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Cognitive enhancement and education

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Abstract

Cognitive enhancement – augmenting normal cognitive capacities – is not new. Literacy, numeracy, computers, and the practices of science are all cognitive enhancements. Science is now making new cognitive enhancements possible. Biomedical cognitive enhancements (BCEs) include the administration of drugs, implants of genetically engineered or stem-cell grown neural tissue, transcranial magnetic stimulation, computer/brain interface technologies, and (perhaps someday) modification of human embryos by genetic engineering and/or synthetic biology techniques. The same liberal–democratic values that support education as a public institutional endeavor also supply reasons for institutionalizing and publicly supporting BCE. Pursuing the goals of education may require changing what we have hitherto regarded as the individual's 'natural' potential, even in the case of normal individuals, and this may require recourse to BCE. The prospect of BCE raises no novel issues of distributive justice. Like other beneficial innovations, BCEs have the potential to worsen existing unjust inequalities, but they also have the potential to ameliorate them.

Keywords

biomedical cognitive enhancement, education, evolutionary theory, institutionalization, nature

Biomedical cognitive enhancement

Cognitive enhancement – increasing or augmenting the cognitive capacities of human beings – is not new. Literacy, numeracy, and traditional memory training skills are all examples of cognitive enhancement, as are electronic, digitalized information technologies. Science, as a social practice, is a profound cognitive enhancement. Enhancement is typically contrasted with *therapy*, which aims to cure or prevent disease, often understood as an adverse departure from normal species functioning.

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'Biomedical cognitive enhancement' (henceforth BCE) may be defined as the application of biomedical techniques to increase or augment human cognitive capacities. Biomedical cognitive techniques include the administration of drugs, implants of genetically engineered or stem-cell-grown neural tissue, transcranial magnetic stimulation, computer/brain interfacing (already used to simulate vision and enable movement in people with severe neurological damage), and (perhaps someday) the application of genetic engineering and/or synthetic biology methods to human embryos or gametes.

Cognitive capacities include various types or dimensions of memory, reasoning skills, the absorption and organization of information, and so-called executive function, whereby the mind monitors and regulates its own activities. Cognitive functioning might also be improved by augmenting perceptual skills, as when better visual acuity or the ability to encode visual data more rapidly enables an individual to absorb information from a computer screen more effectively. In addition, biomedical interventions that modify affect could improve cognitive functioning by increasing motivation or by calming anxiety. The notion of increasing or augmenting cognitive capacities is broad enough to encompass a pair of distinctions: the improvement of existing capacities versus the creation of new ones; and improvements within the normal range of the cognitive capacities in question versus raising the upper bound of the normal distribution.

At present, BCE is largely limited to the administration of several drugs, all of which were developed as therapies, not enhancements. Drugs designed to treat the symptoms of Alzheimer's dementia (including Aricept), to treat attention deficit disorder with hyperactivity (including Ritalin and Adderall), and to treat narcolepsy (Provigil) have all been shown to improve cognitive function in the cognitively normal. Chemical cognitive enhancement is not new, however: nicotine and caffeine are impressive cognitive enhancement drugs. Hundreds of millions of people take caffeine and nicotine daily, in part to increase alertness, and a substantial number of people, including students at elite colleges and universities, take the therapeutic drugs listed above, in order to improve their cognitive functioning.

Education, like science, is an institutionalized, nonbiomedical cognitive enhancement. In developed countries, this institutionalized cognitive enhancement is available to all citizens. Given that cognitive enhancement is a proximate goal of education, it is surprising that the copious literature on the ethics and social implications of biomedical enhancement has done little to explore the implications of biomedical enhancement for education.

There has been some discussion of the possibility that enhancements might exacerbate inequalities in educational opportunities, on the assumption that they would be affordable only to the better off. But, for the most part, the bioethical literature does not take seriously the possibility that the use of biomedical enhancements will be or should be incorporated into education as an institutional endeavor. Instead, the tendency – especially on the part of the critics of enhancement – has been to assume that, at least in liberal democratic countries, the use of biomedical enhancements will be extra-institutional: that they will be market goods, items of personal consumer choice, and that they will predominantly be zero-sum – that a person's having an enhancement will disadvantage those who lack it.

In this article, I explore the implications of BCE for educational practices and for the philosophy of education, but I will also examine how the values that underlie education

should shape society's response to the growing potential for BCE. My main conclusions can be previewed as follows.

(1) Regardless of whether a BCE qualifies as an instance of education, the same values that support education as a public institutional endeavor also supply reasons for institutionalizing and publicly supporting BCE. Like education, BCE can contribute to the individual's flourishing, can help equip her for fulfilling the role of citizen in a democracy, can contribute to the general well-being by fostering the skills needed for more productive and fulfilling forms of cooperation, and can enable her to avoid economic dependency or, put more positively, to be an effective contributor to productive social cooperation.
(2) (Therefore) in order to argue for public support for and institutionalization of BCE, it is not necessary to rely on illiberal, eugenicist, or perfectionist arguments; the standard liberal democratic arguments for education speak strongly in favor of BCE, whether BCE is viewed as an aspect of education or an adjunct to it.
(3) If BCE is viewed as distinct from education (rather than as an element of it), then it may come to break education's monopoly as the only institutionalized form of cognitive enhancement in which all citizens are expected to participate, with the result that it may compete with education for social resources.
(4) Psychological research indicates that normal human beings typically have a number of cognitive deficiencies, and this result is hardly surprising given an understanding of biological and cultural evolution and interactions between the two. Given that this is so, we must consider the possibility that our conception of education should be expanded to include scientifically informed efforts to remedy biologically or culturally grounded normal cognitive deficiencies, and that in some cases effective remedies may include BCE. At present, the remedial aspect of education is usually understood to include only ameliorating cognitive deficiencies that fall below the low end of the normal distribution of cognitive capacities, but perhaps this will and should change.
(5) In the context of a proper understanding of evolutionary biology, the possibility of BCE undercuts one historically important strand of the philosophy of education, the Rousseauan idea that the proper task of education is to facilitate the actualization of the individual's natural potential, where natural potential is implicitly assumed to be fixed. Given a plausible understanding of molecular-developmental and evolutionary biology, the cognitive potential that human beings typically have is not unalterable and not likely to be optimal. Pursuing the goals of education may require changing what we have hitherto regarded as the individual's 'natural' potential, even in the case of normal individuals, and this, in turn, may require recourse to BCE.
(6) The chief obstacles to a rational appraisal of the potential of BCE and its implications for education are likely to be (a) biomedical enhancement exceptionalism – the failure to appreciate the ubiquity of enhancement in human history, with the result that *biomedical* enhancement is incorrectly assumed to be peculiarly problematic, (b) adherence to an idealized, pre-Darwinian view of the natural as a benign, stable, and densely connected web likely to be disrupted only by deliberate

