Societal, ethical, and regulatory dimensions of forensic DNA phenotyping

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EXECUTIVE SUMMARY

This Report is an output of the VISAGE project, which aims to develop, validate and implement a set of new prototype DNA-based tools to allow for appearance, age, and biogeographical ancestry (BGA) prediction testing of unknown perpetrators from various crime scene traces in an efficient way.

In this Report such prediction testing is defined as forensic DNA phenotyping (FDP), though we do acknowledge, and indeed our previous research has identified, that professional stakeholders differ in their views regarding whether age and/or BGA should fit under the umbrella of FDP.

The Report specifically aims to:

- Systematically review the scientific, ethical, and grey literature, and the collection of data from interviews with stakeholders in partner countries to identify challenges for the implementation of FDP in an ethical and societally responsible manner, with particular emphasis on impacts on privacy.
- Conduct a societal impact analysis of FDP using the toolkit developed by the ASSERT-consortium (Assessing Security Research: Tools and methodologies to measure societal impact; assert-project.eu) with a special focus on privacy- and other data protection-related aspects.
- Triangulate the findings from the above two aims.

The Report achieves its aims using analytical analysis as well as empirical data from two main sources. These include (a) a comprehensive review of the scientific, ethical, and grey literature relating to FDP as it pertains to age, BGA and appearance prediction testing; and (b) a range of interviews with professionals and civil society groups who have a stake in FDP. These include 36 professional interviewees with members of the criminal justice system, governmental representatives, (forensic) scientists, social scientists, and academic lawyers; and 30 interviews with members of civil society groups representing data protection, privacy and/or human rights issues, minority groups, ethics-related issues, families of missing persons, and victims of crime. Interviews were conducted in VISAGE partner countries, which include Austria, France, Germany, Poland, Spain, Sweden, the Netherlands and the UK.[1]

This Report does **not** aim to interpret or draw normative conclusions from our review and societal impact assessment findings; and it does **not** aim to form policy recommendations. This will be tackled in a forthcoming 2020 Report.

[1] One interview was conducted in a country outside of the eight VISAGE partner countries, which was included in the analysis.

The key findings of the Report are highlighted below and discussed in more detail in the remainder of the Report. Academic publications discussing the findings of the Report will be published in due course within the year 2019.

Key findings: ethical and social challenges

Ethical/social challenge	Key concerns (as voiced by the scholars & interviewees)
Discrimination	● Concerns have been raised that the FDP technology only has use to implicate or rule out minority populations leading to questions about the value of the technology as a basis for discrimination. ● Discrimination can occur during police interpretations of the FDP findings. This could lead to racial profiling. Though it is noted that profiling itself (categorising potential suspects by a group of certain characteristics, such as hair or eye color) is an important aspect of a criminal case. ● If FDP findings are released to the public it could upset community and social relations. Whilst some argue that this issue is not specific for FDP, but for general eyewitness photofits, most consider it best if FDP findings are not released to the public, or the possibility of public dissemination is thought about very carefully. ● The use of FDP may lead to reification of a genetic basis of race and may lead the public to interpret that racial differences are a "hard" biological given, which might, in turn, deepen the social divide between different groups or individuals, and lead to discrimination.
Inflated expectations, over-reliability, and inaccurate test results	● Over-interpretation of FDP findings is a concern because of (a) the 'CSI' effect, (b) the probabilistic nature of FDP findings and the inherent difficulties in interpreting such findings, and (c) the presence of ethnic, racial and other stereotypes in European (and other) societies that could influence how probabilistic statements on pigmentation and BGA are interpreted. ● Some scholars are concerned that over-interpretation of findings may lead the police to follow false leads. Others argue that FDP findings should never be used to follow leads without other corroborating evidence. ● Whilst education and communication approaches have been called for to address these issues, these approaches are problematic for a number of reasons, including issues of capacity, and issues relating to ineffective strategies which cannot overcome deep-seated bias.
Privacy and the 'right not to know'	● Most scholars do not view FDP predictions for age, appearance and BGA as infringements of people's privacy or their Right not to Know. ● Issues are raised if the trait being tested can also provide information about a health condition, which - in contrast to pigmentation or age or biogeographical ancestry - is likely not to be known to the person if the disease has not (yet) caused specific symptoms. In cases where it is known that information

	about a trait also discloses (probabilistic) health-related information that is unlikely to be known to the affected person, scholars suggest refraining from making predictions about that trait. Others suggest an approach which asks an apprehended suspect if they would like information about any incidental health findings which might have emerged during DNA analyses in the investigative process. ● Most authors agree that the Right not to Know is not absolute, but rather it must be balanced against other values and rights, such as the need to identify a perpetrator.
Storing FDP findings and data protection	● Nearly all stakeholders and authors stressed that genetic findings from an FDP test should remain within the laboratory and the police should only receive the narrative descriptions of the findings. Though this raises questions relating to how findings can be accurately interpreted and checked by specialist police officers if required. ● Nearly all stakeholders and authors emphasised that once a criminal case has been closed, narrative FDP information should be deleted, though in practice this may be more difficult than perceived, and provides little information in terms of how long the FDP information should be kept if the case is not closed. ● Decisions need to be made regarding (a) how long FDP findings should be stored in the laboratory in instances where a case is not closed (and even if it is), (b) whether current measures of data protection are sufficient to protect the needs and interests of individuals and groups, and (c) whether current practices within laboratories are set up for deleting and encrypting FDP data.
The cost-effectiveness of FDP, its value and utility	● There have been calls to evaluate the utility of FDP in quantitative terms, so that it can be compared to the financial cost of using the technology in a cost-benefit analysis. ● It is difficult to evaluate the utility of FDP in practice, and questions such as how to evaluate; what to evaluate; and by whom all need answering. ● The expectations and interests attached to FDP - whether that be from the market, the public, the media or the professional stakeholders themselves, likely play more of a role in shaping the development, application and implementation of FDP than a rigorous cost benefit analysis.
FDP as a 'biological eyewitness'	● Analogies are frequently drawn between eyewitness statements and FDP findings, though these analogies are problematic for a number of reasons. First, the fact that eyewitness statements are *also* often biased is not a compelling argument in favour of using FDP. Rather, FDP should be assessed against independent criteria. Second, by analogising FDP to eyewitness accounts, we forget to consider the trust people place in DNA information and the effect this may have on how they interpret

	FDP outcomes even if they are told that such outcomes are only predictions. As such, we cannot assume that whilst police understand the uncertainties related to eyewitness statements the same will be true for FDP predictions. Third, the eyewitness-FDP analogy suggests that FDP can "see" a person from the outside. This statement seems problematic: FDP makes probabilistic predictions about what a person *may* look like from an analysis of DNA.
Bias: databases, algorithms and availability of tests	• Bias can occur from the way that DNA data sets and algorithms are used for the FDP analysis.
Misuse of the technology	• Potential exists for the misuse of FDP. Misuse can manifest in terms of excessive surveillance whereby security services or civil society use FDP in circumstances that may not be illegal but ethically or politically problematic. • Proportionality is a useful principle for determining when FDP should be used and in which situations, but there is also a need for regulation to inform police officers when to use the technology, which traits to analyse, and to guide them with relation to which services should conduct the analysis.

Key findings: Triangulation of review and societal impact assessment findings

CONSIDERATIONS IN FAVOUR OF A SPEEDY INTRODUCTION OF FDP
● FDP is uniquely placed to provide leads in criminal justice cases where no other leads are available ● The solution of crimes is a public good, and respects the rights of victims ● Ethically we should honour our commitment to try to solve crimes and enhance security.
CONCERNS WITH FDP IN PRINCIPLE
● The effectiveness of FDP in solving crimes is not certain, ● There are other ways of addressing the threat of crime and so FDP should not go ahead. This argument could also be made on the basis of the responsibility to use public funds prudently.
ISSUES WHICH NEED ADDRESSING
Privacy ● FDP could interfere with people's privacy by including people in the investigation who would otherwise not have been included. While this is not necessarily disproportional or otherwise undue, public authorities need to be transparent about the use of FDP in casework to allow for monitoring and evaluation. ● If FDP were to increase the number or scope of innocent people who are included in investigations, then this may have a negative impact not only on privacy but also on people´s family lives and other rights and (personal or public) goods. ● Measures need to put in place to ensure FDP is not misused in terms of excessive surveillance. ● Issues arise if an FDP finding can also provide information about a health condition, which is likely not to be known to the person if the disease has not (yet) caused specific symptoms. Scholars suggest refraining from making predictions about that trait.
Data protection An ethical imperative remains to safeguard any FDP data or findings against misuse or abuse. A wide number of questions remain about how this can be achieved, including: 1. how findings can be accurately interpreted and checked by specialist police officers if they do not have access to the genetic data; 2. what systems are in place to ensure all data is deleted once a case is closed (there seems to be a near consensus for deleting the files) ; 3. how long FDP findings should be stored in the laboratory in instances where a case is not closed (and even if it is); 4. whether current measures of data protection are sufficient to protect the needs and interests of individuals and groups; and 5. whether current practices within laboratories are set up for deleting and encrypting FDP data.

Discrimination

FDP could be used in ways that unduly discriminate against, or stigmatise, persons and groups. This would affect people's civil rights and liberties as well as their culture and community. This discrimination could happen at a number of levels.

- If there is bias in FDP algorithms and data sets this may lead to discriminatory practices.
- Police misinterpretations of FDP findings could lead to racial profiling.
- The use of FDP may lead to reification of the belief that race is genetic, and may lead the public to interpret that racial differences are a "hard" biological given, which might, in turn, deepen the social divide between different groups or individuals, and lead to discrimination.

Over-interpretation of FDP findings

- Over-interpretation of FDP findings could lead the police to follow false leads.
- Even though some remind us that FDP findings should never be used to follow leads without other corroborating evidence, if FDP is used as a last resort, there may be very little corroborating evidence available.
- Education and communication approaches have been called for to address these issues, though these approaches are problematic for a number of reasons. First, there are issues of capacity, and second, there are issues relating to ineffective strategies which cannot overcome deep-seated bias if over-interpretation is related to discriminatory practices.

CONCLUSION

- Rather than trying to weigh up security against privacy/discrimination, we fully support the view of scholars who argue that this is not a zero-sum game where one can be "traded" for a bit of the other; instead, we need to explore whether security technology actually address security needs.
- Robust research must show that the effect of FDP in case work is beneficial - in the sense that it increases detection rates (and does not lead to false leads), reduces cost and/or investigation time, saves public resources, and does not lead to undue harms for people or groups such as those related to discrimination or bias.
- Questions such as how to evaluate this in practice; what to evaluate; and by whom all need answering.

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1. Introduction

1.1 Forensic DNA phenotyping

The VISAGE project aims to develop, validate and implement in the relevant environment of routine forensic DNA service, a set of new prototype DNA-based tools to allow for appearance, age, and biogeographical ancestry (BGA)[2] prediction of unknown perpetrators from various crime scene traces in an efficient way.[3] FDP findings are probabilistic i.e., they can only infer a specific phenotypic feature to a certain degree of probability. Whenever the word 'prediction' is used in this Report, it is to be understood as *probabilistic* inference. Below we provide more information about FDP for appearance, age and BGA inference, as well as the purpose of FDP findings in the criminal justice system.

1.2 Biogeographical ancestry, age and appearance inference

1.2.1 Biogeographical ancestry inference (BGA)

Biogeographic ancestry describes the geographic region in the world where the person's genetic ancestors originate from (also referred to as genetic ancestry). Genetic-geographic structure of worldwide human populations, representing the scientific basis of biogeographic ancestry prediction from DNA, is weak with ~90% of the genetic variation between individuals independent of their population of origin and just 10% between different populations from different places (Rosenberg et al. 2002). Nevertheless, this minor proportion of genetic differences between people from different places can be used to derive ancestry informative DNA markers and for developing DNA tests for ancestry prediction, which are useful in forensic applications.

The genetic markers used to infer BGA in the VISAGE project mainly include Single Nucleotide Polymorphisms (SNPs).[4] These genetic markers are found on all autosomal chromosomes as well as the sex chromosomes and the extrachromosomal mitochondrial genome. At present BGA is mostly predicted at the continental level and cannot be used to provide information

[2] Not to be confused with lineage ancestry which mainly seeks to give information about an individual's paternal or maternal lineage.
[3] This could include "composite sketches" in the way that we explain on the VISAGE website: http://www.visage-h2020.eu/#FAQ
[4] SNP: a variation in a single nucleotide that occurs at a specific position in the genome.

about a suspected perpetrator's nationality. Nationalities and borders have political and cultural, not biological roots (Karberg 2018).

1.2.2 Age inference

In this Report, age inference refers to the prediction of the age of an unknown crime scene sample donor from DNA found at a crime scene. Whilst various genetic tests have been used to infer biological age, those based on the analysis of DNA methylation patterns (the presence of a specific 'methyl' molecule on the 'cytosine' nucleotide), otherwise known as epigenetic markers, have been shown to be the most reliable in the sense that they perform best in 'predicting' chronological age (Hannum et al. 2013). DNA methylation regulates gene expression (whether a specific gene is active or not active), and an individual's DNA methylation pattern (i.e., which parts of their DNA are methylated and which are not, as well as the relative proportion of methylation at a single site) changes with age. Specifically, about 20% of variation in DNA methylation in the human genome is correlated with the change in age and this relates to the presence of specific 'methyl' molecules on cytosines in a specific context of a DNA sequence motif.

1.2.3 Appearance inference

In this Report, appearance inference refers to the prediction of the appearance i.e., the externally visible characteristics (EVCs), of an unknown crime scene sample donor from DNA found at a crime scene. EVCs can be distinguished from a person's 'invisible' or 'hidden' traits, such as those related to a specific health condition or disease. Prediction tests for appearance normally involve SNP testing and examples of EVCs which have been used for FDP include eye, hair and skin colour.

1.3 Purpose of FDP findings

In current police and judicial practices, DNA profiling is used to either exclude a suspect or to ascertain the identity of a suspected perpetrator and can be used as evidence in court. FDP is different: rather than providing confirmatory evidence, the key utility of the technology is seen to be in an investigatory context i.e., as a probabilistic predictor of characteristics about an unknown person to aid as one part in a wider investigation to identify an individual. Moreover, among experts working within the criminal justice system in European Union (EU) member countries, there is wide agreement that whilst FDP findings in a criminal case need to remain in a case file as evidence, FDP findings would never need to be used as confirmation that a suspected perpetrator had committed a crime, since once arrested, the suspected perpetrators'

DNA has to be confirmed against the original DNA sample found at a crime scene using “traditional” STR-based DNA analysis (Cino 2017; de Cerqueira et al. 2016; Kayser and Schneider 2009). Having said that, if the obtained statistical power is strong enough, FDP allows excluding suspects from having been the sample donor, though using FDP for exclusionary purposes is a much less likely scenario. It is the ethical and societal challenges relating to the investigatory purpose of FDP that are the focus of this Report.

2. Methods / terms of reference

Our Report relies on two data main data sources:

- Scientific, ethical and grey literature
- Stakeholder interviews in VISAGE partner countries.

In addition we answered questions for societal impact assessment (SIA) developed by the ASSERT project: http://assert.maisondx.com.

Below we describe our data collection methods for data collection and analysis..

2.1 Scientific, ethical and grey literature

2.1.1 Scientific and ethical literature

A growing body of ethical, sociological, STS (Science and Technology Studies) and grey literature explores the ethical and societal dimensions of FDP. The literature discusses a range of different purposes for which FDP could be used, namely for testing both known and unknown DNA samples,[5] and for prediction testing beyond that of age, BGA and appearance characteristics. In this literature, the types of ethical and social issues that are highlighted include, for example, FDP's use to determine information about health, disease or behaviour (Haga 2006; Koops and Schellekens 2008; Kayser 2015), and issues of consent within the context of FDP research (Toom et al. 2016). Other strands of the literature explore ethical and social concerns associated with photofit face recognition technologies, typically originating in the United States (U.S.), where a range of for-profit companies make claims about their abilities to produce such a product from DNA-based information. Finally, there is a substantial literature discussing BGA testing and its implications in terms of race and ethnicities, both within the forensic literature, and beyond.

[5] The difference between testing known and unknown samples has been discussed in the literature in terms of use, but also it is the predominant distinction in terms of US regulation of DNA testing. Here, the US federal statute outlines the permissible scope of collection and testing DNA from known offender samples (eg from a DNA database) but says nothing about testing unknown samples (eg from a crime scene). Therefore there is no regulation, and it is not forbidden to use FDP (unless regulated at State level) in the situation it is most likely to be used – the collection and testing of crime scene unknown samples (Murphy 2013),

In this Report we focus on the ethical and social challenges specifically for the responsible implementation of FDP on unknown DNA samples from a crime scene to predict age, BGA and appearance characteristics in order to try and ascertain the identity of an unknown perpetrator. All other ethical and social discussions have been excluded.

Data collection started in October 2018. To collect data for our review of the scientific and ethical literature, we employed the following procedure: As a first step, we searched the academic publications database Google Scholar using four different keywords. We used Google Scholar because it is the most inclusive search tool for publications; other databases are limited to indexed journals or use other criteria that narrow the range of publications included. The table below includes the specific keywords used for each of these searches, and the rationale for choosing them.

Table 1. Specific keywords used to search the scientific and ethical literature for the review

“Forensic DNA phenotyping”	This keyword represents the target literature we wished to collect
“Forensic DNA [and] ethics”	A broader search of the forensics, DNA and ethics literature ensured we had collected all necessary literature
“Molecular photofitting”	This term is sometimes used instead of FDP in the United States
“Forensic ancestry testing ethics”	BGA testing is considered by a number of scholars as distinct to FDP, and is discussed separately in the literature. Searching with these keywords ensured we collected articles which explored issues relating to this type of prediction testing which may not have been collected in searches related to FDP.

As a second step, we scanned all results and separated them into papers for closer reading - namely those that did address ethical, societal, or legal aspects relevant for FDP - and papers that did not merit closer reading. We made this decision on the basis of reading titles and abstracts, and if this did not provide a conclusive answer, skim-reading the entire document to make an informed judgement. As a third step, we read in detail, and carried out a thematic analysis, of all papers that met the inclusion criteria i.e. that contained at least one section within

the paper which discussed ethical or societal aspects relevant to FPD. We also included papers providing the sociological context of FDP. As a fourth step, we used the method of snowballing to identify further relevant literature that was not included in our initial search. Steps 2-3 were carried out for these papers and books too. In total, seventy-four publications were analysed for the literature review.

2.1.2 Grey literature

Data collection commenced in October 2018. To collect data for our review of the grey literature, we employed the following procedure: as a first step, we searched Google using the key terms, “forensic DNA phenotyping” and “molecular photofitting” (the latter is the term for FDP often used in the U.S.). As a second step, we selected all articles returned in the first ten pages of the google results since these articles would be the most relevant for the purpose of this review. As a third step, we read in detail, and carried out a thematic analysis of, all articles that discussed at least one ethical or societal aspect relevant to FDP, specifically for age, BGA and appearance. Articles selected included news media articles, commentaries on professional association webpages, and articles in professional magazines. In total 27 articles were analysed.

2.2 Interviews

2.2.1 Interviews with professional stakeholders

This source of information was derived from data gathered from a range of interviews with professional stakeholders from the eight VISAGE member countries. Interviews were conducted June-October 2017. Respondents included members of the police, representatives of government agencies, academic scholars, lawyers and scientists, and also some members of the wider VISAGE team. To conduct the interviews, a list of potential relevant stakeholders was sourced from VISAGE team members and their networks, and then a snowballing method was applied. All but one interview (which was carried out by the second author, BP) were conducted by the first author of this Report (GS). Thirty-six interviews were conducted in total. Table 2 provides a breakdown of the number of participants we interviewed from different professions. Interviews were conducted in English via skype and digitally recorded for transcription. Where language was a barrier to audio interview, interview schedules were emailed to participants and

responses given in written format. Ambiguities which arose during both types of interview were resolved via follow-up emails.

Table 2. Number of participants interviewed from different professions

Profession	Number of participants
STEM scientist (geneticist, statistician etc)	14
Social scientist	5
Government agency representative	8
Police representative	6
Academic lawyer	3

2.2.2 Interviews with civil society groups

Data were obtained through interviews conducted with civil society groups in the eight VISAGE partner countries (plus one interview which was conducted in a non-VISAGE represented country). Interviews were conducted June-November 2018. We approached members of civil society groups who we deemed to have an interest in FDP. These included groups advocating for human rights, privacy, data protection, ethics, minority-groups, victims of crime, and missing persons.

A list of relevant civil society groups was sourced from two main publications: *European Privacy and Human Rights* 2010 by Privacy International, the Electronic Privacy Information Center, and the Center for Media and Communications Studies; and *Victims of crime in the EU: the extent and nature of support for victims. 2014* by the European Union Agency for Fundamental Rights. These publications contained details of privacy-/victim support- related civil society groups in each of the VISAGE-represented countries. Alongside this, all VISAGE members were asked to supply a list of relevant groups to contact; and a snowballing methodology was used. All civil society groups were contacted three times by email, after which, if they had not replied, they were considered non-responders. The below tables highlight the number of civil society groups contacted in each country, and the number

who responded. To maintain the confidentiality of our participants we have not supplied details of how many different types of civil groups were contacted in each country, though we have supplied the number of each category of civil society group interviewed overall (Tables 3 and 4).

Thirty individuals responded. Most of these individuals were interviewed orally, either in person or by phone or video link (n=17). Interviews were primarily conducted by the first author of this Report (GS) (the second author, BP, assisted when the interview was conducted in German). Interviews were conducted in English, and digitally recorded for transcription. Where language was a barrier to audio interview, interview schedules were emailed to participants and responses given in written format (n=11). If necessary, interview schedules were translated into relevant languages. Some interviewees replied to our request for interview by supplying some of their written works which directly addressed the interview questions (n=2).

