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Social and Ethical Aspects of Forensic Genetics: A Critical Review

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Social and Ethical Aspects of Forensic Genetics: A Critical Review


ABSTRACT: This review describes the social and ethical responses to the history of innovations in forensic genetics and their application to criminal investigations. Following an outline of the three recurrent social perspectives that have informed these responses (crime management, due process, and genetic surveillance), it goes on to introduce the repertoire of ethical considerations by describing a series of key reports that have shaped subsequent commentaries on forensic DNA profiling and databasing. Four major ethical concerns form the focus of the remainder of the paper (dignity, privacy, justice, and social solidarity), and key features of forensic genetic practice are examined in the light of these concerns. The paper concludes with a discussion of the concept of “proportionality” as a resource for balancing the social and ethical risks and benefits of the use of forensic genetics in support of criminal justice.

KEYWORDS: Ancestry informative markers, dignity, DNA databasing, DNA profiling, ethics, externally visible characteristics, forensic DNA phenotyping, justice, privacy, proportionality, SNPs, STRs.

INTRODUCTION

Since their first appearance in the 1980s, forensic DNA profiling technologies have become an increasingly important aspect of criminal, security, and mass disaster investigations. This has been made possible by a combination of technical, organizational, and legislative developments that include improvements in DNA collection, extraction, and analysis processes; the establishment of national and international laboratory standards; judicial acceptance of the robustness of DNA evidence; and the growth of national forensic DNA databases as a means of storing, searching, and comparing crime scene DNA profiles with profiles obtained from known individuals and retained under a variety of legal regimes. It is generally accepted that the majority of these applications are more effective in supporting investigations and prosecutions wherever legislation permits criminal investigators to take, use, and retain biological samples from a large number of crime scenes and from many categories of individual subjects.

Scientific and technical features of these developments have been described in detail elsewhere (see for example [8,20,21,136]). Advances in the chemistry and uses of standardized STR multiplexes have occurred globally, and there has been increasing use of Y-STRs and of mitochondrial sequencing to support more specialized investigatory uses like familial searching for offenders, and the identification of human remains [89]. Recently, there has been a significant growth of research and innovation concerned with the analysis of genetic data where crime scene DNA samples are available, but where profiles derived from these samples have not matched databased profiles obtained from known subjects. Three areas of work have become increasingly prominent: the inference of externally visible characteristics (EVCs) [70]; biogeographic ancestry-informative markers (AIMs) [117]; and the increasingly comprehensive genetic analyses that are made available by so-called “next generation sequencing” (NGS) or “massively parallel sequencing” (MPS) technologies [12]. Alongside these efforts there is also ongoing work which attempts to identify the source of the body fluids from which biological samples have been extracted in order to more rigorously test assertions about the potential significance of DNA evidence in particular cases [137].

Forensic genetics technologies have been introduced into routine criminal justice uses alongside collective discussions of their ethical legitimacy and legal evaluation of their reliability. The history of these social considerations reminds us that it is important that forensic genetics researchers and claims-makers avoid the promotion of “technologies of hubris” [64] in which scientific certainty and technological robustness are overstated, and social consent is assumed in advance of detailed deliberation. Scientific knowledge production and technological innovation are part of the ordering of contemporary societies and impact on personal and communal life in significant ways: scientific knowledge influences how we understand the world, while technologies guide us in the ways we can engage with it. Over the last decades it has become apparent that research and innovation are not independent of society but are social processes interwoven with other social domains such as education, health, law, politics, the economy, and the environment (see for example [10,49,53,65,80]). Social structures and cultural narratives shape scientific and technological endeavors. Accordingly it is vital for researchers, as well as the commissioners and users of research, to develop an understanding of the various...
social and ethical promises and problems of emerging technologies. Studying such aspects can offer insights into their “ramifications” and potential effects on human practices [124], thus helping to better articulate the rationale for, and use of, particular technologies. The aim of such interventions is to help render technologies socially acceptable rather than shutting down viable lines of development because of assertions of their potential ethical or wider social hazards.

I. SOCIAL PERSPECTIVES ON FORENSIC GENETICS IN CRIMINAL JUSTICE

This review maps the landscape of discourses around the social and ethical aspects of using forensic genetics in the criminal justice systems of Europe and beyond. In the review we follow what we have described elsewhere as a series of waves of technological innovation in this field [157,162] and pay attention to the variety of standpoints that can be found in social and ethical commentaries on them. Our starting point is an observation of the tension between three commonly held perspectives in contemporary debates on the use of genetic science and technology in support of security and justice. These perspectives are described below. Although not mutually exclusive, they emphasize different features of criminal justice objectives and processes, and their location within wider social structures.

A. Crime Management

The first perspective celebrates innovation in forensic DNA profiling and databasing as contributing positively to the detection and conviction of criminal suspects [14,149] by arguing that the expansion of the scientific toolbox available to law enforcement and other users of forensic genetic technologies increases the effectiveness of investigations. Acceptance of this argument by legislators and criminal justice agencies has led to a significant increase of biological samples — from crime scenes and individuals — being taken, stored, and used in those jurisdictions permitting the adopting of various kinds of DNA technologies. This increase has been accompanied by a widening of the categories of individuals subject to forensic profiling and analysis, and the expansion of jurisdictions’ adoption of DNA technologies globally. A further development under this perspective — fueled by the potential investigatory gains that may result from cross-border exchanges — is the emerging routine sharing of DNA profile data across national boundaries. For example, the Prüm Treaty evidences the commitment of a large number of European Union states to making such gains. The efficiency argument finds its strongest expression in the consideration of “universal” DNA databases [29,68].

A recent commitment to setting up a universal database of citizens, residents, and visitors was made in Kuwait [146] and remains, as far as we are aware at this writing, the only attempt at doing so globally.

The notion that forensic genetic technologies can improve the capacity of their state users to control crime instantiates a longstanding preoccupation with police uses of novel technological interventions of various kinds, including information and communications technology, surveillance equipment, weaponry and vehicles, as well as the expanding repertoire of forensic science. The use of these interventions, it is often asserted, will lend scientific and technological support to efforts to improve the effectiveness of crime detection, and may also contribute (although this may be more difficult to establish) to the deterrence or desistence of offenders. The historical context for this “scientification” [36] of policing, along with the extension of police powers required for its uses to control crime through effective detection, was the political necessity to confront rising crime rates in many jurisdictions during the second half of the 20th century, along with increasing awareness of, and attention to, the economic, social and emotional effects of crime (see [26,45] for discussions of the “crime control” model in the UK and the US).

Recently, there has been an internationalization of crime-control considerations in efforts to counter cross-border criminality and terrorist threats. The European Union has witnessed the introduction of a number of distinct measures, some of which have direct relevance to the use of DNA profiling to assist investigations and prosecutions. The most important of these is the Prüm Treaty, a development that reflects the earlier Hague Principle of Availability, and which establishes infrastructure and procedures to make it possible for European states to share particular forms of intelligence [121]. Among these cross-border exchanges is the sharing of DNA information, albeit under strict conditions that ensure that only anonymized profiles are compared, and where “national contact points” manage the process whenever matches are obtained. Another is the creation of the European Investigation Order (EIO) [28], suggested in 2010 and negotiated between the Council of the European Union and the European Parliament since 2011. Taken together, these measures expand existing police powers to include mutual cross-border investigative support that may require the use of genetic and other technologies for criminal investigation by authorities in one state in order to fulfil the investigative requirements of authorities in another state. The EIO itself goes beyond the data-sharing agreements of the
Prüm Treaty, leading to unease about a dominance of criminal justice functionality and forensic utility over civil liberties within and between different national jurisdictions [156].

The notion of “investigative value” is a central good within the crime-control perspective, and much of the enthusiasm for advances in DNA profiling and databasing is informed by the assumed capacity of these technologies to add to such value. This assumption entails that new or enhanced investigative affordances are made possible through scientific and operational developments in the collection, analysis, and uses of genetic material, producing intelligence in investigations, evidence to support prosecutions, and in some cases, grounds for the exoneration of wrongly convicted individuals. The development of national DNA databases, and the expansion of police powers to collect, retain, and use DNA samples in many European member states, reflect the crime-control model’s utilitarian approach to increasing the effectiveness and professionalization of crime-investigation services through the exploitation of technological opportunities and operational improvements. It is regularly asserted that increased access to ever-growing DNA databases, as well as investment in new DNA-profiling technologies, will further enhance the capacity of the police to use genetic information to detect suspects quickly and unequivocally, and in this way contribute to the detection and reduction of crime and an improvement in public safety.

In an increasingly “geneticized” and technological society, such promissory narratives about technology have become commonplace. It is almost universally accepted that DNA intelligence and evidence can be technically superior to that provided by other forensic disciplines. Its basic assumptions are much better supported by peer-reviewed research carried out in a range of contexts, and its routine practices have been subject to extensive external scrutiny [105]. This technical superiority means — for the wider criminal justice community as well as for the general public — that DNA analysis can be expected to be able to deliver fast, clear, and precise answers for the typical questions asked in the course of criminal investigations: what has been described as the “CSI effect” of public perceptions of DNA analysis. This (imagined) capacity in turn strengthens the perceived “exceptionalism” of DNA, and its actual and promised role in criminal investigations [160].

