words of Habermas, "[…] genetically programmed persons might no longer regard themselves as the sole authors of their own life history" (2003, 79). Genetic manipulations challenge the moral identity of contemporary humanity and that of future human beings. Similarly, Fukuyama argues that genetic enhancement technologies defy the very idea of a human nature that grounds human dignity and human rights. By tinkering with the genetic constitution of humans we risk undermining the ideal of personal autonomy, and destroying the basis for moral equality (2002, part II). Others have defended the claim that inheritable genetic modifications can be seen as crimes against humanity because they alter the essence of humanity itself by taking human evolution into our own hands and directing it toward the development of the post-human (Annas et al., 2002).

Significantly, those who are cheering for the development of the post-human have a similar understanding of the role of genetics in human life. They hope that by using biotechnologies in presumably responsible ways, we will eventually become beings with vastly greater capacities than present human beings. They want to create the opportunity to live much longer and healthier lives, to enhance our memory and intellectual capacities, such as verbal fluency, memory, abstract reasoning, social intelligence, spatial cognition, numerical ability, or musical talent, to refine our emotional experiences and increase our subjective sense of well-being, and generally to achieve a greater degree of control over our own lives (Bostrom, 2003). Some have embraced the possibility of intellects that can read books in seconds (Bostrom, 2003), envisioned brain-to-brain interactions (Hughes, 2004), or conceived of beings whose capacity for rational thought would make non-rational drives superfluous (Hudson, 2000). Others, imagining the possibilities of doubling our cranial capacities to produce super-intelligent beings, are concerned with the need for a correlative widening of women's birth canal so that these post-human babies can be born (Agar, 2004, 16–17). Some argue that, because traits such as intelligence, memory, temperament, patience, empathy, or sense of humor can profoundly affect our lives, we have a moral obligation to enhance our children (Savulescu, 2005, 37).

It is unclear however, why and how tinkering with people's genomes would affect human dignity or human freedom. It is obvious that there are no genes for dignity or freedom. It is also the case that there is no single human genome representative of all humans, given that genetic variation is the norm. Moreover, humans have been directing human evolution by means of environmental and social factors without anybody thinking that such actions constituted crimes against humanity or that they threatened human dignity. Similarly, there is no available scientific evidence supporting the belief that characteristics such as intelligence, memory, abstract reasoning, musical talent, emotional sensitivity, empathy, or even health are determined, controlled, or influenced exclusively, or even mainly by nuclear DNA.

These arguments then rest on the disputable assumption that one's genetic endowments completely determine one's physical, psychological, and intellectual characteristics. It presupposes that a simple correlation between genotype and phenotype exists for what undeniably are very complex human traits. But such an assumption has no scientific basis. It simply ignores that genotypes have a range of

phenotypic expression, overlooks the importance of the environment, and disregards the significance of one's choices in building a unique and distinctive life. It seems that unless we incorrectly assume that our genome completely determines who we will be, then there are no reasons to believe that genetic manipulation by itself would interfere with human dignity or human freedom, or that it will be able to create creatures so smart, talented, sensitive, or imaginative as to make them unrecognizably human or post-human. Contrary to these ideas, the evidence that we have about the feasibility of using genetic engineering to change or influence these or similar characteristics significantly is that human biology is far more complex than it might appear by reading discussions of human genetic enhancement.

Think of a relatively "simple" characteristic such as, for example, being healthier. We have good evidence that most diseases affecting humans are multifactorial (Weiss, 2005; Becker, 2004; Cummings, 2003; Wilkie, 2001; Risch, 2002). Unlike Mendelian diseases, the transmission of these diseases is governed by multiple factors, and familial patterns of inheritance do not follow a strictly Mendelian mode. Alleles contributing to these complex diseases are neither necessary nor sufficient to cause the particular disease; that is, some people might suffer the disease without having the related mutations, and some people might carry the mutations but might not have the disease in question. For many of these complex diseases, more than one gene at different loci contribute to the disease, and those loci might interact with each other. Depending on their roles on the pathogenesis of diseases, these interactions might be additive, multiplicative, or might have no additional effect. Modifier genes can also interact with mutations involved in the production of some diseases. The effects of interaction between an allele that might predispose to a particular disease and a protective allele might be especially difficult to predict with any accuracy. Similarly, epigenetic factors can modify the expression patterns of genes without altering the DNA sequence (Jiang et al., 2004; Dennis, 2003). The expression of most human diseases also involves the relations of multiple genetic and environmental factors. Additionally, cases of incomplete penetrance and variable expressivity introduce even more difficulties in our ability to predict the risks of developing a particular disease and thus of preventing it (Wilkie, 2001; Risch, 2002). The different penetrance of mutations is not entirely an intrinsic character (Veneis et al., 2001). On the contrary, it appears to depend on several factors such as the importance of the function of the protein encoded by the gene, the functional importance of the mutation, the interactions with other genes, the interactions with the environment, the onset of the disease, and the existence of alternative pathways that can substitute for the lost function. What is more, some of these factors can vary between individuals. Things are then not as simple as sometimes they are made to appear. So, making people healthier by tinkering with their DNA does not seem that easy: and, where there is the possibility of doing so, it does not seem that the changes would be significant enough to talk about a different species of post-humans.

Consider another characteristic often mentioned in the debates on human enhancement: longer life spans by slowing the aging process. Presumably, our first concern would be to ask how much longer a human would need to live to become a