human interventions, and (c) the dogmatic assumption that all mandatory (non-consensual) biomedical enhancement interventions, including the administration of cognitive enhancement drugs, are *ipso facto* unacceptable from a liberal standpoint.

(7) The prospect of BCE raises no novel issues of distributive justice. Like other beneficial innovations, BCEs have the potential to worsen existing unjust inequalities, but they also have the potential to ameliorate them. Whether BCEs will worsen existing unjust inequalities will depend primarily not only on whether they are (and remain) expensive, but also on whether they are viewed – as education is – as a social good, and more specifically, on whether 'basic biomedical cognitive enhancement,' like basic education, will be publicly subsidized rather than distributed solely according to ability to pay.

Education in an era of biomedical cognitive enhancement

The aims of education

For present purposes, I will simply assume a conception of the goals of education that is relatively uncontroversial, at least from a broadly liberal point of view. Education should aim (i) to promote the individual's flourishing, (ii) to equip her for fulfilling the role of citizen in a democratic polity, (iii) to help her to avoid economic dependency by enabling her to be an effective contributor to productive social cooperation, and (iv) to promote the general (social) well-being by contributing to the development of skills and knowledge that make more productive and fulfilling forms of cooperation possible.

Item (iv) requires comment. In his outstanding volume, *On Education*, Harry Brighouse does not include (iv) among the proper aims of education (Brighouse, 2006). Although he does not consider (iv), he explicitly considers and rejects a possible aim that on a superficial reading might be mistaken for (iv): equipping individuals to contribute to economic growth. Brighouse presumably would agree that the promotion of the general well-being is a legitimate goal of education, so long as it is pursued in ways that do not violate individual rights. Otherwise, it would be hard to explain his inclusion of goal (ii), since, for many people, their participation in political processes contributes only minimally, if at all, to their own well-being.

Brighouse's rejection of the promotion of economic growth as a legitimate aim of education has a different source: he thinks there is good empirical evidence that, beyond a certain point, increased wealth does not bring greater well-being. That may be the case, but there are two reasons why that point does not imply that promotion of the general well-being through increased productivity should not be an aim of education, albeit a subordinate one. First, and most obviously, most of the world's population has not reached the point where increase in wealth due to greater productivity does not improve well-being. Brighouse might agree and say that he is only specifying the goals of education for affluent societies. Second, Brighouse seems to overlook the possibility that education, or other modes of cognitive enhancement, may eventually make possible new, more complex, more productive, and more fulfilling forms of cooperation in the future. Being able to participate more effectively in more complex forms of cooperation may not

just be conducive to creating more wealth, but also valuable for two other reasons: it can enable us to accomplish things we couldn't accomplish through less complex forms of cooperation, and participation in complex forms of cooperation can itself be fulfilling. Engagement in more complex forms of cooperation can make a significant contribution to human flourishing, independently of its greater effectiveness in achieving ends that are external to it.

Future enhanced cooperators may think that today's most complex forms of cooperation are to what they are capable of as the child's card game Go Fish is to contract Bridge. To make this point still more concrete, consider the case of literacy, perhaps the most impressive cognitive enhancement to date. Literacy, when taken along with other developments, including numeracy, and the transition from hunting and gathering to agriculture and later to industrialization, has contributed to the creation of wealth; but it has also improved human life in other ways, in part by making possible new accomplishments and new, fulfilling forms of human interaction that extend across space and time, linking not only contemporaries who will never meet face to face, but also individuals who are separated by thousands of years.

Education, like cognitive enhancements generally, is characterized by *network* effects: the benefit of the enhancement to an individual tends to increase as more individuals have the enhancement. (Being literate or having access to a computer is much less valuable if only you or a few people have these enhancements.) Focusing only on aim (i), education's contribution to *the well-being of the individual who is educated*, obscures the importance of network effects and hence overlooks important contributions that education can make to the general well-being. The same is true for cognitive enhancement. Generally speaking, more productive and fulfilling forms of cooperation are made possible by the diffusion of enhancements that are characterized by network effects. This point has considerable significance for the prospect of biomedical cognitive enhancements, because, qua cognitive enhancements, they are almost certain to be characterized by network effects.

Biomedical enhancement and the aims of education

It is difficult to know to what extent biomedical enhancements could further the aims of education, simply because we are only now beginning to develop the relevant technologies. Moreover, at present there is relatively little research aimed at enhancement. All of the cognitive enhancement drugs mentioned earlier were developed as therapies, not enhancements. If enhancement comes to be viewed as a legitimate use for biotechnologies, then BCEs may develop systematically, rather than as a fortuitous spin-off from therapies, and may become valuable for promoting the aims of education.