Although we aimed to interview a representative from at least two civil society groups from each country, we had a number of difficulties with (a) identifying relevant organisations in some countries and (b) response rates. Although we offered to conduct interviews in local languages, initial emails were sent in English, which may have decreased response rates. Moreover, many organisations were unwilling to be interviewed on the topic of FDP, which they did not feel was relevant for them to engage with at this time. We must remain attentive to this, and the fact that members of the public may not always wish to engage in ways mapped out by us, the researchers. This raises broader questions about the most appropriate and respectful time/approach to engage the public and civil stakeholders. Some scholars have argued that trying to engage individuals when the discussion is “un-contextualised” can be particularly difficult, and also onerous for participants (Smith and Samuel 2018). We did have higher number of respondents from four countries: Germany, the Netherlands, the United Kingdom (UK), and Austria. The higher number in Germany may be explained by the fact that there are currently extensive debates with regards to proposed legislative plans to permit the identification of certain externally visible characteristics (EVCs), age and BGA. These debates have left expert and professional circles and are covered by public media. Second, in the Netherlands, where FDP is explicitly legislated and practiced for sex, BGA, and eye and hair colour, there may be higher familiarity with FDP, and practical experience with the technology that stakeholders sought to share. Third, while the UK has no similar policy discussions, the fact that the initial contact email was written in English could have increased response rates. We do not have a plausible explanation for why the response rate in Austria was higher.

Table 3. The number of organisations which (a) were invited to take part and (b) took part in our interview study, categorised by their country of representation.

Country of representative individual or organisation	No. of organisations /individuals invited to take part in study	No. of organisations /individuals taking part in study	% of respondents
Austria	8	3	38%
Belgium	1	1	100%
France	6	1	17%
Germany	16	8	50%
Poland	13	2	15%
Spain	33	3	9%
Sweden	6	1	17%
The Netherlands	6	3	50%
UK	18	6	33%
EU-level	1	1	100%
International-level	6	1	17%
TOTAL	**114**	**30**	**26%**

Table 4. The number of organisations which (a) were invited to take part and (b) took part in our interview study, categorised by their interest/advocacy area.

Type of civil organisation or interest	No. of organisations /individuals invited to take part in study	No. of organisations /individuals taking part in study	% of respondents
Victim/missing persons organisation /offender support groups	58	12	21%
Human rights/data protection/digital rights/privacy related	40	10	25%
Ethics-related group	6	3	50%

Minority-group related	3	2	67%
Other non-profit or advisory groups	7	3	43%
TOTAL	**114**	**30**	**26%**

3. FDP: Ethical and societal challenges

Our results from the literature review, as well as the interview study, led to the identification of eight predominant areas of ethical/societal challenge for the implementation of FDP. These are:

1. Discrimination
2. Stakeholders' inflated expectations, over-reliability, and inaccurate test results
3. Privacy and the 'right not to know'
4. Storing FDP findings and data protection
5. The cost-benefit ratio of FDP
6. FDP as a 'biological eyewitness'
7. Bias
8. Misuse of the technology

In this section, we describe and discuss each of these ethical/societal challenges. Given the overlapping nature of concerns identified from the literature and interview studies, we report these findings in an integrated manner. Concordance and discordance respectively in findings between the two data sources are summarised in table 5. Issues related to privacy and discrimination featured prominently in the literature and were less frequently mentioned in our interviews, whereas issues related to discrimination, as well as stakeholders' inflated expectations, over-reliability, and inaccurate test results featured most in the interviewees' narratives and played a less prominent role in the literature.

Table 5. The prominence given to various ethical and societal challenges related to the implementation of FDP as distilled from the interview and literature studies.

Prominence of challenge	Data source	
	Literature	**Interviews**
High	Discrimination	Discrimination
High	Privacy	Stakeholders' inflated expectations, over-reliability, inaccurate test results
Medium	Data protection	Cost-benefit ratio of FDP
Medium	FDP as a 'biological eyewitness'	Data protection
Medium	Stakeholders' inflated expectations, over-reliability, inaccurate test results	FDP as a 'biological eyewitness'
Low	Cost-benefit of FDP	Privacy
Low	Bias	Mis-use (over surveillance)
Low	Mis-use (over surveillance)	Bias

Each sub-section of this section maps out, in detail, a predominant area of ethical/societal challenge, and concludes with a summary of key findings.

When reporting our findings, we have been careful to only discuss key challenges specific to FDP as it pertains to age, BGA, appearance. Many scholars have already made valuable contributions to the ethical and societal issues related to forensic DNA profiling more generally, including the EUROFORGEN-NoE ('European Forensic Genetics Network of Excellence') project (Williams and Wienroth 2013), and we wish to complement, rather than duplicate this work. Having said this, we note that many of the concerns we encountered in both the literature and our interviews, such as those relating to privacy, discrimination and surveillance, are concerns which have not only been raised with relation to FDP, but mirror those which have been extensively raised about the use of forensic technologies more generally within the

criminal justice system (Hindmarsh and Prainsack 2010; Williams and Wienroth 2013; Pavone et al. 2016).

3.1 Discrimination

Discrimination was by far the most prominent ethical and social concern associated with the implementation of FDP in both the literature and the interviews. Our interviewees and the authors of papers and other publications that we analysed argue that using FDP to help find suspected perpetrators of crimes could lead to stigmatisation or discrimination of certain groups within society. This discrimination was perceived to work at a number of levels.

3.1.1 Police and justice officer level

There is particular concern that FDP findings - and BGA findings in particular - will exacerbate ethnic, racial or religious biases already present within the criminal justice system by appealing to such prejudices, and steering investigating authorities in the direction of minority populations (Koops and Schellekens 2008; Weichert 2017; Scudder et al. 2018b). Here, many scholars worry that such biases will lead to racial profiling: a test result stating a person ‘‘is likely of African origin’’ may be translated by non-specialists into the social language of identity or race, such as ‘‘African American’’ or ‘‘black’’, so that BGA information pulled from a DNA profile may lead law enforcement to make decisions based on predisposed expectations about the link between BGA and racial/social identity (Augenstien 2016; Matheson 2016; Sankar 2012; Toom 2010). One interviewee questions the value of a BGA test if it is not for racial profiling: ‘*what should this bring me if I have the biogeographical origin?...And how, if not via racial profiling, do you want to follow up on this report?* (Civil interviewee 17, Germany). Another of our interviewees speaks about how BGA findings could be used in a discriminatory way:

> *It is well-established that racism is inherent in police forces and thus even communicating such information to the police would seem to open up the possibility for discriminatory action against certain groups of people* (Civil interviewee 29, UK).

Furthermore, one civil society interviewee refers to how, even if people strive to “do the right thing” and try to act morally, they can still hold unconscious biases, which in turn can contribute to racial, ethnic, religious, or cultural discrimination. Unconscious biases are social stereotypes about certain groups of people that individuals form outside their own conscious awareness. Everyone holds unconscious beliefs about various social and identity groups, and these biases

stem from one's tendency to organize social worlds by categorizing[6]. Recent initiatives to educate the public about hidden biases include Harvard's implicit bias project.[7] The concern for FDP is that if a prediction reflects a police officer's unconscious bias the police officer may be quicker to accept the finding than if the opposite was the case:

> *Ancestry is in a different category of course because it goes much quicker into the discriminatory biases so this one I think is more sensitive than others…let's say if you find a DNA trace at a crime scene and it turns out to be let's say African ancestry…then people might jump to conclusions based on biases…I don't know the practice of forensic experts but I think we have reason to worry that even experts might jump to conclusions. There are many cases out there, I am not saying it's all of them, but from what I have seen people try their best but biases are unconscious and conscious and they are really complex to handle. So will someone make the same effort and have the same rigour once they have determined ancestry against which they tend to be unconsciously biased, this is worrying* (Civil interviewee 1, Belgium).

These concerns voiced by our interviewees are also found in the literature, particularly in the grey literature, though the examples provided mainly come from the U.S., a country often viewed as having unique racial issues.[8] For example, in a National Geographic piece, Veronique Greenwood (2016) refers to a study that identified bias within fingerprint examiners to highlight the power of bias and to promote discussion around the issue as it relates to FDP. Andrew Purcell (2016) exemplifies a similar study in his piece in the Australian national newspaper, the *Sydney Morning Herald* - this time exploring bias and perceptions relating to "black" and "white" suspects of crime:

> *One study found that [fingerprint] examiners sometimes came to different conclusions about the same fingerprint if they were told the print had come from a suspect who had confessed to the crime or was in custody* (Greenwood 2016);

> *In an experiment run by psychologists at Harvard University, white and Asian students were asked to read a "crime alert" describing a violent robbery. In half the reports, the*

[6] https://diversity.ucsf.edu/resources/unconscious-bias
[7] https://implicit.harvard.edu/implicit/aboutus.html
[8] For a viewpoint piece in the BBC news see https://www.bbc.co.uk/news/world-us-canada-44158098

> *suspect was black; in the other half, white. Those who received the black suspect alert were subsequently much more likely to see blacks as dangerous potential criminals. The same blanket prejudice towards whites was not observed among volunteers who received a white suspect alert* (Purcell 2016).

While these two particular examples are from outside the EU, our interviewees' concerns underscore the importance of considering these issues in a European context.

Concerns about racial profiling were seen as compounded by the probabilistic nature of FDP (see section 3.2), and the scenario that police officers may be searching within the wrong populations due to false leads, with the possibility of an innocent person becoming the target of such profiling:

> *I do have concerns. This technique might help police to narrow the pool of suspects, but it can lead to stigmatisation and racial stereotyping. Especially when the technique is not 100% reliable (*Civil interviewee 30, the Netherlands);

> *If you say we suspect that a black person*[9] *has done this then I wouldn't have a problem with it. But if it was brought as an uncertainty then I would consider that it's dangerous..[..]..*(Civil interviewee 15, the Netherlands).

Others reject these concerns, arguing that if evidence points to an individual from a specific continental region being involved in a crime, this is not to be considered racial profiling (McLean 2014; Matheson 2016; Kopec 2014)**.** Rather, as lawyer Charles MacLean believes, FDP might do the opposite – that is, prove that a perpetrator does not have ancestry from a specific continental or sub-continental region, which might lead even racially biased investigators to overcome their prejudices (Van Laan 2017; Kopec 2014; Koops and Schellekens 2008).

Most scholars consider the issue of racial profiling as a problem broader than FDP and call for police education and the strengthening of control mechanisms in police practice. Specifically for

[9] Note: FDP findings would not be reported in this way - they would be reported as "Sub-saharan ancestry with "X" probability of dark skin'. The point this interviewee is making is about how such findings could be interpreted.

FDP, they call for the establishment of guidelines for the way FDP results will reported (Staubach 2017).

3.1.2 Dragnets and suspect populations

Some scholars and interviewees raise concerns about the possibility of using FDP findings for dragnets (also known as intelligence-led mass screenings), where a specific group of the population - defined according to criteria that are believed to apply to the perpetrator, such as sex, age, place of residence, or ethnicity - is asked to "voluntarily" submit a DNA sample for testing (Lipphardt et al. 2017; M'Charek et al. 2012). They stress that FDP can turn individuals into potential suspects merely because they resemble an EVC profile, or because they belong to a particular biogeographical ancestral group that the suspected perpetrator is assumed to belong to. Once considered potential suspects, individuals' rights to privacy and bodily integrity may be violated as they may be obliged to provide 'voluntary' samples in order to prove their innocence, and to be eliminated from an inquiry. This de facto shifts the burden of proof onto the individual (M'Charek et al. 2012; Williams and Wienroth 2017). As Jay Stanley notes in his article on the American Civil Liberties Union webpages:

> *It should not be used to pressure people to "voluntarily" provide DNA samples or to submit to any other intrusive investigatory techniques. We don't want police using these genetic analyses to run around conducting dragnets for every person in a neighborhood with black hair, hazel eyes, and freckles, for example. It should not be considered to constitute probable cause* (Stanley 2018).

One of our interviewees (Civil interviewee 26, Spain) also explains that the characteristics used to create suspect populations may not even be correct since there may be a lot of circumstantial DNA left at the crime scene and so FDP could potentially lead to incorrect descriptions of suspect groups (Dewey-Hagborg): '*you could blame an innocent person, or you could incriminate a collective without a foundation*'.

While it could be argued that individuals also have their privacy violated when people become suspects because they fit an eye-witness description, anthropologist Amade M'Charek and colleagues argue:

> *The case of DNA-based EVC is different as incrimination here is achieved through population genetics instead of crime-related leads and clues. This poses the question whether such forms of 'genetic policing' are desirable in an atmosphere in which DNA-technologies are seen by many stakeholders as infallible 'truth machines', and knowledge of forensic science in the police force is generally low* (M'Charek et al. 2012: e17).

This point - that stakeholders may place more "weight" on DNA findings than those from other forms of evidence irrespective of the probabilities attached to the DNA findings (whether high or low) - is echoed by sociologists Robin Williams and Matthias Wienroth (2017) who explain that '*the positive and negative meanings accorded to genetic science mean that more investigative weight as well as more social freight accompany its deployment'* (Williams and Wienroth 2017: 161).

Many of our interviewees were also concerned about the creation of 'suspect' populations and the social and ethical implications this may have on their rights, especially given the probabilistic nature of the findings. One civil society interviewee (Civil interviewee 14, Germany) explains that:

> *If the DNA phenotyping analysis shows, well, this is someone with an 80 percent probability of having green eyes, I think one of the tricky questions is what does it mean green. And then they start to search the public registers…I have to register when I move from one place to another…and this file is connected to my national ID…which is my date of birth, my place of birth, my age, how tall I am colour or my eyes, colour of my hair..[..]..even if the police find at the very end that they are not the offenders if I imagine I am here in my office will be visited by the police who are investigating a sexual crime it can damage your reputation very much.*

This interviewee also worries that if FDP findings are used for dragnetting, a situation would eventually arise when computers (FDP algorithmic data) essentially talk to other computers (the dragnet database) – each computer with their own inherent biases and subjectivity: '*what to do about when computers start to talk to computers...I have no idea how to..tackle the issues'.*

Bioethicist Pilar Ossorio and STS scholar Victor Toom and colleagues bring discussions about suspect populations back to concerns about discrimination by stressing that suspect populations will invariably be minority groups since an FDP description that directs police attention towards individuals who belong to a numerical majority are often too large to investigate, but a description that focuses police on minority populations is more likely to be productive, and so can easily render minority groups into suspect populations (Ossorio 2006; Toom et al. 2016). This belief, that '*the results of this technology will above all be useful in investigations when they point to minorities'* (Civil interviewee 23, Germany), was echoed by a number of interviewees, who gave various examples of situations in which FDP would and would not be useful depending on the demographic of minority populations ('*such a Technology is only operational if the result of this analysis is deviating [sic] from the appearance of the majority society, which automatically leads to general suspicion towards minorities. Nobody benefits from this technology*' (Civil interviewee 17, Germany)). One civil society interviewee (Civil interviewee 11, Germany) explains that this is why FDP is '*so popular in Europe because Europe is very big [diverse] if you look at hair colour, eye colour, skin colour so it makes sense to use this method*'. And another civil society interviewee (Civil interviewee 10, Germany) also speaks about minority populations in European countries:

> *You have the skin colour of someone, and probable ancestry, it's obvious that you use this only for people who have a migration background…you are searching for people who are not white. Because it doesn't make sense in a very European country where the vast majority of people are still white to look for somebody who is obviously white and blonde and green eyes, it doesn't make sense.*

As lawyer Nathan Scudder and colleagues (2018) state:

> *In locations with relatively homogenous populations, only a prediction rare in that population would likely be of any real assistance to investigators. For example, investigators in Asia may find results particularly probative if this method suggested a suspect may be a red haired Northern European. As such, the adoption of the technique, if made public, could be criticised for reinforcing racial prejudice: a view that foreigners or ethnic minorities are more likely to be responsible for crime.…There is also potential for the technology to be applied in a skewed manner, more likely used in such cases and again facilitating a bias against minority groups* (Scudder et al. 2018b: 154).

At the same time, as noted above, forensic molecular biologist Manfred Kayser and others explain that if an unknown perpetrator's predicted phenotype does not match a minority group this may help avoid discrimination (Kayser and de Knijff 2011; Kayser and Schneider 2009; Murphy 2013).

Overall, the dragnetting argument has been contested by many scholars who view these issues as relating more to the use of dragnets themselves than to FDP (Koops and Schellekens 2008). As lawyer Erin Murphy states, '*to the extent that DNA dragnets are a problem, it seems that phenotypic testing is not a fair tool to blame, and that the issue is more properly handled by forbidding dragnets, rather than forbidding the development of phenotypic profiling'* (Murphy 2013). Whilst this may be true, the specific issue of creating suspect populations, and the issues this raises in terms of privacy and discrimination, are very much seen as a challenge by scholars.

3.1.3 Communicating FDP findings to the public

If FDP results are made public, discrimination can also occur at this level, particularly if smaller communities are targeted with few representatives of a particular population (e.g. with a specific skin, hair or eye colour). Specifically referring to BGA testing, Melba Newsome explains in her WIRED article that '*rational as it may be, [FDP] is no match for the emotions that surface with any pairing of race and crime…..'* (Newsome 2007). Several of our interviewees echoed this sentiment when they talked about the social sensitivity of disseminating FDP results and their potential for harmful effects in terms of community relations. A UK and German interviewee discuss this for their respective contexts:

> *We already know that in some places particularly in London and other urban centres and various parts of England that if you put out a description like that that would be potentially very harmful in terms of community relations without having any other additional information to go on* (Civil interviewee 5, UK);
>
> *In Germany we already have a situation where with the migration movement in the last two or three years, people are a sensitive on these matters, and if you had more and more public information about criminals with migration backgrounds, and only those*

> *cases will be very prominently reported about, it will worsen the situation (*Civil interviewee 10, Germany).

In her article on genomeweb, Turna Ray similarly reports on her conversation with Veronika Lipphart, an academic exploring the sociology of FDP, who reflected on the Ladenburger murder investigation in Germany,[10] and the possible impact that communicating FDP findings could have on the community:

> *During the Ladenburger murder investigation, she [Lipphart] recalled that people in Freiburg who looked like they might belong to a minority group were subject to verbal attacks — something that might be exacerbated if a DNA test provides evidence that a perpetrator might belong to such a group….When it came out that an asylum seeker had murdered Ladenburger...Freiburg's mayor Dieter Salomon made conciliatory statements, urging people not to treat all refugees as criminals, he received so much hate mail…* (Turna 2018).

Given the political climate in Germany, this country's context seems particularly sensitive to racial sensitivities, and another example is provided the "Phantom of Heilbronn" case. Here, a female Polish factory worker packaged cotton swabs contaminated with her own DNA. These swabs were used in a range of forensic labs where it contaminated investigations analysing crime scene stains, resulting in an unsourced female Eastern European DNA profile. This, in turn, led to a large-scale, multinational hunt for an allegedly poly-criminal woman whose DNA was linked to 40 crimes in France, Germany, and Austria (Turna 2018). Racial sensitivities and discrimination surfaced in society as a result of these unsolved serious crimes. The particular pattern of the crimes, which covered a relatively large geographical area, led to the assumption among some police officers that the perpetrator must belong to "traveller populations", which, in turn, led to members of Roma and Sinti minorities becoming the target of racist attention (Turna 2018). This was the wrong assumption because BGA analysis showed only that the mitochondrial DNA of the suspected perpetrator was most often found among people with Eastern European descent, not that the suspected perpetrator was likely to be a member of "traveller populations". Some observers diagnosed a rise in *'general suspicion against*

[10] Maria Ladenburger was a 19-year-old medical student from Germany, who was found raped and drowned on 16 October 2016. The Freiburg police arrested a suspect, who was identified by a hair found at the crime scene and a CCTV recording from inside a tram. DNA evidence linked him to the crime scene and he was ultimately convicted.

minorities' all the way *'to a criminalisation of minorities and the public perception of crime in general*' (Civil interviewee 17, Germany). As this interviewee continues, '*what has happened in this case is a tremendous, gross racial discrimination against a minority, a blatant hate speech, media agitation against the minority. There are no apologies or compensation for those affected*'.

In response to the above concerns, forensic molecular geneticists Manfred Kayser and Peter Schneider[11] (2009) stress that the same public reaction could arise from an eyewitness statement indicating that a member of a particular population or minority group was seen near the crime scene (Kayser and Schneider 2009). As such, they and others note that the issue is not with FDP, but rather related to whether or not to publish FDP results in a newspaper or television report (Koops and Schellekens 2008). There is a variety of views about whether FDP findings should be communicated to the public among the texts and interviews we analysed. A number of scholars, as well as some of our interviewees, argue that there is a necessity to keep FDP prediction outcomes from the public to avoid media and other public stereotyping (de Cerqueira et al. 2016; Toom et al. 2016; Zieger and Utz 2015). Kayser and Schneider note:

> *It would be in the domain of the police to decide which descriptions for the EVCs/biogeographic ancestry…should be used in their investigation, and whether such information should be disclosed to the public, we would urge to develop a catalogue of unbiased statements for this purpose prior to the implementation of this technology into routine casework to avoid misinterpretation'* (Kayser and Schneider 2012).

Other people, mainly among our interviewees and to a lesser extent in the literature, stress the importance of good communication. For these interviewees, murder cases need to be solved, and if communicating the findings to the public may help (which they stress may only be in limited cases) the question should be reframed as how to communicate these findings to minimise the potential danger of profiling, and not whether or not to communicate them at all:

> *There might be some...experts in communication which may be can help the police to bring across the message which might be less likely to incite hatred…I can understand no matter the cultural background, the skin colour, the case has to be solved no matter*

[11] Manfred Kayser and Peter Schneider are respectively principal and co- investigators on the VISAGE project.

