was issued in the context of violent riots in major cities: Today, even NSF's Director, Deputy Director and Assistant Director (SBE) may not know where the rule came from, who approved it, and whether Congress knows about it. In a 21st century America, with a Black President, it simply may be an outdated rule that lives in the NSF culture, with a life of its own.

4.) It would be helpful to understand how long this racism rule has existed, how it has been interpreted and applied, and how much damage has been done. Concerning this historical issue, there are two data points: I enclose a letter about the David Winter ethics case at the University of Michigan (written on October 1, 2011 to NSF's social science advisory committee). In this earlier Republican-era ethics case at the University of Michigan, its Administration claimed that it was credibly threatened by federal scientific agencies and, thus, it removed research by one of our most distinguished psychologists, David Winter, from a larger institutional application.[6]

Thank you for your attention to these issues. If I can be of further assistance, please call me at 301-365-5241.

Yours truly,

Lloyd S. Etheredge

Dr. Lloyd S. Etheredge, Director
Government Learning Project

cc: President Melba Vasquez; Dr. Norman Anderson

Enclosures: Testimony of Dr. Cora Marrett to the U. S. House of Representatives Committee on Science, Space and Technology. Subcommittee on Research and Science Education. (July 26, 2011).
Letter to Dr. Suresh and Dr. Bowen (March 19, 2011).
Letter to Dr. Saxenian et al. re "Reparations for David Winter" (October 1, 2011)

Notes

1. The new neuroscience paradigm and the potential for breakthroughs are outlined in a letter of January 2010 to the President's Council of Advisers on Science and Technology (PCAST) in a Recapitalization discussion. A copy is available online at www.policyscience.net at II. A.

The links to hierarchical psychodrama syndromes studied in clinical psychology and political ideology are discussed in my "Wisdom in Public Policy" chapter in Robert Sternberg and Jennifer Jordan (Eds.), A Handbook of Wisdom: Psychological Perspectives (NY: Cambridge University Press, 2005), pp. 297-328 at pp. 312-314. Further discussion of ideology and clinical psychology links are presented in working papers online at www.policyscience.net.

2. I have seen no evidence that NSF's Assistant Director (SBE) disputes that his meeting took place and that he is being accurately quoted.

3. The NSF bureaucracy has gone much further than the NIH system. NIH uses a Common Fund for initiatives by its Director but it preserves for the nation's biomedical researchers the substantial core of a competitive, peer-reviewed grants for investigator-initiated proposals.

4. There is an unhealthy degree of narcissism in NSF's rules. Hierarchical psychology, ethnic prejudice, and discrimination are ubiquitous in the world beyond the water's edge. Humankind (and American foreign policy, in the case of the Arab Spring) can benefit from discoveries made by American psychologists with NSF support. It is offensive and short-sighted for NSF to think only of US-based societal and political processes when making its rules.

5. Whatever views one holds about this question, I think it is unconstitutional for NSF to adopt rules on this basis. The objections cannot be the publication of coefficients in scientific journals. The objections are to (subsequent) *public speech and persuasion* and this kind of unwanted behavior, in our democracy, is unconstitutional for the government to use as a basis for policy.

6. The case also is scary because under the new NSF regime (as discussed by Dr. Marrett) the final decisions on all grants and lines of investigation are made by NSF officials who (now) know the identities of the institutions and individuals involved. Thus any criticism of the NSF hierarchy by the University of Michigan - or, today, by APA - runs the risk of being ineffective and of future penalties by the NSF officials who are criticized and publicly embarrassed. No federal agency should have a design that can engage such apprehensions and inhibit legitimate criticism.

Testimony of

Dr. Cora Marrett, Deputy Director
National Science Foundation

Before the

U.S. House of Representatives
Committee on Science, Space, Technology
Subcommittee on Research and Science Education

The Merit Review Process:
Ensuring Limited Federal Resources are Invested in the Best Science

July 26, 2011

Chairman Brooks, Ranking Member Lipinski, and distinguished Members of the Subcommittee, thank you for inviting me to participate in this hearing on "The Merit Review Process."

I am delighted to discuss the National Science Foundation's (NSF) Merit Review Process with you. As you well know, NSF is the primary Federal agency supporting research at the frontiers of knowledge, across all fields of science and engineering (S&E) and all levels of S&E education. Its mission, vision and goals are designed to maintain and strengthen the vitality of the U.S. science and engineering enterprise. As part of the overall national R&D enterprise, the basic research and education activities supported by NSF are vital to the economic advancement of the U.S. and provide the know-how that allows the U.S. to respond rapidly and effectively to a range of unexpected challenges. The NSF merit review process lies at the heart of the agency's strategy for accomplishing its overall mission. As such, NSF is continuously striving to maintain and improve the quality and transparency of the process.

Before I begin my discussion of the unique elements of the NSF merit review system, let me first describe the essential features of merit review writ large. In general, merit review refers to an independent assessment of a plan's worthiness. The Code of Federal Regulations (Section 600.13 of title 10) defines Merit Review as a "thorough, consistent and objective examination of applications based on pre-established criteria by persons who are independent of those individuals submitting the applications and who are knowledgeable in the field of endeavor for which support is requested."

I would also like to note here that although the terms "merit review" and "peer review" are often used interchangeably, they are not equivalent terms. NSF made this distinction clear back in 1986, based on a report from an external Advisory Committee on Merit Review, established by then-director Erich Bloch at the request of the National Science Board. As is described by Marc Rothenberg, the NSF historian, in his 2010 article "Making Judgments about Grant Proposals: A Brief History of the Merit Review Criteria at the National Science Foundation:"

> "According to the committee, the term 'peer review' was properly a restrictive term referring to the evaluation of the technical aspect of the proposal. However, for more and more federally funded research, 'technical excellence' was, in the words of the committee, 'a necessary but not fully sufficient criterion for research funding.' Acknowledging that the NSF (as well as other federal agencies) was using a wide range of nontechnical criteria as part of the decision-making process, the committee suggested that the term 'merit review' more accurately described the NSF selection process."

The committee's recommendation was accepted by Director Bloch, and since then NSF has used the term "merit review" to describe our process.

Since its founding, NSF has relied on the merit review process to allocate the vast majority of its funding. As in other agencies, this has involved the use of proposals from prospective researchers that are judged on their merits by knowledgeable persons. But there are several elements that give merit review at the NSF its distinct features. For one, right from the beginning, NSF utilized the project grant mechanism (as opposed to a contract mechanism) for providing funds. This was a rather radical concept back in 1951, when most government operations used contracts. Since that time, the use of the grant mechanism has been adopted by many federal extramural research funding organizations.

NSF's process for deciding which proposals to fund differs from the approach of a number of other funding agencies and organizations (such as philanthropic foundations) nationally and internationally. Perhaps the most distinctive differences are our reliance on expertise from

both outside and within the Foundation, and the discretionary authority vested in the NSF program officer to make funding recommendations. Unlike many philanthropic foundations (and even some federal research funding programs), NSF policy requires that the program officers seek external expert advice before making most of their funding recommendations. However, in contrast to a number of other funding bodies, the external reviewers do not make binding recommendations that the program officer is obliged to follow, although program officers always pay close attention to all external reviews. Because of the responsibility we give our program officers, NSF sets a high standard for excellence in that position. Our program officers are subject matter experts in the scientific areas that they manage, and bring strong credentials with them, including advanced educational training (e.g., a Ph.D. or equivalent credentials) in science or engineering, and deep experience in research, education, and/or administration.