Suppose, for example, that safe new drugs are developed for the purpose of facilitating learning in cognitively normal people. They might do this by increasing our ability to concentrate for longer periods of time (without the nervousness that caffeine often produces); or they might increase the efficiency with which the brain transfers items from short-term to long-term memory; or they might increase the efficiency of information retrieval from long-term memory. Alternatively, drugs might be developed that would enhance our ability to process visual information from computer screens. At

present, the capacities of computers far outstrip the capacities of humans fully to utilize them, in part because of the limitations of normal human vision. Ameliorating the deficiencies of the human terminus of the computer/human interface might be achieved through drugs or, radically, through direct brain–computer interface technologies, perhaps utilizing nano-connectors to mate nerve endings to electrodes.

Here it is worth noting that using ingested compounds to enhance learning is already a widespread practice in schools: school meal programs are designed to improve cognitive function by supplying needed nutrients. In particular, fish often figures prominently on school menus because it is thought that the fatty acids it contains are good for the brain (whether that benefit outweighs the detrimental effect of mercury contamination is another matter). Similarly, pregnant women take vitamins to facilitate the neurological development of the fetus, and this too eventually helps to increase the efficacy of educational efforts.

Glucose is especially important for brain function. Whether they understand the relevant brain science or not, many people manipulate the levels of glucose in their brains – for example, by eating a candy bar in the mid-afternoon to counteract the tendency to become less alert. In the future, individuals may manage this aspect of brain chemistry more scientifically, perhaps through self-administered monitoring technologies that will enable them to determine optimal doses of glucose and by using delivery systems that get glucose to the brain more quickly (and without the health risks of high-calorie, fat-laden candy bars).

In the broadest sense, a drug is any chemical substance introduced into the body with the aim of producing a physiological effect. In that sense, sugar and caffeine are drugs, and presumably there is nothing wrong with using them to enhance cognitive function. So, if pharmaceutical enhancements – *designed* chemical enhancements – are objectionable, it must be for some other reason than that they are drugs. The question, then, is whether, in addition to those drugs we call nutrients (like sugar or omega oils from fish) or stimulants (such as caffeine), we should also include drugs developed by pharmaceutical companies, in our efforts to affect human physiology in ways that promote learning. On the face of it, the answer seems to be 'yes'.

Notice that it would be a mistake to think that pharmaceutical enhancements are inherently more risky than the 'folk' enhancements we already use. As I already mentioned, eating fish to improve cognitive functioning carries a serious risk, neurological damage from mercury; and managing the levels of glucose in one's brain by consuming candy bars has negative side-effects as well. Moreover, 'natural' foods often contain toxins that have developed, through natural selection, to prevent predators from eating them. Indeed there is evidence that in some cases organic vegetables, again through natural selection, evolve to develop higher levels of these 'natural' pesticides than vegetables that are treated with man-made pesticides. Here, as elsewhere, it is important to avoid both biomedical enhancement exceptionalism and the more general error of thinking that the 'natural' is inherently good or safe.

Educational practice in some countries has already incorporated the administration of pharmaceutical enhancements for certain subpopulations. So far, the routine administration of drugs such as Ritalin, for purposes of facilitating learning, has been restricted to individuals diagnosed as having a cognitive disorder or disease. As the technology of

pharmaceutical cognitive enhancement progresses, two questions will rise to the top of the agenda for educational policy: (i) should educational practice be expanded to include the administration of drugs to facilitate learning in individuals who do not have a disease or disorder but who are at the lower end of the 'normal' distribution of some dimension of cognitive functioning, and (ii) should educational practice be expanded even further to include administration of cognitive enhancement drugs to individuals who are at average or better levels of cognitive functioning? By 'educational practice' I mean both what goes on in schools and what is accepted, as a matter of social practice, as supporting the educational effort within schools (for example, parents administering drugs to their children in order to facilitate learning in the school context).

Enhancement, nature, and the natural

Given that cognitive enhancement pharmaceuticals could further the goals of education, there is a *prima facie* case for incorporating them into educational practice or using them to supplement education, if they are safe and cost-effective. Yet I am sure that many would object to their use. My surmise is that those who would object would do so for one or both of two reasons: (i) They assume that man-made drugs (i.e. pharmaceuticals) are less safe than sugar and caffeine because they are not 'natural'; or (ii) they have no objection to administering drugs to improve lower than normal cognitive functioning, but disapprove of using them to boost normal functioning. The first assumption is easily disposed of: As I have already observed, 'natural' chemical compounds, that is, those that are not man-made, are not inherently safer than man-made drugs – in fact, nature produces the most deadly toxins (so far). As a 'natural' cognitive enhancement drug, global use of nicotine may rival or exceed that of caffeine, but it is much less safe than any of the existing pharmaceutical cognitive enhancements. Large-scale substitution of a safe pharmaceutical enhancement for the deadly folk cognitive enhancement we call smoking would be a major public health victory.

There is every reason to believe that safe pharmaceutical enhancements will be developed and probably quite soon. The point is that when it comes to drugs, being 'natural' (i.e., not a product of pharmaceutical research and development) is not a good proxy for safety. So the question remains: If pharmaceutical BCEs become safe and cost-effective, why shouldn't they be used to further the goals of education?

Now consider (ii), the assumption that using drugs to treat cognitive diseases or disorders is permissible, but that using them to improve normal functioning is wrong. If the goal is to facilitate learning, why not use safe cognitive enhancement pharmaceuticals whenever they will do that (and are cost-effective)? To say that it is permissible to treat disorders but not to enhance normal function simply begs the question regarding enhancement.[1]

I suspect that what lies behind both assumptions (i) and (ii) is a pre-Darwinian view of nature, one according to which nature produces stable, harmonious, optimally functioning organisms that will continue indefinitely to function well unless the benign complexity of their interrelated parts and functions is unwittingly disrupted by the deliberate interventions of human beings. Russell Powell and I have argued elsewhere that the harshest critics of biomedical enhancement tend to assume this view of nature, even

when they use the language of evolutionary biology (Buchanan, 2009; Buchanan, 2010: chs 2–3; Powell and Buchanan, 2010). For example, they think of the individual organism as the product of the Master Engineer of evolution (more specifically natural selection), an exquisitely 'balanced', stable product, artfully designed to function well in its environment, as the result of 'eons of exacting evolution' (Kass, 2003: 287–8).

