

Robert Plomin

Blueprint

How DNA makes
us who we are

Afterword to the
paperback edition



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I was worried about *Blueprint*'s reception for the same reasons I waited thirty years to write the book. As described in the Prologue, it was dangerous back then, professionally and sometimes personally, even to raise the possibility of genetic influence on who we are as individuals – our personality, mental health and illness and mental ability and disability. I thought the zeitgeist had been shifting towards genetics. One sign was the gradual acceptance in psychology and society of the evidence pointing to the importance of genetics. A second sign was the huge impact of the DNA revolution, beginning with the sequencing of the human genome in 2003.

Still, I didn't know how people would react to *Blueprint* especially because for the first time I didn't pull any punches, as indicated by the subtitle: 'How DNA Makes Us Who We Are'. I was braced for a negative reaction, even the possibility of becoming a pariah. This was the fate of several other authors who broached the importance of genetics during the past few decades. And this is what most of my friends and colleagues predicted would happen to me. That possibility was especially painful to contemplate because *Blueprint* is the culmination of my forty-five years of research in the field.

Publication of this paperback edition of *Blueprint* gives me an opportunity to reflect on the initial reaction to the hardback publication. This Afterword, written three months after that publication, is based on reviews and interviews in national newspapers including the *Daily Mail*, *Evening Standard*, *Guardian*, *Financial Times*, *The Sunday Times* and *The Times*, as well as in other publications such as *APA Monitor*, the *Economist*, *Nature*, *Prospect*, the *Spectator*, *TES*, *The Wall Street Journal* and the *Washington Post*. I have also had a good

sense of the public reaction from presentations at events such as the Royal Institution, Battle of Ideas, Intelligence Squared, Technocurious, several literary and science festivals, and talks at universities, as well as from social media and emails.

I'll respond to some of the criticisms that have been raised, summarize my take on the public reaction, and discuss issues about polygenic scores.

RESPONSE TO CRITICISMS

The title

My working title at the proposal stage was *DNA Matters: The Essence of Human Individuality*. When the title *Blueprint* was first suggested to me, I said 'no way', because I knew that the word 'blueprint' is anathema to some academics. This view was most strongly expressed by Matt Ridley at the end of his otherwise enthusiastic review in *The Times*: 'I hate the word "blueprint" in association with genetics . . . We are cakes baked to a recipe, not buildings assembled to a blueprint.'

However, I've come to see that use of the word 'blueprint' has gone well beyond its original meaning. Indeed, how many people would even know that the origin of the word lies in a process of photographic printing that creates white lines on a blue background, a process no longer used by architects? In common parlance, the word has come to mean 'a detailed outline or plan of action'. I think this is a reasonable metaphor for how DNA makes us who we are.

The subtitle is also provocative: *How DNA Makes Us Who We Are*. The phrase 'makes us' has been deemed too deterministic. The phrase 'who we are' is ambiguous. It could refer to who we are in the sense of our identity. It could also refer to who we are as humans, the 99 per cent of our DNA that is the same for all of us. Instead, *Blueprint* focuses on the one per cent of our DNA that makes us who we are as individuals. It is this one per cent that accounts for about half of the differences between us on all psychological traits. To avoid these difficulties, the title should be something like this: *Inherited DNA*

Differences Account for About Half of Individual Differences for Psychological Traits.

Try attracting a publisher with that title.

Fatalism

Fatalism is the single most common concern about the book's message that inherited DNA differences are the major systematic source of individual differences in psychological traits. Almost every interviewer has raised this issue. For example, Stephen Sackur on the BBC World Service programme *Hard Talk* asked:

'Isn't there something deadening, even worrying, about your explanation of who we are because in so many ways it challenges fundamental aspirations and ambitions we have for ourselves as human beings, notions of betterment? . . . Your theory would lead us all to be fatalistic, full of weary resignation . . . we would accept that this is our destiny.'

This was also the main gripe in a review in *Nature* by an historian who summed up *Blueprint* as 'vintage genetic determinism' and 'a road map for regressive social policy.' The reviewer did not address the science of the book; he just didn't like what he misinterpreted as its message. His last words are: 'Plomin has made it pretty clear what kind of world he wants. I oppose him.'