NSF has chosen to give the program officer the responsibility for making funding recommendations to enable a more strategic and long-term approach for building the award portfolio. As important as the input of the external scientific experts is, they have only a snapshot view of the current set of proposals they are evaluating. The NSF program officer is responsible for putting that snapshot view into the larger context of the entire award portfolio they are managing, which can lead to a more diverse and robust portfolio overall. Together with the division directors, who have the authority to review and act on the program officers' recommendations, program officer teams are poised to identify promising research that responds to national priorities identified by Congress and the Administration. In addition, program officers can incorporate agency or programmatic priorities, which are articulated in the annual agency budget, special solicitations, and standing program descriptions, all of which are available to the community via the NSF web site.

The NSF merit review process is described in full detail on the NSF web site (http://www.nsf.gov/bfa/dias/policy/meritreview/). There is also a summary of the major steps in the merit review process in the annual Report to the National Science Board on the Merit Review Process (the most recent report covering activities in FY 2010 can be found at http://www.nsf.gov/nsb/publications/2011/nsb1141.pdf). It is worth noting here that the key features of the NSF process have remained remarkably stable over time. Any changes that have been incorporated have sought primarily to clarify the process and make it more transparent. For example, initially only excerpts of the external reviews were shared with the proposal authors. Over time, NSF provided the verbatim reviews (but not the identities of the reviewers) to the applicant. Similarly, over time there have been modifications to the number and clarity of the review criteria. In the America COMPETES Reauthorization Act, the broader impacts criterion is specifically mentioned, and the National Science Board is in the process of analyzing the many comments received on this topic.

A flowchart that graphically depicts the major steps in the merit review process and a timeline is attached to this testimony as Appendix I. These steps include:

- *Assignment to the appropriate program for review.* Principal investigators initiate this process by selecting the program or programs to which they wish to submit their proposal. Once submitted, the cognizant program officers for those programs confirm that the assignment is appropriate. On occasion, a proposal may be reassigned to another program where there is a better fit. During this initial assignment process, it is not uncommon for proposals to be assigned to multiple programs for review, if the subject is interdisciplinary in nature, or if the question is of interest and relevance to more than one program.

- *Administrative review of all proposals for compliance with NSF regulations.* These regulations, which are intended to ensure fairness in the review process, are described in the Grant Proposal Guide, which is widely available to the NSF community on the NSF web site (http://www.nsf.gov/pubs/policydocs/pappguide/nsf11001/nsf11_1.pdf). Proposals that do not comply with these regulations may be returned without review.

- *Merit review of all proposals that pass the administrative review.* As noted above, a critical feature of NSF's process is the use of both external review by experts in the field and internal review by NSF's corps of program officers. The program officers are responsible for administering the merit review process from beginning to end, starting with identifying and recruiting appropriate peer reviewers from the external community to serve either as individual reviewers for a particular proposal (referred to as "ad hoc" reviewers) or as members of a panel of reviewers who evaluate a larger set of proposals. To ensure that they receive substantive reviews from a variety of perspectives, the program officers reach out to a broad range of experts for input—in fiscal year 2010, over 46,000 external peer reviewers from academia, government, and occasionally industry provided authoritative advice to the Foundation. Selection of expert peer reviewers may be based on the program officer's knowledge, references listed in the proposal, individuals cited in recent publications or relevant journals, presentations at professional meetings, reviewer recommendations, bibliographic and citation databases, or suggestions from the proposal author (subject to the program officer's discretion). In making these selections, program officers pay very careful attention to avoiding conflicts of interest, both real and perceived.

  NSF takes seriously its responsibility to ensure that the merit review process is fair and equitable. One of the ways in which we address this responsibility is through the briefings that are given to each review panel before it begins its work. In these

briefings, panelists are instructed on NSF's review criteria (Intellectual Merit and Broader Impacts), and on maintaining confidentiality and avoiding conflicts of interest. In addition, review panel briefings typically include alerting the reviewers to the phenomenon of implicit bias, which may adversely impact new investigators, smaller institutions, and underrepresented groups. By guarding against the effects of implicit bias in the review process, NSF is working to ensure that there are equitable opportunities for all investigators.

I should note here that while the vast majority of the proposals received at NSF (~96%) are subject to both external and internal merit review, for some proposals the external review requirement is waived. This waiver provides necessary flexibility for handling proposals for which most of the external community would be conflicted (such as proposals for small conferences, workshops, or symposia), those for which there is a severe urgency (submitted through the Grants for Rapid Response Research, or RAPID, mechanism used, for example, on rapid-response research to the Deepwater Horizon oil spill), and those that request support for high-risk, potentially transformative exploratory work (submitted through the Early Grants for Exploratory Research, or EAGER, mechanism). These proposals are usually only reviewed internally by program officers with appropriate expertise.

- *Development of funding recommendations.* A central tenet of the NSF merit review process is that the reviewer input is advisory in nature. Funding recommendations are developed by the program officer, who is responsible for synthesizing the advice of the reviewers along with several other factors, with the goal of allocating funding to a diverse portfolio of projects that addresses a variety of considerations and objectives. In addition to their scientific expertise noted above, NSF program officers bring their own unique perspective born from their experience of working with hundreds, thousands, or – in some cases – tens of thousands of proposals. In developing recommendations within the larger context of their overall portfolio, program officers consider carefully the individual merits of each proposal with respect to both its intellectual merit and the potential broader impacts of the project, and how each proposal might help advance a variety of portfolio goals such as:
    - Achieving special program objectives and initiatives;
    - Fostering novel approaches to significant research and education questions;
    - Building capacity in a new and promising research area;
    - Supporting high-risk proposals with potential for transformative advances;
    - Supporting NSF's core strategies of integration of research and education and integrating diversity into NSF's programs;
    - Potential impact on human resources and infrastructure;

- Other available funding sources; and
- Geographic distribution.

NSF has set a goal for completing this process within six months, from the time the proposal is submitted to the point at which the proposal is either declined or recommended for funding and forwarded to the Division of Grants and Agreements for the final stages of review and processing. The proposal assignment and administrative review stage is typically complete within a few weeks. The bulk of the time is spent in the merit review stage, which can take three to four months to complete. Despite the volume of proposals that NSF receives annually (in FY 2010, over 55,000 proposals were submitted, an increase of 23% over the previous year), NSF routinely processes the majority of these proposals (>75%) in fewer than six months.

To ensure the integrity of the process, all program officer recommendations are reviewed by the division director (or other appropriate NSF official), who examines whether the process used to arrive at the decision has been executed in accordance with NSF's policies and that the decision has been based on a thorough analysis of the merits of the proposal. Large awards may receive additional review, either by the Director's Review Board (DRB) or additionally by the National Science Board (NSB). The DRB examines award recommendations with an average annual award amount of 2.5 percent or more of the awarding division's prior year current plan. The NSB reviews recommended awards with an annual award amount of one percent or more of the awarding Directorate's or Office's prior year current plan, or less than one percent or more of the prior year total NSF budget at the enacted level. Once the funding recommendation is approved (at whatever level is appropriate), the Division of Grants and Agreements ensures that the award recommendation meets all of NSF's requirements before officially issuing the award.