However, these expectations about effective crime control through DNA technologies have been contested by some critical observers [9,29,47,91,101]. These and other critics have argued that the results of existing research have shown that it is much more difficult than is normally understood to establish the utility of various DNA profiling and databasing techniques and their impact on crime detection. Although crime-control imperatives stress notions of efficiency [31], relevant data have proven to be difficult to capture and hard to interpret [161]. This criticism applies to well-established technologies, and is even more relevant to the assessment of more recent innovations such as familial searching, the use of ancestry-informative markers, and those that seek to infer externally visible characteristics from DNA samples. There have been no systematic case-based studies of the use of DNA in support of crime detection and prosecution in the UK since the Pathfinder study carried out between June 2000 and May 2001, and published in 2005. This is one of the reasons behind the call by the UK Human Genetics Commission for the development of a much more systematic approach to the measurement of “forensic utility” to be applied to the evaluation of DNA profiling in the UK [63]. Researchers in Australia [15–17,126–128] and US-based studies have begun to provide much better data on the contribution of DNA to detections and prosecutions. One US study is based on a randomized control trial of the use of DNA profiling in support of property crime [129], and a second series of studies [114–116] is based on the analysis of a large number of case trajectories.

B. Due Process

A second perspective emphasizes the contribution made by DNA profiling to the quality of expert evidence provided in support of prosecution or defense cases in criminal trials. Lawmakers and law enforcers in contemporary liberal democratic societies recognize that criminal justice systems cannot be driven by crime management imperatives alone. Another set of imperatives are regularly brought into play alongside them, and — to an extent — also modify their application in practice. These alternative “due process” considerations require that the proper operation of a criminal justice system provides fair treatment and trialing of suspects and defendants, and strong measures to protect their rights in the judicial process of criminal investigations. Central to a due-process focus is the idea that the criminal justice system acts not to convict offenders — although that may be one of its outcomes — but to discern and adjudicate truthfulness and fairness in the administration of justice. From this perspective, it is the courts rather than the police who hold definitive authority for the disposition of those suspected of or charged with criminal offenses. Although the police should be afforded relevant and legitimate powers to investigate possible offenses and detect suspects, those powers, including the authority to draw on scientific expertise, must be “balanced” with
the rights of individuals guaranteed by civil society. Furthermore, where scientific intelligence and evidence play a significant role in contemporary criminal justice investigations, it is essential that courts are understood as the source of final authority in determining whether these forms of intelligence and evidence are based on valid foundations and reliable methods. Although forensic scientists have sometimes found the ways in which courts exercise this authority unresponsive to what they regard as principled scientific practice, and courts have sometimes struggled to cope with new science, the legitimate authority of the courts in these matters is an essential feature of the rule of law in modern democratic societies.

The forensic science community in general continuously faces both internal and external anxieties about the reliability and strength of its research base as well as some of its routine practices [35,81,93,103,104]. Inspired by such concerns, the recent review of forensic science by the US National Academy of Sciences [105], and a FBI retrospective enquiry into all criminal investigations that have relied on forensic hair and fiber data and expertise [60,85], continue to threaten judicial investigations that have relied on forensic hair and fiber technologies. Early challenges to the uses of forensic data and expertise [60,85], continue to threaten judicial investigations that have relied on forensic hair and fiber technologies. Early challenges to the uses of forensic genetics in courtroom deliberations included those in 1989 in the USA “Castro case” [63,66,79] throughout which the presented DNA “evidence” was challenged on the basis of nonstandardized local DNA-profiling practices that diverged considerably between US laboratories. An equally significant challenge to police management of forensic evidence was made throughout the O. J. Simpson double-murder trial in 1995. It is an inherent matter of fact and concern that forensic work is “messy”. Samples are taken in inclement environments and can be partial, degraded, or contaminated. Physical laboratory-based sciences may consider the work with such materials — for example, due to the nature of a crime, conditions at a crime scene, or owed to collection and storage practices of samples — as “impure” technical rather than scientific work. Contamination, in practical rather than epistemic terms, is a concern in forensic work and has been raised by practitioners, users, and courts. The significant message from the defense’s critique of DNA evidence in the O. J. Simpson case was that forensic genetic investigative and adjudicatory values are as dependent on the correct and transparent management of evidence as they are on the underlying science and its technological application. In fact, critics of the use of DNA evidence in particular cases tend to confuse the two concerns, often claiming “flaws in the science”, where errors could in fact be more accurately describe as “flaws in the handling of evidence”. Evidence handling is important for all kinds of forensic science, but the superabundance and persistence of DNA means that particular care needs to be exercised within this domain. As tests have become increasingly sensitive, and knowledge of DNA persistence and transfer has grown, concerns have surfaced about the possibility of contamination in earlier cases; and some more recent cases have also been problematized. The advent of DNA technologies that are capable of generating profiles from vanishingly small amounts of biological material has made the issue of potential contamination increasingly urgent.

In addition, judges and advocates have sometimes struggled with the reasoning practices of forensic DNA scientists and — at least in the UK — the judiciary has not supported attempts by some advocates to educate factfinders in Bayesian versions of these practices. The difficulty of engaging with the probability basis of forensic genetics has been problematized constantly since the emergence of this field [7,75,76,82,143], and was the focus of two US National Research Council reports on forensic genetics published in the 1990s. Due process considerations require expert scientists to be balanced in their findings in order to avoid prosecution or defense bias. Several US and UK groups have sought to provide clear accounts of the kinds of statistical reasoning preferred by forensic genetic scientists and expert witnesses in order to support efforts at proper balance (UK examples include [1,123]; US examples include [59,67,97,144]). Expert interpretations can be misleading, as argued in a recent piece in the UK Law Society Gazette:

‘The DNA profile from the handgun matches that of the suspect; the chance that some unknown person unrelated to the suspect would have the same profile is one in a billion.’ … If the DNA had come from a close relative of the suspect then the chance of a match would be much greater than one in a billion — perhaps one in 10,000. Why not give that alternative? The reality is that the choice of an unrelated person for the alternative maximises the weight of evidence against the suspect. A balanced approach would not do this; indeed a balanced approach would not offer any evaluative opinion, or statistic unless the circumstances of the case implied a clear defence alternative. [40]

Yet despite such historic and ongoing procedural and methodological difficulties, it is obvious that the contribution of DNA profiling to the due-process principles of liberal-democratic societies has been overwhelmingly positive. Its use in exonerating innocent individuals and righting wrongful convictions has provided a spectacular instance of this contribution. This has been especially so in the United States, where the
In a significant number of previously contested convictions [109,135]. Reanalysis, of biological evidence retained from a crime scene in question. He and other participants in the Innocence Project subsequently have obtained judgments requiring the analysis, or reanalysis, of biological evidence retained from a number of previously contested convictions [109,135]. In a significant number of these cases, DNA profiling has helped to establish that miscarriages of justice have taken place and that innocent people have been incarcerated, in some cases for long periods of time. Scheck in particular has become a supporter not only of DNA profiling, but also of DNA databasing, which he argues is capable of providing “prospective exoneration” of individuals who otherwise might well become the subject of police suspicion and worse, but for the fact that their databased DNA profile does not match samples recovered from the crime scene in question.

C. Genetic Surveillance

The third perspective on social and ethical aspects of forensic genetics emphasizes concerns about new forms of biological surveillance of citizens, residents, visitors, and migrants, enabled by the expansion of forensic DNA profiling and databasing [33,107,147]. Various academic, legal, and civil society groups, especially those that have applied to the forensic field prior bioethical anxieties concerning the collection and use of human genetic material, have reacted more critically to many of these developments and applications. Central to these more critical standpoints has been a concern with the potential effects of the increased surveillance of citizens made possible by the expansion of forensic DNA profiling and databasing, as well as questions about which agencies will have access to DNA samples and profiles and for what purposes. Problems have also been raised about the governance of this new domain, especially in light of the typically restricted participation of non-police actors in key policy and decision-making fora. There has been particular criticism of instances of unthinking enthusiasm for increasing the size and scope of forensic DNA databases, and also of the use of unsupported assumptions about the relationship between genetic and phenotypical characteristics.

In the United Kingdom, two major agencies — the Nuffield Council on Bioethics and the Human Genetics Commission — have both published substantial critical reports on the distinctively forceful legislative and operational developments in DNA databasing that occurred in England and Wales between the establishment of the National DNA Database in 1995 and the decision of the Council of Europe’s European Court of Human Rights (ECtHR) in the 2008 case of S and Marper v the UK Government [27]. In addition, the monitoring group GeneWatch UK have also been actively interrogating official statements and statistics on the National DNA Database for a number of years as well as appearing before several Parliamentary House of Commons Committees that have inquired into aspects of forensic DNA profiling and databasing in England and Wales. In the United States, the American Civil Liberties Union has frequently criticized the state and federal expansion of DNA collection and retention [78]. Elsewhere in Europe, similar criticisms have been voiced sporadically and in an insular manner, for example by the activist German “Campaign against DNA collection frenzy” [46]. The Hungarian Civil Liberties Union has delivered evidence to the Hungarian Parliamentary debate into surveillance and data protection of human genetic data [62]. It is widely acknowledged that the collection, retention, and use of various kinds of biological materials, usually without the consent of those from whom they were taken or retrieved, along with the information routinely derived from them, raises significant policy questions. These policy questions have traditionally focused on the establishment, exercise, and monitoring of powers necessary for the effective and ethical collection and use of such materials, and the balance between the state use of these powers and the rights — to autonomy, liberty, privacy, and justice — of individual subjects.