I plead not guilty to this charge of genetic determinism. Genetics is the main systematic force in shaping who we are as individuals, but genes are not destiny. Many times in *Blueprint*, I explicitly deny determinism, with statements such as 'genetic research describes *what is* rather than predicting *what could be*' (p. 9); 'genetic influences are probabilistic propensities, not predetermined programming' (p. 43), and 'genes are not destiny' (p. 92). I consistently use the verb 'influences' rather than 'determines', 'causes', or 'hard-wired'. I talk about genetic influences as 'nudges' and 'whispers'. I don't say these things as a palliative; I mean them.

Fatalism most often comes up in relation to *Blueprint*'s message about parenting. The most quoted phrase from *Blueprint* is 'Parents matter, but they don't make a difference.' The phrase 'don't make a difference' is often misconstrued to mean 'can't make a difference'.

‘Don’t make a difference’ means that differences in parenting as they exist in the populations we study do not make much of a difference in children’s psychological outcomes. It is worth emphasising the caveat that this conclusion refers to the normal range of genetic and environmental influences, not rare genetic mutations that can have devastating effects or severe abuse or neglect.

This is another example of the distinction between *what is* and *what could be*. For example, using extreme, highly authoritarian parenting techniques, it is possible that parents could push their children towards becoming what the parents want them to be – a musician, an athlete, or a scholar. However, this tiger parenting could come at a cost. Instead of preordaining what we want our children to become, why not go with the genetic flow? Try to find out what children like to do and what they do well and help them do it.

Parenting is not a means to an end. It is a relationship, one of the longest-lasting relationships in our lives. Just as with our partner and our friends, our relationship with our children should be based on loving them, not changing them. We should not justify loving and supporting our children because of the effect this has on their psychological development. Conversely, we should stop mistreatment of children regardless of its effects on developmental outcomes.

Judith Rich Harris, who popularised the ideas of non-shared environment and the nature of nurture in her 1998 book, *The Nurture Assumption*, died at the end of December 2018 as I was writing this Afterword. Harris made this point beautifully by reminding readers that parenting is a moral responsibility: ‘We may not hold their tomorrows in our hands but we surely hold their todays, and we have the power to make their today very miserable.’

I am not advocating that parents should just let their children do whatever they want to do. Parents can and should control their children’s behaviour, for example, monitoring their children’s activities and setting limits on aggressive behaviour. But controlling children’s behaviour does not change who they are – their personality or mental health and illness. For example, zero tolerance of bullying in schools can wipe out bullying behaviour on the school grounds, but it doesn’t change bullies once they are freed from the control of school rules.

That's why we have laws in society. If you get caught drink-driving you will go to prison, but this law doesn't change your genetic risk for alcoholism.

As I conclude in the section on parenting, I hope this is a liberating message for parents. I think parents should relax and enjoy their relationship with their children. Part of this enjoyment is in watching our children become who they are genetically.

Eugenics

Another topic that nearly every interviewer raised is eugenics and especially the Nazis. Stephen Sackur, for example, said 'Your work gets into very treacherous moral and ethical territory . . . the seductive siren call of eugenics . . . that goes back to the Nazi era.' He asked, 'Do you understand why people worry about the implications of your research?'

In these two months since the publication of *Blueprint*, the issue of eugenics has never come up in my many interactions with the public, so I suggested to Stephen Sackur that this issue seems more of an obsession with the media than with the public. In his review in *The Times*, David Aaronovitch said, 'It does seem to me that all too often, critics of Plomin's conclusions switch with too much alacrity from scientific arguments to ethical ones.' An editorial in the journal *Nature* in 2017 concluded that modern genetic research should not be held back by its past. Indeed, this editorial suggested that 'the nuances achieved by modern genetics can be used to dispel' its historical abuses.

Totalitarian regimes like Nazi Germany do evil things, but they don't need a rationale to do it. The Nazis misappropriated genetics as a rationale to justify their atrocities. However, most totalitarian regimes assume an environmental rationale: that people can be moulded as the state wishes. For example, Stalin's USSR, the 1948 model for George Orwell's 1984, actively denied genetics and purged scientists who doubted the inheritance of acquired characteristics. During Stalin's Great Purge, millions of citizens deemed 'enemies of the working class' were imprisoned or killed. Other examples of totalitarian regimes with an environmental rationale include Mao's China and the Kim dynasty in North Korea. Has any interviewer ever asked an environmentalist about 'the seductive siren call' of the assumption that the state can make

people be what it wants them to be that goes back to Stalin's Soviet Union?