In addition to having multiple layers of review of individual award recommendations, NSF requires that all programs undergo an external review by Committees of Visitors (COVs) every three years. COV reviews provide NSF with external expert assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to the merit review and final proposal decisions. Finally, retrospective analysis of the process is periodically performed on a Foundation-wide basis, including the statistical reports submitted to the NSB every year and the Impact of Proposal and Award Management Mechanisms (IPAMM) report of 2007 (http://www.nsf.gov/pubs/2007/nsf0745/nsf0745.pdf).

At the request of Congress, in 2005 the NSB undertook an examination of NSF's Merit Review Process (http://www.nsf.gov/nsb/documents/2005/nsb05119.pdf). The report concludes that:

> "The Board fully supports the current NSF system of merit review, which utilizes the peer review process as the principal driver in funding decisions. The Board also strongly

> endorses the role of NSF program officers' discretionary authority, in concurrence with division directors, for ensuring the implementation and goals of both Merit Review Criteria, along with achieving a balanced portfolio of research and education awards, both within directorates and across the suite of NSF programs. Unlike a system based solely on peer reviews' scores, NSF's merit review process incorporates peer review in a system that also considers those attributes of a proposal (risk, multidisciplinary nature, novelty) that are not readily accommodated by a numerical score, but essential to identifying the most innovative proposals."

The National Academy of Sciences, in the 1994 report "Major Award Decisionmaking at the National Science Foundation," stated that, "The United States has built the most successful research system in the world. The use of peer review to identify the best ideas for support has been a major ingredient in this success. Peer review-based procedures such as those in use at NSF, the National Institutes of Health, and other federal research agencies remain the best procedures known for ensuring the technical excellence of research projects that receive public support." In November 2009, the Executive Director of the Transportation Research Board at the National Research Council, provided testimony before Congress on how to facilitate the implementation of research at the Department of Transportation. In that testimony, the Director endorsed strongly the fact that NSF's merit review process is well suited to the mission of the agency. His observation: "The more applied mitigation and adaptation research topics should be steered by the concerns and needs of policy makers and practitioners, while the fundamental research topics should be organized along the NSF model in which scholars and experts are guiding the decisions about which projects are likely to be most promising."

NSF's merit review process has served the agency, the scientific community, and indeed the country well for many years. Many Nobel Laureates, National Medal of Science and Technology winners, and MacArthur Foundation Fellows (popularly known as recipients of Genius Grants) have been supported by NSF at various stages in their careers. Through separate programs and in the course of funding specific scientific progress, over the past 25 years NSF has also supported the training of hundreds of thousands of graduate and post-graduate scholars in STEM fields. Discoveries stemming from NSF-funded projects have led to advances across all areas of science, engineering and education, with far-reaching impacts in the fields of nanotechnology, information technology, environmental science, genomics, STEM education, and many others.

The high quality of NSF's merit review process is recognized globally, as evidenced by the fact that it has been used as a model by countries around the world that are newly establishing their own funding agencies. The merit review system for L'Agence Nationale de la Recherche (ANR), the French counterpart to NSF, is explicitly modeled after NSF, as is that of the Foundation for

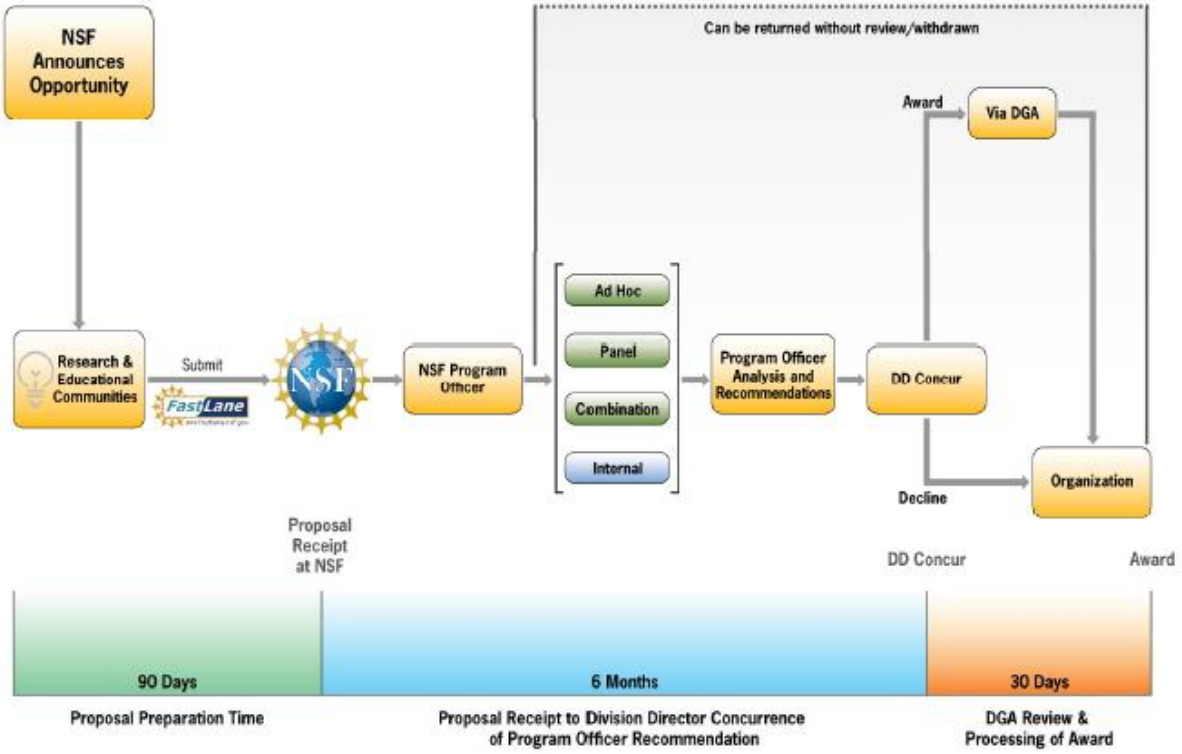
Polish Science. NSF helped the European Research Council establish its merit review system some five years ago, and was instrumental in helping Ireland establish Science Foundation Ireland. Back in 1986, a Chinese official came to NSF for 6 months to learn about our merit review and decision making processes, and subsequently incorporated what he had learned in establishing the National Natural Science Foundation of China (NSF-C). These are just a few examples of international agencies where NSF has had an explicit role in helping develop their merit review systems, but there are literally dozens of others that have borrowed our approach over the years.

As the nature of research and the scientific enterprise continues to change – becoming more interdisciplinary, technological, international and collaborative – NSF continues to explore ideas and strategies that could strengthen the merit review process by enlarging the range of tools that can be used in proposal evaluation. These ideas have come from a variety of sources – internally, from the research community, from the practices of other funding agencies, and from the scientific literature on merit review. One idea that we are actively exploring is a greater use of technology-mediated virtual panels when and where it makes sense, with the hope that decreasing the travel burden will expand the potential pool of reviewers. Among the benefits that NSF would derive from an expanded pool of reviewers are the inclusion of more and varied perspectives, increased opportunities for participation by underrepresented groups, decreased review burden per individual reviewer, and decreased travel costs for the agency. We have established an internal working group to identify other viable candidates for pilot activities, and to develop plans for running and evaluating those pilot activities. We will be discussing these with an advisory committee over the next few months to get their help in refining the processes.