The emergence and development of forensic genetic technologies has facilitated the introduction of a wide range of novel social institutions (such as forensic DNA databases and their governing bodies) as well as new stakeholders (such as the commercial providers of DNA hardware, software, and DNA analysis services) relevant to crime detection and prosecution. They have sparked the public and professional imagination, translated into popular culture imaginations around DNA (e.g., the CSI-effect; DNA as the locus of one’s self [108]), but also into investigative expectations that persons can be individuated using biological matter, that such matter can be transferred between a person and an object or crime scene, and that such traces can usefully inform investigations (termed “forensic imaginary” in [158]).

II. APPLYING ETHICAL PRINCIPLES TO THE USE OF FORENSIC GENETICS

In this section of our review we bring together a wide variety of social commentaries on forensic genetics technologies and their application in security
and justice contexts, and suggest a thematic reading of these. A large number of ethical principles and concepts appear in contemporary discussions of the human and social implications of advances in biotechnology; only the most important of these principles and concepts — as we perceive them to be — are outlined below. We go on to discuss how they have already appeared in previous assessments of the ethical dimensions of three longstanding aspects of forensic genetics: biological sample collection, autosomal STR profiling, and forensic DNA databasing; and also provide a reconsideration of the application of these principles and concepts to several of the new and emerging forensic DNA technologies that have recently become available to support criminal investigations.

A. Laying the Foundation: Major (English Language) Reports

Four independent expert groups have provided signposts for much of the social, ethical, and policy discussions of forensic genetics. These groups are:


2. The American Society of Law, Medicine & Ethics (ASLME) Project on DNA Fingerprinting and Civil Liberties (which held meetings at the Kennedy School of Government, Harvard University, between 2003 and 2005, and whose work is represented in a series of papers in a special issue of the Journal of Law, Medicine & Ethics published in Summer 2006) [3];

3. The Nuffield Council on Bioethics Working Party on the Forensic Uses of Bioinformation: Ethical Issues (which took evidence from a variety of experts between 2006 and 2007 and published its report in late 2007) [110]; and

4. The UK Human Genetics Commission Working Party on the National DNA Database (whose work was informed by a “Citizen’s Inquiry” into the UK National DNA Database in 2008, and who published “Nothing to Hide, Nothing to Fear?” in 2009) [61].

The work of these four groups took place between 1998 and 2009 and drew on a variety of disciplinary perspectives. The US National Commission was especially concerned with legal and technical features of the development of DNA profiling. Although it recognized that “a number of issues raised in this report have social, ethical, and legal implications beyond the assignment of the working group” and identified some of these issues, it called on other groups to pursue them in more detail. At the same time, it considered a number of policy questions, including questions concerning the appropriate scope of DNA sampling and retention as well as the reduction of sample backlogs. It also recommended the establishment of systematic research efforts to determine the effectiveness of police uses of DNA profiling and databasing and “how the technology affects the investigative process”.

The ASLME project (funded by the US National Institutes of Health) took up many of the topics that the US National Commission had declared itself unable to pursue: a range of social, ethical, and legal issues, especially those that surrounded questions of privacy and civil liberty. There was no effort to produce a consensus report by those involved in the workshops, and (perhaps unsurprisingly) more attention was given to US preoccupations and practices than to those from elsewhere. Instead of attempting to generate agreement, participants were encouraged to provide normative and factual resources that would “direct the public discourse so essential for shaping how DNA forensics and technology is applied and used” [99]. Recurrent questions that were explored included database inclusiveness, sample retention, “racial identification”, informed consent, the scope of profile uses, and the effects of DNA identification on family relationships.

In addition to these US efforts, two UK projects (by the Nuffield Council on Bioethics and the Human Genetics Commission) also sought to provide resources for future public deliberations, but also undertook formal public consultation among their working methods. The two projects used very different methods to structure these consultations. The Nuffield Council on Bioethics Working Party disseminated, to individuals and organizations known to be active in the field of forensic bioinformation (and also more generally on its public website), a “consultation paper” containing information and a series of questions. The consultation received 135 responses, and an analysis of these responses was presented in the Working Party’s Report. The report itself focused on the ethical, social, and legal issues that the authors argued were current at the time, alongside what they could discern as “potential future” uses of forensic bioinformation. The group supplemented a focus on forensic genetics with consideration of fingerprint collection and comparison. They argued in general terms that although “well-functioning forensic databases have the potential to promote the public interest to a significant degree” [110], it was equally important that their existence and uses did not significantly challenge the inventory of ethical values generally upheld in liberal democracies, identified as those of “liberty, autonomy, privacy, informed consent, and equality.” The report
contained a large number of recommendations for changes in the governance of research and operational uses of forensic genetics informed by a rights-based approach that sought to balance the demands of public protection against the protection of these core ethical values, or between the common good of security and the individual good of personal liberty.

The UK Human Genetics Commission (HGC) had a longstanding interest in forensic DNA profiling and databasing dating back to the early years of this century, even though on some occasions they had struggled to sustain this interest in the face of government reservations about including this domain within their work program. Before undertaking the study that led to “Nothing to Hide, Nothing to Fear?”, the HGC had included consideration of the UK National DNA database (NDNAD) in several of the previous studies, and they had successfully lobbied government for representation on the NDNAD Strategy Board. In preparation for what has been their most detailed work on forensic genetics, the group had (along with the Economic and Social Research Council Genomics Policy and Research Forum in Edinburgh, and the Policy, Ethics and Life Sciences (PEALS) Research Centre in Newcastle) commissioned a “Citizens Inquiry” into the NDNAD. This inquiry established two public panels who heard evidence from “interest groups, the police, database governance bodies, forensic scientists and journalists” [61]. The panels also visited Scottish Parliament and a community center in the London Borough of Hackney in order to hear from a variety of people with political interests in, and personal experience of, the police uses of forensic genetics. Following completion of the Citizens Inquiry, the HGC also undertook a wider public consultation, with some of the results included in the published report. The report itself made a number of significant observations, many of which supplemented and extended those made earlier by the Nuffield Council on Bioethics Working Party.

Emphasizing the often unappreciated novelty of forensic DNA databases, they noted policy confusion in how the UK NDNAD was characterized and governed as well as the inadequacy of current ways of determining its utility. One chapter of the report was devoted to an analysis of the “consequences, both experienced and implied, of the NDNAD for individuals and society” [61], and another to understanding the implications of newly emerging forensic genetic technologies, and the relationship between forensic and medical genetics. Finally, the report’s authors offered a series of recommendations aimed at redressing the shortcomings in policy and governance they had identified. Among these were: the commissioning of privacy and equality impact assessments of NDNAD regimes; the development of agreed measures of “forensic utility” and the public dissemination of data on uses; the harmonization of biomarkers across the EU (and possibly elsewhere), along with the development of measures to control and monitor international datasharing; and improved NDNAD governance, including the establishment of an independent oversight body and a strengthening of the powers and standing of the NDNAD Ethics Group.

When read together, these four sets of deliberations provide a good general sense of the range of social and ethical issues raised by developments in, and operational applications of, forensic genetics to criminal justice. Although participants in them did not all come to the same conclusions, there was some overlap in what they chose to examine in detail, and they are useful in reminding us of the prevailing repertoire of concepts and concerns that make up the application of ethical principles to forensic genetics. This “prevailing repertoire” we mean to denote debates over the following values and how they are engaged in the application of forensic genetic innovations, especially in liberal democratic societies: dignity and respect for persons; personal privacy; justice and equality; and social solidarity. These concepts have been used to inform the themes and narratives that have emerged in the course of the main academic and policy debates and exchanges over the benefits and risks of innovations in forensic genetics over the last few decades. In the next section of this review we undertake a more detailed examination of this repertoire and point to some of the controversies, both historical and contemporary, that surround the elements that make it up.

B. Dignity and Bodily Integrity

Much contemporary discussion of bioinformation tends to treat the bodies on which such technologies are focused as “informational objects”, and then focuses on social, ethical, and policy issues that arise in the course of the further analysis and/or uses of that information. This tendency forecloses consideration of important issues of human dignity and bodily integrity that arise in DNA profiling and databasing from the initial sampling of bodies as anatomical subjects. Although some observers are content to label these issues as “bodily privacy”, the terms chosen in this heading more apparently frame invasive procedures that cross the boundary of the body (for example through the collection of blood or tissue using a variety of instruments to penetrate the skin, or via body openings such as the mouth) as potentially challenging a person’s innate right to bodily integrity. As Gerlach points out, “Privacy is about protecting
information, while bodily integrity is about protecting the thing itself.” [48] There is a long history of legislation that recognizes this right in a large number of liberal-democratic jurisdictions, and its meaning and significance have been explored in deliberations about medical treatments and in penal practices.