> *who the murderer was, but if we look, OK [sic], what you can do to minimise the potential dangers of profiling* (Civil interviewee 11, Germany).

Another civil society interviewee (Civil interviewee 4, the Netherlands) purports that FDP findings can be framed in such a way when released to the public that they can mitigate discrimination concerns, and that in the Netherlands, where FDP testing is permitted for BGA and for eye and hair colour, discrimination is not an issue:

> *It just depends how you put it isn't it. If you start with saying this is going to be discriminating certain people you think "well no we can't do that". But if you just see everybody has got certain markers and it's going to help solve a crime then everybody is happy to do it. I think discrimination is a sensitive subject but that's what we make of it isn't it. You can be proud of your ancestry as well and you can be, if somebody in that group has done something nasty you can say "well he shouldn't be part of our group so we have to talk to the police about that"….. I can't see the problem I mean in Holland it wasn't a problem…*

This interviewee also notes that in the Netherlands, where FDP is permitted for specific traits, she has never come across any discrimination, *'not in a sensitive way - they ask for yeah, a certain person from Moroccan descent and a certain age group - the community they just accept it. …. they say the same when it's a white man with blue eyes*'. One civil society interviewee from the UK (Civil interviewee 9, UK) echoed this view, that '*if a black man walked in I would say you are a black man, facts are facts'*. Such a view seems to be at least partially supported by a small Swiss survey of 284 members of the Swiss public about FDP for EVCs and BGA. The survey found that respondents were generally in favour of FDP, though notably depending on the severity of the crime, and the reliability of such analyses (Zieger and Utz 2015). Indeed, in contrast to much of the theoretical literature, discrimination was not viewed as a major concern by most the respondents in the survey in terms of BGA prediction testing, and testing for skin colour was generally viewed as more useful than testing other EVCs such as hair or eye colour, which respondents thought could be more easily manipulated by suspects. Though the authors note the different historical background and population structure of Switzerland to other European countries and the U.S. (including, for example, biased police forces and racial disparities in arrest practice) making like-for-like comparisons between countries difficult. Finally, and most interestingly, the authors of the Swiss survey note that, in comparison to when

respondents were asked their views of the FDP technology in general, when BGA, eye, hair and skin colour were separately presented in detail to respondents as types of FDP, the acceptance of the technology decreased slightly. This suggests that people may become more skeptical the more they get to know about the details of the analysis (Zieger and Utz 2015).

3.1.4 BGA, race and genetics

FDP and, by default forensic geneticists, are steeped in a controversial history of classifying human individuals and groups through their genetic properties akin to notions of 'race' (Williams and Wienroth 2017). Whilst many FDP scientists stress that BGA is not the same as race and pertains *only* to ancestral biogeographical origin rather than the specific physical appearance, ethnicity, language, culture and/or religion of individuals[12], some scholars have dedicated much effort to emphasising issues with inferring race from BGA as it pertains to FDP (Duster 2006; Ossorio 2006; Quan 2011). These scholars argue that the premise of FDP is firmly rooted in the concept of their being different human races because of its biological link to population genetic research (Sankar 2010), and that attempts to predict BGA for the purposes of criminal investigation are just the latest attempt to find genetic categories of difference between different humans, and as such can be viewed as masquerades of racial testing (Dewey-Hagborg 2015):

> *Biogeographical ancestry...relies on the social definition of a phenotype, while claiming a biological basis for ancestry and human difference more generally, blurring population genetics and racial science..[..].. we can see that despite the popular refrain that there is "no genetic basis for race" which emerged in the wake of the Holocaust and was reiterated at the completion of the Human Genome Project, scientists have been all the while calculating frequencies to create associations between different genetic profiles*

[12] For example, Kayser and Schneider (2012: e18) note that 'there seems to be a general misconception among the public, including parts of the scientific community, that biogeographic ancestry in general is externally visible. Although this may be true for some people, it certainly is not true for everybody. In particular, it may be true for those who have most, if not all, of their biological ancestors originating from one and the same geographic region, and that region being one of the few, such as Europe, where people have recognizable homogeneity in appearance traits being distinct from those in people from distant geographic regions. But even for Africa, usually considered as a geographic region that can be assigned based on appearance (and vice versa), this is not completely true since the dark skin color and some facial morphologies usually associated with an African origin are similarly found in Aboriginal people from Near Oceania (e.g. New Guinea), and from Australia. Moreover, being able to infer appearance traits of a person from (e.g. DNA-based) information of biogeographic ancestry becomes almost impossible in people who are of mixed biogeographic ancestry having ancestors from different geographic regions' (Kayser and Schneider 2012).

> *that they say have nothing to do with race, and then contrasting these profiles according to existing ethnic and racial groups. Though race doesn't exist at the genetic level, scientists can still create it by correlating large genetic datasets into classic racialist categories. This desire to find correlations pointing to race while simultaneously denying its existence is what sociologist Troy Duster calls the "molecular reinscription of race."……*(Dewey-Hagborg)

Lisa Gannett (2014) adds weight to this argument which links race and BGA testing through her sociological exploration of the emergence of BGA testing and ancestry informative markers (the markers FDP scientists use to in their BGA prediction analyses). She shows how the development of the BGA testing was shaped by a range of diverse interests, all of which are built on the construction of race:

> *We have seen that the research context surrounding the invention of biogeographical ancestry-AIMS [ancestry informative maker] technology was shaped by diverse interests - social and commercial as well as scientific - in DNA forensics, gene mapping, pharmaceutical development, and direct-to-consumer genealogy testing. Close attention to this research context reveals that biogeographical ancestry is itself a construction built upon race as race has been socially constructed in the European scientific and philosophical traditions* (Gannett 2014: 174).

Medical Ethicist Pamela Sankar sums up these arguments in her conclusion that *"simply declaring a technology not to be about race does not make it so. The meaning or character of a technology emerges through its history and use"* (Sankar 2010: 58). Here, Sankar is reflecting on the very premise of science and technology studies which explains that scientific research and technological innovation is a socio-cultural and material practice shaped by the society and representing the (re)production of social and political reality and so how a technology becomes socially anchored, institutionalized and interwoven in society is result of social, political, psychological, ethical, and environmental factors (Bibri 2015: 19).

Scholars exploring FDP, race and BGA testing are particularly worried about the way FDP findings may be interpreted with relation to race, and how this will affect the relationship between BGA, race and genetics (Lee et al. 2008; Williams and Wienroth 2013). M'Charek, for example, uses an STS perspective to argue that whilst professional experts know FDP and

understand the predictive nature of the technology, publics may come to react to FDP in a different way, and come to have very different understandings of the technology as it pertains to race (M'charek 2013):

> *The DNA profile of the externally visible characteristics of the suspect is not finished when it leaves the laboratory. That particular fact of biology is not fully fixed, but fluid and in the making as it travels from laboratory to society. Since laboratory scientists are not in charge of biological fact making, we might take the insights of laboratory studies to society, to study how facts are made there.*

M'Charek argues that *'putting this technology to use in criminal investigation requires the work and normative articulations of a variety of actors'* (M'Charek 2008) and it is here that socio-political history and public discourse around 'race' and 'ethnicity' may become infused with any FDP results about BGA or appearance. In this context, scholars are concerned that viewing race as a genetic category when it comes to superficial traits may lead to a number of consequences, including (a) the reinforcement of existing prejudices against ethnic minority groups (Koops and Schellekens 2008); (b) the reification of the belief in the biological basis of race ((Haga 2006); see above); (c) the public interpretation of racial differences (which are essentially a socio-cultural construct) as a "hard" biological given, which might, in turn, deepen the social divide between different groups or individuals and lead to discrimination (Koops and Schellekens 2008); and (d) the misapprehension that a visible basis for distinction also applies for more sensitive characteristics. As Murphy states *'the public may begin to conflate the "biological" finding that the suspect meets a certain set of descriptors with a supposed "biological" finding that the class to which the suspect belongs is itself genetically distinguishable on other grounds – what this leads to is people starting to look for biological answers to link to criminality rather than other social factors'* (Murphy 2013). Ossorio points to current knowledge in cognitive psychology which suggests that by merely connecting race, genetics and crime, forensic descriptions could activate racial stereotypes that operate pervasively to diminish and impede the lives of racial minority individuals (Ossorio 2006). Ossorio is critical about the use of FDP in connection with BGA:

> *To transform genetic test results into suspect descriptions, scientists build complex architectures of inference. They infer ancestry from DNA sequences, and then infer visible morphology and race from ancestry (and, perhaps, from direct morphology-gene*

data discussed infra). Or, they infer race from ancestry and then infer visible morphology from race. This chain or circle of inferences is weak and fallible, because the relationships among ancestry, race, and morphology are complex and fluid. Genetic ancestry information does not always provide a strong basis for inferring morphology, and conversely, morphology does not always support reliable inferences about ancestry.

Because of such issues, sociologist David Skinner is frustrated that ethical debate often precludes fundamental existential questions about whether we should even use BGA testing in the criminal justice system. Instead it focuses too narrowly on how to implement such testing responsibly (Skinner 2018). For Skinner, during BGA testing, categories of race are constructed by technologies and data sets, which provide key points of convergence and 'stabilisation' ('race-making'). This 'stabilisation' enables the intellectual, political, and commercial exploitation of group differences. He says this is problematic because it glosses over questions of categorisation, such as why we pick particular race[13] categories and how people should be placed in or out of those categories, and how they can encourage over-policing of 'visible' minorities whom fall into this category structure. Skinner concludes that *'the troubling logic of phenotype prediction is that it is likely once again to heighten the visibility of race in ways that mask the individual humanity of the people who are its subjects'* (Skinner 2018).

Philosopher Matthew Kopec attempts to provide a solution to this issue. He suggests that there is a legitimate role that race could play in criminal justice that does not depend on it being genetically or biologically legitimate. If we we operationalise race in terms of 'self-identified race', he argues, rather than a something that can be ultimately "proven" or "disproven" by scientific evidence, then we can bypass many of the broader issues discussed above. Kopec argues that '*self-identified race is something that individuals assign for themselves*' and that *'we can view the kinds of...forensic determinations of race or ethnicity...simply as pieces of evidence about the self-identified race of the perpetrators or suspects at issue'.* He concludes that '*if those in the criminal justice system treat all uses of race as inferences concerning an individual's self-identified race, this would bypass the main issues in The Race Debate entirely'* (Kopec 2014: 241). Kopec suggests that we should not privilege FDP outcomes as a marker to infer self-identified race, but rather view this technology as just one of a number of approaches to identify a suspected perpetrator (including, for example, eye-witness testimonies), each of which can only offer an approximation to self-identified race. In other words, the genetic

[13] In his article, Skinner uses the term 'race' to refer to concepts of both race and ethnicity.

perspective on race that FDP offers should be seen as one among many possible perspectives on self-identified race, of which none is a priori “truer” or better than any other. Such conceptions of race are helpful, but might not fully address the difficulties with re-conceptualising notions of race which are firmly rooted within the social fabric of society as ‘biological’, as well as the fact that at the basis of the re-conceptualisation argument BGA ancestry testing is still using biology to make inferences about what a person may look like.

Key points:

- Concerns have been raised that the FDP technology only has use to implicate or rule out minority populations leading to questions about the value of the technology as a basis for discrimination.
- Discrimination can occur during police interpretations of the FDP findings. This could lead to racial profiling. Though it is noted that profiling itself (categorising potential suspects by a group of certain characteristics, such as hair or eye color) is an important aspect of a criminal case.
- If FDP findings are released to the public it could upset community and social relations. Whilst some argue that this issue is not specific for FDP, but for general eyewitness photofits, most consider it best if FDP findings are not released to the public, or the possibility of public dissemination is thought about very carefully.
- The use of FDP may lead to reification of a genetic basis of race and may lead the public to interpret that racial differences are a “hard” biological given, which might, in turn, deepen the social divide between different groups or individuals, and lead to discrimination.

3.2 Stakeholders' inflated expectations, over-reliability, and inaccurate test results

Scholars have raised concerns about the utility of information FDP can provide, and the possibility of such information being overinflated, or considered more reliable than it should be (Murphy 2017; Stanley 2018). This is because, as one of our respondents put it, '*regardless of the actual accuracies (or inaccuracies, if you wish) of this technique, somewhat equally as important is how people actually perceive it'* (Lab 2015). Irrespective of actual scientific accuracy of FDP, the presumed scientific accuracy of any kind of DNA information among publics and among some professional groups (such as judges) can be very high. Theodore Porter (1996) famously used the term 'mechanical objectivity' to refer to the greater authority bestowed upon 'impersonal numbers' in many spheres of our political, economic, and social realities than on human experience and judgment (Porter 1996). One of our civil society interviewees voices the same concern in the following words (Civil interviewee 1, Belgium): '*even professionals struggle with risk and now we are throwing these things around and giving them an air of authority. The numbers…can quickly turn into a very oppressive system actually because of the authority they have'.*

This kind of mechanical objectivity has been shown to have led to greater trust in the scientific accuracy of forensic DNA technologies than other types of information and evidence in forensics and criminal investigation. This phenomenon is also known as the 'CSI effect' (e.g. (Baskin and Sommers 2010; Cole 2015; Cole and Dioso-Villa 2009; Schweitzer and Saks 2007; Holmgren and Fordham 2011; Mancini 2013). In addition, it is also the 'physical and ontological location of DNA' (Prainsack 2009) which contributes to the image of forensic DNA evidence as being a 'truth machine' (Lynch 2008). Because it is in the centre of our cell, and because it has a history of being described as the 'book', 'blueprint', or 'code' of life, DNA has assumed a symbolic place as the bearer of (at least part of) the essence of individuals, and the essence of humanness, in collective imageries (Nelkin and Lindee 1995).

As one interviewee with a professional stake in DNA testing (Professional interviewee 7, France) notes, '*the tendency is to allow more and more about DNA and especially for the police*

use and justice use. And I think there may be a temptation of our society for genetic exceptionalism'[14].

In contrast to this, many scholars have shown how the accuracy of a prediction based on crime scene DNA is contingent on many variables related to the collection and preservation of DNA, the likelihood of contamination, the type of genetic markers used during FDP (Cino 2017; Sankar 2012; Seo et al. 2017; Murphy 2017; Beck 2017), and the potential risks of false positive and false negative test results (Haga 2006). A number of scholars also emphasise that FDP is still in the early stages of development and that tests must be both reliable and valid before we can consider implementation of the technology into the criminal justice system (Buchanan et al. 2018; Samuel and Prainsack 2018a). Differences and similarities in phenotypes may be more to do with environmental conditions than genetic ancestry (McLean 2014), and at best, FDP is a probabilistic technology which uses a range of genetic markers to make a series of predictions regarding what an individual will look like. Sankar, for example, argues:

> *FDP cannot reliably predict...appearance..[because of].. the practical details entailed in the series of claims...that FDP requires, starting with the predictability of phenotype from genotype and continuing on to the idea that phenotype can be objectively described and understood in such a way that police can use it to routinely and reliably distinguish who might and who might not be a suspect in a particular crime'.* (Sankar 2012: 105).

Nandi Slabbert and Laura Jane Heathfield argue that these issues apply in particular to countries with a large percentage of admixed populations, such as such as, for example, South Africa (Slabbert and Heathfield 2018).[15] Though MacLean argues that '*our entire system of criminal justice, and the human experience more broadly, is predicated on probability*' and so this should not be a reason to refrain from using FDP, which he suggests could become an indispensable tool for solving crimes (McLean 2014: 13).

Given that the results of FDP profiling are always probabilistic, a lot hinges on how findings are interpreted by police and other criminal justice actors (Cino 2017; Enserink 2011; Sankar 2012;

[14] Genetic exceptionalism is the belief that genetic information is special and so must be treated differently from other types of data.

[15] The concern here is that in admixed populations, an individual's specific ancestry informative markers may be less likely to reflect the appearance of an individual because ancestral biogeographic origin does not necessarily correleate with appearance.

Seo et al. 2017; Toom et al. 2016; Weichert 2017). A number of scholars and interviewees have concerns about the predictive nature of FDP findings, and the possible danger of over-interpretation of FDP predictions:

> *The capacity we have to infer with precise and trustworthy probability the traits in one given person is not good…it's giving too much importance to overselling what...we can do with DNA information..[..]..with DNA having such an image of scientific and precise and real and true information, we tend to forget this inevitable imprecision.…*
> (Professional interviewee 4, France).

Many of our interviewees call for police to '*be aware of this uncertainty [from FDP] and not over-interpret the results'* (Professional interviewee 8, Germany).

3.2.1 Complexity of findings - beyond the 'CSI' effect

For many scholars and interviewees, the issue of over-interpretation of FDP findings was larger than the 'CSI effect' and the placing of too much weight on the information DNA data can provide. It was also related to the complexity and the probabilistic nature of FDP findings. Robin Williams and Matthias Wienroth, for example, note that difficulty '*engaging with the probability basis of forensic genetics has been a concern since the emergence of the field'* (Williams and Wienroth 2017), and many scholars both within (forensics) and outside of the field (e.g., in health, public policy, and climate) have put huge effort into exploring how best to communicate probabilistic and uncertain findings to relevant actors in law enforcement and criminal justice (de Keijser and Elffers 2012; service 2014; Spiegelhalter 2017).

The concern that police officers may not be able to understand the predictive nature of FDP findings (Beck 2017), and the possible consequences of this lack of understanding, was one of the most discussed issues in our interviews:

> *Even people who are working with genetics in the [UK] NHS who are healthcare professionals, the problem is misinterpretation and lack of knowledge about genetics and what risk means, so you can imagine amongst the police force they have even less medical scientific background to be able to interpret it* (Civil interviewee 2, UK);

> *I don't believe that even the police laboratories themselves have enough knowledge about the certainty or uncertainty of any information they give or they provide to the police* (Professional interviewee 33, UK).

One civil society interviewee (Civil interviewee 14, Germany) is particularly worried about this. Using hot spot crime mapping as an analogy, this interviewee explains that police officers struggle to ask "correct questions" when looking at hot spot crime mapping, suggesting they would similarly struggle to interpret FDP findings: *'if you look for instance on hot spot crime mapping…it's very, "yes this is a crime hot spot" without taking any further consideration, well, what type of crime, what kind of algorithms are used, so what might be alternatives'.*

Scholars and interviewees are also concerned that there are a lack of (and, thereby a need for) established standards governing the interpretation and presentation of probabilistic FDP findings (Branicki et al. 2014; Fullwiley 2008; Wagner 2009; Weichert 2017). Here, their concern is twofold. First, currently there is no single "reference" database of genetic sequences which is used for FDP analysis. Rather, forensic scientists may compare a suspected perpetrator's DNA with any number of different databases to produce an FDP outcome (see section 3.7). The type of database used during the analysis will affect the results of FDP profiling and this raises concerns about the meaning of the findings produced. And second, with no established standards explaining what a predictive FDP finding will relate to in terms of physical appearance, police officers may misinterpret the findings:

> *If I send it off to you or if I send it off to someone in the UK to see what my ancestry is does everyone use the same ones, the same bits of DNA?...I would suggest that some kind of standard markers should be used...when you say if you test your DNA, you were talking about your eye colour…do people have different databases, are they not standardised either? Depending on the database you use I guess that the outcome could differ to at least some extent…*(Professional interviewee 24, Sweden).

Specifically related to BGA testing, biomedical ethicists Mildred Cho and Pamela Sankar (2004) note that because methods for assigning BGA have not yet undergone a process of standardisation, they are more often than not dependent on the interpretation of the individual conducting the assignment (Cho and Sankar 2004). As will be touched upon in section 3.7, Pamela Sankar's work, along with the work of others, also highlights questions around how to

standardise different interpretations of data, since people will have very different perceptions about what a person with a specific BGA will look like: '*what is a person of Caribbean descent supposed to look like...or what is a person with "strands" of DNA described as Native American, European and sub-Saharan African supposed to look like'?* (Sankar 2012: 110) . Williams and Wienroth summarise this point in their review of the ethical and social issues relating to FDP:

> *Categories such as ethnic identity are socially constructed...and even biological categories — and reference populations — are products of human classification. Using these to make factual statements...could...at least support, existing unreflective social assumptions about race and ethnicity, including simplistic associations between biogeographic ancestry and phenotype* (Williams and Wienroth 2017).

These authors conclude that it will be important for forensic geneticists to explain the basis of the genetics of biogeographical ancestral markers, especially how they may be distinguished from popular (mis) understandings of "race" or "ethnicity"[16] (see section 3.1.4).

Michele Van Laan (2017) and others argue that various steps should be taken to regulate and define the acceptable use of FDP so as to ensure that it is only practiced in a way that is intended and for permissible purposes (Van Laan 2017). As one civil interviewee (Civil interviewee 15, the Netherlands) stresses: '*you want to make sure that when people are using these kinds of evidence that they are collected in the right way, that they examine it in the right way, and they report it in the right way. Which is actually three totally different expertises. In which I think not everybody is educated well enough'.* As Weichert says, the procedures for carrying out FDP, and the authorities and organisations which perform the analysis, must have undergone a process of certification and documentation of scientific quality, professionality, and reproducibility (Weichert 2017).

3.2.2 False leads

All of the above - the predictive nature of the tests, coupled with the possible certainty that may be attributed to their results - led to substantial concerns amongst scholars, commentators and

[16] The concern is that BGA prediction testing may re-ignite (false) beliefs in society that "race" is linked to genetics, even though BGA can only provide information on ancestral biogeographical location, it cannot provide information on ethnicity, "race" or nationality.

interviewees that FDP findings could potentially produce false leads, and cause police officers to target their search for a perpetrator in the wrong direction (Scudder et al. 2018b) wasting valuable resources and time (Gannon 2017; Stanley 2018). One of our respondents put it as follows:

> *They [police] should properly understand that this analysis is not like simple identification when…we are quite certain about the results….[of] predictive DNA analysis, it's completely different. There is an influence of environment for example and in many cases we can be wrong so this kind of misinterpretation can potentially slow down an investigation and not speed it up* (Professional interviewee 20, Poland).