For over 60 years NSF has been forward looking in terms of how the agency manages its research and education portfolio. Merit review fosters the "process of discovery," the means by which researchers can identify emerging scientific challenges and innovative approaches for addressing them. NSF is dedicated to ensuring that the merit review process remains robust, rigorous, and beyond reproach, in support of our mission and enabling us to pursue our goal of funding the world's best research in science, engineering and education.

I appreciate the opportunity to appear before the Subcommittee to speak to you on this important topic. I would be pleased to answer any questions that you may have.

Appendix I: NSF Proposal and Award Process and Timeline



THE POLICY SCIENCES CENTER, INC.

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October 1, 2011

Dean AnnaLee Saxenian - Chair
National Science Foundation - Advisory Committee on the
Social, Behavioral and Economic Sciences
c/o School of Information
University of California, Berkeley
Berkeley, CA 94720-4600

Re: Reparations for Dr. David Winter

Dear Dean Saxenian and Colleagues:

I write to ask your Committee to investigate NSF's role in suppressing research by Prof. David Winter at the University of Michigan. If you believe that the facts warrant, I hope that you will disclose the facts and make a public recommendation to the National Science Board that it apologize to the scientific community and pay reparations to Dr. David Winter.

Background

My understanding is based on the case that was brought to the Ethics Committee at the University of Michigan: The University's Administration removed a grant application of Dr. David Winter, a distinguished psychologist, from a larger package in a federal grant application. The Administration claimed that there was credible evidence to believe that the university's entire package, and thus the research programs of many other social scientists at the University, would be killed by the recipient science agency in Washington unless it did so.

Dr. Winter had proposed to extend his research on motivation with a national probability sample measuring N-Ach (achievement motivation) and related variables. The Administration's claim was that the federal science agency receiving the package would imagine the possibility that Black-White differences in achievement motivation could be computed from the dataset. Next, these numbers could be interpreted and used for public policy advocacy [by Blacks, or the political Left or the political Right - it is unclear (LE)]. This political visibility, in turn, would lead to political attacks against the granting agency. By this chain of thought, the University of Michigan Administrators believed, the

federal science agency would - to avoid future controversy - kill the entire University of Michigan package. And - again, to avoid criticism - it would not disclose the real reason. So, they were justified in their suppression and Dr. Winter should recognize legitimate social and peer pressures to accept the ruling.

Sorting-Out the Issues

I write to ask that you engage this case in your formal role to recommend scientific standards (i.e., as representatives of the nation's scientific community) for legitimate, ethical, and honorable behavior to NSF and its governing body, the National Science Board. At issue are both the suppressive policy itself and the (non-public and non-appealable) methods and intimidating processes by which a government agency made and enforced national policy decisions. In science (and in a democratic society) a small group at the top should not wield such power without public disclosure and accountability nor should it (still) falsely present itself as making awards on the basis of scientific merit.

Your Committee can express an expert judgment about legitimate and honorable scientific behavior without engaging in hand-to-hand legal combat with NSF's general counsel, who has a different job.

Paying Reparations to Dr. David Winter

By my standards, Dr. David Winter is entitled to an apology and, also, to reparations. The reparations should include both immediate funding of his research and an additional NSF settlement that, in the eyes of the courts and the scientific community, will be sufficient punitive damages to make the settlement historically memorable. It should, as a precedent, be of sufficient size to strengthen instincts for integrity and deter NSF misconduct in any future eras of Republican mindlessness and pressure.

Your findings also will be helpful for the design of the Scientific Integrity Board and the Bill of Rights for Scientific Freedom. My drafts did not include the possibility that the Administrations of leading national research universities also might be successfully pressured and decide to pressure their own faculty members rather than take a public stand for the integrity of our scientific research system.

-I have a degree of personal knowledge about the earlier University of Michigan ethics case and would welcome the opportunity to offer rebuttal testimony and evidence if it is appropriate. Also, I am willing to testify under oath and provide, or point you to, additional documentation if that is necessary. (For example, my perceptions of the David Winter case, recounted in this letter, were part of a written filing with the University of Michigan ethics committee at the time.)[1]

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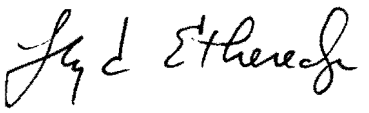
[1] Dr. David Winter's research would have extended earlier national sample data of N-Ach measures in 1956 and the mid-1970s. The data would have been a brilliant national

The current NSF Assistant Director (SBE) - a holdover appointment made by the last Bush-era NSF Director - was an Administrator at the University of Michigan at the time. His conduct may have been part of the ethics investigation.

Yours truly,



Dr. Lloyd S. Etheredge

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investment to evaluate (in the spirit of the late Donald Campbell) the experiment of Reaganomics, which had claimed to change national modal personality and entrepreneurial motivation. Republicans also claimed a different causal mechanism (than had yet been tested by social psychologists in the N-Ach tradition) for the (unmeasured) changes they claimed to produce.

Dr. Philip Converse, also an institutional leader at the University of Michigan, helped to kill these (economic policy and ideology-testing) extensions of the earlier N-Ach datasets when he was a member of an agenda-setting panel at the National Academy of Sciences Division of Behavioral and Social Sciences and Education. Thus their "Racism!" justification may not have been the only reason for the later and continuing NSF and Michigan alarms and suppression.

Beginning with the leadership of Converse et al., the University of Michigan has been a major, competitive, NSF contractor and agenda-setter for social science research. If its Administration has engaged in a continuing pattern of social pressure and aggressive self-censorship of faculty grant applications to maintain conventional theories and prevent disruptive tests of Republican truth claims and racism (etc.) this would be worrisome and should be known.

The Influence of Social Hierarchy on Primate Health

Robert M. Sapolsky

Dominance hierarchies occur in numerous social species, and rank within them can greatly influence the quality of life of an animal. In this review, I consider how rank can also influence physiology and health. I first consider whether it is high- or low-ranking animals that are most stressed in a dominance hierarchy; this turns out to vary as a function of the social organization in different species and populations. I then review how the stressful characteristics of social rank have adverse adrenocortical, cardiovascular, reproductive, immunological, and neurobiological consequences. Finally, I consider how these findings apply to the human realm of health, disease, and socioeconomic status.

One of the greatest challenges in public health is to understand the "socioeconomic gradient." This refers to the fact that in numerous Westernized societies, stepwise descent in socioeconomic status (SES) predicts increased risks of cardiovascular, respiratory, rheumatoid, and psychiatric diseases; low birth weight; infant mortality; and mortality from all causes (*1*–*4*). This relation is predominately due to the influence of SES on health, rather than the converse, and the disease incidences can be several times greater at the lower extreme of the SES spectrum.