This view of evolution, and more specifically of how natural selection operates, is wildly inaccurate. What natural selection does is to produce cobbled-together, imperfect solutions to short-term environmental challenges. This fundamental point is expressed forcefully in a letter Darwin wrote to his friend Joseph Hooker: 'What a book a Devil's chaplain might right about the clumsy, low, and horridly cruel works of nature' (quoted in Dawkins, 2003). In fact, contrary to common opinion, it is misleading to say that Darwin showed there can be intelligent design without God. It would be more accurate to say that he showed that the origins of complex biological functions and the seemingly goal-directed behavior of biological systems can be explained without recourse to *intelligent* design. That is the point of the adjective 'clumsy' in the passage cited above.

Not all traits are adaptations; many are results of drift or are 'spandrels', that is, mere concomitants of adaptations that make no contribution to inclusive reproductive fitness. Further, it is crucial to remember that to say that a trait is an adaptation is to use the indicative to make a statement about the past. In other words, 'adaptation' is an etiological term: to say a trait is an adaptation is to say that it spread through a population at some time in the past because having it tended to contribute to inclusive reproductive fitness *in the environment that existed at that time*. Hence a trait's being an adaptation implies nothing whatsoever about its current contribution to fitness. What was valuable from the standpoint of inclusive reproductive fitness may now be useless or lethal.

Moreover, gains in inclusive reproductive fitness almost always come at a price. For example, the transition to bipedalism may have increased the inclusive fitness of our ancestral hominids, but it also saddled us with lower back and knee problems. Similarly, spread of the sickle cell genes improved resistance to malaria but at the price of a debilitating and lethal illness for those who inherited two copies of the gene in question.

To say that the current ensemble of traits in a given species is optimal means only that there is no *incremental change of the sort that the combination of blind variation and natural selection could achieve* that would improve its members' chances of passing on their genes to future generations. One consequence of this crucial point is that species are liable to 'local optimality traps': there is some alteration of their traits that would elevate them to a higher level of inclusive fitness, but because of the constraints under which natural selection operates, they 'can't get there from here', because some of the incremental changes needed to reach a higher fitness peak would critically reduce fitness.
According to the Darwinian view, evolved organisms are not harmonious, stable wholes: they are internally conflicted, because selection operates on individual traits, not systematically across the whole ensemble of traits, with the result that newly selected traits can clash with pre-existing ones. In other words, natural selection can act on multiple biological levels simultaneously, and antagonistically so. Selection can push one way at the level of genes within cell lines, another at the level of cell lines within organisms, another at the level of organisms within populations, population within species, species within clades, and so forth. The fact that there may be natural selection arms races at different

biological levels simultaneously (as well as among conspecifics and between species) seriously undermines the potential for selection-created 'balance.' Selection not only does not produce harmony – it actively undermines it.[2]

Organisms are no more stable than they are optimal or harmonious. Traits undergo modification in response to environmental challenges and the environment is constantly changing (the so-called Red Queen effect – organisms have to run faster just to stay where they are, as the ground crumbles beneath their feet).

Most important of all, in the case of human beings, our own actions, usually unwittingly, continue to produce ever more rapid and profound changes in our environment. That is why there is good reason to worry that natural selection is too slow to enable us to adapt successfully to the problems we are creating. In some cases, cultural changes may occur soon enough to solve the problems we create, but it would be unreasonable to assume that we will never need to intervene in normal human biology to help cope with them.[3]

A proper understanding of evolutionary biology also explodes the idea that organisms are such seamless webs, such densely interconnected wholes, that it would never be prudent to intervene by biomedical means to try to improve their normal functioning. The grain of truth in the seamless web metaphor is that organisms are complex (and some, like humans, are more complex than many others), but complexity is not the same as seamlessness. Biological complexity, in simplest terms, is a matter of the number of individuated structures in a particular organism, while seamlessness implies extreme density of the interconnections between various structures. Complexity does not imply seamlessness.

The seamless web metaphor conveys the idea that the components of organisms are so densely interconnected that changing one component is likely to have disastrous results. In fact, given how natural selection works, we should expect just the opposite. Because natural selection works incrementally, an organism that was prone to unravel in the face of small changes wouldn't be likely to survive. If organisms were so 'finely balanced' that any attempt to improve their normal functioning would be foolhardy, it is hard to see how they could be resilient and flexible enough to adapt to changing environmental challenges.

There are at least three specific features of complex organisms that also militate against the seamless web metaphor: modularity, redundancy, and canalization. A module, by definition, has denser connections within than it does to systems or subsystems outside it. There are good evolutionary reasons why we should expect modularity to be pervasive; in particular, modularity allows for the development of new functions without wholesale revision of the organism's design. The big point about modules is that they are like seams (or, to switch metaphors, firewalls). Genetic canalization is the tendency of an ontogenic system to produce the same phenotype across variations in genotype. In layman's terms: different recipes, same dish. Where canalization is present, it is false to say that the organism is a 'finely balanced' whole, if this implies that any intervention is likely to produce catastrophic results. Finally, redundancy occurs at many levels, from multiple copies of the same gene, to organs and subsystems that do the same work, to the plasticity of the brain, which can reconfigure or create new neural connections to perform the functions of damaged issue. Redundancy provides a degree of safety, an obstacle to a seemingly small intervention producing disastrous results.