While false leads are intrinsically ethically problematic in terms of harm to the wrongfully suspected, as well as wasted resources and time, they are also ethically and socially problematic in terms of the false hope they may produce if communicated to the public (also see section 3.2). Here, scholars explain, they can ultimately lead to a losing of trust in police services. As journalist Andrew Purcell reports in his *Sydney Morning Herald* article, a police detective involved in a rapist case in Australia stated: '*If we put an image of a 25-year-old out and the person turns out to be a 45-year-old, it does damage us* (Purcell 2016). Indeed, Nathan Scudder and colleagues' (2018) also note this issue in their privacy assessment of FDP:

> *There may be a temptation to provide as much information about an unknown crime scene sample to investigators as possible. However, this could result in undermining public confidence in the capability...this may well be the case if, as could reasonably occur, it is later found that the crime scene sample was deposited not by a suspect but by an innocent passer-by, then subject to intensive and intrusive genetic analysis"* (Scudder et al. 2018a: 227).

Others are less concerned about FDP. Whilst they see issues with the technology and the interpretation of its findings, they note that FDP is just one tool at the disposal of the police officer; proportionate weight should be placed on FDP findings; and the purpose of FDP is to act as one part of many pieces of evidence (Van Laan 2017): '*I would use the technology, but this cannot be the only lead probably to follow'* (Civil Interviewee 7, the Netherlands). One interviewee explains how this would work in practice:

> *If the science tells you that someone is from a particular ethnic origin or geographic region that to me is a scientific probability or a fact, and you work on that basis, because at the end of the day if we have got nothing else and that evidence tells you that your perpetrator is potentially from there and of that ethnic origin then you have to focus your investigation. And you need other corroboration, you need other evidence to support….You look at all the other investigative opportunities, it's just one strand in the whole investigation, it's a guide..[..]..the point about this is if it gives you an indicator as to ethnic origin of the individual...or their general hair colour etc...It's not just potentially that one piece of evidence will convict someone…we all know that trace DNA can be left at the crime scene and you can sneeze or something and leave your DNA there...*(Civil interviewee 3, UK).

Another interviewee, however, was concerned that this would not always happen in practice. He has first-hand experience of DNA analyses being used in cold cases, and explains that very little other evidence exists so many years later, which means there is the risk of too much weight being placed on the DNA analysis:

> *Especially with cold cases...you don't have anything anymore [bar the DNA tests], you can't hear witnesses in something that happened 20 years ago. So then either you are lucky that your suspect confesses or you have to assume. And assumption is, well I don't know, it's not a very polite word but the mother of all f** ups* (Civil interviewee 15, the Netherlands).

As many scholars have stressed, FDP should only be used for the purpose of excluding potential suspects and should not be sufficient to establish probable cause to search or arrest someone (Cino 2017). As Jennifer Wagner (2009) states, *'technocratic statements that a DNA ancestry estimate is the equivalent of evidence of race or ethnic identity are dangerous exaggerations of the weight and relevancy law enforcement should give to genetic test results'.*

Instead, they call to train, educate and provide information to stakeholders in the field (e.g. police and justice officers), to establish common standards of FDP use, and to implement them at the local level (Branicki et al. 2014; Enserink 2011; Haga 2006; Kayser and Schneider 2012; Scudder et al. 2018b). As Martin Zieger and Silvia Utz stress, '*the fact that we are dealing with a highly probabilistic approach, confidentiality requires society to ensure that all police and justice*

staff get proper training and strict rules for the interpretation and handling of the data (Zieger and Utz 2015). This point is re-emphasised by Susanne Haga (2006) who notes that *'although it is probably not necessary for police investigators to understand the minute details of genome profiling, it is imperative that they understand the limitations of the test'* (Haga 2006). How this will be established in practice is not discussed in the literature, and Polish forensic geneticist Wojciech Branicki[17] notes in relation to forensic DNA technologies in general, that at least in Poland there is no institution responsible for educating experts in DNA analysis, and for verifying their knowledge (Branicki et al. 2014). This is in spite of Greenwood noting that '*a DNA sequence in a lab is only as good as the training of the person conducting the analysis'* (Greenwood 2016).

3.2.3 Communicating FDP findings to the police and other law enforcement actors

Many scholars have emphasised the need for FDP findings to be communicated accurately, but there was less discussion about what this should entail. This discussion was much more prominent in our interviewees' narratives. Our interviewees spoke at length about the need to communicate FDP findings from the laboratory to the police services and prosecutors/Magistrates in a way that was clear and understandable. It was vital for them that such police services/Magistrates were able to understand the findings and be able to put them in the correct context ('*it's important to have investigators that are very well educated on this matter*' (Civil interviewee 10, Germany)). Especially important was the need for police investigators and Magistrates/prosecutors to understand the inherent bias associated with FDP and its predictive nature so that, rather than relying on the technology instead of their own faculties, they used it as a helpful tool: *'There must be a caveat that this is only to aid in further investigations if communicated to the police and that the results may be biased. The police shouldn't delegate their duties to technology'* (Civil interviewee 22, Germany).

To address this need for communication, Scudder and colleagues' (2018) privacy assessment of FDP concludes that '*valuable in guarding against the inadvertent misdirection of police resources away from the real offender, would be establishing a group of senior police officers and forensic scientists, similar to an ethics board, to authorise release of less reliable or privacy intrusive predictive information on a case by case basis'* (Scudder et al. 2018a: 227). Interviewee 25 (Civil interviewee, Spain) concurs with this approach, arguing for the '*final values*

[17] Wojciech Branicki is a co-investigator on the VISAGE project

of the tests carried out must always be checked, under other supervision outside the police, because, simply, it could be the case that some sectors of the population may consider the tests, or their findings are unreliable'.. Interviewees from the UK and the Netherlands provide case examples of how communication systems were already implemented into police practice in their respective countries, with a specific unit of the police charged with the role of interpreting FDP findings (the Netherlands)/DNA findings (UK) for detectives:

> *We have got hundreds of scientists that we…send them [the test results] off, they then liaise with a front line forensics manager who is again in forensics. Who then disseminates out to the officer. So we have got that tiered, but anything specialist would have to come through to these guys for authorisation first. So I set that up so we have got a gatekeeper, the results are monitored, there are trends analysis done within this team as well. So this type of work would be very closely monitored* (Professional interviewee 35, UK);

> *That's the role we try to fill now…it's much easier for us to speak to policeman…[than scientists] because...scientists [are] in a different field so they are not really familiar or comfortable in a detective environment. We are, so we can easily discuss the situation with them and even advise them on how to handle a crime scene or how to look at an old crime scene... like telling them well there is a possibility for eye colour and hair colour…if they are struggling with the information then we pop in again and we will read the actual reports from the scientists and try to translate it to normal language as the police tend to speak it* (Professional interviewee 29, the Netherlands).

Such a solution seems commendable, though a capacity issue must be noted, as well as the issue of whether such gatekeeper systems can easily be introduced into the social and cultural systems of all police services both nationally and internationally, many of which are already struggling with ensuring accurate and standardised technical forensic practices. For example, in their open letter, Veronika Lipphardt and colleagues (2017) emphasise that there are still on-going instances of contamination, mix-ups and misunderstandings in "traditional" DNA profiling: *'while the technical standards in forensic DNA profiles are now very good and are constantly improving, there may still be contamination, mix-ups, and misunderstandings during the police investigation'* (Lipphardt et al. 2017). The infamous "Phantom of Heilbronn" (see Section 3.1.3), is a case in point. Indeed, there were calls from interviewees to educate police officers,

Magistrates and lawyers about this case so they can get a better feel of the limitations of DNA based technologies (Civil interviewee 17, Germany).

In spite of these calls, one interviewee explains how in the Netherlands, where FDP is permitted for certain traits, there is still little training for lawyers, magistrates and prosecutors, all of whom have very little understanding of DNA techniques, including FDP:

> *At least in the Netherlands I know that that is not the situation [that the legal professionals are trained about FDP]. We have judges who don't know what they are talking about with these new kind of techniques, we have prosecutors with the same, lawyers with the same…I did a case last month in which complex DNA related subjects were going on and you could notice that people were not talking on the same level because they had different views on how techniques could be used or how techniques could be interpreted* (Civil interviewee 15, the Netherlands).

Moreover, some interviewees were concerned that any communication and training would be futile because of a resistance against new ways of doing things, which could also extend to other safety measures being put in place (‘*a lack of will to even consider proper safety measures, and when these are installed, human workarounds, because the measures are too impractical*’ (Civil interviewee 18, Austria)). One civil society interviewee (Civil interviewee 10, Germany) refers to a particular example of German police officers’ understanding statistics around crime and migrant communities to explain this. He notes how, if the police have a certain way of thinking about a situation (in the case of FDP this could be a misunderstanding of the findings), it is incredibly hard to change that mindset, especially without a big investment into educational capacity:

> *In the crime stats they [immigrants] have a presentation of almost three times higher but this can be easily explained by all kinds of factors.…And I have been two or three situations where I have witnessed these kind of scientific results are just refused by the police officer, they don't want to believe it, they just do not accept it. And this is why I think education of this kind is so very important...but I am personally very pessimistic we can install that in Germany in the way it would be needed.*

Only one interviewee felt that there was no real issue with police interpreting findings of FDP. For this interviewee, whose family member was a victim of crime and who had interacted closely with the police throughout the investigations, police 'are not stupid' and understand probabilities as well as 'anybody else':

> *Some people say that with eyewitness statements the police understand that they are not very reliable. So if they get one then they know it's not very reliable. But with DNA the police very often, because they don't understand the technology they think that the DNA evidence is definite, its secure, its 100% certain. The police are not stupid and they get informed and all you have to do is tell them. I mean as you said 70% is 70% and the police understand that more than anybody else* (interviewees' identity withheld).

Key points:

- Over-interpretation of FDP findings is a concern because of (a) the 'CSI' effect, (b) the probabilistic nature of FDP findings and the inherent difficulties in interpreting such findings, and (c) the presence of ethnic, racial and other stereotypes in European (and other) societies that could influence how probabilistic statements on pigmentation and BGA are interpreted.
- Some scholars are concerned that over-interpretation of findings may lead the police to follow false leads. Others argue that FDP findings should never be used to follow leads without other corroborating evidence.
- Whilst education and communication approaches have been called for to address these issues, these approaches are problematic for a number of reasons, including issues of capacity, and issues relating to ineffective strategies which cannot overcome deep-seated bias.

3.3 Privacy and the 'right not to know'

Issues of privacy and the 'right not to know' were discussed heavily in the literature, and to a lesser extent, by interviewees.

3.3.1 Appearance and age

The 'Right not to Know' and issues with privacy have been discussed prominently within the literature (2014a), as well as more specifically with relation to FDP. In the latter, this has mostly been in relation to testing for non-EVCs, and Caio César Silvia de Cerqueira and colleagues note that the origin of the controversy around this topic is likely from concerns about non-EVC testing predictor polymorphisms of disease, sensitive or stigmatising characteristics (genetic predisposition to homosexuality, violence, etc.) (de Cerqueira et al. 2016). Most scholars purport that if data is not stored in a central police or criminal justice database (see below), FDP for EVCs (including age and appearance) does not violate any aspects of a suspect's privacy, or create issues related to the Right not to Know because appearance traits are not only known to the person already, but to everybody who has ever seen the person, and as such cannot be considered private data (de Cerqueira et al. 2016; Kayser 2015; Kayser and Schneider 2009; McLean 2014; Smith and Urbas 2012). In his piece in the Boston College Law Review, David Gusella corroborates this, arguing that an individual is unlikely to have a significant privacy interest or privacy expectation in this situation (Gusella 2013). And if a perpetrator is apprehended, say Koops and colleagues (2006), only in marginal cases will the DNA tell us something about the person's private life and therefore '*has little to do with privacy*' (p219). They note that any other type of reasoning will place too much emphasis on the notion of privacy and may, ironically, ultimately undermine the right to privacy because '*those who consider everything to be related to privacy can easily dilute this human right with ever-needed exceptions*' (Koops et al. 2006).[18]

[18] Some authors argue that FDP would arguably not touch the Right not to Know because the DNA left at crime scenes would be classified as *res nullius*, which means that no person holds property rights in the sample, and as such, has no legitimate interest or Right not to Know. Two issues arise here. First, the classification of DNA samples left at crime scenes as *res nullius* is problematic because it assumes that the owner of the DNA intended to leave it there ('abandoned property'). It is plausible to argue that those committing a crime do not normally intend to leave biological traces. Following this rationale DNA at crime scenes would need to be classified as 'lost property', and thus the rightful owner continues to hold a rightful interest in this property after having lost it. Consequently the Right not to Know would be applicable.
Note that this statement is not an assessment of whether or not the sample owner had a reasonable expectation of privacy regarding DNA left behind at crime scenes, which merits a discussion in its own

Moreover, even if we accepted a legitimate interest in the crime scene sample by the sample originator, it could still be argued that in the case of serious crimes, public interest outweighs an individual's Right not to Know. In fact, some jurisdictions have codified the Right not to Know one's DNA into national laws and this Right not to Know is never absolute: public interest can always outweigh an individual's right not to know.[19] The possibility – in many countries of the world – to take DNA samples from suspects against their will could be supported by a public interest justification.[20]

Some of our respondents were more cautious about classifying information derived from FDP for EVCs as not personal or not private. One civil society interviewee (Civil interviewee 29, UK) notes that:

> *The information obtained via such a test [FDP] is clearly private, given that it relates to a concrete individual and concerns their personal characteristics (or, their presumed*

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right; the discussion here pertains merely to whether or not a Right not to Know would need to be respected. And it is important to note that a Right not to Know would be respected if it could be ensured that the owner of the sample does not learn the results of the DNA analysis. This, in turn, would be impossible if the characteristics that led to the apprehension of the person are the very characteristics to which the Right not to Know pertain, if these characteristics come to the knowledge of the individual. See also (Gusella 2013).

A second reason why it is problematic to assume no Right not to Know because the DNA is *res nullius* is *because* in most European jurisdictions, personal information is seen as an inalienable possession that is protected by privacy rights and not property rights. It is thus possible to have a legitimate interest in a thing even if one does not hold property rights (see also (Quigley 2018)). In addition, even if we accepted that the qualification of a DNA sample left behind as *res nullius* implies that the originator has no legitimate interest in the information derived from the sample, this would not automatically mean that the person can be told health-related findings from the sample. If the sample is seen as unrelated to the person (as the idea that the originator holds no legitimate interest in the sample after it has been disconnected from his or her body does), then why would any findings from analysing this this sample be disclosed to this person?

[19] Koops and Schellekens mention Dutch legislation which assumes the Right not to Know to be absolute regarding disease-related and other sensitive traits; 'where it is not certain whether the source of the DNA knows of a disease-related trait, the DNA may not be investigated to this trait' (p.176). This, by definition, pertains to crime scene samples. Insofar as they have no bearing on appearance and age, disease-related traits are outside of our own review; and the Dutch law explicitly allows phenotypic profiling for any traits that are visible from birth.

[20] In the context of 'traditional', short-tandem-repeat (STR)-based DNA-testing, one could argue that the result of this test – a string of numbers representing DNA repeats at specific loci on the genome – does not disclose anything potentially sensitive about people and thus the Right not to Know is not applicable (Koops and Schellekens do not address this explicitly but they raise the question of whether the Right not to Know extends beyond the medical field; p.179). Such a stance would ignore, however, that also traditional STR-based DNA testing can disclose information on biological relatedness (such as paternity) and the Right not to Know would thus be applicable in principle (this aspect is discussed in more detail in the literature on the ethical and social aspects of familial searching).

personal characteristics). Indeed, it should presumably be considered sensitive personal data, given that it comes from genetic traces.

Furthermore, Pilar Ossorio discusses a possible infringement on privacy in situations where the face an individual presents to the world is not reflective of her genetic endowments. Ossorio notes that many innocent people have altered their visible traits through hair dying, plastic surgery and/or judicious use of contact lenses, and people who make such changes often conceal that they have done so, thereby exhibiting their desire for, if not their expectation of, privacy in information about the extent to which their observable attributes reflect unenhanced nature (Ossorio 2006). Gusella contends that although such disguises can change one's physical appearance, these alternatives do not change the fact that an individual knowingly risks exposure of his or her phenotypic information, whether it be from a contact lens falling out, a visible surgery scar, or a brown hair peeking through a full head of blond hair (Gusella 2013). One of our civil society interviewees (Civil interviewee 2, UK) explains that whilst EVC testing may be 'sensitive', this must be 'weighed up' against the need to find a perpetrator:

It's a definite intrusion of privacy on some level, lots of people find their age a sensitive personal piece of information. But it's all on a scale, isn't it, and again weighing it up with if that's going to help you identify a violent criminal, then I think it's a proportionate invasion of privacy.

Koops and Schellekens (2008) discuss possible infringements of the Right not to Know in these circumstances and conclude that scenarios of such infringements are far-fetched and not strong enough reasons to forbid the use of FDP (Koops and Schellekens 2008). They provide the two following examples related to the recessive gene for red hair and a possible gene for baldness:

Since having one recessive gene for red hair does not mean that the person's hair color is red, knowing this fact is of no use for the criminal investigation. Should the perpetrator be found by other means, however, and the fact of the red-hair gene be listed in the criminal file, the person would find out about this gene. In some admittedly far-fetched cases, this might lead the person to question his parentage. Consider an Italian with black hair, and with no occurrence of red hair in his family for generations back...

If a genotype were found to be closely related to men starting to bald around the age of twenty-five, then this would be a helpful trait to determine for investigating a serious crime. If the DNA source is found and confronted with this knowledge, this may be unpleasant knowledge for him if he is twenty-two and proud of his hair.

Scudder and colleagues (2018) note that FDP findings can actually be privacy-enhancing in situations in which they are used to invite members of the population for mass screening (Scudder et al. 2018b). This is because FDP can decrease the pool of possible suspects whom need to be tested, thereby protecting the privacy of wider groups of people who would otherwise be "invited" to submit a sample as well.[21]

3.3.1.1 When the findings of an FDP test can also give information about a more sensitive issue

More ethically problematic is the fact that genetic information about a non-sensitive EVC trait may in some circumstances also give (risk) information about a more sensitive issue (Ossorio 2006; Weichert 2017). Susanne Haga uses the widely known example that individuals with fair skin are at higher risk to melanoma given their increased sun sensitivity to explain this (Haga 2006). In testing specimens for the red hair and fair skin genetic marker, she says, additional information is revealed pertaining to the individual's risk of melanoma.[22] Scudder and colleagues take this concern that genetic information about a non-sensitive EVC trait may in some circumstances also give (risk) information about a more sensitive issue further, noting that genetic marker information about a specific EVC trait which at first does not provide information on a specific health risk and/or status, at a future time, could be found to do so (Scudder et al. 2018a). Moreover, Koops (2006) reminds us that *'for each externally perceptible personal characteristic there is an extreme value that is considered a [health] disorder'* (p.223) (consider, for example, short height versus Dwarfism). Our own (Samuel and Prainsack 2018a) interviews with professional stakeholders in the field of FDP show the complexity of views regarding which phenotypic tests are considered more or less concerning in terms of the health traits they may reveal. For example, whilst most interviewees view age predictions as relatively unproblematic

[21] Also see https://www.rtlnieuws.nl/nederland/pastoor-die-lichaam-milica-vond-fantastisch-dat-25-jaar-later-verdachte-is-aangehouden

[22] We note that just having pale skin is not predictive in terms of getting skin cancer. There are a range of other environmental factors (exposure to UV) and genetic factors (in addition to those related to pale skin) which also need to be considered.

due to the visible nature of age, other interviewees are concerned that such testing could reveal health issues related to premature aging/underlying health conditions (Samuel and Prainsack 2018a). Some of these views, though by no means all of them, vary with interviewees' professions, with police officers less likely to be concerned about a test which is linked to a health trait (Samuel and Prainsack 2018a).

Some interviewees and a large number of authors think that FDP testing which also has the potential to reveal a health condition is 'intrusive' and should not be permitted (Civil interviewee 18, Austria)(Weichert 2017). Others are of a different view. One civil interviewee (Civil interviewee 4, the Netherlands) argues that these concerns are far-fetched because it is highly unlikely that if a suspect is apprehended, an underlying health condition will be identified:

> W*hat is the statistics of that happening, that somebody with this underlying [condition] - they will commit a crime, the statistics are minimal isn't it [sic]….I mean honestly, you know. If you'd be realistic and not go "oh dear, oh dear", like what if the man then finds out that he has got a disease that is ageing him prematurely…* (Civil interviewee 4, the Netherlands).

A recent study by Cedric Bradbury and colleagues (2019) suggests that 1.5% of SNPs commonly used for FDP analysis are associated with characteristics relevant to health and disease (Bradbury et al. 2019). Specifically, they argue, 27 SNPs revealed health- or disease-related information, of which 11 are associated with skin cancer (i.e. SNPs associated with skin pigmentation). Correlation was also observed with, for example, alcohol metabolising enzymes and the DARC (involved in malaria resistance and HIV progression) and complex disease (e.g.Diabetes, Crohn's, Multiple sclerosis). Though the authors note that many of the associations they identified were based on studies which comprised limited numbers of individuals, and hence should be considered with caution until further association studies are performed. Moreover, association studies, such as the one they performed, are not very powerful for predicting disease status.