One set of questions raised by the gradient concern its external causes. Despite human aversion to inequity in some settings (*5*), many Westernized societies tolerate marked SES gradients in health care access. Is this the predominant cause of the health gradient, or is it more a function of differences in lifestyle risk factors or of the psychosocial milieu in which poverty occurs?

Another set of questions concern the physiological mediators of the SES-health relationship—how, in a frequently used phrase in the field, does poverty get under the skin? These physiological questions are difficult to study in humans, and an extensive literature has focused instead on nonhuman animals. Despite the demonstration that some nonhuman species can also be averse to inequity (*6*), groups of social animals often form dominance hierarchies, producing marked inequalities in access to resources. In such cases, an animal's dominance rank can dramatically influence the quality of its life. Does rank also influence the health of an animal?

The study of rank-health relations in animals has often been framed in the context of stress and the idea that animals of different ranks experience different patterns of stress (Fig. 1). A physical stressor is an external challenge to homeostasis. A psychosocial stressor is the anticipation, justified or not, that a challenge to homeostasis looms. Psychosocial stressors typically engender feelings of lack of control and predictability and a sense of lacking outlets for the frustration caused by the stressor. Both types of stressor activate an array of endocrine and neural adaptations (Fig. 2). When mobilized in response to an acute physical challenge to homeostasis (such as fleeing a predator), the stress response is adaptive, mobilizing energy to exercising muscle, increasing cardiovascular tone to facilitate the delivery of such energy, and inhibiting unessential anabolism, such as growth, repair, digestion, and reproduction. Chronic activation of the stress response by chronic psychosocial stressors (such as constant close proximity to an anxiety-provoking member of one's own species) can increase the risk of numerous diseases or exacerbate such preexisting diseases as hypertension, atherosclerosis, insulin-resistant diabetes, immune suppression, reproductive impairments, and affective disorders (*7*).

In most social species, dominance rank influences the extent to which an individual sustains physical and psychosocial stressors. Thus, dominance rank can potentially influence an individual animal's vulnerability to stress-related disease. In this review, I first consider which social ranks are most stressful, with an emphasis on nonhuman primates; stress can be experienced by both high- and low-ranking animals, and it varies as a function of the social organization in different species and populations. I then review the pathology that occurs in animals suffering from the most rank-related social stress. Finally, I consider the relevance of these hierarchy/health relationships to humans.

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Which Ranks Are More Stressful?

No consensus exists as to whether dominant or subordinate animals are more physiologically "stressed." Research in the 1950s, since discredited, argued that high rank was more physiologically stressful (that is, the "executive stress syndrome," which was purportedly valid for both humans and other primates) (*8*). By the 1960s, the prevailing view had become that lower dominance rank carries the greatest risk of stress-related disease (*9*). It has now become clear that this too is an incorrect generalization. The contemporary view reflects the heterogeneity that is the core of ethology: Rank means different things in different species and populations. Patterns that occur amid this heterogeneity help to resolve many inconsistencies in the data, showing that the rank that experiences the most physical and psychological stressors tends to display the most severe stress-related pathologies (Fig. 2).

Resource inequity. The extent to which resources are divided unequally among individuals varies as a function of the dominance style of different species. At one extreme are top-down "despotic" hierarchies in which resource access is skewed markedly and dominant positions are attained through aggression and intimidation. In contrast, bottom-up "egalitarian" hierarchies have more equal resource distribution, and dominance is attained with the support of subordinate individuals (*10*). As will be seen, social subordination in despotic species can be associated with the greatest physiological indices of stress. In contrast, this is not a feature of subordination in egalitarian species.

Maintenance of dominance. In some species, rank is lifelong and inherited (for example, in female rhesus monkeys); in others, it may fluctuate, reflecting what has been aptly termed shifts in group "politics" (*11*). In species where ranks shift, how does an individual, once attaining a high rank, maintain it? At one extreme among species with despotic hierarchies, high-ranking individuals frequently and aggressively reassert their domination over the subordinate cohort (even in the absence of an overt challenge). In such species, which include dwarf mongooses, African wild dogs, and ring-tailed lemurs, dominant individuals have the greatest physiological indices of stress, most plausibly reflecting the physical demands of frequent fighting (*12*, *13*). In contrast, in other

