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LETTERS

Wagnerian Genetics

The recent report of an "Abnormal fear response and aggressive behavior in mutant mice deficient for α-calcium calmodulin kinase II" by Chong Chen *et al.* (14 Oct., p. 291) provides what may be an unusual insight into the presumably inherited deficiency manifested by a certain Siegfried Volsung. While his entire pedigree has long been open to speculation, it is asserted that he was the offspring of the consanguineous mating between brother (Siegmund Volsung) and sister (Sieglinde Neidung, née Volsung), who were separated at birth, only to reunite in early adulthood (R. Wagner, *Die Walküre*, Act I). Although Mendelian genetics was awaiting rediscovery at the time this kindred became the subject of a lengthy report (*Der Ring des Nibelungen*, 1876), such laws of inheritance would predict that Siegfried was significantly at risk for genetic disorders. Indeed, it is a wonder that the only phenotypic evidence of consanguineous parentage was a *complete lack of fear*. In a manner somewhat comparable to the α-CaMKII–deficient mice described by Chen *et al.*, Volsung was also disposed to remarkable acts of defensive aggression and risk-taking behavior [for example, Siegfried versus Fafner (*Siegfried*, Act II)].

While genetic counseling was not generally available to the community in which he lived, Siegfried is unlikely to have heeded prudent advice since, in typical fashion, he fearlessly won the affection of his aunt Brunnhilde (*Siegfried*, Act III). Because the murine machismo reported by Chen *et al.* clearly demonstrates a dominant inheritance pattern, one must scrutinize the behavioral phenotypes of Siegfried's parents for evidence of intermediate forms of fearlessness. And, in fact, usual precaution is not a feature of their daring escape from Sieglinde's oppressive domestic trappings while at the same time singing constantly at great volume in the middle of the night (*Die Walküre*, Act I). The first and second filial offspring of the inevitable proband-aunt (Siegfried-Brunnhilde) mating may have provided valuable insight into the penetrance and mode of inheritance in this unusual disorder; however this will never be known because a complicated family dispute ended in not only Siegfried's death but the immolation of all known inhabitants of the region (*Götterdämmerung*, Act III, final scene).

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Response: We appreciate that Vogel brings to our attention the fascinating story of Siegfried Volsung, as depicted in Wagner's opera *Der Ring des Nibelungen*. Our previous work has shown that an autosomal dominant mutation in the α-CaMKII gene is associated with a phenotype of increased defensive aggression and a lack of fear. In contrast, the neuropsychiatric condition exhibited by Siegfried, whose parents are brother and sister, seems to be derived from an autosomal recessive mutation. Thus, it is not clear at all whether there is any genetic parallelism between the α-CaMKII heterozygous knockout mouse and the man. There are, of course, other possible interpretations. For example, Siegfried may have carried a sporadic mutation in the α-CaMKII gene; or one of his parents may have had heterozygous or homozygous mutation in the α-CaMKII gene. Siegfried's father, Siegmund, appears to share similar traits. As Bernard Shaw has characterized [*The Perfect Wagnerite: A Commentary on the Ring of the Nibelungs* (Constable, London, 1956)], "The boy Siegfried inherits . . . all his father's hardihood. The fear against which Siegmund set his face like flint, and the woe which he wore down, are unknown to the son. . . ." If Siegfried's mother, Sieglinde, is normal, both the father and the son may have had the heterozygous mutation. In this case, the genetic parallelism may be justifiable.

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Teaching Engineers and Scientists

The Policy Forum by Mary Lowe Good and Neal F. Lane "Producing the finest scientists and engineers for the 21st century" (4 Nov., p. 741) contains little that is either new or provocative. It reads like a sermon based on the gospel according to the Office of Science and Technology Policy and the National Science Foundation, chiefly the "Platitudes." Good and Lane recommend that (i) "teaching and learning must be reinvigorated as the primary mission of academic institutions," (ii) federal policies should support education and training of scientists and engineers, and (iii) graduate education must reflect changes in the economy and in the labor market for these professionals.