Koops and Schellekens (2008) argue that the issue of markers used for FDP being associated with health- or disease-related characteristics should be dealt with in a pragmatic manner. If such a correlation is found, then the use of the marker(s) in question for FDP should be

reassessed (Koops and Schellekens 2008). The same argument was put forward by one of our civil society interviewees:

> *If it was discovered that some kind of hair colour type was massively linked to some kind of cancer then yes there would be some big questions about that and maybe use a different marker. If you have already got two other things then maybe don't include that one* (Civil interviewee 2, UK).

Kayser (2015) also notes that in the Netherlands FDP for forensic purposes is not allowed for disease-linked appearance (Kayser 2015).[23] He adds that the same reasoning is not always followed in other jurisdictions such as in the U.S. state of Texas which he states implicitly allows FDP, even for genetic diseases. Here he references author Michelle Hibbert (1999) who states that:

> *The Texas DNA databasing law states that information contained in the state DNA databank may not be used to "obtain information about human physical traits or predisposition for disease unless the purpose for obtaining the information is related to a purpose described by this section." One section of this law, however, states that "the purposes of the DNA database are only for use in the investigation of an offense, the exclusion or identification of suspects, and the prosecution of the case." Thus, under this statute, a law enforcement agent would be free to gather physical trait and potential disease status information where this kind of data would be useful in generating a lead or in exculpating an individual.*

Moreover, even if a health condition was revealed, Mahsa Shabani and colleagues argue that privacy concerns can be addressed by ensuring that these incidental health findings are not disclosed to the police (Shabani et al. 2018). Alternatively, Koops and Schellekens (2008) (see below for a more in-depth discussion), as well as a number of our civil society interviewees, suggest a suspect should be given the right to decide if they want such information revealed to them. Here, interviewees suggest that police officers ask suspects, as routine practice, whether they would like to know any additional (incidental) information which may have been discovered

[23] Even though red hair (often linked to pale skin colour) provides an increased risk of skin cancer, this is only given the correct environmental exposures as well as other genetic predispositions. Because of this, the law in the Netherlands permits hair colour prediction testing.

during the FDP analysis if STR DNA profiling later confirms that the FDP analysis was conducted on DNA which originated from them:

> *If you inform every time if you do DNA phenotyping that there could be an issue, so that people don't think OK they inform me that there could be something just so they do it every time, there could be something. And they have to decide in that situation for themselves whether they want to be informed or not.* (Civil interviewee 10, Germany).

What is important for these interviewees is the need for psychological support in any instances when health-related findings are revealed that the suspect may not have been aware of:[24] *'psychosocial support should be also part of the sharing information with the perpetrator'* (Civil interviewee 7, the Netherlands). As discussed earlier, many interviewees did not perceive the Right not to Know as absolute right but rather needing to be balanced against other rights and interests, such as apprehending the perpetrator (Koops et al. 2006). As one interviewee notes, "*a criminal who murders someone does not have the same privacy rights as someone who has not murdered anybody*" (Civil interviewee 1, Belgium). Having said this, several interviewees and scholars (Dewey-Hagborg) emphasise that the tested DNA may not have originated from the perpetrator, meaning that an innocent person could have had their DNA analysed in such a way that revealed health information, which would, they say, be an intrusion of privacy:

> *There is an ethical issue there about the extent to which certain people might become part of that suspect population purely because of where they tend to spend time… some people are more prolific shedders of DNA than others…* (Civil interviewee 5, UK).

Though we, the authors, note that inevitably any criminal investigation will include innocent people, and so this intrusion of privacy might be justified.

3.3.2. Biogeographical ancestry

The Right not to Know becomes more contentious when considering BGA testing (Dewey-Hagborg ; Karberg 2018). While ancestry with low levels of admixture tends to correspond with

[24] The association of fair skin with higher melanoma risk is something that people with fair skin can be assumed to be aware of. The situation is different in cases where either the trait that corresponds with the disease risk is not apparent to the person, or where the association between the trait and the risk are not well known.

certain externally visible traits at the individual level (hence is less likely to be considered private information), this does not apply to mixed ancestry (Kayser 2015). As Koops and Schellekens note:

> *It is possible that a subject of forensic phenotyping may be ignorant of the ancestral information in his DNA. For instance, it might be the case that someone who appears Caucasian has certain genotypes left from a Chinese ancestor three or four generations back. He might not look Chinese at all and so would not necessarily know of his Chinese connection…The psychological impact of new knowledge of "racial roots" might sometimes lead a person to question his sense of identity* (Koops and Schellekens 2008).

Ossorio also argues that such information may disrupt a person's settled views of her/himself or the community's views about him/her, and its disclosure could be misleading, confusing and stigmatising (Ossorio 2006). In a similar vein, Scudder and colleagues argue that harm could be inflicted upon an individual if the disclosure of such predictive information does not match an individual's beliefs, based on their own cultural or familial identity (Scudder et al. 2018a, 2018b). Moreover, Haga (2006) explains that such information may not just affect the suspect, but - due to the fact that genetic information is similar among genetic relatives, it can also reveal information about the perpetrator's relatives (Haga 2006). Such concerns were not discussed in any depth by our interviewees.

As is the case for appearance and age prediction testing (see section 3.3.1), Koops and Schellekens (2006) have explored the issue of privacy and a Right not to Know in intricate detail for BGA testing, asking questions about whether the suspect should be able to choose whether he wants to know the results of a test, and how much we must consider the chances of the suspect deducing the test results, or coming across them by mistake (Koops and Schellekens 2008). Following on from the discussions in section 3.3.1, these authors reject notions that choosing not to know the test result is a serious breach of equality of arms; they note that privacy implications could be avoided by refraining from making the test results publicly available (e.g. in the media); and they note that the chain of events leading to the DNA source unwillingly gaining knowledge that she or he did not have before by deduction or by mistake seems unlikely. Therefore, they suggest that the Right not to Know can be negotiated by leaving it to the suspect to decide. They refer to Article 5 of the Universal Declaration on the Human

Genome, which places the decision of whether or not to be informed of the result of a genetic test in the hands of the tested individual. They state that if this approach is not chosen, regulators should individually weigh the usefulness of the trait in a criminal investigation against the harm that a subject will suffer. Indeed, many scholars are generally in agreement that the privacy/ Right not to Know implications related to BGA are minimal and will be infringed only rarely, as such they should not prohibit the use of FDP. Rather, in general, privacy violations and the 'Right not to Know' must be weighed against public safety, and in the case of BGA, public safety should prevail (this would not be the case for all other traits, and scholars purport that each trait be considered individually) (Haga 2006; Koops and Schellekens 2008).

Key points:

- Most scholars do not view FDP predictions for age, appearance and BGA as infringements of people's privacy or their Right not to Know.
- Issues are raised if the trait being tested can also provide information about a health condition, which - in contrast to pigmentation or age or biogeographical ancestry - is likely not to be known to the person if the disease has not (yet) caused specific symptoms. In cases where it is known that information about a trait also discloses (probabilistic) health-related information that is unlikely to be known to the affected person, scholars suggest refraining from making predictions about that trait. Others suggest an approach which asks an apprehended suspect if they would like information about any incidental health findings which might have emerged during DNA analyses in the investigative process.
- Most authors agree that the Right not to Know is not absolute, but rather it must be balanced against other values and rights, such as the need to identify a perpetrator.

3.4. Storing FDP findings and data protection

A range of guidelines and literatures have emphasised the need to respect different ethical values when collecting, processing and/or storing personal data. These include, for example, accountability, transparency, trustworthiness, justice, harm minimisation and social value (Ballantyne 2018; Deparment for digital culture 2018). Many of these ethical values are also enshrined as principles in governance systems and legislation. The EU's Police Directive[25], which regulates the purpose of collecting and storing information for police and forensic uses, and is a *lex specialis* to the more general EU General Data Protection Regulation (GDPR), enshrines a number of these principles. For instance, the need to ensure data minimisation (only collecting data which is required for specified purposes); transparency; data storage limitation (only storing required data); transparency and fairness in data collection, processing and storage; and accountability (responsibility for how the data is used, and being able to demonstrate the steps taken to protect a person's data). One challenge for FDP development is to ensure that the implementation of the technology, as well as the storage of FDP outputs, align with these above ethical and legal principles.

Regarding storage, as we have described previously (Samuel and Prainsack 2018b), in principle, there are four possible ways of 'storing' FDP:

a) storing the computerised genetic data used for narrative description of the phenotypic prediction in the lab that carried out the analysis (decentral storage of DNA)
b) storing the narrative description of the phenotypic prediction and/or the genetic data in the hard-copy or soft-copy case report (and thus wherever case reports are stored; decentral storage of narrative information)
c) storing the narrative description of the phenotypic prediction in the central/national DNA database (central storage of DNA)
d) storing the genetic data used for the narrative description of the phenotypic prediction in the central/national DNA database (central storage of narrative information).

Table 6. provides examples of these different types of FDP information storage.

[25] Directive 2016/680 on the protection of natural persons with regard to the processing of personal data by competent authorities for the purpose of law enforcement

Table 6. Examples of different types of storage for FDP information.

Storing	Genetic "raw" data	Narrative FDP information
Decentrally	A forensic lab in Bluetown, a small town in Greyland, carries out a SNP-based analysis on the DNA of an unknown perpetrator of a rape and murder case to probabilistically infer cues about the appearance (hair, skin and eye colour) and age of the man. The SNP and epigenetic data remains stored in a computer in the lab beyond the end of the investigation.	The lab of Bluetown informs police investigators of the probable likelihood that the perpetrator has blue eyes (80%) and is light-skinned (92%). They also state that it is probable that the unknown perpetrator is approximately 40-50 years (95%CI). This information remains stored, together with the rest of the case material, in the archives of the police force of Bluetown.
Centrally	SNP and epigenetic data, as well as subject information are added to the central DNA database of Greyland.	The unknown suspect is apprehended and STR analysis confirms them to be the perpetrator. The suspect is 31 years old. The Parliament of Greyland decides to issue a law that allows the storage of information on likely accelerated or delayed biological ageing as an additional subject-related data point in the central forensic database.

Thilo Weichert (2017) views genetic data as more sensitive than other data (a concept known as 'genetic exceptionalism') and argues that such data can never be truly anonymised (Weichert 2017). Victor Toom and colleagues (2016) note that digital storage of any information relating to FDP '*renders the information usable and losable for different purposes and by different actors'* and therefore, as described above, has a range of ethical concerns attached to it, such as autonomy, justice, dignity, confidentiality, and solidarity; legal principles such as due process and proportionality; and democratic values such as equality, transparency, and pluralism (Toom et al. 2016: e1). Interviewees, too, were concerned about storing FDP findings, given that DNA '*has its own immutability, and because we have no control over where we leave DNA…so it has sensitive, non-anonymisable information about us, but also about our family and is especially worth protecting*' (Civil interviewee 17, Germany).

Some of these concerns can be minimised by choosing not to store FDP findings in a national or otherwise centralised database. Indeed, all scholars as well as interviewees have indicated no value, and there has been no discussion or suggestion, that FDP findings need to be stored in a national database. Alongside this, following their privacy assessment of FDP, Scudder and

colleagues (2018) note that sharing FDP findings between police forces could be beneficial, but that such intelligence sharing does not require phenotype markers to be included in any criminal database, the full genetic output available only to selected laboratory technicians, and a laboratory should err on the side of actual deletion of genetic data, where possible (Scudder et al. 2018a). Indeed, interviewees believe generally there is no reason for the police to have access to the genetic data from the FDP analysis, but rather they only require the phenotypic information (‘*there is…no benefit at all to provide the pure genetic data to the police’* (Professional interviewee 28, the Netherlands)). And, as some interviewees note, there are already requirements for the storage of genetic data in laboratories due to quality management and assurance guidelines within accreditation rules.

Whilst keeping genetic data within the laboratory may seem like a sensible option, one interviewee was cautious about this, and about the lack of regulation surrounding certain laboratories and the data stored within them. What would happen, she questions, if the laboratory closed down? This is in comparison, she explains to the keeping data within police institutions where regular audits are conducted to ensure data is sufficiently protected:

> *How can you trust that this laboratory is going to do the right thing, that it will not disappear tomorrow what would happen with this information? How are you going to control that the data are not decentralised...I will maybe trust more that this information is in the police with strong audit trails of what is going on and who is accessing* (Civil interviewee 16, Spain).

Other complications arise if we only store FDP outcomes in a laboratory. Due to the nature of the genetic findings, which can be difficult to understand and interpret, data may need to be interpreted by a specialist, as is the case in the Netherlands, where the specialist is a police officer (see Section 3.2.3), and some of the genetic FDP findings will need to be transferred to these specialists (see below). At this point, decisions need to be made about how this data is handled, filed and/or deleted and who is allowed access to the data (‘*only certain people [should] have access to the data...and are allowed to communicate and use it’* (Civil interviewee 11, Germany)). One civil interviewee (Civil interviewee 18, Austria) notes that the data should be ‘*encrypted, in a locked room, no copies are possible, only the minimum amount of people has access, subject to random checks, by control institution, etc’.* They emphasise that such measures of caution are needed because *‘we don’t know yet all the things that DNA will inform*

us about in the future, as in, if DNA is stored for decades, and in the future, we can find out even more from it'. In the literature, Scudder and colleagues argue for 'masking' or encrypting personal information and revealing it only as investigative priorities dictate (Scudder et al. 2018a). They remind us that the concept of encrypting genetic information is being considered across a number of health care applications as well (e.g. (Vayena and Gassrer 2016)).

A near consensus seems to have emerged that once a suspected perpetrator has been apprehended, his/her identity confirmed, the information garnered from FDP serves no further purpose and should be permanently destroyed ('*[the data] needs to be destroyed within a reasonable time that does not justify storage'* (Civil interviewee 26, Spain)) (Haga 2006; Kayser and Schneider 2009; McLean 2014; Van Laan 2017). By choosing not to store the genetic data in a centralised database, many concerns ordinarily related to storing genetic data, such as privacy and data protection, are minimised. As Kayser and Schneider state, *the police will not be interested in the genotype data of the predictive markers but just in the predicted likelihood derived from such data that the sample donor carries a certain appearance trait* (Kayser and Schneider 2009: 158).

One civil interviewee (Civil interviewee 16, Spain) who seems to have very little trust in data handlers (such as laboratories and the government) is particularly concerned that laboratories would not actually destroy the genetic data in spite of a possible contract saying they would: '*I do not trust that even if you put in the contract that they [the laboratories] are going to delete it [FDP findings] they are actually doing this'.* In fact, Scudder and colleagues (2018) stress that it is very difficult to destroy such data given the way modern computer systems function:

> *The physical destruction of data is a particularly difficult task, given the way modern computer systems operate and the necessary backup regimes. A privacy assessment would need to consider whether reasonable efforts to delete data from a laboratory's operational systems are sufficient, when coupled with policies that would prevent inappropriate access to deleted data, and note that there is a residual privacy risk if, for example, a decision was made to restore a backup tape to access previously deleted genetic information* (Scudder et al. 2018a: 229).

Moreover, Koops and Schellekens, as well as a number of our interviewees, note that deleting FDP data might not always be possible (Koops and Schellekens 2008). This is because the

criminal investigatory process is subject to internal transparency, and also because a defendant charged with a criminal offense must be able to review all evidence for and against him, including information that gives insight into the procedure the police used (such as FDP) to trace down the unknown suspect. Koops and Schellekens (2008) make it very clear, however, that the stored information could not be used in future investigations, and, as above, their ultimate recommendation is not to store FDP results at all (Koops and Schellekens 2008). Even so, one professional interviewee (Professional interviewee 7, France) explains that sometimes data will need to be archived rather than deleted even when the case is closed, and that raises questions about '*who has access to it, how long will it be kept, what can you do with it*'. And when cases are left open, there is also an interest in storing this information. Since cases can be open for a long time, this raises questions about how such information should be stored in the case file, and whether there is an analogous need to maintain the genetic findings. Another civil society interviewee (Civil interviewee 5, UK) explains:

> *Because cases are often multiple complex things where you have solved all of it but there is one bit that hasn't been solved. My understanding is that if there is that one bit of it that hasn't been solved you can retain all of that evidence indefinitely. And I think there should be questions around how long that type of data should be retained and precisely what it can be used for..[..]..this is data that is held and used for purposes without the owners knowledge or consent in any way. And because it's part of the criminal justice system the assumption is that it's a legitimate use of that data.*

Only one interviewee disagreed that the information garnered from FDP serves no further purpose once a perpetrator has been identified, and should be permanently destroyed. This interviewee argues that retaining the data could enable further research with the (de-identified) data to improve FDP analysis calculations wherever this is legally possible:

> *You could of course consider having that data also available for scientists to do more research to improve the calculations of likelihood ratios etc. that would be beneficial for everybody in general*. (Civil interviewee, the Netherlands 14).

Key points:

- Nearly all stakeholders and authors stressed that genetic findings from an FDP test should remain within the laboratory and the police should only receive the narrative

descriptions of the findings. Though this raises questions relating to how findings can be accurately interpreted and checked by specialist police officers if required.

- Nearly all stakeholders and authors emphasised that once a criminal case has been closed, narrative FDP information should be deleted, though in practice this may be more difficult than perceived, and provides little information in terms of how long the FDP information should be kept if the case is not closed.
- Decisions need to be made regarding (a) how long FDP findings should be stored in the laboratory in instances where a case is not closed (and even if it is), (b) whether current measures of data protection are sufficient to protect the needs and interests of individuals and groups, and (c) whether current practices within laboratories are set up for deleting and encrypting FDP data.

3.5. Financial cost of FDP versus its utility in forensic investigations

Some scholars and a number of interviewees stress that the use of FDP in criminal investigations should be determined by weighing up the financial cost of implementing the technology against its potential benefit. Here, potential benefit is mainly discussed in terms of utility i.e., how useful the technology is in terms of apprehending suspected perpetrators. Any choice to use the technology is therefore viewed as hinging primarily on whether the technology increases utility in terms of the number of suspects apprehended, decreasing resources to apprehend a suspect (by, for example, narrowing the suspect pool) or increasing the speed with which suspects are apprehended (Haga 2006; Ossorio 2006; Smith and Urbas 2012).[26] As Civil interviewee 5 explains:

> *If we were to look at the costs of doing an additional test and the cost for the laboratory fees, and I don't know how much additional cost it is beyond a DNA sample but I would imagine there is some additional cost attached to that. And then the analysis costs. So there is a kind of cost benefit analysis from a criminal justice side of things in terms of whether you would want to use that type of technology*.

Some authors and stakeholders have concerns that the utility of FDP in a police investigation could be diminished in a number of ways. There is a particular concern, for example, that since external characteristics can easily be modified the usefulness of the technology (even if it has very high predictive values, see below) might be negated (Amorim 2012; Koops and Schellekens 2008; Murphy 2013; Dawson 2015; Lab 2015; Stanley 2018; McLean 2014). As Sascha Karberg explains in *European Biotechnology*, '*a suspect's external appearance could still easily be changed by cosmetics, plastic surgery, coloured contact lenses, dyed hair, a deep tan or even disease. Hair colour also alters with age*…' (Karberg 2018). This issue also troubles a number of our interviewees: *'the face and appearance of the person are also made by the life they have lived. So it depends where you live [i.e., whether you have a tan or not] on your skin [colour], you can change the colour of your eyes,..maybe your hair will change etc'* (Professional interviewee 7, France). Though Kayser (2015) notes that significant effort and planning are required to successfully avoid FDP-guided police investigations via falsified appearance –

[26] Authors and stakeholders also noted that the utility of the technology needs to be balanced against any harms that may be attached to it in terms of infringements on human rights, discrimination etc. These issues are not discussed here as they have been discussed in detail above.

planning which, if we consider the use of gloves to protect fingerprints, is not often practiced (Kayser 2015).

Authors and stakeholders also provide other examples of how the utility of FDP as a tool to aid criminal investigations can be diminished. One interviewee, for example, explains how the perception of hair, eye and skin colour is ultimately subjective and so stating that a person has, for example, dark brown hair, may be perceived differently by different people: '*at the moment it [FDP] is mainly to describe extremes. So someone who is, let's say, dark and someone who is bright. If I was to ask my daughter what is the colour of my eyes we have very different opinions, my daughter says "it's brown", I would say "maybe it's a bit green"'* (Civil interviewee 14, Germany).

Some of our interviewees also question the utility of FDP as a useful forensic tool in comparison to other forensic methods: *'it is not helpful in a case with one perpetrator to find hints that could lead to millions of citizens. In those cases, tips by neighbours, maybe even cell-phone location data, highway surveillance, etc. etc. can be much more useful'* (Civil interviewee 18, Austria). Talking about the specific criminal case in Germany which sparked politicians to call for a change in FDP legislation (it is currently illegal in Germany), one civil society interviewee (Civil interviewee 14, Germany) explains that '*they had other traces available, there were other clues available….they used cell phone data…I can hardly imagine a case where the police have no other clues rather than a few blood stains at the crime scene'.* Similarly, our discussion with a professional stakeholder outside of Europe and therefore not a part of this analysis raised an important issue - that the utility of FDP to aid with criminal investigations may quickly be superseded by other forensic genomic technologies. The pertinent and timely example of this is familial searching of genealogy databases. Here, police compare a DNA sequence originating from a crime scene stain with the DNA sequences contained within a consumer-based genealogy database (people upload their genome sequences to these databases with the hope of identifying long-lost relatives, adopted children/parents etc) with the aim of identifying a familial match (i.e., a relative of the suspected perpetrator) (Erlich et al. 2018). Police have used this approach on a number of occasions, and most infamously during the criminal investigation which led to the arrest of the U.S. Golden State Killer (Callaway 2018). Even U.S.-based Parabon Nanolabs, which markets FDP as a technology capable of creating composite faces of individual (see Section 3.5.2) is adding genealogy database searching to the list of analyses it conducts for the police (Molteni 2018). However, such searching may be more difficult in

Europe, which has strict data protection laws, and in which many countries are yet to legally permit familial searching or have Criminal Codes of Conduct which are interpreted as not permitting this type of DNA analysis (i.e., are only permitted to analyse "non-coding"[27] regions of DNA).[28]

Finally, one interviewee, who strongly believed the technology incites racial profiling, explains that while FDP supporters contextualised the technology's utility in terms of safety and security, the very notion of public security is problematic because it excludes - at least in media portrayals and many public discussions - minority populations. Minority populations, rather than being considered as part of 'us', are portrayed as a threat to public security and thus always on the outside. In the words of our interviewee, *'whose safety is [the concern] here?...Certainly not that of refugees…..Whose security is it about?....'* (Civil interviewee 17, Germany).