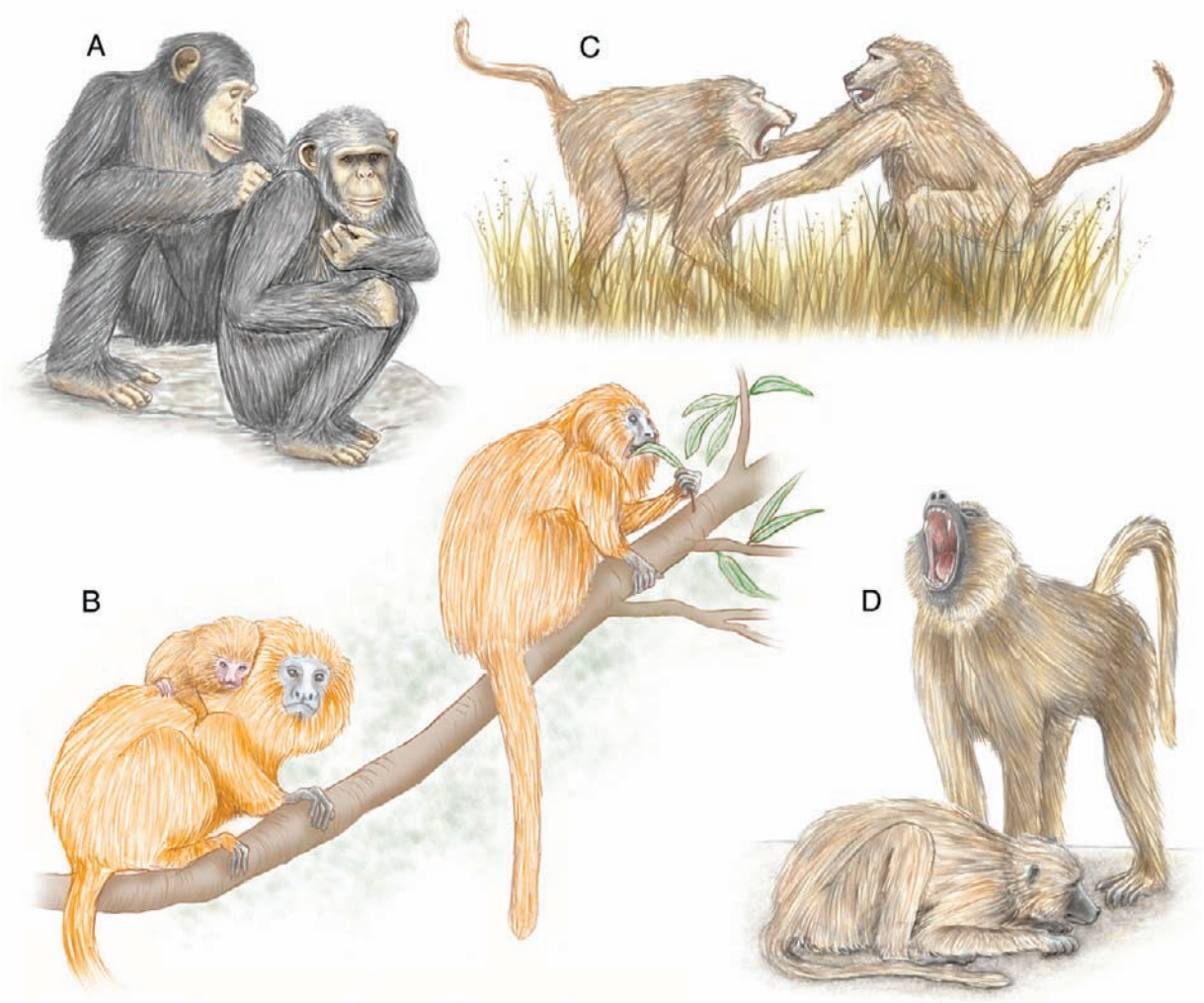

Fig. 1. (**A** and **B**) Affiliative behavior among subordinates can reduce the effects of stress. (A) Chimpanzees engage in social grooming. (B) A female tamarin monkey cares for another's young while the mother feeds. (**C** and **D**) Stressful dominance behavior may take physical or psychosocial forms. (C) Male savanna baboons may fight over a kill. (D) A dominant male baboon intimidates a subordinate. [Image credit: Carin Cain/*Science*]

despotic species, high-ranking individuals maintain dominance through psychological intimidation rather than aggression (where, for example, mere eye contact with the alpha individual might elicit subordination gestures). In such cases (e.g., savanna baboons, rhesus and squirrel monkeys, mice, rats, and white-throated sparrows), subordination is associated with the greatest physiological indices, plausibly reflecting the frequent psychological stressors for subordinates and the paucity of physical stressors for dominant individuals (*12*–*18*).

Breeding style. In many species, including some Old World primates, dominant alpha individuals of both genders monopolize breeding through aggression and intimidation. This can be sufficiently stressful to impair fertility in subordinates, producing ''social contraception.'' A different picture occurs in cooperative breeders, where one breeding female dominates other females, who are anovulatory. However, this subordination is minimally stressful, not involving aggression or harassment by the dominant female. Instead, the anovulatory individuals are mostly younger sisters, waiting their turn to breed and helping to raise nieces and nephews (*19*). Among cooperative breeders such as marmosets, ring-tailed lemurs, marmots, wolves, and Florida scrub jays, subordinates show no more stress-related pathophysiology than do dominant individuals and may even have fewer indices (*13*, *19*–*21*).

Stability of social ranks. When the hierarchy is stable in species where dominant individuals actively subjugate subordinates, it is the latter who are most socially stressed; this can particularly be the case in the most extreme example of a stable hierarchy, namely, one in which rank is hereditary. This reflects the high rates of physical and psychological harassment of subordinates, their relative lack of social control and predictability, their need to work harder to obtain food, and their lack of social outlets such as grooming or displacing aggression onto someone more subordinate. During major hierarchical reorganization, however, dominant individuals at the center of the social tensions typically experience the greatest amounts of physical and psychological stress. As a result, during such reorganization among wild baboons or soon after group formation among species of captive primates, dominant individuals have the greatest physiological indices of stress; this has been shown in talapoin monkeys, squirrel monkeys, various macaque species, wild baboons, and chimpanzees. Once hierarchies stabilize, subordination becomes associated with the greatest physiological indices of stress (*22*).

Subordinate coping strategies. Stress-related physiological endpoints not only reflect the frequency and severity of stressors but also the availability and efficacy of coping outlets. Such outlets most commonly involve social support (such as grooming, physical contact, or coalition formation). Moreover, the occurrence in some species of reconciliative behaviors between two individuals shortly after a competitive interaction can be interpreted as a coping outlet for the loser of that interaction (*23*). The issue of coping outlets has been examined in a meta-analysis of rank-physiology relationships in both genders of an array of primate species.

Numerous variables related to social structure were considered, and three were collectively highly predictive of the occurrence of elevated stress hormone levels among subordinate animals: (i) high rates of being subjected to stressors; (ii) low availability of social support; and (iii) minimal presence of kin (*24*).

Subordinate avoidance of dominants. The inability to physically avoid dominant individuals is associated with stress, and the ease of avoidance varies by ecosystem. The spatial constraints of a two-dimensional terrestrial habitat differ from those of a three-dimensional arboreal or aquatic setting, and living in an open grassland differs from living in a plain dense with bushes. As an extreme example, subordinate animals in captivity have many fewer means to evade dominant individuals than they would in a natural setting (*25*). Thus, although dominant wolves have elevated stress hormone levels in the wild (*21*), subordinates demonstrate this trait in captivity (*26*).

Subordinants' use of alternative strategies. Implicit in being subordinate are the notions that one has reduced access to desirable resources and that this can translate into reduced Darwinian fitness. Sometimes, however, subordinate animals can pursue alternative behavioral strategies that, in effect, move them outside the hierarchy. For example, low rank among males of various Old World monkey species, as the result of male-male competition, has been thought to mean minimal reproductive access to females. However, females actually have considerable control over who they mate with. These are often low-ranking individuals with whom they have affiliative relationships (such as frequent, nonsexual bouts of reciprocal grooming) (*27*). Such males not only have greater reproductive success than originally thought but also fewer physiological indices of stress than would be expected for their rank (*28*).

A different alternative strategy occurs among orangutans. Dominant males have pronounced secondary sexual characteristics, whereas subordinate individuals appear "juvenile." This appearance is not merely a chronological stage. Instead, it is a state of arrested development in the presence of a dominant male and can persist for years. When the dominant male is removed, the apparently juvenile individual develops secondary sexual traits. This arrested state might seem to be a case of stress-induced social contraception. However, "juvenile" males are fertile, have some reproductive success (as they will force copulations when a dominant male is absent), and do not have elevated stress hormone levels or stress-related reproductive impairments. Rather than a stress-induced pathology, the arrest appears to be an alternative strategy. It is actually males in the process of the conspicuous, slow transition to the dominant form with the most marked physiological indices of stress (*29*).

Stress of dominating mating. In species with a sharply demarcated mating season, or where a few males disproportionately dominate mating, male-male competition for mating access can be fierce, dangerous, and at the cost of feeding and of affiliative behaviors. This raises the ironic possibility that dominant males may be sufficiently stressed by such competition that their testicular axes are suppressed. However, various endocrine mechanisms have evolved that buffer reproductive physiology under that circumstance, either through blunting the release of stress hormones or blunting their ability to suppress the testicular system (*30*).

Atmosphere and culture. The nature of dominance varies with species and gender. Additionally, different populations of a species vary in their social milieu, and rank-physiology relationships can vary as well. For example, patterns of foraging by subordinate female spotted hyenas differ markedly between the enclosed Ngorongoro Crater and the open Serengeti Plains in East Africa, and only in the latter is subordination associated with elevated stress hormone levels (*31*). As another example, the elevated stress hormone levels observed among subordinate female macaques do not occur in a troop with atypically high rates of affiliative support (*32*, *33*). In the realm of animal "culture," multigenerational transmission of a culture of low aggression and high affiliation in a troop of wild baboons results in subordinate males that do not display the stress-related pathophysiology found in other troops (*34*).