I hope that anyone reading *Blueprint* will see that my view is opposed to any totalitarian approach: 'One general message that should emerge from these discoveries is tolerance for others – and for ourselves' (page 91). I want to use insights from modern genetics to help people help themselves and their children reach their full potential and be healthier and happier.

Group differences

Several reviewers criticise *Blueprint* for not discussing group differences, especially differences between ethnic groups. *Blueprint* explicitly focuses on psychological differences between individuals in a population and asks why we differ so much in personality, psychopathology and cognitive abilities. It's about individual differences, not average differences between groups, such as differences between genders, social classes or ethnic groups.

Blueprint explains why it is crucial to distinguish between individual differences and group differences:

'It is an important principle that the causes of average differences between groups are not necessarily related to the causes of individual differences within groups. . . . This principle also applies to more politically sensitive differences between groups, such as average differences between males and females, between social classes, or between ethnic groups.' (p. 194)

In other words, individual differences can be highly heritable for a trait but that does not mean that average differences between groups for that trait are also caused genetically.

There are two main reasons why I have steered away from group differences. The first is that most differences are within groups rather than between groups. That is, if all you know about a person is a group to which they belong, you know very little about who they are as an individual. The second reason is that there are powerful methods for studying the genetic and environmental origins of individual differences but not for studying the causes of average differences

between groups. I think this is why there is so much heat and so little light in understanding the origins of group differences. There is one other reason: I don't have to study everything.

Nonetheless, it should be noted that polygenic scores are, at present, generated largely from genome-wide association studies of European populations and so they do not predict as well in other groups. Several new research initiatives are attempting to study more diverse populations to ensure that the benefits of the DNA revolution can spread to everyone, not just a small percentage of the world's population.

Shared and non-shared environment

Blueprint's message about nurture is just as important as its conclusion about nature. Some reviewers find it unbelievable that the salient environmental influences on psychological development are not the shared, systematic and stable effects assumed by environmentalists and subsumed in the word *nurture*. For example, the reviewer in *Nature* said, 'the benefits of good teaching, of school lunches and breakfasts, of having textbooks and air-conditioning and heating and plumbing have been established irrefutably.' The reviewer conflates means and variances. Yes, children need to be taught, they need food, and they need not to be freezing or fried. But where is the evidence for the effect of *differences* in these variables – differences in the quality of teaching, food, and temperature – on individual differences in school performance, especially after controlling for genetic influence?

Several academic commentators point out that a few traits show evidence of some shared environmental influence, especially for intelligence and educational achievement. In *Blueprint* I noted that the finding of the importance of non-shared environment is now so widely accepted that attention has switched to finding any shared environmental influence at all. I show that intelligence and academic achievement are apparent exceptions to the rule that the salient environmental influences are not shared by children growing up in the same family (pp. 75–6). However, even for these traits, shared environment accounts for less than a third as much variance as does genetics in childhood, and disappears after adolescence as children leave home and make their own way in the world.

Aside from these possible exceptions in the cognitive realm, no one questions the crucial role of non-shared environment, for example, for all of personality and psychopathology. I think it is an amazing finding that the way the environment makes us who we are is so different from the way environmentalists assumed that it worked. The salient environmental influences are not systematic factors in the family implied by the word *nurture*. To the contrary, the influential environmental factors are those that make children growing up in the same family as different as children reared in different families, *non-shared environment*. These environmental influences seem to be largely random.

What this means is that if you had been adopted at birth, reared by different parents, gone to different schools, and had different friends, you would be similar to who you are now in personality, mental health and illness and cognitive abilities and disabilities. More specifically, you would be as similar to this version of yourself as identical twins are to one another.

This is not just a thought experiment. A recent award-winning documentary, *Three Identical Strangers*, tells the true story of identical American triplets who had been separated at birth in 1961 and placed with lower-, middle-, and upper-class parents. The triplets met by chance when they were nineteen, and the film shows how strikingly similar they were not just in looks but also in personality (outgoing), psychopathology (depressive) and interests (acting), despite the very different environments in which they were nurtured. These separated identical triplets are a dramatic illustration of what a century of adoption studies have found not only for identical twins but also for first-degree relatives.

Predictive power of polygenic scores

One criticism of my cheerleading for polygenic scores is that they are not yet sufficiently accurate to predict outcomes for individuals. *Blueprint* acknowledges the limits of individual prediction (pp. 142–6 and 156–8). Prediction cannot be perfect because heritability is only fifty per cent. Suppose we have a polygenic score that accounts for all of the fifty per cent heritability of intelligence. For individuals with a polygenic score at the 50th per centile, most would have IQ scores

between 90 and 110, but a few would have IQ scores of 80 or 120. *Blueprint* shows this empirically for height (pp. 142–3) and for educational achievement (pp. 156–8).