Human dignity refers to the inherent worth of a human being in a community of equal beings. A central premise of this principle is that persons have to be treated as ends in themselves, and not as a means to the ends of others. An additional element in the principle is that the diversity inherent to humanity is deserving of respect. The UNESCO 1997 Universal Declaration on the Human Genome and Human Rights refers to this when it asserts the necessity “not to reduce individuals to their genetic characteristics and to respect their uniqueness and diversity,” and further suggests that the collection of DNA samples must observe the dignity and bodily integrity of the donor. In the European Union (EU), the right to be treated with dignity is enshrined in Article 1 of the Charter of Fundamental Rights of the EU [23]. The preservation of the physical and mental integrity of the person (as posited in Article 3 of the Charter) supplements the principle of dignity. The concept of bodily integrity used here refers to the requirement that people are treated as “whole beings” so that the boundaries of their bodies are to be preserved from unreasonable interference or intrusion, and this requirement also underpins notions of human freedom and liberty. Häyry [54–57] has written extensively about dignity as one of a series of fundamental European ethical values. Although the significance of the term can vary according to the different traditions in which its use is located, there remains for Häyry and Takala a core meaning, that “our physical, moral and genetic integrity must be defended both against violations stemming from other people’s interests, and from violations arising from our own whims and desires” [57]. Ethical reasoning underpinning the criminal justice systems of liberal-democratic societies usually recognizes the necessity of balancing guarantees of individual human rights and civil liberties against the effectiveness of the criminal justice system in its delivery of public interest objectives. For forensic DNA profiling this reasoning may suggest that sampling, storage, and use of DNA profiles is only a minor infraction of human rights compared to the delivery of social goods that are in the public interest. Nevertheless, there remain dignitarian and liberty questions about which individuals should be subject to compulsory sampling, how, and at what stage in the criminal process.

1. Invasiveness of Sampling

The long history of efforts to secure the body of citizens from interference by state authorities is noted in Gerlach’s account of deliberations on the establishment of forensic DNA sampling and databanking regimes in Canada. In Canada, and elsewhere, according to Gerlach, there has been a tendency to exclude issues of bodily integrity from consideration, instead displacing it with an attentiveness to privacy: “it normalizes a shift in how we conceive of the body in criminal law, a shift that was enshrined in legislation through the exclusion of bodily integrity and the inclusion of privacy safeguards” [48], and in this way privileges state interest and power over citizens’ sovereignty over their bodies. Entwined with this development is another kind of shift about the level of intrusiveness into the human body that is permissible for sampling. Van der Ploeg [153] reminds us that issues of bodily integrity come into focus whenever medical or criminal justice procedures involve crossing “internal” and “external” bodily boundaries; and while penetrating the skin (for example, to take a blood sample) is a clear instance of such boundary crossing, naturally occurring bodily openings are also zones of particular contention, and cultural and personal sensitivities. Along with others, she argues that the breach of bodily integrity — and thus a limitation to a person’s dignity — that results from the taking of material from the mouth in the form of buccal swabs is a serious one, and one whose significance is acknowledged by the extensiveness of legal debates about the practice of such “bodily searches” in a number of criminal jurisdictions. Although not arguing against such sampling, Steventon has cautioned against increasing the range and number of criminal cases that require sampling from formerly intimate body areas such as the mouth [141]. Although Mooki traces “a direct link between greater interference by the state with the bodily integrity of individuals” [98] in the extension of police powers to sample from formerly intimate body areas. The general concern here seems to lie with the possibility of a creeping redefining of further areas of the body as not intimate in nature, although it is difficult to imagine the criminal justice necessity for any such extension, especially as emerging technological innovations will enable less-invasive sampling.

2. Consent in Sampling

In many jurisdictions, police and/or prosecutors seek to obtain DNA samples from persons suspected to be involved in an offense — for example, on arrest or at the point of being charged. Where legislation permits the taking of samples without consent, it has become normal practice to take such samples with buccal swabs,
3. Sampling from Crime Scenes

In the forensic context, biological material is gathered for DNA extraction and profiling from a variety of sources in addition to the consensual or nonconsensual sampling of known donors. Regimes for the collection, analysis, and retention of biological material recovered from scenes of crime have not especially troubled those who have expressed worries about the expansion of forensic short tandem repeat DNA profiling. The only exception to this concerns the practice in some jurisdictions of the surreptitious sampling of objects known to have been in contact with criminal suspects, such as cigarette ends, bottles, or clothing, where investigators either do not have the power to request samples or do not wish their interest in a subject to become known. However, there are new forensic technologies that are focused not on samples collected from individual subjects but only on samples collected from crime scenes. For this reason it can be argued that no new dignity or integrity issues are raised by their application. Nonetheless, both of these issues can clearly arise when the results of crime-scene sample analysis are fed into investigations, and individuals or groups that have the characteristics inferred through phenotyping or through ancestral analysis are approached to provide DNA samples. Individuals who come to police attention because they share characteristics uncovered by the analysis of crime-scene samples may be interviewed and asked to give a sample, or they may be asked to come forward to donate samples together with others in an intelligence-led mass screen. In either case, it is reasonable to ask what protection dignitarian principles may afford these individuals, and how this protection may be balanced against the operational needs of lawful criminal investigations.

A concern with this issue may also extend beyond a focus on those individuals who have been approached, to a focus on the social group who are — rightly or wrongly — associated with the specific ancestral or externally visible characteristics of interest. This is primarily a concern about the dignity of a group of people, and how they may potentially be treated as generally suspected of involvement in the crime under investigation. Certain measures (for example, a restriction in the dissemination of relevant information) may be required to protect such groups from increased public vilification. In such cases, ethical support for criminal justice objectives may need to balance two different types of public interest: public safety as the objective of the criminal investigation, and the safety of particular minority groups as a matter of social inclusion or cohesion [25,34,95]. The most significant instance of such a dilemma arises in the use of markers for biogeographic ancestry since it is likely that minority population groups (who might...
already have asserted a history of police discrimination) may experience the application of this technology as another instance of a racialized investigation. Insofar as the issue is also one of distributive justice, we will discuss it in more detail later in this review, but it will be important for forensic geneticists involved in the use of these technologies to explain fully to investigators the basis of the genetics of ancestral markers, especially how they may be distinguished from popular (mis) understandings of “race” or “ethnicity”. Some potential affronts to dignity may be avoided if the scientists provide detailed guidance on which population groups should be approached to provide DNA samples wherever analysis has shown that it is likely that a member of such a group is the potential source of a particular crime-scene sample. Assistance to investigators in the wording of requests and the characterization of the ancestral groups, as well as in managing expectations about the nature of the information investigators may receive, will also help with dignitarian issues that relate to voluntary participation in such investigative strategies.

C. Genetic Informativity and Personal Privacy

Dignity and integrity issues relate largely to how human bodies should be treated as well as to an understanding of the relationship between bodies, personal identity, and autonomous action. The concept of privacy refers less to the treatment of a person’s body itself, and more to information about persons and their bodies [48]. Most societies recognize that persons have a legitimate expectation that certain kinds of information about them be kept private. Although the concept of privacy is an essentially contested one [44] with a variety of connotations, the breadth of such an expectation encompasses a number of related concepts and principles such as “confidentiality, secrecy, anonymity, data protection, data security, fair information practices, decisional autonomy, and freedom from unwanted intrusion” [122]. Largely because of this conceptual looseness, legal and ethical deliberations of privacy rights and the conditions under which some such rights may be breached (and by whom) have been complex and extensive.

Privacy issues have always been at the center of ethical interrogations of forensic genetics from its first appearance in the mid-1980s. There exists a large body of commentary concerned with assessing the seriousness of the potential infringement on privacy rights occasioned by the sampling, profiling, retention, and subsequent sharing of DNA profile information derived from individuals sampled in the course of criminal investigations. Many relevant international investigative instruments recognize privacy as a fundamental human right. Many different kinds of genetic information are mobilized in a number of diverse environments, including medical research, health care, paternity testing, advertising, popular culture, and forensic science. In each of these domains, claims for genetic informativity — that analysis of the human genome can provide domain relevant information — are subject to differing criteria of evaluation and accountability. The kind of genomic information sought and produced by those using DNA profiling in support of criminal investigations and prosecutions varies according to the specific technologies used and on the context in which such data are required, produced, and negotiated. This context has administrative, legal, and social dimensions that influence the production and interpretation of forensic genetic data, and as such its informative value and normative authority. Despite these differences, the legitimate privacy expectations of individuals whose genomic information has been collected and used have always been foregrounded as requiring consideration by publics, policymakers, and practitioners.

