

Motivated research

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Three years ago, a senior politician attended his country's Annual Congress for the Advancement of Science to give the introductory lecture. He asked the attending scientists to make science and research more attractive to young students and the general public, and asked his countrymen to support scientists to address the urgent challenges of global climate change, energy needs and dwindling water resources. It was neither a European nor a US politician, but the Indian Prime Minister Manmohan Singh who made this speech about the relationship between research and its practical applications. This is such an important topic that one might think it deserves appropriate attention in Europe, yet we fail to address it properly. Instead, we just discuss how science should serve society or contribute to the 'knowledge-based economy', or how 'basic' or 'fundamental' research is opposed to 'applied' or 'industrial' research and how funding for 'big science' comes at the expense of 'little academic' research.

This dichotomy between the research to generate knowledge and the application of that knowledge to benefit humankind seems to be a recent development. In fact, more than 100 years ago Louis Pasteur avoided this debate altogether: one of his major, yet forgotten, contributions to science was the insight that research and its applications are not opposed, but orthogonal to each other (Stokes, 1997). If Niels Bohr 'invented' basic academic research—which was nevertheless the basis for many technological inventions and industrial applications—Pasteur developed what we might call 'motivated' research.

How is research motivated and by what? By definition, scientists are citizens and members of the general public and, like the public, they are motivated by two forces: on the one hand, in Rudyard Kipling's words, "man's insatiable curiosity"; on the other hand, a desire for maintaining and improving

their well-being. These are not contradictory to one another; curiosity nourishes dreams of a brighter future and leads to discoveries that contribute to well-being.

Pasteur understood that it is essential to take account of society's demands and desires; that science must be motivated by what people want. Still, there are severe misgivings about the nature of research. These stem from the mistaken but popular assumption that the scientists' main task is to find solutions to current problems or to fulfil our desires. Problems and desires, however, are not enough, because finding solutions also requires creativity and discovery, which, by their very nature, are unpredictable. Often we do not even know what we need or desire and it is only through curiosity and more knowledge that we find new ways to improve our well-being. Motivation by itself is, therefore, not enough to lead to discovery. Motivation simply helps us choose between many different goals and an infinite number of paths to gain novel knowledge. Subsequently, each path, once chosen, must be explored using the scientific method, which is the only way to new discoveries.

Motivation helps us to ask relevant questions. For example, why do wine and beer go sour without any apparent reason? Pasteur set out to design experiments that showed that fermentation is caused by microorganisms. A few years later, silkworms were suddenly dying of a terrible disease in the silk factories of southern France. The French government called on Pasteur for help, who eventually found that a parasite had infected silkworm eggs and proposed solutions to eradicate the disease. The original question therefore led to germ theory and bacteriology, helped to develop solutions to infectious diseases, and eventually created the whole field of microbiology.

Motivation leads to conceptual and experimental research, which generates discoveries and new technologies. Discoveries,

in turn, are the basic resource for the creation of general knowledge and the development of new products, services and other goods that fulfil public demands and generate jobs. The study of the 'diseases' of beer and wine also led to the development of fermentation processes that are still in use today. The same motivation that drove Pasteur in the nineteenth century now enables us to tackle current problems, such as pollution, by studying microbial communities that make compost or thrive in garbage dumps. Motivated research therefore reconciles our curiosity with the creation of knowledge and enables us to address pressing needs for humanity.

Because it is strongly inspired by—even rooted in—society's demands and desires, motivated research also raises accompanying ethical, legal, social and safety issues that should be compelling for all research. As mentioned above, scientists are members of the public who share the same concerns and demands as their fellow citizens and therefore participate with a general, public intelligence that, too often, is absent from academic research. This absence of 'common sense' or societal expectations generates the misunderstandings concerning research in biology and the development of biotechnology. These misconceptions—whether about the purported risks of genetically modified organisms or the exaggerated expectations for cancer therapies—can create real suffering in society and inefficient allocation of limited resources. It is therefore advisable for researchers to listen more to the public at large in order to find the motivation for their work.

REFERENCE

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EMBO reports (2010) 11, 488. doi:10.1038/embor.2010.85