Personality. Precedent exists for modulation of stress reactions by individuals' personalities. For example, independent of rank, primates who distinguish poorly between threatening and neutral stimuli, lack social outlets for support, and are hyperreactive to novelty have elevated stress hormone levels (*35*, *36*) and increased rates of atherosclerosis (*37*).

Thus, under a variety of circumstances, social dominance can be associated with the most stress-related pathology, whereas in other situations, this is a trait of subordinate individuals. Are there common themes underlying this variability? Broadly and logically, adverse physiological profiles are most pronounced among animals of the rank exposed to the most physical and psychological stressors. This can arise from (i) low degrees of social control and predictability (as in dominant animals in unstable hierarchies and subordinate animals in small living spaces); (ii) a paucity of outlets after exposure to stressors (such as subordinate individuals in species lacking alternative strategies to hierarchical competition); (iii) a paucity of social support (for example, subordinate animals in settings with few kin and little access to social grooming); or (iv) high rates of physical stressors (such as dominant individuals who, as a function of their species or the instability of their hierarchy, must constantly reassert their dominance by physical means). Moreover, these links between rank and pathology can be made even more dramatic by the culture of a particular social group and by a personality prone toward interpreting ambiguous social circumstances as psychologically stressful.

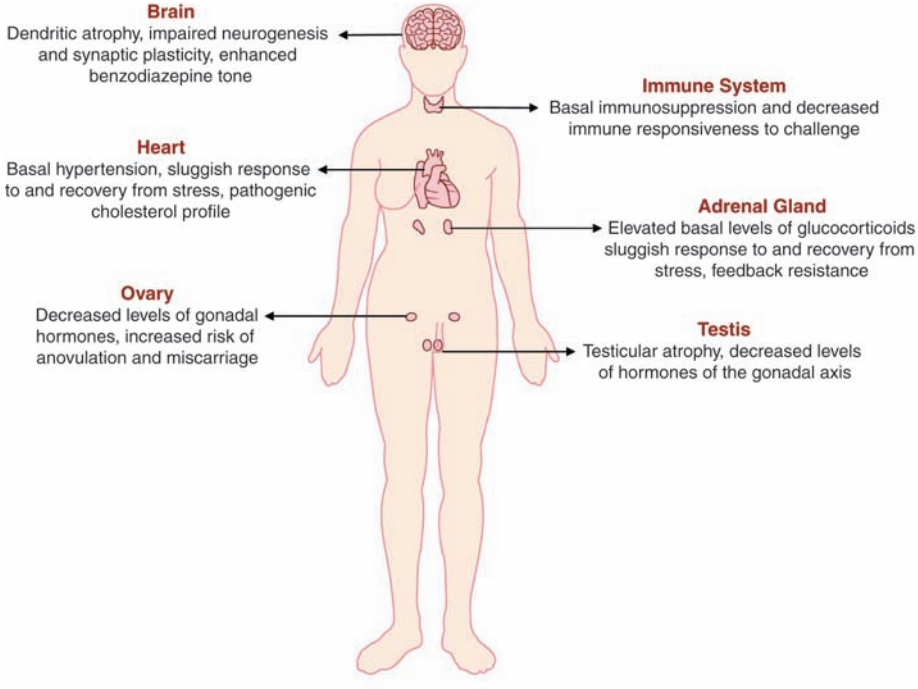

Fig. 2. Physiological correlates of the more stressful social rank. [Image credit: Bayard Colyear, Stanford Visual Arts Services]

Negative Physiological Effects of Stressful Social Ranking

Studies of both feral and captive animal populations show that animals with specific

dominance ranks tend to show characteristic stress-related physiological profiles (Table 1). We know that a particular rank gives rise to a particular physiological profile, rather than visa versa, because studies of individual captive animals before they are placed in social groups indicate that physiological profiles of singly-housed subjects do not predict their subsequent ranks in a social group (*38*).

Several stress-related physiological endpoints have been found to be sensitive to rank. The most frequently studied endpoint is the blood level of glucocorticoids (GCs), adrenal steroid hormones that are secreted during stress, such as cortisol or hydrocortisone in primates and corticosterone in many rodent species. GCs typify the double-edged nature of the stress response, as they help mediate adaptation to short-term physical stressors yet are pathogenic when secreted chronically.

Consistently, animals who are more socially stressed by the dominance hierarchy show indices of hyperactivity of the GC system. This includes elevated basal levels of GCs, the enlarged adrenal glands that accompany such increased secretion, a sluggish GC stress response in the face of a major homeostatic challenge, and impaired sensitivity of the system to negative feedback regulation.

In some cases, it is dominant individuals who show this profile. This includes species where dominant individuals have to repeatedly and physically reassert their rank (e.g., feral populations of dwarf mongooses, African wild dogs, female ring-tailed lemurs, and male chimpanzees) (*12*, *13*, *39*); those that are cooperative breeders (feral wolves and captive marmosets and tamarins) (*16*, *21*); and those with transient periods of major rank instability (feral baboons and captive populations of talapoin, squirrel, and rhesus monkeys) (*22*).

In contrast, this profile is seen among subordinate individuals in species where high rank is maintained through nonphysical intimidation and the hierarchy is stable (feral male baboons and captive populations of squirrel and rhesus monkeys, tree shrews, rats, and mice) (*22*, *40*, *41*); where subordinates are exposed to frequent social stressors amid low availability of social support and minimal presence of kin (feral ring-tailed lemurs and captive populations of male rhesus or female talapoin monkeys) (*13*, *24*); and when animals are in an enclosure too small to allow subordinate individuals to evade dominant ones (*26*).

A second prominent feature of the stress response is secretion of the catecholamine hormones (epinephrine and norepinephrine). These hormones of the sympathetic nervous system are secreted within seconds of the onset of a stressor (versus minutes for GCs) and have many of the same effects as GCs upon metabolism and cardiovascular tone. Thus, as with GCs, although the acute secretion of catecholamines is adaptive, prolonged secretion can be pathogenic. The speed with which catecholamines are secreted typically precludes measuring basal circulating levels (because of the stress caused by the restraint of subjects for taking blood samples), and the hormones are poorly and variably preserved in urine and feces. Thus, little is known about rank-catecholamine relationships.

Prolonged stress adversely affects cardiovascular function, producing (i) hypertension and elevated heart rate; (ii) platelet aggregation and increased circulating levels of lipids and cholesterol, collectively promoting atherosclerotic plaque formation in injured blood vessels; (iii) decreased levels of protective high-density lipoprotein (HDL) cholesterol and/or elevated levels of endangering low-density lipoprotein (LDL) cholesterol; and (iv) vasoconstriction of damaged coronary arteries. A small literature demonstrates that animals who are more socially stressed by the dominance hierarchy demonstrate (i) basal hypertension; (ii) a sluggish activation of the cardiovascular stress response after a challenge and delayed recovery when it abates; (iii) a pathogenic cholesterol profile; and (iv) increased vulnerability to the atherogenic effects of a high-fat diet. These are traits of subordinate individuals when the dominance hierarchy is stable (among captive fascicularis macaques of both genders and among feral male savanna baboons) but of dominant individuals of the same populations when the hierarchy is unstable (*37*, *42*, *43*).