Broad data-protection principles are often implicitly or explicitly deployed in discussions of the data generated by forensic DNA profiling. The primary claims here posit that processing should be limited to the specific purpose of criminal investigation and prosecution, data should be kept securely and confidentially, it should be fairly processed following legislative and regulatory frameworks, and, once an investigation has been completed, genetic data obtained from witnesses and victims as elimination samples should be destroyed. Jurisdictions differ markedly in their willingness to destroy data derived from samples taken from arrestees, those charged with, and those convicted of a crime. However, privacy issues in forensic genetics cannot be reduced to data-protection issues, and in any case, the criminal justice context is recognized generally to require a different approach to data protection than that which applies in other social contexts.

Four topics have recurrently been most often in discussions of privacy pertaining to autosomal STR sampling and profiling, and DNA databasing. They are listed below.

1. The Nature of the Genetic Information Contained in Forensic DNA Profiles

From the instantiation of DNA profiling, research scientists, forensic practitioners, policymakers, judicial actors, and police users of this technology have consistently argued that the loci included from such profiles are drawn from noncoding regions of the human
genome, and as such contain no personally sensitive private information about the person sampled. A typical instance of such assertion made by a Spanish group of researchers is that “Legal and specific regulation is absolutely essential with regard to criminal investigation, so that only markers or loci whose alleles are not associated with any kind of phenotypical information are used. These should only possess an identifying value without providing any medical information whatsoever.” [51]. The authors of the paper explain that such an approach helps to safeguard forensic practice from some of its critics, and also that it reduces concerns about the safe storage and possible sharing of such data since profiles generated from these kinds of data provide no useful information beyond their identificatory function. Therefore there is no reason for individuals whose DNA is profiled during criminal investigations to be concerned that profile data could be shared with, or interrogated by, those with medical, employment, or insurance interests. Forensic STR DNA profiles contain no information relevant to such interests. This argument has played an important part in securing public support for the technology, which might otherwise be thought to intrude unacceptably into the private lives of citizens, even those suspected of involvement in criminal acts.

2. Sample and Profile Retention and Access

Because of the potential information that resides in the biomaterial samples, legislative frameworks have often carefully specified rules for sample retention or destruction following successful profiling and/or the conclusion of criminal prosecutions for which samples have been relevant. Analysis, retention, and destruction regimes have usually treated crime-scene samples differently from samples taken from known subjects, in that a wider range of genetic interrogations may be made of the former when STR profiles generated from them have failed to match known subject profiles. Greater protection from additional forms of analysis is given to the latter when they are retained, or they may be destroyed after profiling to prevent further analysis taking place.

Closely related to this is a concern with the retention of, access to, and uses made of profiles. Every jurisdiction specifies that profiles are only to be used in support of police investigations or criminal justice objectives. However, the inclusiveness of what is meant by “police” or “criminal justice” may not always be clear, and so ethical deliberation has to take into account any elasticity in the meanings of these terms. Most jurisdictions concede the value of continuously speculatively searching all lawfully obtained DNA profiles against all incoming profiles obtained from crime scenes, but questions arise about which category of persons, once profiled, should be retained for such searches. Privacy rights are engaged by such a practice. Although the privacy rights of those convicted of a crime may rightfully be reduced by the fact of their criminal actions, jurists and ethicists may also ask whether the same reduction in rights is justified for those who have been arrested but not charged, or for those charged but not convicted. And is the same regime to be imposed regardless of the age of the person who has been subject to the criminal process?

The most important judicial ruling on such privacy of significance to forensic genetics was delivered in December 2008 by the European Court of Human Rights (ECtHR) in the case of S and Marper v the UK Government [27]. In this case, an 11-year-old boy, “S”, and an adult, Marper, had each been arrested and sampled during the course of investigations that did not result in their conviction of any offense. Their subsequent efforts to have these samples destroyed and profiles removed from the UK NDNAD met with failure at each level of relevant UK judicial deliberation. The final decision in this case, that of the House of Lords in 2004, was that the retention of their DNA did not breach either their privacy right or their right against discrimination in relevant articles of the European Convention on Human Rights to the extent that the state should be denied this contribution to the prevention and detection of crime. However, members of the ECtHR disagreed with the lower court’s judgment and unanimously ruled that

the blanket and indiscriminate nature of the powers of retention of the fingerprints, cellular samples and DNA profiles of persons suspected but not convicted of offences … fails to strike a fair balance between the competing public and private interests and that the respondent State has overstepped any acceptable margin of appreciation in this regard. Accordingly, the retention at issue constitutes a disproportionate interference with the applicants’ right to respect for private life and cannot be regarded as necessary in a democratic society. [27]

The strength and clarity of this judgment is such that all subsequent European legislation and practice relating to the retention of DNA samples and profiles taken from individual subjects (and hence any uses that can be made of these samples and profiles) should be prudent in taking it into account (for example, the UK Protection of Freedoms Act 2012 has done so). The reasoning used by the ECtHR judges on this issue invites us to balance the contribution of forensic genetics to the general good of crime detection and crime prevention against the individual good of privacy. The notion of a
balance between public and private interests (of which privacy is simply one of the latter) is a common trope in discussions of such measures. For some academic and legal authorities, a person has no reasonable expectation of privacy in their DNA profile if the sample from which the profile was developed was taken lawfully during the course of a criminal investigation. Proponents of this argument usually cite its value to crime-control imperatives, but also restrict the uses of such profiles to “law enforcement” or to the “investigation of crime and the prosecution of offenders”, “criminal justice,” or “police” uses. A recent decision by the Supreme Court of Ohio, US, instantiates this position in its judgment that, following the lawful procedure of DNA collection and profiling, defendants/donors have no standing to object to the retention of the sample and profile in the national US DNA database CODIS [142].

This judgment, and similar ones made by legal and other scholars about DNA profile and sample retention, are informed by what one of us has already called a “genomic minimalist” rendering of the informational significance of forensic DNA profiling [160]. This characterization emphasizes that the genomic data used for the construction of profiles are derived from noncoding regions of DNA and therefore cannot be used to infer any personal or private attributes of the subject from whom the sample was taken. Although the ECtHR judges were not impressed by this argument, arguing that the mere possession of genetic data was already a breach of privacy rights, others have been more willing to cite it as grounds for limiting the significance of privacy critiques.

One final feature of privacy aspects of sample and profile information arises from assertions concerning a person’s right to know what data has been collected about them. In most liberal-democratic societies, donors of biological samples whose genetic profile has been retained as part of a criminal investigation are likely to have the right to their profile information, and to know that such data have been destroyed once they are no longer needed for legitimate purposes and as regulation requires or permits it. This issue of data deletion as part of information management is informed in part by reference to the “right to be forgotten” (sometimes the “right to deletion” or “right to oblivion”). Although not fully settled as a legal notion, a right to be forgotten resonates with the rehabilitative objective of criminal justice systems, and may even be argued as a prerequisite in the fulfilment of this legitimate aim. Equally, the informational rights of convicted offenders may be seen as very different from suspects, “persons of interest”, or witnesses [163].

3. Privacy and Investigative Intelligence

In many criminal jurisdictions, the tenor of forensic genetic privacy deliberations has been shifted by efforts to enhance the informativity of genetic analysis of crime-scene stains. Some of these efforts have been based on enriched uses of the conventional STR multiplexes utilized for forensic DNA databasing. The techniques of “familial searching” (or “genetic proximity testing” to use the term preferred by Prainsack [119] to distinguish between biological and social relatedness) provide a conspicuous instance of this trend, and for some commentators, the use of these techniques contradicts the minimalist claim even as it relates to noncoding genomic information. The ECtHR judgment referred to above certainly took this view, arguing that the use of DNA profiles to identify genetic relationships as well as genetic distinctiveness was an interference with the right to private life of those people potentially caught up in this process.

The other main development concerning DNA-based intelligence lies in efforts to develop single nucleotide polymorphism (SNP) panels capable of proving information about attributes of the source of the biological sample in question. SNP markers refer to biallelic differences (alternatives, insertions, or deletions) at single points on the genome. Taken singly, they will not necessarily discriminate well between two sources, but when a large number of SNPs are combined in “SNP panels” or “SNP arrays”, then their discriminative power is enhanced. It seems generally agreed that SNPs provide exceptionally useful supplements to standard STR methods since they provide a very large number of potential markers; the analysis of SNP arrays can be highly automated; and they do not require the longer genomic sequences necessary for STR analysis [4–6,73,74,113]. The move from the analysis of noncoding to coding areas of the genome and the use of such analysis to inform investigations require forensic genetic practitioners to revisit existing understandings and assertions of privacy issues in forensic DNA profiling and databasing. Again, the European Court of Human Rights ruling from 2008 [27] provides European practitioners and policymakers with a useful baseline for a reconsideration of privacy issues in the light of these new forensic genetic technologies. For this court, even autosomal STR profiles contained “substantial amounts of unique personal data” to make their collection, storage, and use an interference to the right to privacy. Moreover, the court also commented that “the possibility … created for inferences to be drawn as to ethic origin makes their retention all the more sensitive and susceptible of affecting the right to private life” (§76) [27]. It is clear
that the court was focusing on samples taken from known subjects and not on samples taken from crime scenes, but both Murphy [100] and Koops and Schellekens [77] have already made the point that where information is first obtained from an unknown donor’s crime-scene stain and such stains are later shown to originate from a particular donor, then information obtained about an unknown person turns into private information about a known person. At the very least there is a question about the subsequent retention and use of such information.

