etics make possible studies that hold out the prospect of discovering whether there are any specific genes that contribute to differences in IQ (R. Plomin, Pennsylvania State University). It is almost certain, however, that no single gene contributes more than a tiny portion towards the overall variability of IQ. This means that traditional methods of linking genes to phenotypes must be modified. Plomin's group employs a technique called allelic association, which uses large samples of unrelated individuals at the two extremes of the IQ range, and analyses DNA markers in or close to genes having products of prima facie neurological relevance (such as dopamine receptor protein and neurofilament protein). The first results using this technique are expected to be published during the coming year.

Third, IQ tests were specifically designed to help predict scholastic achievement, which usually requires specific analytical skills, measured through pen-and-paper tests. Achievement in many endeavours requires other attributes, such as creativity or practical problem-solving. Many of the scholastic tests used to determine entry to higher training have little or no long-term predictive value; for instance, the Graduate Record Exam (GRE), used widely in the United States to select students for graduate study, fails to predict any important outcome other than first-year grades (R. Sternberg, Yale University).

A study of 34 successful mechanical inventors (N. Colangelo, University of Iowa) reinforces this point. None of them excelled at school, won any academic honours, or occupied any positions of leadership. Instead, they all grew up with easy access to materials and tools (many were raised on farms). They began tinkering with things at an early age, and were as likely to take toys apart as to play with them. Their invention was often sparked by the desire to make a household task less of a chore, and by the time of the study the average number of patents filed was 20. Several were millionaires.

Fourth, there is converging evidence that specific biographical and environmental factors are necessary for the development of high ability, such as arduous practice (K. A. Ericsson, Florida State University), motivation for the subject area and family support (M. Csikszentmihalyi, University of Chicago). Biographical studies of large numbers of similar individuals, supplemented by day-to-day tracking through diaries or event sampling, are yielding rich and specific environmental hypotheses which cannot currently be matched by genetic explanations of equal sophistication. For instance, there are simple but effective ways in which parents can secure substantial and long-lasting gains in the speech of their children through a few minutes each day spent in structured, interactive language games (W. Fowler, Center for Early Learning and Child Care, Cambridge, Massachusetts)[3].

The symposium revealed many unresolved scientific challenges. I shall mention two. Different types of high ability require different personal characteristics and 'enabling' conditions, both within certain pursuits and between them. For instance, the individual who redefines a field (the 'genius') may be produced by a very different route to that taken by a successful practitioner who is content to work within the existing constraints of the same field (the 'expert'). What those routes are remains unclear. The same applies to the manifestly different resources and processes required for the creation of a permanent work, such as a symphony or a painting, compared with those involved in bringing off a 'high stakes' performance, such as a successful military campaign (H. Gardner).

The second challenge comes in a variety of forms, and is the need for adequate controls in these studies. Several of the research projects reported at the symposium showed what high achievers had in common. What they did not demonstrate was that appropriately matched low achievers lacked these common features. Although there is a whole range of methodological, conceptual, and practical problems in providing adequate controls, it is clear that some avenues of progress will remain blocked until they become available.

Despite intellectual acknowledgements of the essential duality of the origins of high ability, most individual researchers are emotionally — sometimes passionately — attached to the defence of one extreme. Maybe we should welcome such polarization, for vigorous defence of extreme and sometimes unpopular positions may well be a component of the motivation that spurs creative thinkers forward. But passion within a scientific community is one thing, outside it is another. In the wider world people have done massive violence to one another in the name of such extreme beliefs, and those of us who choose to work in this potentially explosive area bear the responsibility of ensuring that our work does not fan the flames of intolerance. □

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1. Bouchard, T. J. & McGue, M. *Science* **212**, 1051–1059 (1981).
2. Howe, M. J. A. *Fragments of Genius: the Strange Feats of Idiots Savants* (Routledge, London, 1989).
3. Whitehurst, G. J. *et al. Devel. Psychol.* **24**, 552–559 (1988).

DAEDALUS

Slipping along

As a snail or a slug drags itself over the ground, it leaves a trail of slime behind it. This subtle lubricant must save the creature more energy than it needs to make and discard it along its path. Daedalus is now applying the same strategy to those other victims of excessive skin-friction, ships and aircraft.

What sort of slime best lubricates a metal surface? Daedalus recalls the metallocenes — compounds in which a ring of carbon atoms is jointly bound to a metal atom. The ring is loosely coupled to the metal: it can spin freely, for example. Daedalus reasons that such a carbon-ring molecule should be able to wander about a metal surface, stepping sideways from atom to atom. A molecule with several carbon rings, their spacing poorly matched to the atoms of the surface, should 'skate' over it quite freely. As it moved, some rings would bind while others disengaged; so its energy of binding would be almost constant for all positions.

A metal surface, coated with such a bound but perfectly mobile monolayer and placed in an airstream, should lose all viscous drag. Viscosity arises from the sideways diffusion of molecules between adjacent streamlines of different velocity; but the monolayer cannot diffuse away from the surface. It will simply be swept over the metal surface at the speed of the airstream. By travelling freely with the moving air, it will abolish drag.

A dragless, monolayer-lubricated aircraft will be wonderfully economical. It will need to be fitted with special ports along all leading edges, to replenish the lubricant monolayer as fast as it is swept downstream over the metal skin. Along its trailing edges, local heating elements will boil the lubricant away as fast as it arrives. A monolayer contains so few molecules that even a transatlantic flight would disperse a mere few litres of lubricant: comparable with the oil lost by the engines during the flight. The same system on a smaller scale could lubricate the fan and compressor blades of those engines. Enormous savings in fuel would result. The bare, polished metal skin of the craft might offend some airline operators, who would have to abandon the tasteless colour schemes in which they now paint their fleets — at least until a monolayer-lubricated paint can be invented.

The trick should also work with ships. Exuded continuously from the bow, the monolayer will sweep freely back towards the stern, abolishing skin-friction. Barnacles and limpets will also slide along with the monolayer and find themselves tumbling helplessly in the vessel's wake. David Jones