If we wrongly think of the evolved organism as a stable, harmonious, optimal, densely interconnected whole, we will think that the greatest threat it faces is human intervention, so we will regard biomedical interventions generally as forever unconscionably risky. We may make an exception for therapies, thinking of them as remedies for the exceptional cases where an individual organism for some reason has experienced an adverse departure from the wonderful adaptiveness that we wrongly take to be typical.

This distorted understanding of nature encourages the view that we will never know enough to make reasonable biomedical interventions for the sake of improving normal functioning. Once we dispense with it, we are in a better position to attempt rational assessments of the risks and benefits of cognitive enhancement. In particular, we can begin to develop a proper appreciation of how beneficial various cognitive enhancements might be. To do that, we must first gain an accurate understanding of the limitations of normal cognitive functioning in human beings. If these limitations turn out to be significant, then, other things being equal, there is a stronger case for BCE.

Normal cognitive deficiencies

Over the past two decades, an impressive body of empirical research has accumulated on cognitive biases in cognitively normal human beings. One central strand in this research understands at least some cognitive biases as heuristics – simple strategies that serve as proxies for complex solutions (to cognitive challenges) that are not ordinarily available to beings characterized by the sort of 'bounded rationality' found in humans. Whether or not all 'normal' cognitive biases are heuristics and whether, if they are, they are acceptably good proxies for more complex solutions that are in principle more satisfactory, are difficult questions on which expert opinion is divided. But this much is clear: even if (as seems doubtful), all 'normal' cognitive biases make some positive contribution to cognitive performance in some circumstances, there is no reason to think that they are all cognitively optimal, that is, that none of them can be improved upon. For one thing, even if we assume that existing 'normal' cognitive biases are adaptations, the environments in which they developed may no longer be predominant in human life, and new ways of coping with present environmental challenges may be needed.

Consider the tendency to discount excessively future benefits or costs. Both rigorous research and common sense acknowledge that this cognitive defect is typically most pronounced in children and adolescents, but there is also evidence that adults are prone to it as well. Consider also confirmation bias – the tendency to be more attentive to and/or to give more weight to evidence that supports beliefs one already holds than to evidence that disconfirms them. It is doubtful whether these biases now serve any useful purpose that would compensate adequately for their interference with sound cognitive functioning. But, even if they did, it would be close to miraculous if they happened to be optimally calibrated to deliver maximal cognitive performance.

At present not enough is known about the underlying biology of actual risk assessments or belief-formation to even begin to suggest biomedical interventions that would ameliorate excessive discounting of future consequences or confirmation bias. But suppose that our knowledge continues to increase and that at some point we are able to devise effective strategies for ameliorating such 'normal' cognitive defects. There is little reason

to think that effective amelioration would be by purely biomedical means; instead, it might be a matter of combining biomedical interventions with something more like traditional educational techniques. We already have examples of how the latter can overcome pervasive cognitive defects: for instance, a person who studies elementary probability theory can come to recognize the gambler's fallacy and deliberately avoid committing it.

How might a biomedical intervention, perhaps in combination with a traditional educational intervention, help overcome a 'normal' cognitive defect? Anything one might say here will be uncomfortably speculative, but speculation may nonetheless be useful for testing our moral intuitions.

Some contributors to the research literature on cognitive biases distinguish between System I and System II cognitive processes. The former are more intuitive and perception-like; the latter are more consciously discursive and rule-bound. Suppose, as some researchers think, that System I processes are prone to certain errors. Suppose also that there is a biochemical element in the mechanism by which System II gets activated. Suppose further that the activation mechanism for System II processing in normal human beings is less than optimal: cognitively normal humans tend to underutilize System II processing – System I frequently comes into play when it would be better, from the standpoint of cognitive performance, if System II were used instead.

Suppose also that when certain emotions are present or reach certain levels of intensity, individuals tend to underutilize System II processes, that is, that the emotions in question block activation of System II. Understanding the biochemistry of the system activation mechanism might eventually make it possible to administer a drug that would result in a more efficient allocation of tasks between System I and System II processes, by reducing the emotions that are blocking the activation of System II. This would be an instance of a BME: a biomedical intervention to improve cognitive functioning in cognitively normal individuals. This hypothetical example suggests a more general point: BCE to ameliorate 'normal' cognitive deficiencies would be distinctively valuable in cases in which the trigger for a defective cognitive operation is not within the individual's conscious control – in other words, in cases *unlike* the gambler's fallacy.

The threads of this brief discussion of normal cognitive defects can now be pulled together. An accurate picture of how evolution works generates the expectation that our normal cognitive processes are not perfect, and empirical research on cognitive biases confirms this suspicion. If the goal is to improve cognitive performance, then this should include ameliorating defects in normal cognition, as well as adverse departures from normal cognitive functioning, as occurs in cognitive disorders. Further, if *biomedical* interventions can help ameliorate normal cognitive errors, then there is a strong case for using them when they can be used safely and are cost-effective.

An appreciation of the fact that normal human cognitive functioning is defective has important implications not just for BCE but for education as well. Education should include efforts to ameliorate normal cognitive defects, not just 'special education' to cope with those whose cognitive performance falls below what is normal for humans. To the extent that normal cognitive defects depend even in part on our biology, we must recognize that normal human biology is not sacrosanct. In some cases, pursuing the goals of education may require measures to override our biologically grounded cognitive responses; in others it may require altering our biology.

Rousseau's error

There is a perennial strand of educational philosophy that received its most forceful and perhaps most influential expression (at least in the West) in Rousseau's *Emile*. In simplest terms, Rousseau's message is that the proper goal of education is to facilitate the unfolding or realization of the child's natural potential. I suspect that Rousseau's advocacy of this view rested on two assumptions: that the natural is wholly good and that an individual's nature is unalterable.