Much of the discussion of developments in DNA phenotyping and their implications for privacy protection has focused on the distinction between the prediction of externally visible characteristics (EVCs) and the prediction of other bodily characteristics that are not visible to an external observer. It is often argued that EVCs are, by definition, publicly available information and do not therefore engage legitimate privacy concerns [69,70]. Some have argued that if and when the use of EVCs leads to the inclusion of a group of persons in an investigation, all of whom share the characteristics of interest, they are effectively defining all members of this group as suspects. Once considered as suspects, their right to privacy may be reduced and they may be obliged to provide samples in order to be eliminated from an inquiry [96]. Although this may be no different from the process undergone by members of such groups who might have been approached in nongenetic, intelligence-led mass screens, it is already recognized that when such mass screens have seemed to target vulnerable minorities, they are not always trusted, and often resented, by those who feel at risk. Others have suggested that EVCs are similar to eyewitnessing but more reliable, and as such there is no reason for excessive privacy concerns to surface in relation to visible physical traits [71,72]. In addition, Koops and Schellekens characterize visible characteristics as “non-privacy sensitive” [77] and suggest that as long as the analysis of EVCs is lawful and adds value to a criminal investigation, it is likely to be proportionate to criminal justice objectives. The data arising from such analysis may even be instrumental in retrospectively tracing the police investigation process once the donor of the sample has been identified as a suspect, and may thus contribute to addressing informational rights of the suspect. However, others argue that it is important that EVC data from a specific case are not centrally retained and therefore do not contribute to the establishment of new kinds of policing or criminal justice DNA databases [148].

The use of ancestry informative markers (AIMs) certainly raises issues concerning the private lives of individuals inasmuch as familial and communal lineage is widely regarded as a private matter, even though it is one that is often shared with (some) others under circumstances freely chosen by the individuals concerned. However, it is the use of such markers in specific case contexts that has to be directly addressed when deliberating the legitimacy of potential privacy breaches of this kind. We have already indicated the circumstances in which investigative leads based on such markers may become relevant. A claim to the privacy of the genetic information available in a crime-scene stain would be difficult to sustain, although this does not address the privacy rights of those who might later be approached to be sampled because they are a member of a particular population subgroup. When the agreement sought is voluntary (as it usually is where intelligence-led mass screening is used), there is already an implicit recognition of the informational privacy rights that reside in the person’s sample. When samples are requested or required following other investigative actions to identify potential suspects, then these rights may already be in jeopardy. In either case, principles of retributive justice and solidarity (discussed below) may be used to justify the request. Nevertheless, the persistence of opposing values means that some assessment of the proportionality of the privacy breach will need to be made on a case-by-case basis, or at least on the basis of what kind of case is being investigated and what other investigative actions may alternatively be taken.

4. Privacy and Massively Parallel Sequencing

Massively parallel sequencing (MPS), also known as next-generation sequencing, makes possible, in one DNA reaction, the collection of autosomal STRs, Y-STRs, mitochondrial markers, and mRNA as well as a variety of EVC- and AIM-relevant SNPs and “Indels” (or insertions/deletions). More SNPs may also be included in the arrays that comprise commercially available MPS kits. It is possible to run reactions for STR identification separately but it is also possible to use the whole array if required. Genealogical connections are already routinely interrogated by the use of Y-STRs and mitochondrial DNA, but the inclusion of these in MPS kits may make their uses more common. Although the privacy implications of this increase are insignificant when confined to the comparison of DNA collected in the course of criminal investigations, additional considerations may arise if crime-scene DNA is searched against commercially managed “recreational” or research genealogical databases. One recent US case involved access to the “Sorensen Y Chromosome” database [52] for information about a person identified through a familial search supplied to police following court-warranted actions, and since that case, access to the database has become more restricted. The possibility
that future police searches of such databases — with or without judicial authority — may undermine undertakings given to individuals who donated their samples is a matter of concern that needs close consideration. Even more care would need to be exercised if it became possible to search medical research databases or other kinds of medical records for genetic results that allowed comparison with results obtained from the analysis of crime-scene samples. Even though it is likely that such searches could only be conducted on a case-by-case basis and supported by judicial authority, the prospects of such a development may reduce the willingness of individuals to donate samples to medical databases in particular, and also have a chilling effect on individuals’ trust of key social institutions.

It is not beyond the bounds of possibility that investigators may seek further information from the application of MPS technologies in situations where none of the currently standard technologies have provided actionable intelligence. It is likely that progress in DNA analysis will increasingly deliver the capacity to derive disease propensity as well other kinds of medically relevant information from crime-scene stains. Clearly such developments engage many of the ethical principles and issues we have already raised in this guide, and forensic geneticists are encouraged to engage with these. A complicating fact here is that the seemingly clear boundary between forensic genetic applications and the use of genetic knowledge within clinical medicine (or medical research) is actually rather opaque. Genetic inquiries can cross contexts of use (for example, there may be medical issues relevant to a criminal investigation or a paternity determination). A similar permeability may occur because medical information and genetic information have to be used in combination (for example, to determine the robust identification of bodies), and it can also occur because some data generated by the application of particular genotyping methods have relevance to both medical and nonmedical contexts (for example, analysis of ancestral lineage may be relevant for biomedical research and for forensic identification). Access to medical records in order to follow up investigative leads based on these kinds of analysis are likely to require judicial approval, but when such approval is granted, forensic science practitioners will find themselves in possession of information about a sample donor that is unknown to themselves, which they may or may not want to know, and which they may or may not want shared with others. If cases occur in the future in which the application of MPS technologies results in knowledge of more sensitive genomic information, policymakers and practitioners may have to consider what ethical obligations attach to those who gain this information in such circumstances. Following Maclean [87], the question is how to balance state criminal-investigation interests against the right of individuals to have certain information about themselves if that information is available to others, their right not to know some such facts, and their right to control the circulation of this knowledge.

D. Justice and Equality

Rawls has argued that justice — considered as the fair or equal treatment of all members of a society — is the “first virtue of social institutions”, and for this reason justice and equality are central concepts in applied ethics [125]. Borrowing notions from Aristotle, we can give a clearer focus to thinking about the application of these concepts to forensic genetics by distinguishing between questions of retributive, procedural, and distributive justice.

1. Retributive Justice

Also called corrective justice, this concept is concerned with the righting of wrongs, especially but not exclusively through the operations and outcomes of the criminal justice system. There is a large body of evidence showing that the development of DNA profiling and databasing has contributed hugely to crime control and to retributive justice outcomes by providing actionable intelligence to investigators and evidence to adjudicators [11,30]. Official statistics (often issued by database custodians) have shown the number of database matches and (sometimes) their contribution to investigations. A variety of research studies have also examined the contribution of DNA profiling to the investigation of both property crime and crimes against the person [16,17,86,129]. Some commentaries have positioned forensic genetic developments by reference to the turn toward a biological culture in criminology, embedded in the increasing “biologization” and “geneticization” of society, specifically of popular culture and research cultures [50,107,131,154]. Since the late 1990s, the crime-control discourse has expanded efforts into understanding the causes of criminal behavior to include the genetic dimension. What Nikolas Rose has called the “biology of culpability” [132] has aimed to explore “genetic risk” — the genetic predisposition toward violent or antisocial behavior — which has not only become a consideration in sentencing but also for crime prevention. Specifically behavioral genetics aims to further understanding of tendencies toward violence and/or criminal behavior by exploring the genetic causes of crime, and social scientists have taken an interest in exploring its impact [41,83,111] as well as the potential
2. Procedural Justice

This concept of justice is closely connected to the due-process perspective we mention in the “Introduction” section, and its objective is to guarantee that all those subject to legal proceedings are accorded their full rights. It is also concerned with the appropriate treatment of offenders. Procedural or due-process justice objectives have also benefited from the introduction of DNA profiling into modern criminal justice systems. Two related developments are especially significant. The first is that the scientific basis and standardized laboratory application of this technology has often been contrasted with other less well-grounded forms of forensic technology. This has been given particular attention in recent major policy developments in forensic science in general, especially the work of the US National Research Council [105] in which DNA profiling is singled out for particular commendation as a source and model of the application of robust science in support of procedural justice. The second development is the use of postconviction forensic DNA analysis, which has made possible the exoneration of individuals whose convictions were not secured by adequate due process at the time [130,159].

