CONTRIVERSY

The bioethics of enhancing human performance for spaceflight

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There are many ways of enhancing human performance. For military aviation in general, and for spaceflight in particular, the most important tools are selection, training, equipment, pharmacology, and surgery. In the future, genetic manipulation may be feasible. For each of these tools, the specific modalities available range from the ethically acceptable to the ethically unacceptable. Even when someone consents to a particular procedure to enhance performance, the action may be ethically unacceptable to society as a whole and the burden of risk for the individual may be too great. In addition, there are several characteristics that define the quality and the acceptability of the consent. Each method of enhancing performance will be examined in the context of the principles of medical ethics in a western society: autonomy, non-maleficence, beneficence, and justice. The aim is to draw the attention of aeromedical practitioners to the complexities of ethical dilemmas such as this particular one in order to help them to develop a morally justifiable code of practice that balances society's needs against individual ambitions and corporate goals.

Ethics is that branch of philosophy concerned with human character and conduct.¹ The study of ethics has given rise to a system of morals or rules of behaviour, including those governing professional conduct. Scientific advances in the last century have demanded corresponding development in ethical analysis. This is as true for biological sciences as for other realms of science. Bioethics has had to evolve to cope with genetics and transplantation as well as with numerous issues relating to the beginning and end of life.

There are several possible methods of enhancing human performance in general, including selection, training, special equipment, pharmacology, surgery, and genetic manipulation. These techniques may be applied to almost any form of human endeavour, including flying and space travel. Each of them may embrace processes that involve different degrees of ethical acceptability. An analysis of the basic principles involved should help us to develop a morally defensible code of conduct for the enhancement of human performance for spaceflight. This article will examine each of the techniques for enhancing performance with the aim of defining what would be, and what would not be, ethically acceptable.

Beauchamp and Childress² define the principles of biomedical ethics as autonomy, beneficence, non-maleficence, and justice. Beneficence is the positive requirement to promote goodness and to do good; non-maleficence is the requirement to do no evil; and justice is the quality of impartiality and integrity. Arguably, the most important aspect of biomedical ethics for the present article is autonomy.

Autonomy comprises respect and action for an individual's right to determine his or her own destiny. The legal basis for this was expounded 90 years ago by Judge Cardozo in a case in New York:

... every human being of adult years and a sound mind has a right to determine what should be done with his own body ...³

Autonomy implies the concept of consent to either an action or, conversely, an inaction. Consent has two main

preconditions. The first of these is competence. Individuals must have the capability of understanding the implications of actions to which they have consented. The second is that the decision must be voluntary for consent to be valid. An important aspect of the ability to make a decision is the information that is presented to the individual to allow the decision to be made. The information must be germane to the course of action and must be presented in such a way as to aid understanding of the subject. Moreover, for consent to be meaningful, a decision has to be made on the basis of that consent and there has to be authorisation of the actions flowing from that decision.

Consent should ideally be given without undue pressure being brought to bear on the individual. Persuasion, and even some pressure on occasion, may be acceptable. An example would be the need for medical personnel to be immunised against hepatitis B. If you wish to work in such a capacity, then you must consent to the immunisation. It is possible to refuse the course of injections but employment in direct patient care will no longer be sanctioned. In addition, the requirement for consent can be overridden in certain circumstances by competing moral considerations—for example, when there is a conflicting requirement for scarce resources, when there is a risk to public health, or when there is a danger to others. Thus it has been argued that the US Armed Forces' mandatory anthrax vaccination programme is morally justified.⁴ At the other end of the spectrum, coercion or involuntary consent is never morally justified. It can be seen that autonomy, and the freedom to make a choice, may be in conflict with beneficence and non-maleficence, but it is generally accepted nowadays that there is no place for the "doctor knows best" type of paternalism.

Another aid in deciding whether or not a proposed course of action is ethically acceptable is the concept of risk. Risk is the probability of loss or injury and has two main components. The first is the magnitude of the possible harm arising from an action and the second is the probability of that harm actually happening. Thus an action involving the highest amount of risk is one that has a high degree of

Abbreviation: NBC, nuclear, biological, chemical

probability of a great deal of harm. A lower degree of risk would accrue in an activity that had a very low probability of causing serious harm (such as a crash when flying) or a high probability of causing a very small amount of harm (such as getting a blister when walking a long way). The lowest degree of risk therefore applies when there is a low probability of very minor harm. Against risk must be balanced the potential benefit of the activity. As risk rises and as the potential benefit falls, then any ethical test of whether or not that activity is acceptable becomes harder to satisfy.

Personnel in the armed forces give up some of their rights when they join the military. In some circumstances their autonomy can be legally and ethically overridden by the interests of their colleagues, commanding officer, or, ultimately, the state.⁵ Spaceflight is one area of high risk that may possibly be combined with a potential for benefit.