Given an evolutionary biological view of the natural, the first assumption, for reasons already noted, has nothing to be said for it. The second claim is also clearly false, if by the child's nature we mean its biological endowment. If our normal human biology is in some respects deficient from the standpoint of that which we rightly value, including good cognitive performance, and if we can safely and cost-effectively correct for these deficiencies, then we ought to do so, other things being equal. Depending upon one's conception of education, biomedical correction of normal cognitive deficiencies would be either a part of the educational enterprise or a supplement to it. If biomedical interventions are thought of not as part of education, but as a supplement to it, then the proper conclusion to draw is that education should not have an institutional monopoly on the improvement of normal cognitive performance. Education and BCE would have to compete for funds allocated for improving cognitive performance.

Concerns about biomedical cognitive enhancement

The worry about (over-)medicalization

Those who are already concerned about the use of drugs like Ritalin to treat attention deficit disorder with hyperactivity (ADDH) in school-age children, may find the prospect of more extensive pharmaceutical interventions in the service of educational goals very troubling. In particular, they may fear that there will be a strong temptation to seek chemical magic bullets for solving problems better addressed by other means. Such worries should not be dismissed, but it is important to understand that if pharmaceutical BCE became an accepted component in a larger social effort to further the goals of education, one problem associated with the current use of drugs like Ritalin might actually be alleviated. At present, in order to get (legal) access to Ritalin to improve concentration, a child must be diagnosed as having a disorder. This has two unfortunate results: first, there is a risk of stigma; second, there is an understandable tendency toward diagnosis creep – pressure for lower standards for what counts as having the disorder. Once it is recognized that even normal cognitive performance is less than optimal, then being diagnosed as suffering a disorder will no longer be the price of access to pharmaceutical BCEs, and both the risk of stigmatization and the tendency to stretch diagnostic criteria should be diminished. The question will not be whether the child has a cognitive disorder, but whether her cognitive performance can be safely and cost-effectively improved.

The concern that BCEs might provide an overused quick-fix may be related to an assumption about the nature of education. On some accounts, education involves cognitive gains that are about brought in ways that engage the student's will. Some such notion may be invoked to distinguish education from indoctrination. Those who hold this view will

insist that BCE cannot be a part of education, because it bypasses the will. In one sense, this may not be correct: if I deliberately choose to take a cognitive enhancement drug, then my will is certainly engaged. Nonetheless, it is true that the way this cognitive enhancement works does not involve my will. On this conception of education, BCEs would not be part of education properly speaking; they would not be alternative forms of education to traditional learning techniques. Yet they might still be important contributors to the success of education properly speaking, and incorporating them into educational practices, as useful facilitators of learning, might be appropriate.

Some might fear that cognitive enhancement drugs would diminish the active engagement of the student's will and the rich web of human interactions that they believe are essential to education. This fear is based on an unjustified assumption about how cognitive enhancement drugs work: they do not substitute for the normal cognitive processes; they enable them to function better. Consequently, if cognitive enhancement drugs were routinely used to facilitate learning, there is no reason to believe that engagement with the student's will or human interactions would be detrimentally diminished. Here, an analogy with performance enhancing drugs in sport may be helpful. Such drugs do not enable a sedentary, unatheletic individual to magically acquire athletic skills. Instead, they enable an athlete to get more out of her natural talents, by rendering the hard processes of training and conditioning more productive. Even if cognitive enhancement drugs did in some cases reduce the effort needed to learn, it is absurd to fear that they would produce a shortage of opportunities for exerting effort. For example, if they reduced the amount of rote learning of basic facts in a domain of learning, they would thereby free the student to exert effort on more challenging tasks.

Distributive justice

Some oppose biomedical enhancements generally, including BCEs, not because they have scruples against humans being 'better than normal' or because they think it is always too risky to try to improve upon our natural endowments, but because they assume that enhancements will worsen existing distributive injustices. It is quite proper to be concerned about access to BCEs (and other enhancements), but there are several reasons to reject the extreme view that the risk of injustices is so great that we should abstain from developing BCEs.

First, BCEs could be used in ways that would lessen inequalities that constitute or can result in injustices. For example, it appears that current cognitive enhancement pharmaceuticals tend to produce the greatest gains in cognitive performance in those who are at the lower end of the normal distribution of the cognitive capacities in question. If this pattern of relative efficacy turns out to be a general characteristic of pharmaceutical BCEs, then this will be good news for those who are concerned with unfairness in the distribution of natural endowments.

Second, those who believe that BCEs will pose serious if not insurmountable problems of distributive injustice apparently make two highly problematic assumptions: that BCEs will be and will remain very costly, and that access to them will be determined by ability to pay. In the case of pharmaceutical BCEs, which are for the foreseeable future

the most likely form that enhancement by biomedical means is likely to take, prices will fall markedly once drugs go off patent and generics become available. At present Walmart offers more than a hundred prescription drugs in generic form, at $4.00 for a monthly supply. That is almost 30 times cheaper than a month's supply of a daily chemical cognitive enhancement at Starbucks. If pharmaceutical BCEs are distributed as market goods, according to individuals' ability to pay from their own resources, then the price may be high at first, but it is not likely to remain high.

It is a mistake to assume, however, that BCEs will be treated as market goods. If pharmaceutical BCEs are seen to be important resources for furthering the goals of education or if governments come to see them as means of increasing national productivity, then they may be publicly subsidized, as education is today.

Third, generally speaking, it would be unreasonable to hold that justice demands that cognitive enhancements should not be available to any until they are available to all. If that were the case, then literacy campaigns in India should cease until literacy levels in Pakistan catch up. At present, there is no reason to assume that the justice-related effects of pharmaceutical BCEs are likely to be anywhere near as powerful as those of literacy. To allow different rates of progress toward literacy while banning pharmaceutical BCEs until they are available to all would be a clear case of biomedical enhancement exceptionalism.