Nonetheless, polygenic scores are quickly becoming the best predictors we have (p. 156). For example, we can now predict school achievement better from DNA than from parents' educational attainment or occupational status. This predictive power can be seen most clearly at the extremes. For polygenic scores for educational attainment, 75 per cent of children in the top ten per cent go on to university, whereas only 25 per cent of children in the lowest ten per cent go to university. No prediction is perfect, especially in the behavioural sciences. We often make big decisions on the basis of much weaker correlations. For example, the correlation between blood alcohol levels and automobile accidents is weak, but that doesn't, and shouldn't, deter us from making strict laws about drink-driving.

It is also worth reiterating that these are very early days in research on polygenic scores. For example, in my research on school performance, the predictive power of polygenic scores has jumped from zero per cent to fifteen per cent in the last five years. In *Blueprint* I suggest that the predictive power of most polygenic scores will double in the next few years. Especially needed are more specific polygenic scores, such as polygenic scores for aptitude for STEM subjects, rather than scores for coarse variables such as years of education and general traits such as intelligence.

Although there are legitimate concerns about the accuracy of polygenic scores, polygenic scores are already transforming psychological research (pp. 167–77). They will also transform clinical psychology by shifting the focus to causes instead of symptoms, dimensions rather than diagnoses, individually tailored treatments instead of one-size-fits-all treatments, prevention instead of treatment, and a positive emphasis on health rather than illness (pp. 163–7).

Mechanisms

Another criticism from academics about my celebration of polygenic scores is that polygenic scores do not tell us about the many intervening mechanisms that lie between differences in DNA sequence

and their effect on psychological traits. As I say in *Blueprint*, ‘the correlation between a polygenic score and a psychological trait does not tell us about the brain, behavioural or environmental pathways by which the polygenic score affects the trait’ (p. 162). Much of molecular biology is engaged in trying to understand these mechanisms but the DNA revolution has shown us that it will be a long slog because, for any trait, tens of thousands of DNA differences are involved, each with very small and highly pleiotropic effects (pp. 132–3). Moreover, do we now take DNA so much for granted that we don’t count it as a ‘mechanism’? I think of DNA as the ultimate mechanism.

What I think is a cause for celebration is that polygenic scores can predict psychological traits from DNA alone without knowing *anything* about the intervening mechanisms. Polygenic scores summarise differences in DNA sequence that we inherit in the single cell with which we begin life. This unique DNA sequence is the same in all of our trillions of cells and does not change during our lives. Showing that polygenic scores predict psychological traits means that these inherited DNA differences make a difference regardless of the complex pathways between genes and behaviour.

The most common example of this criticism involves gene expression in general and epigenetics in particular. A SNP needs to be in DNA that is expressed (i.e., transcribed to RNA) before it can have an effect on behaviour. However, this implies that a SNP that is correlated with a trait must have been expressed. I should have highlighted the discussion that is buried in the middle of the chapter on the basics of DNA (p. 113), especially the concluding sentences: ‘The key point is that all we inherit is DNA sequence. Gene expression does not change our inherited DNA sequence. If a SNP is associated with a psychological trait, that means the SNP was expressed.’

Another example of this concern about mechanism involves the developmental interplay between nature and nurture. For example, to what extent is the association between children’s polygenic scores for educational attainment and their educational achievement mediated by environmental factors such as parenting? More highly educated parents provide both nature and nurture that work together to affect their children’s chances to do well at school (p. 96).

A large part of my career has been spent studying the developmental interplay between nature and nurture, which is how genotypes become phenotypes. (See Chapter 3, *The Nature of Nurture*.) Having polygenic scores and DNA of parents and children gives us new ways to look at this old issue of correlations between genetic and environmental influences (pp. 169–171). But, again, what I'm excited about is the ability to use polygenic scores to predict behaviour without knowing anything about the mechanisms – such as gene expression, epigenetics or gene-environment correlation – that mediate the effect of inherited DNA differences on psychological traits.