ENHANCEMENT OF PERFORMANCE

Performance of various activities may be improved by selection of the right individual for the task, training for the role, the provision of equipment, the use of drugs or surgery, and, more recently, the potential use of genetic modification. This is as true for spaceflight as for any other activity.

Selection

The practice of selection for employment is well established. Selection on the grounds of ability is not an issue. Physical size may also be an acceptable selection criterion where payload is a significant factor. However, selection on the basis of the ability to perform a job should not include consideration of factors such as gender, ethnic origin, religion, or sexual orientation. Disability should also not be an issue except in two circumstances: first, where the core requirements of the job cannot be performed even with reasonable adjustments if necessary; and secondly, where employment would carry a particular health and safety risk to the individual or others. Selection for driving a car will be less prescriptive in terms of health, intelligence, and even size than for flight of any kind. Similarly, it would be reasonable to expect higher physical and intellectual standards for commercial pilots than for sport pilots, for military aviators compared with those in the civil sector, and for astronauts compared with military pilots. In addition, it would be acceptable to select astronauts from only one country if national security was an issue for a particular space mission.

Training

It is entirely appropriate to provide training for a job. Indeed, it may be unethical not to provide training. However, there may be ethical difficulty with different types of training. In driving, the use of driving instructors or skid pans is acceptable but deliberate experience of crashes would not be ethical because of the risk of injury. In military operations, the use of nuclear, biological, chemical (NBC) simulants, such as CS gas, in controlled conditions is acceptable but exposure to live agents (as practised in some Warsaw Pact countries during the Cold War when, presumably, the justification was that the demands of the state overrode the rights of the individual) is not. Exposure of pilots to simulated high altitude in a decompression chamber to see if they are susceptible to decompression sickness is acceptable because this is done in a controlled manner with ready access to emergency treatment and recompression. This is preferable to disabling symptoms being experienced for the first time in flight when treatment is not immediately accessible. Similarly, in training for spaceflight, activities that expose astronauts to unnecessary and uncontrolled risk, such as prolonged sensory deprivation (with the risk of developing psychological disorders) or bedrest (with the risks of bone

resorption and deep vein thrombosis), would not be acceptable. In short, training must be sufficiently rigorous to be useful but any risk has to be managed and minimised. If the risk is judged to be too high, then an alternative method of training for that activity must be found.

Equipment

It has been claimed by aviation medicine specialists since the 1930s that aircraft engineers believe that a person should be adapted to fit the aeroplane rather than the other way round.⁶ It is entirely acceptable to provide equipment—such as oxygen equipment, pressure suits and anti-g suits—to enable an aviator to survive in a hostile environment. However, that equipment must not, of itself, increase the risk. In operations in the UK, the risk of unconsciousness in flight from not wearing an anti-g suit outweighs the disadvantage of the additional heat stress. In hotter climates, the use of additional layers of protective equipment dictates the provision of effective conditioning systems, which could be cabin or personal conditioning. Different balancing of the risks can give rise to nations adopting different philosophies regarding protective equipment. For example, in the 1970s the United States Air Force used a lightweight helmet that did not impede head movement—and hence look-out—at high gravitational loads but did not provide a high degree of head protection during ejection. Conversely, the British helmets protected better in accidents but, at over 1 kg heavier (and thus effectively 8 kg heavier at a gravitational force of 8g_z, which is routine in air combat) they were more unwieldy in the cockpit. The use of NBC protective headgear during peacetime training may not be acceptable because of the restriction of effective visual fields. However, when gauged against the greater risk of exposure to live agents in wartime, peacetime training with the equipment, in order to build familiarity and confidence, may become ethically acceptable. An acceptable compromise is to fly while wearing the headgear but with a safety pilot who is not similarly encumbered.

One example of an unacceptable item of equipment is a prototype British full pressure suit from the 1950s, which required the pilot to be bolted to the aircraft, thus giving no means of escape (figure 1). That this option was even considered is reminiscent of the objection of the General Staff in the First World War to the provision of parachutes on the grounds that aviators may use them unnecessarily.⁷ For spaceflight, the dilemma lies equally in the failure to provide available equipment, such as an escape capability, and in the provision of equipment that would impact on safety. Initial arguments centred around complexity, cost, and unnecessary payload. Further justification at the time was that, provided the astronauts understood the risks and judged the benefits of spaceflight to be sufficient, withholding this capability would be ethically acceptable. However, after the Challenger accident, which involved personnel other than professional astronauts, a basic escape facility was provided by NASA. What would be more debateable is whether or not, in such a life-threatening situation with no chance of rescue, it would be ethically acceptable to provide astronauts with a means of committing suicide in order to prevent a potentially lingering death.