Chronic stress inhibits reproduction in both genders, a classic example of stress suppressing a costly anabolic process until more auspicious times. In females, this suppression can take the form of delayed puberty, decreased levels of estrogen and progesterone, increased incidence of anovulatory cycles, impaired implantation, greater risk of miscarriage, prolonged interbirth intervals, and accelerated reproductive senescence. Primate studies show that the stress of subordination in a stable hierarchy (of cynomolgus monkeys) is associated with decreased gonadal hormone levels (*42*); there are conflicting data as to whether dominance or subordination in stable hierarchies of feral baboons is associated with higher rates of miscarriage (*44*, *45*).

Among males, prolonged and major stress can suppress fertility; at an extreme in teleost fish, this includes atrophy of testes and of hypothalamic regions responsible for gonadotropin release (*46*). More commonly, stress can suppress circulating testosterone levels (*9*). However, there are many exceptions, as numerous species are resistant to this effect when the stressor is male-male competition during mating seasons; moreover, it is not clear how often these lower testosterone levels actually affect behavior or fertility. There is no consensus as to whether more socially stressed individuals have lower basal testosterone levels. However, such individuals (in this case, subordinate male baboons in a stable hierarchy) are more vulnerable to the suppressive effects of stress on basal testosterone levels (*9*).

Stress has complex time- and severity-dependent effects upon immunity. In general, mild to moderate transient stressors enhance immunity, particularly the first phase of the immune response, namely innate immunity. Later

Table 1. Influence of societal characteristics on stress experienced by high- and low-ranking individuals. An asterisk indicates no rank-related trend.

Societal characteristic	Individuals experiencing the most stress
Dominance style and means of maintaining despotic dominance	
Despotic hierarchy maintained through frequent physical reassertion of dominance	High-ranking
Despotic hierarchy maintained through intimidation	Low-ranking
Egalitarian hierarchy	*
Style of breeding system	
Cooperative	High-ranking
Competitive	*
Stability of ranks	
Unstable	High-ranking
Highly stable	Low-ranking
Availability of coping outlets for subordinates	
High availability	*
Low availability	Low-ranking
Ease with which subordinates avoid dominant individuals	
Easy avoidance	*
Difficult avoidance	Low-ranking
Availability of alternative strategies to overt competition	
Present	*
Lacking	Low-ranking
Personality	
Dominants perceive neutral interactions as challenging; subordinates take advantage of coping strategies	High-ranking
Dominants are adept at exerting social control and highly affiliative; subordinates are poor at exploiting opportunities for coping and support	Low-ranking

phases of the stress response are immunosuppressive, returning immune function to baseline. Should the later phase be prolonged by chronic stress, immunosuppression can be severe enough to compromise immune activation by infectious challenges (*47*, *48*). In contrast, a failure of the later phase can increase the risk of the immune overactivity that constitutes autoimmunity. No studies have examined rank differences in the first immunostimulatory phase of the stress response or in the risk of autoimmunity if the later suppressive stage fails to occur. However, suppression of circulating lymphocyte numbers and blunted immune responsiveness to a challenge have been reported among animals socially stressed by a dominance hierarchy (subordinate rodents and pigs subject to high rates of attack and dominant chimpanzee males in an unstable captive population). Less clear is whether such rank effects are of sufficient magnitude to actually increase the risk of infectious disease (*47*, *49*).

Animals who are socially stressed by the dominance hierarchy for prolonged periods undergo neurobiological changes as well. This can involve inhibition of neurogenesis, dendritic atrophy, and impairment of synaptic plasticity in the hippocampus (*50*, *51*) and altered patterns of apoptotic cell death (increases in the cortex and decreases in the hippocampus) (*52*); these pathologies have been observed in socially subordinate rodents and tree shrews in stable hierarchies in captive populations.

Finally, a socially stressful position in a hierarchy is also associated with alterations in the neurochemistry of anxiety. Receptors exist in the nervous system for the anti-anxiety benzodiazepines (BDZs), which include the synthetic molecules diazepam and chlordiazepoxide hydrochloride as well as an as-yet uncharacterized endogenous BDZ. Pharmacological blockade of BDZ receptors caused the greatest disinhibition of anxiety-related behaviors in subordinate males in a stable hierarchy among feral baboons (*34*). This rank difference was interpreted as reflecting the demands for anxious vigilance among such individuals, necessitating a greater counteracting effect of endogenous BDZ tone.

Human Hierarchies and Health

The literature reviewed raises the obvious question: Are these findings relevant to humans? Initially, they seem to be of minimal relevance. Humans are not hierarchical in the linear, unidimensional manner of many species. For example, humans belong to multiple hierarchies and tend to value most the one in which they rank highest (for example, a low-prestige employee who most values his role as a deacon in his church). Furthermore, the existence of internal standards makes humans less subject to the psychological consequences of rank. Finally, health-rank relations that are easy to study can be highly artificial (e.g., examining the physiological consequences of winning versus losing an athletic competition).

Despite these caveats, the SES gradient of health among Westernized humans is a robust example of social inequalities predicting patterns of disease. As mentioned earlier, stepwise descent in SES predicts a major increase in the incidence of an array of diseases and mortality (*1*–*4*).

These health effects of SES are not a result of poverty causing limited access to health care. Robust SES-health gradients exist in countries with universal health care and documented equality of access. In addition, gradients exist for diseases with incidences that are impervious to preventative health measures (e.g., juvenile diabetes) (*2*, *3*).

Only a small portion of the SES-health relationship is due to SES-related life-style differences. In Westernized societies, lower SES is associated with higher rates of smoking and drinking to excess, less healthy diets, more sedentary life-styles, crime- and toxin-riddled communities, and fewer coping outlets (e.g., health club memberships and vacations). However, the most prominent of these factors collectively account for only a small part of the variability in the SES-health gradient (*3*).

Instead, increasing evidence suggests that the gradient arises from psychosocial factors. Subjective SES can be at least as predictive of health as is objective SES (*1*); in other words, feeling poor may be at the core of why being poor predicts poor health. In the United States, at the level of states or cities, the same low SES predicts poorer health in communities with greater income inequality (*4*). Whereas large inequalities decrease the availability of protective life-style factors for the poor in a community (what has been termed a ''neomaterialist'' explanation for the inequality-health relationship) (*53*), the disease consequences of feeling poor are often rooted in the psychosocial consequences of being made to feel poor by one's surroundings (*4*). Increased income inequality typically decreases a community's ''social capital'' (shown in decreased levels of trust and increased senses of alienation and disenfranchisement), and such decreased capital mediates the relationship between income inequality and health (*2*).

Conclusions

Strong associations between social status and health thus occur in numerous species, including humans, with the poor health of those in the ''wrong'' rank related to their surfeit of physical and psychosocial stressors. In considering these issues in nonhuman species, the variability, qualifiers, and nuances of the rank-health relationship are frequently emphasized, a testament to the social complexity of other species. In contrast, in humans, there is a robust imperviousness of SES-health associations to differences in social and economic systems. It is not plausible that this human/nonhuman contrast reflects human sociality being less complex than in, say, baboons. Instead, it is a testimony to the power of humans, after inventing material technology and the unequal distribution of its spoils, to corrosively subordinate its have-nots.

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