3.5.1 Evaluation

Given the concerns noted above, Haga (2006) and others call for the benefits of FDP, in terms of police utility, to be demonstrated, before the technology is adopted into case work (Haga 2006). Some of our interviewees express the same view, such as this civil interviewee:

> *I think this comes back to the evidence, and as I said I tried to find some evidence somewhere about predictive validity of it and the value in terms of turning a hopeless case into a successful one. And at the moment if the information is there it's not readily available. And actually you don't know how valuable it's going to be until you have actually done it* (Civil interviewee 5, UK).

Such an 'evaluation', however, may prove difficult. A critical assessment of other police-led technologies has shown how designing a thorough and serious evaluation study can be challenging and can also raise a number of ethical issues (for example, in terms of choosing

[27] Information about an individual's non-coding DNA is perceived to provide no information about a person's phenotype, and is therefore viewed as less ethically problematic. This sits apart from coding regions of DNA, which encode proteins and which can therefore provide information about an individual's phenotype. Though it is now well-established that this distinction is problematic and that there is coding information in the previously assumed non-coding part of the DNA.

[28] https://www.euroforgen.eu/fileadmin/websites/euroforgen/media/Ethical_documents/Folder_2/D4.3_EUROFORGEN-NoE_Legal_Audit_Mar2017.pdf.

control groups, etc.). Some of these ideas are discussed by political scientist John Mueller and civil engineer Mark Stewart in their evaluation of cost-benefit ratios of counterterrorism efforts in the U.S. (Mueller and Stewart 2016).

In relation to DNA profiling and databasing, UK scholars' Williams and Wienroth explain that research has shown it is much more difficult than is normally understood to establish the utility of these technologies and their impact on crime detection (Williams and Wienroth 2017). This is because the large number of factors that have bearing on utility, and the complexity of their interaction, which makes it virtually impossible to trace phenomena such as higher or lower detection rates back to specific causes. These factors do not only include technical and operational factors but also cultural ones, such as a neglect of empirical evidence. Talking about the situation in Germany, for example, one of our interviewees perceives police culture to not place as much weight on empirical evaluation of forensic technologies than it is the case in other countries. This interviewee compares the German situation to what he considers is a much more evaluative culture in the UK: *'in Germany the police officers say we have a good idea, and we do it, and maybe it works or maybe it doesn't work, they think they are smart in doing it. It's not like in England where you have empirical evaluation of these things* (Civil interviewee 10, Germany). Another interviewee notes, however, that even in societies with such an evaluative culture, it can often be difficult to act on the findings of such an evaluation; and that once the 'genie has been let out of the box' it is difficult to put it back in, even if the evaluation suggests that FDP is of little use (*'I am a bit skeptical whether such an evaluation will have the potential to put the genie back in the box but nonetheless I think it might help to foster critical discussion about the use of this technology'*). This interviewee refers to the pronounced audit and evaluation culture in the UK, which, whilst more developed than in other countries, according to this respondent has had little impact on changes in practice: '*I am aware of CCTV evaluations that have taken place in the UK around 2005 or so, the impact it had I would say none*' (Civil interviewee 14, Germany).

Those at the forefront of using FDP in police work in the Netherlands, where FDP is currently explicitly allowed for ancestry, hair and eye colour prediction testing, explain that such evaluations are not conducted in their country because of how FDP is used. They explain that FDP will almost never lead directly to solving a case, but rather plays a role in prioritising suspects, checking eyewitness statements, or acting as a 'plus' for the reconstructive value of a crime stain, especially when you have multiple DNA-profiles from a certain piece of evidence. This makes it extremely difficult to isolate the effect of FDP in a given investigation. For those

respondents, what is more important is a good understanding of how the given information can be brought to good use in a police-investigation (Professional interviewee 29, the Netherlands).

Finally, and particularly important from an ethical point of view, even if an appropriate evaluation of the utility of FDP was possible, balancing any financial cost with utility is underscored by questions of value i.e., if we know the cost of the technology, and we know the utility, how much are we, as society, willing to fund the use of FDP, and for how much utility in return. As some of our interviewees note: *'it will cost a lot of money…then there is a question of was it worth it'* (Civil interviewee 11, Germany); '*do these few hundred cases justify the development of an expensive infrastructure with a lot of risks that are inherent to the technology'* (Civil interviewee 14, Germany). Neither the literature nor interviewees speak in detail about how to address such questions of value, though interviewees did discuss at length a whole range of social factors which could influence any weighing up of a financial cost-utility analysis when determining when to use FDP (see below).

3.5.2 Social factors influencing the use of FDP

Whilst it seems well-considered to implement FDP into practice using an 'evidence-based' process based on the utility of the technology, the previous section has shown how difficult it can be to decide what should count as evidence in this context. Moreover, assessing the broader costs, benefits, and effects of a technology requires treating a technology as a socio-technical practice, and not merely as a technological artifact that acts on its own, i.e., how a technology comes to be used in society relates to more than just its utility - it also relates to a range of social-technical factors and actors. As sociologists Nik Brown and Andrew Webster argue (2004), technologies are not value-free and neutral, but rather, the development and use of technology always reflects values and interests of those who developed and use it (Brown and Webster 2004). Much of the work undertaken in Science and Technology Studies has sought to identify exactly how particular interested actors shape the development and application of technology (Timmermans and Berg 2003; Brown and Webster 2004). Our own interviewees' narratives reflect the intertwinement of socio-technological aspects also in the context of FDP. They see FDP as reflecting mainly four sets of values and interests: public pressure to solve crimes, representations of criminal justice in public media, expectations raised by, and interests of, for-profit companies, and interests of other professional stakeholders.

First, a number of interviewees see public pressure as a powerful force for FDP uptake, even when little is understood about the utility of the technology:

> *For a certain category of murder and sex crime no expenditure is too much, but for a lot of murder and sex crime actually expenditure is too much. And then if something gets in the Daily Mail [UK national newspaper] then there will be more resources thrown at it* (Professional interviewee 32, UK).

On top of this pressure, as we have described above, publics have also been shown to have high expectations of forensic DNA technologies and their respective capabilities (see section 3.2). Situations are envisaged by interviewees in which public pressure to solve a crime, and the public's belief that DNA technologies can significantly help police officers, can lead to investigators using FDP even if they can see it as adding little utility:

> *Where you have people who have high expectations on DNA procedures, it probably could raise public pressure on the investigators if the public gets to know that there has been DNA evidence - what are you doing, why aren't you producing results, what is happening, you have DNA, you have the procedures?* (Civil interviewee 10, Germany).

Second, mass media portrayals are also discussed as a medium to shape FDP's use by raising expectations about the limits of the technology's capabilities. This is exemplified in the extract below, taken from a U.S. NBCnews report of FDP. Here the technology is described as "amazing" - something akin to the "revolution" of DNA fingerprinting. Such descriptions suggest an exciting technology which - rather than acting as an investigative tool which may or may not be helpful in a small number of criminal cases (the reality) - "guides" police officers to their suspects. Note synonyms to "guide" include "lead", "escort" and "follow" implying a technology which easily takes police officers to the perpetrator:

> *Amazing DNA Tool Gives Cops a New Way to Crack Cold Cases*
> *DNA fingerprinting brought a revolution in criminal investigations by giving law enforcement officers a reliable tool for linking crimes to known suspects or to individuals listed in criminal databases. But imagine if DNA could also be used to generate a police sketch that would guide officers to the guilty party even if he (or she) wasn't a suspect*

and had no criminal record. It sounds like science fiction, but this futuristic-sounding forensic method is already becoming a reality (Gannon 2017).

The expectation-generation produced by the mass media is seen in the reporting of other innovative biotechnologies. Indeed, Nik Brown states that biotechnology is today synonymous with the language and imagery of futuristic breakthroughs, characterised by heated aspirations, promises, expectations, hopes, desires and imaginings (Brown 2003). Brown and others argue that this hype is put into circulation for a reason – it is performative – that is, it mobilises the future into the present, and has an influence in real time (Michael 2000; Brown and Michael 2003; Borup et al. 2006). Here, the promise of the technology will often be exaggerated in order to command sufficient interest to enroll necessary allies and secure investment (van Lente 1993). The whole language of novelty, newness and revolutionary potential is actually part and parcel of the discourse surrounding the early or opening moments of resource and agenda building (Brown et al. 2000).

Unsurprisingly then, third, expectations associated with FDP are also generated by a number of for-profit companies, such as the U.S.-based Parabon Nanolabs. These companies market FDP as a technology capable of creating composite faces of individuals from a sample of DNA alone; often based on tests which are underdeveloped, not sufficiently specified and documented, and unvalidated (Wienroth 2018).[29] Indeed, many scholars are particularly concerned that Parabon Nanolabs "*neither publishes its methods nor provides any details about their robustness and rigor"* (DeFrancesco 2018) (also see (Dewey-Hagborg)) and call for increase governance and oversight (Curtis et al. 2018). Because of this, interviewee 17 (Germany) notes that '*if anyone does an analysis of such DNA stuff [sic] then it has to be public, independent bodies and not commercial companies….. such highly sensitive things should not fall into the hands of commercial companies'*. In spite of this, tests offered by these companies are already used by some EU law enforcement agencies to aid criminal investigation. Maybe because of this, interviewee France 4 was particularly concerned about the expectations generated by these companies, and the market pressure such expectations produce. For this interviewee, market pressure played a key role in driving forward the 2015 French High Court decision to permit the use of FDP in France for the predictive testing of 'morphological characteristics'.[30] This

[29] For a detailed discussion of the ethics of Parabon Nanolabs see (Wienroth 2018).
[30] In this court case a Magistrate ordered FDP prediction for eye, hair and skin colour. The legality of this FDP request was then examined by the *Cour de Cassation* (France's high court: the final court for civil

interviewee is particularly concerned about this because of the small value she felt FDP had to offer to the criminal justice system. She describes that:

> *I was not happy when the [French] court... made its decision to allow some kind of DNA phenotyping. I thought it was...opening the door to the unknown in the sense that, it wouldn't give much information, it's not a surprise that the technology is not used that often. It's because it has been a lot of years catching thieves and criminals and they haven't had DNA information… But given there is a market, because with genetics it always comes with a market, and some way of marketing things, I am afraid they have opened a door to something* (Professional interviewee 4, France).

The marketing of these technologies, alongside the portrayal of FDP in the mass media, challenges the implementation of FDP because it can lead to misunderstandings in terms of what the technology can deliver. One interviewee, for example, uses the German political discussion to exemplify the unrealistic expectations of FDP for age, appearance and ancestry. These individuals are not only receiving '*one-sided representations'* and *'dangerous half-knowledge*' about FDP and its capabilities, but they are also confusing this technology with the promises of photofitting which, as this interviewee notes, does not work:

> *'I also looked at the political discussion in the Baden-Württemberg state parliament for [FDP]. And so there are the people who talk about the whole time that you can somehow create a phantom image..[..]..in the political, media discussion...somehow people assume that somehow you could create a phantom image of it,….simply not true.* (Civil interviewee 17, Germany).

Finally, FDP implementation has been supported by some vested professional stakeholders. For a number of these stakeholders, FDP is a useful technology, which they would like to see implemented in more routine police work:

> *It's my personal opinion that it [FDP] should be used a lot more and I think that is what will happen….One of the things we do is we started what we call a technical legal group*

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and criminal questions). The *Cour de Cassation* ruled that conducting FDP to determine probable predictions for for eye, hair and skin was legal. For a more detailed description see (Samuel and Prainsack 2018b).

> *…where we try to push the legislation forward…* (Professional interviewee 29, the Netherlands).

One German interviewee explains how, in their view, some proponents of the technology have emotionalised the debate around FDP use to build support for the technology. Specifically, they have contextualised the benefits of the technology within the emotional narrative of rape. As this interviewee describes, '*we are also aware of this in the German context...there is an incredible emotionalisation within this debate...that somehow says...: "they will change their mind about [FDP] when the first child in your neighborhood is raped*'" (Civil interviewee 17, Germany). This narrative, explains this interviewee, not only provides little room for any critical discourse about the FDP, but relies on problematic assumptions, since most rape and abuse happens within the family. Matthias Wienroth discusses how the promissory, epistemic and operational aspects of anticipatory work around FDP have been deployed by FDP stakeholders to construct the technology as reliable and legitimate (Weinroth 2018). This author argues that those who have developed FDP, or have a stake in the technology, are working to create a social environment which allows FDP to be permitted. Thus, he explains, whilst FDP remains innovative and contested, FDP stakeholders have anticipated how to address the contested nature of FDP (including, for example, the need for governance, standardisation, policymaking etc), and by enacting this, they have concomitantly created a landscape to permit its implementation (Wienroth 2018). This is certainly the case in Germany, for example, where the political climate is aiming to create a landscape to allow the use of FDP ('*my position is that under no circumstances may [FDP] come to a nationwide application …but alright, maybe it would be good if we get a little bit ahead [in terms of regulation]'* (Civil interviewee 17, Germany).

Two interviewees in particular (one from the UK and another from Germany) are very concerned that the expectations associated with FDP will drive implementation of FDP down a slippery slope towards its overuse by police officers, including in situations when its use may not be appropriate, useful or cost-effective.[31] Talking about the situation in Germany, where there is currently widespread policy discussion about the possible legalisation of FDP in the criminal justice system, one professional interviewee states that:

[31] In a slippery slope argument, '*a course of action is rejected because, with little or no evidence, one insists that it will lead to a chain reaction resulting in an undesirable end or ends. The slippery slope involves an acceptance of a succession of events without direct evidence that this course of events will happen.*' https://www.txstate.edu/philosophy/resources/fallacy-definitions/Slippery-Slope.html.

> *Germany - I see they are desperate to get the [permission] to use it [FDP] and then every police laboratory is going to want one of these machines to turn up results… [..]..My great concern is that then the population will - once that is allowed - will want this to be done in all cases that they feel very strongly about* (Professional interviewee 33, UK).

While the particular argument made by this respondent does not feature in the literature, Koops and Schellekens (2008), as well as Kayser and Schneider (2009), both raise, and reject as flawed, other 'slippery slope' arguments that the use of FDP for age, BGA and appearance will eventually lead to a range of ethically and socially problematic outcomes, including but not limited to: the analysis of the entire genome to reveal all visible and invisible traits, including risks to develop a certain genetic disease; the analysis of the genome to gain knowledge of genetic propensities for aggression, paedophilia, or schizophrenia to establish probable cause or circumstantial evidence within specific criminal cases; and ultimately the resurgence of eugenics (for example, see (Newsome 2007)) . For Koops and Schellenkens, and Kayser and Schneider, any slippery slope argument is unfounded. As Kayser and Schneider note:

> *The ''slippery slope'' argument is always raised by sceptics when a new technology is under development, and is an indicator of uncertainty and fear in the public about its potential misuse. To deflate these feelings, it is quite essential that the relevant scientific community leads an open discussion and educates the public about the possibilities, as well as the limits, of using predictive markers in the context of forensic investigations.*

One of our civil society interviewees (Civil interviewee 14,Germany) emphasises that slippery slope arguments need to be considered within a social context: The use of a technology will be expanded because the circumstances will be claimed to be changing by those in favour of expansion. This interviewee is concerned that any regulation of FDP will just lead to calls for less stringent regulation in the future:

> *If you look at many, many other instances of technology at the very beginning [e.g. CCTV, DNA analysis] it was usually said "well we will only use this to investigate serious crime and as the last resort". And if you look now, the reality, the daily reality of how the German police use DNA evidence - so DNA profiles, it's mainly for bulk crime…I doubt that the police in Germany will only use it as the last resort. Mainly the first type of*

regulation might limit it but five years, three years, afterwards you will have another case where the police would argue well if we would have this available not as a last resort but maybe as a resort before the last resort then we would have been able to solve the crime. And then they will lower the threshold, so it's a slippery slope.

Key points

- There have been calls to evaluate the utility of FDP in quantitative terms, so that it can be compared to the financial cost of using the technology in a cost-benefit analysis.
- It is difficult to evaluate the utility of FDP in practice, and questions such as how to evaluate; what to evaluate; and by whom all need answering.
- The expectations and interests attached to FDP - whether that be from the market, the public, the media or the professional stakeholders themselves, likely play more of a role in shaping the development, application and implementation of FDP than a rigorous cost benefit analysis.

3.6 FDP as a 'biological eyewitness'

One argument put forward in defence of using FDP draws analogies between the technology and traditional eyewitness statements. FDP findings - just like an eyewitness - are perceived to provide important information about what the perpetrator of a crime looks like. Manfred Kayser, for example, argues that FDP outcomes can serve as 'biological witnesses' (Kayser 2015). This analogy is heavily drawn upon by many of our interviewees too:

> *It's not dissimilar to if they had an eyewitness...who said "I saw a male I think he was about 5'10 maybe 6 foot, I think he had curly brown hair, I only saw the back of him so I don't know the colour of his eyes but he seemed to have big ears". Sometimes that's all the police have got to go on really, and so it feels like this is just a DNA style of doing that* (Civil interviewee 6, UK).

The possible uncertainty relating to the nature of FDP predictions (see below) did not perturb those who were invested in the analogy between FDP findings and eyewitness statements. This is because, they explain, since police officers are aware of the unreliable nature of eyewitness statements, they can similarly be trained about the predictive nature of FDP findings: '*eyewitnesses are often times not very reliable, we change our memories ourselves without recognising it. And investigators know that and they are critical about eyewitnesses. So this should be part of the education too with the DNA phenotyping'* (Civil interviewee 10, Germany). (see Section 3.2.3 for a discussion on FDP training and education). In fact, some stress that FDP outcomes may potentially provide even more accurate information than human eyewitnesses (Kopec 2014; McLean 2014; Kayser 2015).

Others consider this analogy problematic as it essentially dismisses any ethical or social concerns relating to the technology. Assuming that eyewitness statements are ethically acceptable (otherwise they would have been outlawed), drawing an analogy between those and FDP extends the assumption of ethical acceptability to FDP, without scrutinising potentially relevant differences between the two. The notion of a 'biological witness' is deemed problematic by a number of scholars who see key differences between the two types of identification (biological versus eyewitnesses). Toom and colleagues, for example, argue that whilst FDP provides decontextualised statistical information about a person's most likely appearance, eye-

witness accounts often provide important context about the events of a crime (Toom et al. 2016). This point is echoed by a civil interviewee (Germany 14):

> *The eyewitness says "well I have seen this guy on Wednesday the 2nd and I was standing at this point and I was seen passing by from there to there. And he was looking like hm hm hm". And what I know from DNA phenotyping is only well there has been someone at the crime scene with an 80 percent or 95 percent probability of being African origin or Asian origin.*

Toom and colleagues also purport that whereas eyewitnessing has reportedly been of some significance in the criminal justice system for some time, and evidence of its effects is thus available, FDP still needs to be properly evidenced (Toom et al. 2016). As Zieger and Utz stress about eye-witness reports, it is widely known and understood that they have to be interpreted quite carefully because they are not always reliable; with regard to the interpretation of FDP results, there is the risk that they will be done less carefully because people place more trust in the scientific method (Zieger and Utz 2015) (see Section 3.2). Lawyer Jessica Gabel Cino also notes that whilst even the most unreliable eyewitness can be questioned and cross-examined about what the suspect was doing at the crime scene, this is not the case for an FDP generated image (Cino 2017).

Because of this, other scholars take a different approach to describing the relationship between FDP findings and eyewitness statements. For them, the two tools act complementary to each other during an investigation. Fox (2010) explains that whilst FDP may not be as valuable as eyewitness accounts which inform police about certain descriptive traits such as scars and tattoos, in other ways it may be more valuable than eyewitness statements in terms of granularity and falsifiability:

> '[whilst FDP] *could not convey many descriptive traits, like scars and tattoos, or temporary features like clothing and facial hair...it could determine physical appearance with greater granularity and falsifiability than an eyewitness sketch*' (Fox 2010: 74).

Similarly, Scudder and colleagues view FDP as increasing the reliability of eyewitness statements, arguing that (Scudder et al. 2018b):

An eyewitness identification, supported by prediction of EVCs from recovered genetic material at the crime scene, significantly alters the confidence around both the eyewitness and forensic evidence. In this way, investigators can benefit from both the ability of an eyewitness to give context (such as their interpretation of a suspect's actions, demeanour or behaviour) and the ability of predictive phenotyping to add a statistical framework around assertions of their physical appearance.

Interviewee NL 29 provides an example of a double rape case in the Netherlands in which BGA testing was used to complement to conflicting eyewitness testimonies:

There were two really heavy rape cases...The first was a stewardess raped in the early morning...And a couple of weeks, I think, or a couple of months later, another women...in a small park...Both women were raped by the same man so the DNA match was there, but the first one said "well I have been raped by a Pakistani looking guy from India", the second one said "no, no I am raped by a North African Moroccan type of guy"....and this was not a quick one so they both had a good chance of looking at these people...So they did [a BGA test] and the sample came back with a clear indication on India. So following that lead, people from...that origin in certain groups...were more interesting than others and eventually we got the perpetrator. So it was [sic] indeed derived from India….So the detectives had a major advantage by knowing that they had to look more specifically in that group [the Indian population] than the North African group, [i.e., they didn't]... exclud[e] them [the North African population], but prioritis[ed] them [the Indian population].