Those who have been teaching and doing research for the past 30 years have witnessed a startling expansion and contraction of federal support for science and engineering coinciding with the beginning and end of the Cold War. Most faculty members have reflected upon the meaning of these changes both for society and for their own careers and those of their students. They are well aware that science and engineering education will have to respond to new challenges. They do not need to be told that teaching is important, that they had better start doing research of interest to industry, and that "promising and largely unexplored opportunities may reside in the small business sector." Many have already found how difficult and time-consuming it is to develop cooperative research with companies while maintaining a regular load of teaching and advising.

Problems mentioned elsewhere in the "Innovations on Campus" issue—cutbacks in research funding, scarcity of jobs for Ph.D.'s, and the decreasing numbers of undergraduates with interest in and adequate preparation for these fields—will not be solved by "innovative" teaching. It is not yet clear that smaller graduate populations will lead to an increase in quality because there may be a tendency for universities, especially high-tuition private institutions, to continue to accept poorly prepared students so as to survive, and then try to turn teaching into entertainment for the "MTV generation."

It is hard to be as optimistic as Good and Lane about the prospects for university science and engineering in the late 1990s and early 2000s. Daniel E. Koshland Jr.'s editorial in the same issue ("Educating the best and employing them," p. 711) suggests that he has a more realistic view of the future—there will fewer Ph.D. programs, and the emphasis will be on educating the "most interested and the most able" graduate students for a limited number of research and teaching positions. Many universities will not be able to maintain viable graduate programs and will return mainly to undergraduate teaching. This will not be a bad thing if they insist that those who graduate, those with a B.S. or B.A., have a sound understanding of basic scientific and engineering principles together with a better appreciation of society's needs and the ability and willingness to work with other citizens for the common good.

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Koshland's editorial and Good and Lane's Policy Forum point to the importance of maintaining the strength of Ph.D. research while increasing the contribution of academia to the evolving research needs of modern industry. The industrial Ph.D. program that the Northeastern University Physics Department tried to create in the early 1970s may be a model of a low-risk contribution toward that goal.

We proposed the following plan: (i) Students who had passed the department's qualifying examination and all the required course work would be eligible for consideration as Ph.D. candidates. (ii) A thesis committee would be set up by the departmental graduate committee that would include a person in industry who would supervise the student. (iii) A student's work would be published and nonproprietary. Patents based on the research would have to follow university and National Science Foundation (NSF) policies and would in no way be allowed to interfere with publication. (iv) A student would be supported by the program as a university graduate research assistant. While the stipend was to be the standard one in the department, travel or "off site" costs would be allowed. Funding of the program was to come from the NSF, but it was expected that companies would want to make donations to the grant independent of any specific thesis project. (v) (People from industry emphasized the need to distinguish thesis research from regular in-house research. There were pure physics problems that they wanted to see addressed and for which companies could not justify the cost.) For such basic research, companies would supply the environment, equipment, and adviser's time. Industrial proprietary research would be conducted by employees without interference from outsiders. (vi) Because of all the matching requirements for each individual case, the program would start off very slowly and only gradually build up to its full potential.

One of the benefits industry expected from this program was to develop candidates for future regular employment; another was to forge ties with the faculty. A requirement that participants had to be university students rather than company employees distinguished our program from many others. Our industrial partners were concerned that the long-term and basic research needs of industry not be sacrificed to expediency.

The department and about a dozen industrial concerns agreed completely on how the program should work. The NSF, however, was not interested, and as the plan depended on NSF funding, it could not be implemented. Now that a different wind is blowing in Washington, D.C., we hope that the NSF, at least, may wish to experiment with such a program. It is much better to let people in front-line industries propose basic research topics based on deficiencies they have seen than to have government tell them what research is needed.

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Good and Lane make several useful points. However, they also make a typical omission, that of not considering scientists and engineers who develop an interest in academia later in their careers. After 20 to 25 years of practical experience in industry or consulting, some entertain the possibility of transferring their knowledge to students. However, this opportunity is largely closed because of the academic requirement for a doctorate, which is neither a prerequisite nor an advantage in many industrial or consultant positions. As a result, the abilities of these career scientists and engineers (their practical experience, understanding of pragmatic needs, perspective on career path opportunities, and knowledge of marketplace) are being lost. Many of these people have managed field and study programs in the hundreds of thousands or millions of dollars, know how to market industry for funding (and have the appropriate contacts to do so), have adjunct teaching experience, and have a history of mentoring young staff. But until job requirements for professors are altered, this valuable resource will go unused, and educational deficiencies will continue.

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