Finally, any attempt to ban pharmaceutical BCE is likely to be futile anyway. Pharmaceutical BCEs will presumably continue to emerge as unintended benefits of new therapeutic drugs, and preventing 'off-label' uses as enhancement drugs is simply not practical. Even if a ban were achieved in some countries, research and development of pharmaceutical BCEs would simply go underground or relocate in countries that did not attempt to ban them or that lack the administrative and enforcement infrastructure to implement a ban effectively.

A more reasonable and constructive approach would be to try to develop public policies that will speed up the diffusion of highly beneficial, safe, pharmaceutical BCEs, as part of a broader effort to help ensure that valuable innovations become widely available quickly. So far, public and scholarly discussion has focused rather narrowly on only one aspect of the problem of justice in the creation and diffusion of valuable innovations – the so-called 'essential medicines' problem. This is really two distinct problems: first, therapeutic drugs that now exist are not affordable by millions of people in less developed countries; and second, pharmaceutical research invests relatively little in attempts to develop drugs to combat diseases prevalent in less-developed countries because the market for developed country diseases is more profitable. As I have argued in detail elsewhere, a reasonable strategy for coping with the essential medicines problem would be only one component of a broader response to the problem of justice in the creation and diffusion of valuable innovations (Buchanan et al., forthcoming). Although I cannot expand on this point here, it seems evident that this broader response will require institutional innovation at the global level, including modifications of current intellectual property rights. The main point I wish to urge here, however, is that although worries about distributive justice concerning access to BCE are warranted, there is no reason to think that they are unique to BCE or that they will require unique responses.

Mandatory education, mandatory BCE?

Thus far I have explored the possibility of biomedical cognitive enhancement, argued that BCE could become a valuable resource for pursuing the goals of education, and suggested that whatever problems of distributive justice such technologies pose are not unique but instead merely one aspect of a more general problem of justice in the creation and diffusion of valuable innovations.

I have also argued that the same justifications given for public support for education – and for a social commitment to ensuring universal access to education – also apply to BCE. Finally, I have shown that it is a mistake to think that normal human cognition is either optimal or unalterable, and urged consideration of the possibility of improving it either through nonbiomedical educational measures or through BCE or a combination of the two.

It might be objected, however, that there is a morally relevant difference between education as we have known it and BCE: because BCE involves intrusions into the body, considerations that are sufficient to justify mandatory education are not sufficient to justify mandatory BCE, even when it is deployed to further the same goals toward which education is directed.

Although I do not believe that this objection is cogent, I am aware that it deserves more attention than I can give it within the confines of this article. At most, I can only indicate some of the reasons why I believe it does not show that mandatory administration of BCEs as part of a public education endeavor would never be permissible. More specifically, I want to make plausible the view that *if* it is justifiable to make conventional education mandatory, then it is implausible to assume that mandatory pharmaceutical cognitive enhancement in the pursuit of the central aims of education could never be justified.

The greatest difficulty in assessing the cogency of this objection is this: many of us may have strong intuitive aversion to the idea of normal, healthy children being required to take drugs to improve their cognitive performance, but our aversion could have several quite distinct sources. We could be rightly concerned that in this case, as in many others in the history of public education, a supposedly beneficial policy would turn out to be ill advised. In the case of BCEs it might turn out that the drug was not in fact safe. Or it might turn out that the decision to make the drug mandatory was based on a class-biased understanding of what would count as a cognitive enhancement – after all, the track-record of public educators regarding the concept of intelligence does not inspire confidence. In brief, our negative intuitions about mandatory BCE may be grounded in our inability to take seriously the premise that the drug in question would truly be safe and that it would actually improve cognitive performance in some significant fashion. At this point in time, our experience with BCE may be so limited that we are simply unable to access intuitions regarding *it* and accurately distinguish them from intuitions prompted by fears about its safety or misuse.

Suppose for a moment that we can bracket that problem regarding the validity of our intuitions. I suspect that some who would oppose mandatory BCE might try to explain their opposition as follows. 'Unlike ordinary educational techniques, BCE involves intrusion into the child's body, and, quite apart from any issues of safety or efficacy, such intrusion is only justified if it is necessary to avert a harm or prevent a disease (as in the case of mandatory vaccination). Improving cognitive performance in normal children is not a matter of averting harm or preventing disease. Therefore, it would be unjustified.'

There are two reasons why this line of thought is unconvincing. First, depending on how serious normal human cognitive deficiencies are, ameliorating them may in fact avert considerable harm. Perhaps human cognitive capacities, which developed in an environment radically different from the one we find ourselves in now, cannot be relied upon to enable us to prevent some of the harms to which we are now liable, but which our ancestors didn't face. Global climate change may be an apt example.

Here it is useful to distinguish two different senses in which normal human cognition can be deficient. First, human beings who do not suffer cognitive disorders such as Alzheimer's dementia or traumatic damage to the brain – what I have referred to earlier as cognitively normal individuals – may in fact be prone to predictable errors of judgment or reasoning, as the psychological literature indicates. Second, even if all deficiencies of this first type were corrected, normal human cognition may not be adequate to the challenges we now face or may face in the future. It may be valuable, and perhaps even necessary for our survival, not only to eliminate or compensate for predictable errors of judgment or reasoning, but also to increase our capacity for absorbing and integrating information.

It is most likely that improvements of this latter sort will come in the form of what might be called external cognitive enhancements, mainly the development of better computer hardware and software. But it would be a mistake to assume that none of the needed improvements will require any biomedical interventions.