Pharmacology

Military aircrew have used serial “uppers” and “downers” for over 50 years under medical supervision (initially the drugs used were barbiturates and amphetamine derivatives; more recent “downers” have been benzodiazepines), but there has been no suggestion that equivalent pharmaceutical assistance is acceptable to enhance the performance of car drivers or private pilots.⁸ Although it could be argued that everyone has the right to decide what substances to take as long as there is not direct harm or risk to others, in reality laws and

Figure 1 Prototype British full pressure suit, 1950s. ©Crown copyright/MOD.

regulations are in place to control this because these activities carry a greater inherent risk to non-participating individuals than state-sponsored, military, operational flying. However, it would be acceptable for drivers to use therapeutic agents such as antibiotics whereas the condition requiring their use would ground aviators. In some conditions, such as epilepsy, even the use of therapeutic agents may not allow the activity to be performed ethically until the risk is considered sufficiently small. For commercial aircrew, particularly with many current intercontinental flights lasting such a long time, the balance has to be made between the risks of fatigue and subsequent accidents, the potential side effects of the use of artificial stimulants, and the operational justification. So far, operators have relied on carrying additional aircrew to allow rest in flight. On the other hand, for the air raid on Libya in 1986, the United States Air Force allowed the use of barbiturate sleeping pills so the aircrew could sleep through the day before the mission and the use of stimulants (benzedrine) to maintain alertness over the target and for in-flight refuelling on the return journey.⁹ It could be argued that mind altering drugs to change the perception of time on long missions may not be ethical for astronauts because of the unknown risks of developing psychotic disorders, but drugs to stimulate hibernation may be. The administration of female hormones to male astronauts to obviate the need for shaving may not be considered to convey sufficient benefit to make it ethically acceptable. On the other hand, the use of the same drug to control aggression or to diminish sexual urges on long duration missions may involve sufficient benefit to make the procedure appropriate. The self-evident

conclusion is that, for any particular pharmaceutical agent, a robust and defensible risk-benefit analysis should be made.

Surgery

Surgery to correct a pathological condition would be acceptable for drivers and, in certain circumstances, for aircrew and space crew. The British Antarctic Survey used to require its employees who were over-wintering in Antarctica to have a prophylactic appendicectomy before travel. This would also be acceptable before long duration spaceflight, for example a Mars mission, where the benefit outweighs the potential risk. Corneal remodelling, such as Lasik, is now generally acceptable for drivers and many types of aircrew. Provided that the risks remain manageable, this procedure may also be ethically acceptable for astronauts. However, mutilating operations to enhance performance would not be acceptable. One example would be amputation of the legs to enhance tolerance to gravitational forces.

In general terms, the implantation of devices to enhance performance would be ethically acceptable, provided that the operation was not mutilating and the benefits considerably outweighed the risks. The debate would be over the definition of the word “considerably”. The use of surgery to create cyborgs would be more controversial. However, it has been argued that the procedure would be ethical provided that the risk-benefit analysis suggested a significant benefit, that fully informed consent was given, and that the basic humanity of the cyborg was respected and preserved.¹⁰

Genetics

In the same way as for surgery, genetic modification of an individual to cure a disease or to remove the risk of a serious condition developing would arguably be considered ethically acceptable for drivers, aircrew, and astronauts alike. However, genetic modification to transform the physiological or psychological characteristics of an individual may be unacceptable for all classes.

CONCLUSION

This analysis is summarised in figure 2, which gives a representation of conceptual limits for each technique of enhancing performance for a range of activities. It can be seen that, as the activity becomes more intrusive, the likelihood of it becoming ethically unacceptable increases. In addition, as the activity involves fewer individuals (for example there are many fewer private pilots than drivers and

Figure 2 Suggested limits of ethical acceptability of techniques to enhance performance during different activities. 1 = driving; 2 = private flying; 3 = commercial flying; 4 = military flying; 5 = spaceflight.

considerably fewer astronauts) the ethical limit moves to the right, or is potentially eased. Alternatively, as the danger inherent in the activity intensifies, so the ethical limit is more likely to be relaxed provided that the benefit accruing is seen to be sufficiently great. However, what value can be put on a human life? Ackerman and Heinzerling suggest that, where the range of possible risks is large, one should assume that the worst will happen.¹¹ Despite this conservative approach, any form of enhancement of performance for human endeavour in space cannot be acceptable unless there is full, voluntary, and informed consent to the procedure. This applies just as much to physicians' willingness to carry out the procedures as to individuals' willingness to undergo them. In this respect, the aviation medicine practitioner has a key role to play to challenge the ambitions and aspirations of planners, politicians, engineers, and astronauts.

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