3. Distributive Justice

The extent to which benefits and burdens are shared equally among all members of a community is the focus of distributive, or allocative, justice. The practical deployment of forensic genetics in the criminal justice context also engages distributive justice or equality issues that are deserving of consideration. Equality finds its most common expression in the right to not be “discriminated against based on any ground such as sex, race, color, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age, or sexual orientation” (Article 21 [89]). However, it can also be interpreted as an aspect of fairness — equal opportunity — and as a right to equity, such as equal access to the benefits of technology uses and equal protection against any potentially damaging effects of their application. Issues of equal treatment have been a focus of ethical interest both in what categories of people have been the subject of forensic DNA sampling, and the effect on individuals in these categories of the retention and subsequent use of their samples and profiles in forensic DNA databases. Here, ethnicity and “race” are frequently problematized as intended or unintended grounds of unequal treatment of those sampled by police forces or security agencies. Accordingly, it has been argued that the use of this technology is both a reflection and a further development in such unequal treatment. It may reinforce the stigmatization, or even aggravate vulnerabilities, of such minorities. Similar concerns have been voiced about database-retention practices of samples and profiles from children and young people as well as nonconvicted persons.

4. Justice and Databasing

One of the main concerns of the Home Office report “Keeping the Right People on the Database” [59] was to provide evidence for the seemingly common belief that persons arrested but not convicted have a higher chance of offending in the future, and that therefore it is legitimate to retain indefinitely, for future speculative searching, DNA samples and profiles taken from arrestees (see [84] for a discussion of this general assumption). Although forensic genetics is silent on the substantive issue of database retention, there is a sense in which support for all DNA profiling regimes — and therefore our understanding of the utility of forensic genetics in general — is affected by such arguments, and thus necessarily has to confront issues of the equal treatment of all individuals by the criminal justice system along with the potential stigmatization of particular individuals or groups that may result from their treatment within this system.

It seems generally agreed that those who are proven to have committed criminal acts are less deserving of claims to some human rights than those who, to all appearances, have been law-abiding citizens. But this is only the case for those rights that are not absolute, and there are differences in the extent to which jurisdictions define legitimate breaches to such conditional rights. Perhaps the usual policy rationale is that it is the provision of equal treatment within distinctive categories of persons, rather than between all categories of persons, that is most important to achieve. Thus all convicted prisoners may be deserving of equal treatment, but their treatment can legitimately differ from that accorded to law-abiding citizens, and that cutting across these and other categories are other relevant natural and social parameters like age or citizenship. Of course, there is continuous controversy about whether certain categories are legitimate or not, as well as how individuals are placed in one or another category.

Earlier discussions of these matters focused largely on the question of the categories of persons whose DNA was — and should be — retained on forensic DNA databases. There have been many commentaries on the US and UK databasing regimes that have focused on the collection and retention of DNA samples and profiles
from particular social groups that might be thought to be especially vulnerable to the stigmatizing effects of such practices — albeit conditioned by policing processes in general rather than forensic DNA databasing in particular. Studies that have focused on ethnicity and “race” include those of Duster [33,34], Ossorio and Duster [112], and Skinner [138]. Another set of studies has been more concerned with the legitimacy of the retention of samples and profiles from children and young people [90,150,151] as well as the unconvicted [58,91,92].

5. Equality and Forensic DNA Phenotyping

Discussions of more recent innovations have raised questions of equality and stigma in a different way. Here, emerging innovations based on SNPs, such as AIMs and EVCs, have raised expectations that in the near future forensic techniques can, with a convincing degree of certainty, determine the population group origins of a human DNA sample as well as provide information on some of the physical attributes — such as skin pigmentation — of the person whose sample has been analyzed. Already, some studies have reported a degree of progress that gives cause for optimism about the capacity of such emergent technologies [69,72,133,139,155]. The use of these technologies represents a clear departure from earlier assurances to critics that forensic genetics only uses so-called “noncoding” parts of the genome that do not hold any significant information about the individual and its relatives. Some have described this as a significant extension of jurisdictional intrusion into bodies and the information derived from them in support of criminal justice ambitions [96,148]. These techniques continue to face opposition in legal terms, following the European Council Resolution 2001/C 187/01 of 25 June 2001.

The main question here is whether or not it is likely that the use of these technologies in specific investigations will result in the unequal treatment of particular social groups who become the focus of investigative attention following the successful genetic analysis of crime-scene samples. The most obvious instance would be where members of a minority ethnic community become persons of interest as a result of the application of AIMs. The fact that such individuals may become persons of interest for other reasons — typically because of witness statements or other forms of police intelligence — is not especially relevant to answering this question since the positive and negative meanings accorded to genetic science mean that more investigative weight as well as more social freight accompany its deployment. For some critical observers, promises about the potential utility and informativity of emerging technologies, such as forensic DNA phenotyping and biogeographic ancestry, may be heard as conflating scientific principles and cultural categories, an effect that may in turn proliferate or worsen existing forms of unequal treatment based on ethnicity and perceived “race”. Forensic genetic research in these areas taps into a long and controversial history of classifying human individuals and groups through their genetic properties. This means that forensic geneticists are by default steeped in a controversial history of classifying human individuals and groups through their genetic properties. Concerns about the use of “racial” categories in forensic genetics, and their possible relationship to race issues in criminal justice generally have been reiterated recently [25,33,112], with some even warning of a creeping scientified politics of “eugenics” [32] or, more specifically, a “racialization” of forensic genetics [138] through the production of genetic “facts” based on culturally conceived and unreflective assumptions. This sociopolitical history and the discourse around “race” and “ethnicity” used in forensic contexts reflect concerns that traditionally conceived views may be entangled with emergent technologies, and in turn impact on wider public and policy perceptions of legitimate efforts to identify the larger population groups to which any individual may belong. Although contemporary societal, as well as individual, governance mobilizes recent and emergent biological insights, data, and technologies — what has been described as “biopolities” [132,140] — these need to be challenged as to their underlying social and cultural assumptions. Forensic genetic techniques such as the use of ancestry informative markers aim to enable probabilistic statements about the individual through the classification of human populations based on racial and ethnic distinctions for governance purposes such as criminal justice.

Scientists point out that genetic research has increased understanding of the genetic variations within populations and — although the mechanisms of AIMs rely on identifying such variations — these are actually considered to be smaller between different biogeographic ancestry groups than those genetic variations that exist within the same populations, as such challenging racial stereotypes [8,145]. Additional issues arise when dealing with the mixed ancestry of many modern individuals. The concerns raised by Skinner, Duster, and M’Charek [33,94,138], however, focus much more on the cultural bias at individual and institutional levels in law enforcement and security agencies who deploy forensic genetics technologies, which need to be taken into account when EVCs and AIMs are deployed and
analysis results are reported to the user. A recurrent argument attends to the differences between genetic ethnic identification and self-identification of a donor, or even the attributed ethnicity of a donor through the person collecting samples. Cho and Sankar [24] argue that in policing practice it is often assumed that a preconceived reference population and the suspect correspond, yet methods of assigning race or ethnicity have not yet undergone a process of standardization, and are more often than not dependent on the individual conducting the assignment, and her interpretation of local reference populations. There is also considerable concern about their differing social and scientific connotations [13]. Populations (groups and subgroups) are the basis for “knowing” genetically, yet categories such as ethnic identity are socially constructed, indeed are a vital part of active identification of individuals and communities [25,93,138]. Even biological categories — and reference populations — are products of human classification and a necessary reduction of a complex world for efficacious and efficient engagement with it. Using these to make factual statements, critics anticipate, could lead DNA profiling to enforce, or at least support, existing unreflective social assumptions about race and ethnicity, including simplistic associations between biogeographic ancestry and phenotype.

On the technical level, an additional problem can arise because the boundary between the development and uses of ancestry-informative SNPs and the development and uses of phenotype-informative SNPs can be difficult to discern in the operationalization of data gained from deploying these technologies in police practice. AIMs are short sequences of DNA known to vary in frequency between geographically dispersed populations with no concern given to phenotype (some markers may be associated with it, some may not); markers used to predict EVCs are associated with phenotype, with no immediate reference to ancestry/ethnicity; although they may be associated with it. Some studies are concerned to provide descriptors that are neutral with respect to ancestral features, while also being concerned to focus on SNPs “located in and nearby genes known for their important role in pigmentation” in order to predict skin and eye color [139]. Other studies involving coloration — in this case eye color — point to the difficulty caused by the existence of a “complex and continuous range of intermediate phenotypes distinct from blue and brown eye colours” [133]. In addition, of course, cosmetic changes adopted by individuals can change these and other aspects of their appearance. These points of tension are inherent to themes of the convincing — but sometimes contested — capacity of DNA to tell us something about the identity of individuals and populations, and the ability of science and technology to realize that capacity [138].

Even where these social and cognitive dangers are avoided by careful and close attention to what is meant by ancestral groups, it has been suggested that the results obtained from the application of these technologies are more likely to be seen by investigators as useful when they allow attention to be focused on smaller rather than larger social groups [93,94]. Although it can be argued that such attention is justified by the scientific results obtained from the analysis of biological material, it is still possible that existing social prejudices against such minorities can be reinforced if the results are promulgated carelessly. On the other hand, there is a clear possibility that the findings from these technologies in particular cases can result in the removal of suspicion from members of particular minority groups as well as focusing attention on members of other groups.