Key points:

Analogies are frequently drawn between eyewitness statements and FDP findings, though these analogies are problematic for a number of reasons. First, the fact that eyewitness statements are *also* often biased is not a compelling argument in favour of using FDP. Rather, FDP should be assessed against independent criteria. Second, by analogising FDP to eyewitness accounts, we forget to consider the trust people place in DNA information and the effect this may have on how they interpret FDP outcomes even if they are told that such outcomes are only predictions. As such, we cannot assume that whilst police understand the uncertainties related to eyewitness statements the same will be true for FDP predictions. Third, the eyewitness-FDP analogy suggests that FDP can "see" a person from the outside . This statement seems

problematic: FDP makes probabilistic predictions about what a person *may* look like from an analysis of DNA.

3.7 Bias: databases, algorithms and availability of tests

FDP technology uses algorithms to predict specific phenotypic traits. These algorithms have been 'trained'[32] using specific DNA datasets. An FDP prediction outcome for appearance and age will be dependent on the data used for model training as well as those used from model validation based on the DNA markers used (Liu et al. 2009). Concerns arise if care is not taken by the scientists who develop such statistical prediction models such that all forms of the predictable appearance traits are well represented in the underlying reference dataset. In other words, for hair colour prediction, there needs to be red, blond, brown, black etc haired individuals in the model underlying datasets if red, blond, brown, black hair is to be predicted by the model. If all traits are not represented, this can lead to flawed/biased outcomes. This becomes particularly problematic when algorithmic processes are not transparent, for example, as is often the case with commercial suppliers, as such outcomes cannot be checked for rigour.

Regarding BGA, prediction works by using a reference dataset directly. Concerns for BGA arise when, for example, certain geographic regions are underrepresented in the reference dataset meaning that specific populations may respectively be overrepresented, leading to systematic bias in the findings produced from the analysis (i.e., an FDP finding is more likely for populations over-represented in the reference dataset). Because of this, questions have been raised about the possible discriminatory nature of these reference databases (Lipphardt et al. 2017). Such concerns could arguably be addressed by the establishment of more inclusive reference datasets such that they are more representative of populations (no over- or under-representation) and with more predictive markers.

Beyond these issues with reference datasets, as inferred above it is now also widely accepted that algorithms are not neutral "truth-machines", but rather reflect the assumptions used, and the data that they were trained with (Dewey-Hagborg ; Kraemer et al. 2011; Mittelstadt et al. 2016). As FDP analysis relies on algorithms, additional bias can emerge here (Wagner 2009). As one civil society interviewee (Civil interviewee 22, Germany) explains:

[32] For appearance trait prediction algorithms are trained and tested using datasets which contain both the genotypic information as well as the phenotypic information of a large number of subjects that allows to test if a prediction outcome is correct or incorrect and within the latter if it is false positive or false negative.

> *They [FDP scientists] must...avoid biased profiling or results that are targeted on particular ethnic and social groups. They should avoid subjectivity based on existing 'training data' which is the current issue with big data based technologies and algorithm decision making.*

Here, this interviewee is referring to the human decision-making, assumptions and choices scientists make when developing models using algorithms and data sets - something which is prevalent not just for FDP, but for algorithmic processes more broadly. While scientists may be acutely aware of the limitations and caveats of their approaches, Weichert argues that using these algorithms, and analysing DNA information for FDP using complex technological and software tools, means that the findings are not transparent and intelligible for people (Weichert 2017). As such, employing these tools in the criminal justice system may lead to discriminatory practices. There are many examples outside the area of FDP where the use of algorithmic processes have led to discriminatory findings (Eubanks 2018). While these examples may not be directly comparable to the use of FDP, the types of issues they raise do highlight the need for caution when using and implementing FDP into practice.

An additional layer of complexity emerges when biases exist within an algorithmic system that are not apparent, and one particular interviewee speaks a lot about this. He notes that *'maybe there are things that we haven't thought through, and these things take many years to come up before we realise "oh we are building some nasty bias into the system"'* (Civil interviewee 1, Belgium)). While this interviewee was not opposed to the use of FDP, they felt the need to, at the very least, consider these possibilities. As this interviewee explained, when biases - or potential reasons for bias - are not understood, it is impossible to correct them, or to take action to prevent their negative consequences. This interviewee points to the published relationship between the Y-chromosome and a person's surname as an analogy of where the personal information you can gather from DNA analysis may not always be evident initially:

> *For quite a few years we thought if you only have the genome then maybe we can retrieve some information but you don't know who is it. And then suddenly we realise something very silly that forensic DNA analysis have known for a long time if you are a male your Y chromosomes is tightly linked to your last name.*

Whilst the particular study cited by this interviewee has a range of limitations and so may not be the best example of a situation in which relationships emerge “after the event” (it is context dependent, applies only to rare surnames and depends on the name), the point raised - that we should be cautious about biases which are not initially apparent in the algorithmic process, is still valid.

Finally, a number of scholars highlight that if the characteristics of a specific subset of the population, for example a specific group individuals with a specific eye or hair colour, are more readily discerned genetically than others (or are more targeted by scientists than others), this might make criminal prosecution of this group more effective compared to other sub-groups of the population, simply because they can be determined where other DNA types would yield inconclusive information (Koops and Schellekens 2008). This would raise questions of fairness.

Key points:

- Bias can occur from the way that DNA data sets and algorithms are used for the FDP analysis.

3.8 Misuse of the technology

Whilst early literature raised questions about which crimes should enlist the use of FDP (Haga 2006), most scholars now agree that FDP should only be used for serious crimes, predominantly defined as those which cause bodily harm, such as murder and rape. Interviewees generally echo this belief, though there is more variation in opinion ranging from those who believe FDP should not be used under any circumstances to those supporting the use of FDP for a wider range of crimes including, for example, burglary. In spite of this, there is a concern that if the technology is used for anything bar serious crimes, not only might this raise questions about the cost-benefit ratio (see Section 3.5), but it could also open up the technology for misuse. Scenarios of misuse are described in a number of ways. First, there are already examples of FDP being used outside of criminal crimes (Abbott 2018; DeFrancesco 2018). In her piece in *Nature Biotechnology*, Senior Editor Laura DeFrancesco (2018) describes a UCLA scientist who was approached by German police. The police had apprehended a Somali pirate who would be facing imprisonment if he was 18 or older; if he was younger than 18 he would be eligible for protection as a minor. The police services wanted to use age prediction testing to confirm that the Somali suspect's claim to be younger than 18 was true. Whist this is not strictly FDP because it falls outside of the Code of Criminal procedures and because the individual in question was known (Ritz-Timme et al. 2018) it does raise questions about 'function creep' (see (Hindmarsh and Prainsack 2010) for various discussions on this) and about the increasing use of age prediction in situations beyond serious crimes where issues of privacy, discrimination and utility are particularly acute.

Second, concerns are raised about misuse in the sense of police forces outsourcing FDP analyses to private companies. Here one interviewee describes how a for-profit company, who may not use validated methods, can draw rash and incorrect conclusions from the DNA data and FDP findings, and that the police services could then potentially act upon that. Talking about a crime for which an Afghani man is believed to have murdered a girl, this interviewee states that:

> *Some people do say he is from Afghanistan because they put it through a machine and this company's machine puts a red dot in the middle of Afghanistan. And that is the danger - that the police or the labs will get hold of that. The company produces this, puts the red dot there, but how valid is that. So…if you are going to say anything what is the*

value of that particular piece of information that you are saying (Professional interviewee 33, UK).

Finally, the technology was described in the language of inappropriate security force surveillance and unnecessary intrusions of privacy versus little utility of FDP use. One civil society interviewee (Civil interviewee 6, UK) compares the issue to the UK Terrorism Act - an Act seen by many to permit substantial infringements to privacy without clear evidence of benefit - to make this point:

My gut says yes you can't just do it [FDP] if someone spat on the street. And actually I think I stick with that ….And that's always my concern whenever stuff like this happens and it ends up being utilised in the wrong way like we have seen with other things like the terrorism act and other stuff that people end up turning definitions to suit their own needs.

Aligning with the literature on surveillance and security more generally (Pavone et al. 2016), concerns about genetic surveillance have been brought to the fore by Artist and Educator Heather Dewey-Hagborg's art project in the U.S., in which she collected shed hairs, cigarette butts, chewed up gum, and pieces of fingernails to create life-size full-color 3D portraits of the strangers whose DNA had been collected (Dewey-Hagborg). The issue of surveillance cut quite deep for several interviewees who contextualise the use of FDP as a genetic surveillance tool within their own political contexts, and in particular, current powers of surveillance being given to governments, especially right-wing sectors. These interviewees feel that caution was needed when using FDP to ensure that its use did not become another step towards a surveillance society:

How does this technique relate to fundamental human rights and current criminal law, and are there any legal safeguards in place preventing misuse by the government? (Civil interviewee 30, the Netherlands);

The same is true for the fear that the turn to "predictive policing" may be fueled by such techniques. In principle, in view of authoritarian political currents in Europe - as well as Austria-specific, a government that includes extremely right-wing forces, who also appoint the Minister of the Interior - and the concomitant threat to the rule of law and

> *fundamental rights, any expansion of police powers must be discouraged* (Civil interviewee 19, Austria).

As Civil society interviewee 17 (Germany) describes, the political climate was not confined to government, but prevalent throughout society - in Germany, and also Europe - fueled by an increasing right-wing populism and extremism. Making claims about a suspected perpetrator's BGA in this environment, explains this interviewee, is 'very dangerous'.

Only one interviewee is unconcerned about the possibility of applying more surveillance to society. This interviewees' relative was murdered and she firmly believes one of the reasons the perpetrator was never identified was because there was no CCTV footage of the incident. For her, more CCTV, and more surveillance in general, can provide valuable tools for the police services:

> *And even my criminal lawyer said if I am walking down the [STREET] with my mistress I don't want cameras [cctv] looking at that. I felt like kicking him right up the … it's that pompous - about how it affects him personally because he has got a mistress….I just see it as a step forward, not a human rights issue* (interviewee's identity withheld).

To sum address the concerns raised above, one interviewee draws on the notion of proportionality as a key indicator for when FDP should be used:

> *It will never be a hard and fast*[33] *[rule]...because for a high profile stranger rape with a women in fear of their lives in the middle of Edinburgh, yeah, you would probably put more resource into that. Whereas if it was a robbery somewhere else, would you put the same resource? Probably not. So it's a piece of the case, proportionality assessment of the risk about public safety. And cost as well..[..].. But in terms of community impact then you know the police consider each crime in terms of the public protection, community impact, the effect on the victims. So routinely you wouldn't use FDP for robbery because it just depends on the circumstances, extensively a low level robbery then you probably wouldn't use it. I me* (Civil interviewee 3, UK).

[33] Colloquial for a rule which cannot be changed.

Others in the literature have also argued that a proportionate approach seems like an appropriate principle to drive the regulation and use of FDP (Weichert 2017).

Key points:

- Potential exists for the misuse of FDP. Misuse can manifest in terms of excessive surveillance whereby security services or civil society use FDP in circumstances that may not be illegal but ethically or politically problematic.
- Proportionality is a useful principle for determining when FDP should be used and in which situations, but there is also a need for regulation to inform police officers when to use the technology, which traits to analyse, and to guide them with relation to which services should conduct the analysis.

4. Societal impact analysis

We carried out a societal impact analysis (SIA) using the toolkit developed by the ASSERT-consortium (Assessing Security Research: Tools and methodologies to measure societal impact; assert-project.eu, a Coordination and Support Action that ran in 2012-213; see http://assert.maisondx.com/). Special attention was paid to privacy- and other data protection-related aspects of FDP implementation, the findings from which will be applied to a privacy-by-design strategy during the development of the VISAGE FDP prototype. One of the authors of this Report (BP) was a member of the ASSERT consortium and thus has first-hand experience not only with using but also with developing the tool. SIA methodologies are based on a procedural understanding of technology research and development that does not distinguish between the technology on the one side and society on the other side. Instead, technologies are understood as socio-technological practices. It is the goal of SIA to explore the societal dimensions of the research and development process and feed findings back into this process.

It is important to note that SIA are not merely risk assessment exercises. While it is certainly important to identify risks and to take appropriate measures to pre-empt, minimise, or mitigate them, it is equally important to understand SIA as a process that broadens the range of alternatives by reframing an issue. In other words, the potential of the SIA design to reframe the project and research and development process is therefore the first important good practice criterion to plan and assess SIA procedures. We therefore decided to carry out a small-scale SIA in year 2 of the VISAGE project, rather than year 3 or later, to ensure that findings from the SIA have the possibility to inform the research and technology development in the later years of the VISAGE project and hopefully also in other projects on FDP beyond VISAGE.

Given the nature of the VISAGE project and the resources available to us, it was never the plan to carry out a large-scale SIA with stakeholder workshops. Instead, as described above (section 2.2) we sought to speak to as wide a range of experts and stakeholders in the field of FDP. We analysed data from stakeholder interviews to formulate answers to the SIA-relevant questions in the ASSERT toolbox (see below). We triangulated these data with insights from an analysis of the published and grey literature on FDP. We will publish the results of this exercise and invite comments from experts, practitioners, and other stakeholders. We are committed to acting creatively and constructively upon the constructive 'irritation' that this process can create (see http://assert.maisondx.com/?page_id=189) and have already done so - e.g. by bringing insights

from the SIA exercise into the specification of the functionalities and design of the VISAGE tool. Findings from the SIA exercise will also play a key role in developing Recommendations for the implementation of FDP that we will develop as part of a VISAGE Report in year 3.

The ASSERT-consortium list six groups of societal impacts relevant for any new technology. These are:

- **Way of life, fears and aspirations** (how people live and interact with each other on a daily basis, their perceptions about their safety and that of their communities, and their aspirations for future, including the future of their children);
- **Culture and community** (people's shared beliefs, customs, values and languages, the cohesion, stability and character of their communities);
- **Political systems** (participation in the decisions and processes that affect people's lives, the nature and functioning of democratic processes, and the resources available to support people's involvement in these);
- **Environment** (access to and quality of air, water, and other natural resources, the level of exposure to pollutants and harmful substances, adequacy of sanitation);
- **Health & well-being** (physical and mental wellbeing, not just an absence of infirmity);
- **Personal and property rights** (economic effects, civil rights and liberties, personal disadvantage) (2002).

To conduct a SIA, the ASSERT framework requires us to identify for each of the six groups (a) the relevance to FDP; (b) any positive societal impacts; and (c) any negative societal impacts. To aide this analysis, ASSERT provide a list of the types of questions we should be asking. Below, we first answer these questions in the context of FDP (the list has been minimally adapted to fit the nature of this exercise and is presented in table format below). We then return to the six groups of societal impacts to conduct the SIA.

Table 7. Assessment questions (source: (Wadhwa et al. 2015))

Meets needs of society?	1. **Which documented societal security need(s) does the proposed research address? (e.g. life, liberty, health, employment, property, environment, values).** FDP aims at improving tools for criminal investigation; it is therefore, in terms of its goals, closely linked to the aims of protecting the life, health, and property of people. Closely related to this is another societal need that FDP is intended to address, namely security. That FDP aims to foster the life, health, and property of people, as well as security, does not prove, however, that FDP can indeed effectively foster these societal needs. In order to ascertain whether it can help to foster these goals it would be necessary, wherever FDP is used, to track and evaluate the effect that FDP has on detection rates specifically and, more generally, to the development of specific criminal investigations. We fully support the view of scholars who argue that the relationship between security and privacy is not a zero-sum game where one can be "traded" for a bit of the other; instead, we need to explore whether security technology actually address security needs (Pavone et al. 2016)(Jain et al., 2005). As is evident from views expressed by our interviewees and in the literature alike, we also need to take a critical view of what the notion of security entails. The meaning of the term has changed throughout history. As Pavone and colleagues (2018: 640) argue, over the last two decades alone, "the concept of security [...] has shifted from territorial integrity and national sovereignty to human security and, after 9/11, to a new concept of homeland security. New security policies have particularly encouraged pre-emptive security measures, enacted through the development of data-intensive security technologies and public-private security collaboration. These measures have been introduced within policy frameworks which justify the restriction of individual privacy and freedom - a matter of political concern." It has also been argued that newer understandings of security reframe social problems as problems of security; most recently also demographic and social change including migration. Last but not least, in the 21st century, the means by which public authorities and private bodies seek to enhance security has started to rely more heavily on digital surveillance methods where data from privately owned companies with little or no accountability to the public play a key role (see also (Zuboff 2019)).

	Regardless of its specific definition, security is such an important public good that it is also an entitlement of persons enshrined in several human rights declarations and frameworks, including the UN Declaration of Human Rights (1948).[34] In Europe, the European Convention on Human Rights (ECHR), under Article 5.1, provides, under the label of "Rights to liberty and security", that "[e]verybody has the right to liberty and security of the person", and that nobody may be deprived of this liberty except in a clearly delineated range of cases where freedom can be restricted "in accordance with a procedure prescribed by law" for the sake of law enforcement and the prevention of spreading infectious diseases.[35] Also Art 6. of the Charter of Fundamental Rights of the European Union provides that "[e]veryone has the right to liberty and security of the person",[36] which is to be interpreted along the lines of Art 5.1 of the European Convention of Human Rights. It is clear that the right of security of the person is very closely associated with liberty and the freedom of bodily movement as well as physical integrity vis-a-vis state institutions. By some authors it is seen as an expansion of rights based on the prohibition of torture and cruel and unusual punishment. In other words, the *substance of the right to security aims to protect people from undue interference by state agencies and public authorities*. But can the right to security be understood to include the right to be protected from violations of one's body (and property?) by others? The answer to this question is yes. The European Court of Human Rights Guidance on Article 8 clearly states that states have a positive obligation to secure compliance with Article 8 also by private actors and individuals, and that "where fundamental values and essential aspects of private life are at stake, [this] requires efficient criminal-law provisions"(p.9).[37] This means that effective criminal law and its enforcement are, as such, to be seen as included in the right to security. A concept that is relevant in this respect is the state's monopoly on violence. If we accept that one of the central functions of states is to protect the physical integrity, freedom, and property of its citizens, then the state must prevent vigilante justice, and hold a monopoly on the legitimate use of physical force. However, in this conception, the state holds the monopoly on violence as a

[34] http://www.un.org/en/universal-declaration-human-rights/
[35] https://www.echr.coe.int/Documents/Guide_Art_5_ENG.pdf
[36] https://fra.europa.eu/en/charterpedia/article/6-right-liberty-and-security
[37] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf

representative of the sovereign, the people. This means that the exercise of the monopoly on violence must be democratically legitimised and publicly accountable. European states have legal principles, norms and processes in place to ensure that this is so. Part of these legal principles and norms are the protections of other human rights and public goods that can conflict, in concrete situations, with the rights and public goods that FDP - as part of the tool box of criminal justice - seeks to protect and foster. A typical conflict that arises is the one between security and the integrity and health of persons (on the side of the victim and wider public) on the one hand, and the privacy of people who may be implicated in criminal investigations or even become the target of racial discrimination on the other. All of these are public goods. This conflict is particularly pertinent to the use of FDP, due to the focus of FDP on traits (pigmentation, biogeographical ancestry) that are implicated in some of the worst forms of discrimination in European societies. We have discussed this in more detail in section 3.1.

2. **How will the research output meet these needs? How will this be demonstrated? How will the level of societal acceptance be assessed?**

We need to distinguish between two different outputs here: (a) the results of research on FDP, (b) the effects of FDP as a technology if rolled out into casework.

Regarding (a) - the results of research on FDP, new research on new FDP markers for pigmentation, biogeographical ancestry, and age are carried out in academic and other research institutions that regularly publish findings (Kayser 2015). Commercial research is also routinely carried out, most of which is not published. This lack of transparency about the state of the art of research, which characterises many fields of forensic technologies, has led to calls from scientists and researchers from several disciplines for a stronger research culture in forensic science (Mnookin et al. 2011). If FDP is to protect and foster public goods and rights then it is of great importance that research on *all* aspects of FDP, including social and ethical aspects, is submitted to expert scrutiny via publication.