I mentioned earlier that we can think of science as an institutionalized cognitive enhancement. Most would agree that if we are to respond successfully to threats such as global climate change and emerging pandemics, we will have to rely on science. Suppose that it turns out, eventually, that the numbers and the quality of participants in the scientific enterprise can be increased by incorporating certain pharmaceutical BCEs into the public education endeavor. More specifically, pharmaceutical interventions might well enable more people to learn more quickly and to master more complex knowledge. Under these circumstances, BCEs might play a limited though significant role in complex strategies to avert great harms, by increasing the power of science as an institutionalized cognitive enhancement.

Be that as it may, it is simply not clear that safe and effective 'bodily intrusions' as benign as taking a pill are only justified to avert harms or prevent diseases. If the benefits of BCE – in terms of enabling more complex, productive, and rewarding forms of cooperation – are great enough, that may suffice to justify the minor bodily intrusion that pharmaceutical BCE requires. After all, it is a mistake to assume that simply because the administration of a pharmaceutical BCE involves the physical act of ingesting a pill that somehow raises the moral stakes. Literacy and all other traditional BCEs produce measurable and physical changes in the child, including changes in the microstructure of the brain. Moreover, the cumulative psychological changes that education produces in an individual dwarf the changes that administration of a pharmaceutical BCE are likely to cause. Once we realize that traditional education involves profound nonconsensual psychological changes in the child, physical effects (e.g. on the brain), significant interference with liberty, and intrusions into family life, it becomes harder to defend the assumption that pharmaceutical BCE in the pursuit of basic educational goals would never be permissible. It is also worth pointing out that if the benefits of BCEs are made clear and reasonable assurance of their safety is provided, many parents will not object to their children receiving them, so the issue of coercion will not often arise.

In a society in which the better off will predictably utilize BCE, harnessing BCE to the public educational enterprise would have two significant advantages. First, it would avoid the risks that are attendant on a large-scale, uncontrolled and unmonitored social experiment of the sort that is going on right now – where thousands of people are taking prescription drugs in order to enhance their cognitive performance without medical supervision and without any attempt to assess the risk of long-term adverse affects. Second, it would ensure that access to CBE is not limited to the well-off and create the opportunity for using CBE to reduce rather than to exacerbate unfair inequalities in natural endowments.

Conclusion

The aim of this article has been to begin the complex task of exploring the implications of biomedical cognitive enhancements for educational practices and for the philosophy of education. I have argued that from a broadly liberal perspective there is a strong *prima facie* case for developing biomedical cognitive enhancements to help fulfill the central aims of education. I have also argued that the most severe obstacles to a serious consideration of the possibility of using biomedical cognitive enhancements to further educational aims are biomedical enhancement exceptionalism, the unwarranted assumption that enhancements that employ biotechnologies are peculiarly problematic; a distorted, pre-Darwinian, idealized view of 'the natural'; and the mistaken view that biomedical cognitive enhancements will be purely personal, zero-sum consumption goods – which overlooks the fact that biomedical enhancements will have network effects and will have the potential to make significant, large-scale contributions to social well-being, through enabling more complex, productive, and inherently fulfilling forms of cooperation. Finally, I have argued that a scientifically informed understanding of human cognition speaks in favor of developing biomedical technologies to ameliorate widespread cognitive deficiencies in cognitively normal individuals and lends plausibility to the idea that our conception of remedial education should be expanded accordingly.

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Notes

1. Rejections of enhancements per se are unconvincing. Michael Sandel (2007) appears to condemn all enhancements as such, on the grounds that the very pursuit of enhancement 'represents' an unseemly quest for total mastery. As a claim about the concept of enhancement, this is patently false: to enhance is to improve some capacity, and that does not 'represent' the quest for mastery. As a claim about the motivations of those who seek or approve of enhancements, it is a sweeping, counterintuitive, and unsupported generalization: sometimes, probably often, the effort to improve is just that and is not an expression of the delusional quest for total mastery. For example, if a parent seeks to enhance her child's cognitive powers by educating her, the parent need not be striving for a perfect child or trying to achieve total mastery over the child and her situation. Sandel gives no reason to think why biomedical enhancements are different from enhancements generally and his 'arguments', were they valid, would apply equally

to nonbiomedical enhancements, including education, literacy, numeracy, and science. For a detailed analysis of the paucity of Sandel's case against enhancement (which he steadfastly confuses with a case against perfection), see Buchanan (2010). Aside from Sandel's confusion of enhancement with the pursuit of perfection, the other reason usually given to reject all biomedical enhancements is of the slippery slope variety: if we engage in biomedical enhancement, we will never stop our efforts to improve ourselves, with the result that we will fail to appreciate and enjoy the goods we have. The difficulty with this view is two-fold: It doesn't explain why the problem only attaches to *biomedical* enhancements (as opposed to enhancements such as literacy, numeracy, and scientific practice), and it doesn't consider the possibility that a combination of cost and moral constraint achieved through social norms and policies can put the brakes on the supposed slide toward the monomaniacal pursuit of endless improvement.

2. I thank Russell Powell for making this point clear to me.
3. Because of medical advances and various interventions in the human environment (including sanitation and other public health measures, as well as the development of agricultural practices that have resulted in the eradication of chronic malnutrition for hundreds of millions of human beings), life expectancy in many countries has increased dramatically. The result is that many more people will suffer Alzheimer's and other dementias (30% of people over 85 and 50% of those over 90 will suffer Alzheimer's). Biomedical interventions, perhaps in the form of pharmaceuticals or genetically engineered tissue implants, may be needed to remedy this situation. Whether such interventions would count as enhancements or therapies is disputable. On the one hand, if they involved fundamental changes in the normal aging processes of brain cells, they would arguably count as enhancements. On the other, if dementia is regarded as a disease, say an adverse departure from normal species function, they might be regarded as therapies.

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