Despite the critical commentaries referred to above, there is obvious value in being able to provide investigators with information about the visual appearance of criminal suspects by the analysis of genetic material that has been recovered from crime scenes. There have been several conspicuous cases in which forensic DNA phenotyping, specifically AIMs, have been used successfully to support the investigation of serious crime [134,152]. There have also been some cases in which the uses of the technologies have been suboptimal [156,157]. The current accuracy of phenotyping inferences varies according to the physical feature under consideration. Although this does not raise an intractable problem, it reinforces the need for researchers and practitioners to be clear about claims for scope and accuracy — What can be done with what level of predictive exactitude. Some commentators have reminded investigators and others that it is important not to conclude too quickly that a person identified through a phenotype-led investigative strategy is necessarily the perpetrator, at least not before their DNA is taken, their STRs are compared with those obtained from the crime-scene sample, and other corroborative evidence becomes available [88]. An example here is the use of such technologies as “biological witness” as some have claimed that EVCs can provide a significant improvement to what are recognized as especially problematic eyewitness descriptions of individuals and their physical characteristics [22,43]; in this way reliable EVC inferencing may reduce the risk to innocent individuals of misidentification. Others have suggested that the relationship between eyewitnessing and forensic DNA phenotyping is more complicated than that since any of its outputs would still need to be interpreted by those asked to provide further information based on this
intelligence, including what may be called eyewitnesses [148], and since forensic genetics comes with a host of claims and expectations about its reliability and scientific nature that may reduce the weight of concerns over its analyses for some.

If managed carefully, these new forensic genetic technologies can contribute to principles of due process in that they can provide a scientifically based rationale for directing investigations in particular situations. EVCs inferred, or AIMs obtained, from crime-scene stains may allow the creation of a pool of suspects in which some individuals may be included and from which other individuals may be excluded, and this information may be helpful for the design of intelligence-led mass screens. It is also possible that some individuals who have already been suspected of involvement in a crime can be excluded from subsequent inquiries because they do not have the relevant physical or ancestral feature(s).

E. Social Solidarity and Communalism

Described by Cutter [29] as an alternative to the “Naïve Position,” which balances social gains against individual harms, the relevance of social solidarity desiderata have been especially well articulated by Etzioni in a series of books and papers that apply his communitarian perspective to a range of topics, including privacy concerns in general; ID cards and biometric identifiers; and the ethical, legal, and policy aspects of forensic DNA profiling and databasing [37–39]. Relying on both empirical (“benefits to public safety are very substantial” [38]) and normative arguments (privacy is a “social license” to carry out a limited number of acts free from “communal, public, and governmental scrutiny” [37]), Etzioni concedes that forensic DNA tests and databases are intrusive interventions into the lives of citizens (even though minimal ones), but is also keen to distinguish how these technologies should legitimately be applied to different categories of persons — especially “criminals, suspects and innocents” (the first of these possessing only diminished rights that can be weighed against the high public interest in being able to identify them genetically, and the third possessing full rights with only low public interest in collecting and retaining their biological samples). Although Etzioni’s preference is always for “moral persuasion” for achieving a balance between individual and community interests, rather than coercion as a source of social order, his view of the liberal democratic state is a predominantly benign one. This means for him that, as long as both scientific and operational aspects of forensic genetics are predominantly state-provided (or very closely state-regulated) these activities are deserving of civic trust.

Public interest and public goods such as security, safety, and justice can justify the application of such technologies, and the ethical principle that can be drawn upon is that of social solidarity. Legitimate efforts toward achieving such public goods may even be seen as positing obligations on persons to assist the criminal justice system in their work. Nevertheless, as we have indicated above, there is a continued need to consider where such social obligations may conflict with individual rights, and how to manage the conflict of perspectives. The ethical principle of solidarity speaks to the communal cohesion necessary for individual flourishing in society, or what Häyry calls “a sense of togetherness” [55]. As such, it reminds us that the other principles we have listed and discussed above tend to focus largely on the individual person and give less attention to the significance of the collective in deciding on moral courses of action. A recent Nuffield Council on Bioethics report [120] distinguishes between the operation of this ethical principle at:

1. Interpersonal level: “the willingness to carry costs to assist others with whom a person recognises sameness or similarity in at least one relevant respect”
2. Group level: “a collective commitment to carry costs to assist others who are all linked by means of a shared situation or cause”; and
3. Contractual level: where legal obligations exist as in the case of “welfare state and social welfare arrangements.”

The first two levels emphasize that acting on the principle to give up aspects of autonomy in exchange for community benefits is necessarily a voluntary choice that individuals may wish to make. In choosing to act according to a principle of solidarity in liberal democratic societies, there remains a legitimate expectation that rights to dignity, privacy, justice, and equality are respected by others. It is assumed that relinquishing some aspects of such rights will result in a more flourishing life for all than would be possible if each individual insisted on the full and untrammeled exercise of only their own personal rights. The principle of reciprocity then reminds us of our ethical obligations to one another, and applied to the forensic context may help us determine what personal genetic information members of a society should be willing to provide — for research or for operational uses — in order to restore, preserve, or enhance their collective safety. This principle may be appealed to in justification of the uses of forensic genetics in general, but we have already listed two specific kinds of occasions where individuals are not themselves designated as subjects of criminal suspicion but may be approached to provide bodily samples as witnesses of a crime or as subjects in an intelligence-led mass screening. In the latter case, of course, individuals
need to know that they are not subject to unjust kinds of profiling — racial or otherwise — in which there is no mutually beneficial outcome to be derived from the process. A similar question about the proper levels of reciprocity implicitly presumed by demands of solidarity can be asked when individuals are approached to provide genetic information in the course of a familial search. Here individuals may be approached to provide samples for DNA profiling because they have been identified as persons of interest due to their kinship proximity with a databased individual, some (but not all) of whose alleles have matched a crime-scene DNA profile. Finally, and most obviously, a claim on ethical solidarity has been used to support proposals for population-wide forensic DNA databases. However, there have been no liberal democracies in which such proposals have been accepted by legislators. The only societies in which “universal” DNA databases have been seriously considered at the time of writing are several Persian Gulf states, and even here the legislative frameworks and organizational arrangements for these innovations are not yet in place.

CONCLUDING REMARKS

This review has not favored one or another position in the tension field between the three general approaches to forensic technologies in the criminal justice system: crime management, due process, and genetic surveillance. Instead, it has presented the key recurrent arguments and concerns about innovations in forensic genetics and their operational applications. One of the intentions of this review has been to raise awareness of the fact that those who wish to foster the innovation process in this sensitive area can only benefit from a fuller knowledge of the kinds of reception — critical and supportive — that innovations in forensic genetics have received over the last 30 years. There is a need for criminal justice actors, policymakers, and publics to be better informed about the developing uses of forensic DNA, and there is also a need for those involved in the development of science and technology in this domain to engage more fully with civil society organizations, policymakers, and wider publics: “If a technology is intended for use in society — as, arguably, any under development is — its developers, commissioners, and potential users need to engage with its social contingencies … ethical and legal issues are not ‘burdens’ but opportunities for engagement and technology enhancement” [148].

Social issues and ethical principles are subject to considerable interpretation, and there are many instances in which they may come into conflict with one another, causing what some have called “right versus right” dilemmas. There will be circumstances in which, for example, individual rights may conflict with collective rights, when privacy or dignity breaches have to be weighed against the goals of retributive justice, or when distributive justice goods have to be balanced against demands for solidarity. Much international and national jurisprudence, as well as many academic accounts of the ethics of forensic DNA profiling, has invoked the “principle of proportionality” when adjudicating between conflicting ethical and legal imperatives. It is important that forensic genetic researchers and practitioners are able to engage with this principle and so we briefly consider it here.

The Council of Europe proposes that “the principle of proportionality requires that there be a reasonable relationship between a particular objective to be achieved and the means used to achieve that objective.” The principle is most often brought into play in European jurisprudence when consideration is given to the legitimacy of an interference with an acknowledged right included in the European Convention of Human Rights. To be proportionate, any such interference has to be “necessary in a democratic society”, and answer a “pressing social need”. For the application of forensic genetics this means that the uses of any particular variant of DNA technology need to be justified as “necessary” within the context of the legal framework and criminal justice objectives. If analyses are especially ethically intrusive, it will also have to be shown that less-intrusive investigative measures have been tried and failed, or that they cannot be effective in a particular case context. Applications of this very open — textured principle thus require attention to be given to questions of efficacy alongside questions of ethics — judgments of fact have to be made along with judgments of value. Lord Dyson’s judgment in Wood v Commissioner of Police for the Metropolis [164] made it clear that an assessment of proportionality is more than a simple balancing when he stated that “the court is required to carry out a careful exercise of weighing the legitimate aim to be pursued, the importance of the right which is the subject of the interference and the extent of the interference” (§84).

Empirical and normative issues necessarily become intertwined in assessments of proportionality, and perhaps for this reason assertions of the proportionality or disproportionality of a particular measure may be easy to make but also difficult to adjudicate. Accordingly, such assertions often remain contested, although at the very least their assessment encourages policymakers to provide sound evidence concerning factual matters, and sound reasoning concerning ethical ones.
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