PUBLIC REACTION

I cared most about the reaction of the general public since I wrote the book for them. Far from being the nightmare predicted before publication, the public reaction has been positive beyond my wildest dreams. Most rewarding have been my conversations with people as I signed hundreds of copies of *Blueprint* following discussions about the book at events and book festivals. People are excited and enthusiastic about *Blueprint*. A typical comment, and one I love best, is that the book was an eye-opener. That is, people say they were not really opposed to genetic influences on individual differences, even for psychological traits. They just hadn't known much about genetics, and *Blueprint* helped them see its relevance for their lives.

My exposure to the public does not extend much to social media because long ago I decided to ignore the trolls by avoiding it. However, my students look at social media for me and they have summarised what they have found. Although they might well be protecting me from the trolls, their summary suggests that the public response has been decidedly positive.

What's more, completely contrary to expectations, I have hardly had any hostile responses from the public. No one has raised issues like eugenics and race – topics often raised by the media. Indeed, a common comment from the public is to wonder why the idea that DNA makes us who we are as individuals is so controversial – because it seems so reasonable.

GETTING YOUR POLYGENIC SCORES

People often ask me where they can get their polygenic scores. In *Blueprint* I said that direct-to-consumer companies will soon add polygenic score profiles to the single-gene genotyping and ancestry data which these companies have provided to millions of people. Although some companies are moving in this direction, as of this writing there is still no company that provides polygenic scores for psychological traits that approach the quality of those that are described in *Blueprint* for my polygenic score profile (pp. 139–160). Most of the genomic reports from direct-to-consumer companies focus on single genes and on weak polygenic scores based on just a handful of SNPs. It would be easy to use the same genome-wide SNP data to create powerful polygenic scores based on the latest methods and genome-wide association results. I would be very surprised if this does not happen in this fast-moving area prior to the publication of this paperback edition of *Blueprint* in June 2019.

Although direct-to-consumer enterprises will continue to flourish and will soon provide good polygenic scores, I argue that the National Health Service should provide genotyping for everyone, at least for everyone who wants it. Looking back on this moment a few years from now, it will seem unethical that we did not do this. The savings to the NHS would be enormous if we could prevent problems rather than treating them after they occur. Prevention requires prediction, and polygenic scores are the perfect early-warning system.

Universal access to polygenic scores will be driven initially by medical not psychological concerns. For example, a September 2018 paper by Amit Khera and colleagues at Massachusetts General Hospital demonstrates that the current polygenic score for coronary artery disease can identify eight per cent of the population with a threefold increased risk for having a heart attack. The authors conclude that ‘it is time to contemplate the inclusion of polygenic risk in clinical care.’

It seems uneconomical as well as unethical not to let people know about their increased risk for heart attacks because there is much that can be done to prevent them. Preventing a single severe heart attack for one individual could save the NHS hundreds of thousands of

pounds, as well as saving the suffering experienced by the victim. Validated polygenic scores exist right now to predict many other preventable diseases such as diabetes, fragile bones and inflammatory bowel disease.

DNA needs to be genotyped only once, at a cost of £35, and then the same genotyping results can be used to create hundreds of polygenic scores for other medical diseases. It's not a question of *whether* we do it but rather *when* we do it. When this happens, it will be a boon to psychological research because these same genotyping results obtained for medical reasons could be used to create polygenic scores for psychological traits. So, eventually, psychological polygenic scores could be available for any participant in any psychological study, although many issues would need to be sorted concerning access and confidentiality.

Genotyping in general and polygenic scores in particular could be a boon for the NHS. I don't see how private insurance-based medical systems like those in the US can survive the DNA revolution. The bottom line for private insurance-based systems is money, not a healthy population. For example, from a strictly financial perspective, it makes sense for an insurance company to avoid insuring you if you are at genetic risk for some costly disease. In contrast, in a universal health care system where people are not denied treatment because they are unable to pay for it, genetic risks and costs can be distributed across the population. The National Institute for Health and Care Excellence (NICE), which is independent of government, can make the difficult decisions that need to be made to balance costs and benefits in the population as a whole.

Unlike private insurance-based medical systems where hospitals get paid for treating illness not for preventing it, the NHS should be highly motivated to promote health and prevent illness. The availability of low-tech interventions to prevent problems, as in the case of heart attacks, pushes the cost-benefit ratio off the scale and will make it impossible to ignore the potential of polygenic scores for the NHS. Universal health care is not some kind of throwback to 1940's idealism. It is the only sensible way to provide health care, including mental health care, after the DNA revolution. In conclusion, *Blueprint* has done what I hoped it would do: launch a discussion about the applications and implications of the DNA revolution for psychology and society.