Regarding (b) - the effects of FDP as a technology if rolled out, it will be of key

	importance for FDP to track its effects, both positively and negatively. For example, as noted, while criminal justice, as a whole, protects and fosters some public goods (e.g. security), it can also conflict with other public goods (e.g. privacy). Moreover, the contribution of specific forensic technologies to protecting public goods and rights are often unknown. It is thus important to note that the aforementioned call for a stronger research culture in forensic science needs to be applied to the monitoring of technology in use as well, not only of technology in development. 3. **Does addressing the documented societal needs through FDP (assuming that it can effectively do this) require any trade-offs with other documented societal needs? How is this trade-off decided? Is this trade-off still valid if the research is less effective than anticipated?** Having noted our reservation towards framing the protection of different public goods in terms of "trade-offs", we emphasise that addressing the societal need for security via FDP does require balancing with other documented societal needs, such as the privacy and liberty of people who, as a result of FDP, become the suspect of suspicion or who become otherwise involved in an investigation. If FDP was employed in a racist or otherwise unduly discriminatory manner then it would also conflict with the right to non-discrimination (see section 3.1). 4. **What threats to society does FDP address? (e.g., crime, terrorism, pandemic, natural and man-made disasters).** FDP addresses crime, and potentially also terrorism. We are not aware of any visions or plans to use FDP to investigate or prevent terrorism, but this would be conceivable in theory. BGA has, however, been used retrospectively following the 2004 Madrid Terror attacks (Phillips et al. 2009). 5. **How is FDP appropriate to address these threats?** *FDP can be considered to be appropriate to address these threats if it is possible to prove a causal connection between the use of FDP and more effective criminal investigations, e.g. by increasing detection rates and/or*

	reducing the number of innocent people who are being drawn into investigations and/or making criminal investigations more cost-effective, while at the same time not infringing any rights of individuals. As noted, whether such a causal connection exists needs to be established by systematically evaluating the effects of FDP wherever in use. **6. What other measures could be adopted to address these threats?** There are a number of established technologies that help to address crime (and potentially also terrorism). This does not mean, however, that they are effective, as the effectiveness of many technologies has not been systematically and robustly assessed. The use of DNA technologies, and forensic evidence more broadly, has doubtlessly helped to address the threat of crime (Roman et al. 2008; Peterson et al. 2013) (also see (Amankwaa and McCartney 2019)). The key argument in this context - and one that has been made by many critics of FDP - is that, given (a) the risks of FDP of infringing privacy rights and supporting discrimination along racial, ethnic and/or religious lines, (b) that the effectiveness of FDP in addressing the risk of crime is not certain, and (c) that there are other ways of addressing the threat of crime, FDP should not go ahead. This argument could also be made on the basis of the responsibility to use public funds prudently. Following this line of reasoning it could be argued that it would be more prudent to invest in measures and technologies that are known to be effective in solving or reducing crime, and that pose fewer societal risks, than investing into measures that bear a high risk to lead to unintended consequences. Supporters of FDP hold that FDP is uniquely placed to provide leads in cases where no other leads are available, and that the use of FDP in high-profile cases, and paired with suitable safety and accountability measures, is ethically mandated to honour our commitment to try to solve crimes.

Ensuring security research does not have negative impacts on society	**1. Does FDP have a negative impact on the respect for human dignity?** Understood as a person's sense of self and self-worth, dignity is inherent in all humans. Respect for human dignity is a foundational commitment of societies all over the world and enshrined in a number of Human Rights conventions and laws. A range of values and characteristics of our societies express respect for human dignity, such as equality, freedom, justice, and peace, are absent. Human dignity is disrespected when people are prevented from leading free, autonomous, and fulfilled lives. FDP can have a negative effect on human dignity when the technology is used in unduly discriminatory ways (i.e. on the basis of racist or religious stereotypes), or when it unduly restricts people's freedom. The former is a well known risk in connection with FDP that we discuss in detail in section 3.1. Our VISAGE year 3 Deliverable will also include a range of recommendations regarding how to reduce the risk that FDP can be used in such a way if used in case work. In particular, FDP can result in undue restrictions of people's freedoms when people are included in an investigation on the basis of FDP without a justifiable reason. But a lot hinges on what would be considered a justifiable reason; the involvement of people in investigations that are known to be innocent (e.g. as witnesses or family members of suspects), or later turn out to be innocent (as suspects, or as part of intelligence-led mass screening), is not unjustifiable *as such*; is a feature of criminal investigation that cannot be abolished entirely. However, in order to avoid creating a negative impact for the respect for human dignity, FDP should be used in such a way that it reduces, rather than increases, the number and ranges of people who are unduly involved in an investigation. What effect FDP has in this respect would need to be assessed by monitoring FDP in practice wherever it is used. **2. … on the right to life?** The right to life, which is enshrined in international human rights conventions and national laws (e.g. Art. 3 of the UN Declaration of Human Rights),[38] means that nobody should be arbitrarily deprived of her or his life. FDP does not seem to have any impact on the right to life that is specific to it and that is not a characteristic of the criminal justice system as a whole.

[38] https://www.ohchr.org/EN/UDHR/Documents/UDHR_Translations/eng.pdf

3. … on equality before the law?

FDP would have an impact on equality before the law if the technology was used in a racist or otherwise discriminatory manner. We discuss this in detail in section 3.1.

4. … on freedom of thought?

On the basis of the data available to us FDP would not have a negative impact on freedom of thought.

5. … on freedom of opinion and information?

On the basis of the data available to us FDP would not have a negative impact on freedom of opinion and information.

6. … on privacy?

FDP could have undue negative effects on privacy.

Privacy is enshrined in many human rights declarations and treaties. Most pertinent for the VISAGE context is Art. 8 of the European Convention on Human Rights (ECHR). In the interpretation of the European Court of Human Rights, the concept of private life includes aspects of personal identity, such as a person's name, image, or physical or moral identity. As the Court's Guidance on Art. 8 states, "the guarantee afforded by Article 8 of the Convention is primarily intended to ensure the development, without outside interference, of the personality of each individual in his [sic] relations with other human beings." (Guidance II. C, p. 29).[39]

Art. 8 ECHR provides that:

> (1) Everyone has the right to respect for his [sic] private and family life, his home and his correspondence.
>
> (2) There shall be no interference by a public authority with the exercise of

[39] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf

	this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health and morals, or for the protection of the rights and freedom of others (p.7).[40] The European Court of Human Rights issued guidance as to how this right to respect for private and family life should be interpreted. The following aspects are particularly relevant in considering any undue negative impacts of FDP on privacy, and in helping to reduce the risk of such negative impact: ● Possible interference with the right to privacy must be *foreseeable* for citizens. Specifically, "domestic law must be sufficiently foreseeable in its terms to give individuals an adequate indication as to the circumstances in which, and the conditions on which, the authorities are entitled to resort to measures affecting their rights under the Convention" (Guidance I.C.12, p. 10).[41] If FDP is used in actual casework, it could interfere with people's privacy by including people in the investigation (as suspects, witnesses, or family members or friends of suspects) who would otherwise not have been included. This, as such, is not necessarily disproportional or otherwise undue (which would be assessed analogous to the assessment of proportionality in connection with other forensic techniques or technologies that leads to the inclusion of people into investigations). *But the requirement of foreseeability of such possible interference in domestic law means that members of the public need to have good access to information about FDP, and how it is used (if used in casework).* In short, to minimise the risk that FDP unduly interferes with the right to privacy, public authorities need to be transparent about its use in casework. In our view it would be possible to interpret the requirement for transparency in domestic law as such that in countries where FDP is used in casework, there is a duty for legislators to explicitly regulate its use. ● The right to privacy needs to be read in close connection with the right to freedom from discrimination as expressed in Art. 14 of the ECHR (see section 3.1). This is to be understood as a right to freedom from *undue*

[40] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf
[41] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf

	discrimination, that is, discrimination on the basis of characteristics whose use cannot be duly justified in a given situation. To use an example from a different field for the sake of illustration, treating males and females differently in access to breast cancer screening is not considered undue discrimination as there is ample evidence that women are at much higher risk of getting breast cancer than men are. But not all cases are so straightforward. The European Court of Human Rights has problematised classification of some people into a group when this "prohibits the individualised evaluation of their capacity and needs" (Carvalho Pinto de Sousa Morales v. Portugal; See Guidance F.1.e. 38, p. 14).[42] ● In the jurisdiction of the European Court of Human Rights, privacy rights extend to individuals being able to control the use of their image. On various occasions the Court ruled that the release of a person's photograph by police authorities to the media without their consent constitutes a breach of privacy (Guidance II.C.a, p. 30).[43] If FDP was ever used to create visual images to approximate the true appearance of suspects, then the use of such visual images by the police, or - *a fortiori* - the publication of such images could be seen as potential infringements of privacy. This means they would require an assessment of proportionality. Such use of FDP is not currently done or envisaged within the VISAGE project, but services claiming to do so are offered by commercial companies. ● The storing of information on a person's private life by public authorities can, under some circumstances, represent an infringement of privacy rights. To judge whether this is the case in a given instance, the European Court of Human Rights looks at the specific context in which the information has been recorded and retained, as well as the nature of records and the way that they are used, and the types of results obtained. The Court has also held that states have a margin of appreciation. The crucial question in connection with FDP in this respect is whether the collection, use, and the possible retention of FDP data (both the raw data and the narrative interpretation of the data) of an unknown suspect is considered personal data, and if so, whether the

[42] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf
[43] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf

nature of this information renders its collection, use, and storage more sensitive than the use of other DNA-based or other information that is obtained from crime scenes. This question cannot be answered in this Report as it will need to be clarified in national and/or European legislation, or through jurisdiction.

7. … on protection of the family?

The right to protection of the family is enshrined, for example, in Art 12 of the Universal Declaration of Human Rights: "No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks."[44] Besides issues regarding privacy, which we discuss above (see section 3.3), the right to protection of privacy and a family could be impacted negatively by FDP wherever innocent people are drawn into criminal investigations. Such inclusions of innocent people into criminal investigations are a routine occurrence in the criminal justice system that cannot be abolished entirely. However, if FDP were to increase the number or scope of innocent people who are included in investigations, then this may have a negative impact not only on privacy but also on people's family lives.

8. … on freedom of movement?

On the basis of the data available to us FDP would not have a negative impact on freedom of movement. (Even if the use of FDP did lead to a conviction resulting in imprisonment, which may deprive the prisoner of freedom of movement, this would not be considered disproportional. It would be justified by the grounds for the prison sentence that legal systems deem important enough to justify the restriction of other rights.)

9. … on rights of ownership?

On the basis of the data available to us FDP would not have a negative impact on rights of ownership.

10. … on freedom of assembly?

[44] http://www.un.org/en/universal-declaration-human-rights/

	On the basis of the data available to us FDP would not have a negative impact on freedom of assembly. **11. … on freedom to choose an occupation?** On the basis of the data available to us FDP would not have a negative impact on freedom to choose an occupation. **12.** … **on working conditions?** On the basis of the data available to us FDP would not have a negative impact on working conditions. **13. … on collective social rights?** In the EU context, collective social rights refer primarily to the right of collective bargaining enshrined in Art. 28 of the European Charter of Human Rights.[45] On the basis of the data available to us FDP would not have a negative impact on collective social rights. **14. … on social welfare?** In the EU context, the European Pillar of Social Rights,[46] which contains rules and values that are not legally binding but are considered a joint responsibility of all EU institutions, member countries, social partners and other stakeholders, is particularly relevant in this context. These actors committed themselves to implementing the pillars where needed and insofar as they do not conflict with national law. A dedicated monitoring process oversees the implementation. The European Pillar of Social Rights includes three categories of rights: a) equal opportunities and access to the labour market; b) fair working conditions, and c) social protection and inclusion. FDP could have a negative impact on (c) if the use of FDP in case work led to the stigmatisation of specific groups of the population, and specifically minorities.

[45] https://fra.europa.eu/en/charterpedia/article/28-right-collective-bargaining-and-action
[46] https://ec.europa.eu/commission/priorities/deeper-and-fairer-economic-and-monetary-union/european-pillar-social-rights_en

15. … on rights to an education?

On the basis of the data available to us, FDP would not have a negative impact on rights to an education.

16. … on the principle of democracy?

There is no universally accepted definition of democracy. But most definitions contain three main elements: they see democracy as an enabler for liberty, equality before the law and the protection of minorities, and an enabler for civil, social and personal life. Inherent in all understandings of democracy is thus the restriction (by law) and control of authority.

In connection with FDP, the most pertinent aspects of the principle of democracy seem to be the effective protection of minorities, and the control of state power. FDP would be seen as a threat to the principle of democracy if the technology led to discrimination on racist grounds, or if it removed important restrictions of state power.

17. … on rights of access to information?

In the EU context, personal data - understood as any information that is related to an identified or identifiable person - are protected by a general prohibition to process personal data, except (a) when the law authorises such processing, or (b) when persons have agreed to such processing. The latest instantiation of this principle in the EU is the General Data Protection Regulation (GDPR) which became enforceable in May 2018. Under its remit, genetic information and other information about identified or identifiable persons are considered personal information and thus protected (this includes information that is stored without being linked to a specific person by name but that is linkable through a pseudonym or a code). Genetic data is considered particularly sensitive and in need of specific protection.

Having said this, two things need to be kept in mind regarding FDP specifically. First, it is not clear whether FDP information obtained from an unknown crime scene sample falls under the remit of personal information. It is arguable that it is not, because it is not at that time relatable to an identified or identifiable person. If this is the case then the general prohibition of processing these data is

	not applicable. Even if FDP information were treated as personal information, and thus information to which the protections of European data protection law apply, many of these do not apply when these data are processed by so-called "competent authorities" for law enforcement purposes (Samuel and Prainsack 2018b). "Competent authorities" comprise (a) public authorities competent for the law-enforcement purposes set out in Article 1.1 of the Police Directive, and (b) "any other body or entity entrusted by national law to exercise public authority and public powers" for the law enforcement purposes set out in Art 1.1 (e.g. a privately owned company running a prison).[47] When such authorities process personal data, the GDPR does not apply, but the "Directive 2016/680 on the protection of natural persons with regard to the processing of personal data by competent authorities for the purpose of law enforcement" (hereinafter Police Directive) applies.[48] It replaced the data protection rules based on the Framework Decision 2008/977/JHA for the police and criminal justice sector, with the aim of removing barriers to information exchange for law enforcement purposes between member countries by harmonising and simplifying rules. Important differences between the GDPR and the Police Directive lie in the grounds for lawful processing and in the powers of processing authorities. The grounds for lawful processing in the Police Directive are much more narrow than in the GDPR (see in particular Art. 8.2, and Art 10 Police Directive): "Competent authorities" processing for the purpose of law enforcement do have more leeway in how they use data than data controllers or processors within the GDPR. Correspondingly, the information rights of data subjects within the Police Directive are more limited than the information rights of data subjects under the GDPR regime. This means that FDP would be a domain where data subjects have limited access to information about the processing of their own data, compared to other instances of data processing. However, this is the case not because of the specific nature of FDP information or FDP data processing but because the data are processed by "competent authorities" for law enforcement purposes. For any data processed by such bodies for law enforcement purposes, subjects' rights to notification, consent, erasure, etc. are limited. This can be considered proportional if one accepts that the limitations of rights within the Police Directive

[47] Also see https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.119.01.0089.01.ENG
[48] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.119.01.0089.01.ENG

as such is proportional.

18. … on rights of access to the courts?

On the basis of the data available to us FDP would not have a negative impact on access to the courts.

19. … on access to public space?

On the basis of the data available to us FDP would not have a negative impact on access to public space.

20. If implemented, how could FDP have a negative impact on this aspect (culture and community, way of life, etc.)?

If FDP were used in a way that discriminates against certain groups in the population - such as ethnic or religious minorities - then this would clearly have a negative impact on culture and community. Moreover, if FDP were used in such a way that ethnic or religious categories were used to set certain people apart from others in a public-facing manner (e.g. if people with genetic ancestry from certain world regions) then this could have the effect of introducing new, or reinforcing existing, divisions in our society which in turn would have a negative effect on culture and community - especially if these groups were associated with a higher prevalence of crime.

21. How could FDP impact disproportionately upon specific groups or unduly discriminate against them? How could the research increase discrimination? Could the research have impacts upon vulnerable groups (including, but not limited to: women, the elderly, disabled people, children and young adults, homeless people, economically disadvantaged people and people in precarious situations, immigrants or non-citizens, and lesbian, gay, bisexual, transgender or queer (LGBTQ+) identifying people.

In Europe, the right to non/discrimination is seen as a foundational right "because it influences the enjoyment of all other human rights. The aim of non-discrimination law is to allow all individuals an equal and fair prospect to access opportunities available in a society" (European Union Agency for Fundamental

	Rights 2018: 11). The most important sources of non-discrimination law in Europe are the relevant treaties of the Council of Europe (CoE) on the one hand, and pertinent EU law on the other. As noted above, the most important legal source for non-discrimination legal practice in the CoE context is Art. 14 of the European Charter of Human Rights (ECHR). This is to be understood as a right to freedom from undue discrimination, that is, discrimination on the basis of characteristics whose use cannot be duly justified in a given situation. We noted that the European Court of Human Rights problematised classification of some people into a group in some cases, namely when "it prohibits the individualised evaluation of their capacity and needs" (Carvalho Pinto de Sousa Morales v. Portugal; See Guidance F.1.e. 38, p. 14).[49] Protocol 12 (2000)[50] to the ECHR, which has not been ratified by all EU member states, expands the remit of non-discrimination protections to equal treatment in the enjoyment of any right, including rights under national law. Also important to mention in this context is the CoE's (revised) European Social Charter, whose Article E contains an explicit prohibition of discrimination. Its wording resembles Art 14 of the ECHR.[51] The inclusion of Article E in the Social Charter reflects the importance of non-discrimination as a foundational right in the European context (see (European Union Agency for Fundamental Rights 2018: 19). Within EU law, the Amsterdam Treaty (in effect since 1999) gave the EU much wider competences. As a result, EU institutions issued new directives targeting discrimination. Art. 2 of the Treaty of the European Union (TEU)[52] highlights non-discrimination as one of the fundamental values of the EU. Art 10 of the Treaty on the Functioning of the European Union (TFEU) provides that "[i]n defining and implementing its policies and activities, the Union shall aim to

[49] https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf

[50] https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168 0080622

[51] https://rm.coe.int/the-european-social-charter-treaty-text/1680799c4b

[52] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12012M002

	combat discrimination based on sex, racial or ethnic origin, religion or belief, disability, age or sexual orientation".[53] Furthermore, Art. 21 of the European Charter of Fundamental Rights (2000) prohibits discrimination "on any ground such as sex, race, colour, 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".[54] The Charter, previously a non-binding declaration, became a legally binding document with the coming into force of the Lisbon Treaty in 2009.[55] This means that EU institutions are legally obliged to observe the provisions in the Charter, and member states must observe it when acting within the scope of EU law. With specific relevance for the remit of FDP, is also the so-called Race Equality Directive (Council Directive 2000/43/EC of 29 June 2000 implementing the principle of equal treatment between persons irrespective of racial or ethnic origin).[56] Although it was issued as a Directive in labour law, its principles - and the jurisdiction following it - are relevant beyond the remit of labour law as they illustrate the understanding of undue discrimination on grounds of racial or ethnic origin on the side of European Institutions. The Directive does not in itself include a definition of "racial or ethnic origin". It does not list language, colour or descent as protected grounds as such - but these could be protected as part of race and ethnicity "*in so far as language, colour and descent are inherently attached to race and ethnicity*" (European Union Agency for Fundamental Rights 2018: 197). In addition, the European Court of Human Rights has held that language, religion, nationality and culture may be inseparable from race. Regarding discrimination based on race or ethnicity, the Court stated that "no difference in treatment which is based exclusively or to a decisive extent on a person's ethnic origin is capable of being objectively justified in a contemporary democratic society built on the principles of pluralism and respect for different cultures" (European Court of Human Rights 2005). In other words, the Court holds that no instance of discrimination based "exclusively or to a decisive extent" on a

[53] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12012E%2FTXT
[54] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:12012P/TXT
[55] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12012M002
[56] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32000L0043

	person's ethnic or racial origin could ever be justified, meaning that all such instances represent undue instances of discrimination. This could also be argued to apply to FDP if biogeographical ancestry becomes a decisive criterion in the search for suspects, or if skin colour takes on a decisive role. In the context of racial discrimination, for the sake of analytical clarity it is important to distinguish between structural racism on the one hand, and racial prejudice on the other. In order to do so, we resort to sources outside of the EU or other European law. Harrell (2000) defined structural racism as "a system of dominance, power, and privilege [...] where members of the dominant group crate or accept their societal privilege by maintaining structures, ideology, values, and behavior that have the intent or effect of leaving non-dominant group members relatively excluded from power, esteem, status, and/or equal access to societal resources" (Harrell 2000: 43). Such structural racism does not require intent; it is embodied by, and inscribed in, our societal and political institutions and shared practices. For this reason it is also often called "cultural racism", because it is part of a society's dominant shared culture. Thus, t*o say that FDP bears the risk of being used in a racially discriminatory manner does not imply that it is used with the intent of being racist, or that the person or institution doing so has a conscious dislike of certain groups of people. Instead, it is the context within which a discriminatory act takes place that makes it racist (or not).*
Ensuring security research benefits society	**1. What segment(s) of society will benefit from increased security as a result of the proposed research?** If FPD turns out to be an adequate tool to increase security in our societies (which remains to be proven, see above), then all segments of society will benefit from it. **2. How will they benefit?** If FDP turns out to be an adequate tool to increase security, societies - and particularly those members of society whose friends and family were affected from serious crimes that may previously not have been solved - will benefit from criminal investigations of these crimes' progress which may even be solved. They may also benefit from cases being solved faster, and/or investigations being more efficient. It would also be an obvious benefit for society as a whole if perpetrators who may commit additional crimes could be apprehended.

3. **Are additional measures required to achieve this benefit?**

Societal security and human rights protections are not goods to be offset against each other. Nevertheless, in this instance it could be argued that the benefit of increased societal security can only manifest itself if no individuals or groups are infringed in their rights as a result, and no individuals or groups are stigmatised. In this sense, additional measures to achieve the benefit of increased societal security would include the implementation of adequate safeguards to avoid that rights and interests are disrespected.

4. **Are additional measures possible to extend these benefits to other segments of society?**

If FDP proved to be beneficial for enhancing security, and if it was used in a responsible and accountable manner in clearly specified cases, with adequate protections in place, then it could be argued that legal changes should be made in those countries that do not currently allow FDP that would allow the technology to be used (under the same circumstances and safeguards as described above).

5. **In what contexts might this benefit be lacking or not be delivered by the research on FDP?**

Ongoing genetic and statistical research on FDP seeks to increase the scientific validity and reproducibility of FDP testing, which is in line with the objective of strengthening the research culture. We also noted that it would be of key importance to monitor and evaluate the use of FDP in casework in countries and context where it is used, to assess the benefit and potential harms incurred by FDP. If such systematic monitoring and assessing of FDP in use is not carried out, a judgment of benefit or harm of FDP would not be possible.

6. **How will society as a whole benefit from the proposed research?**

If FDP turned out to effectively enhance societal security without causing undue harms, then society as a whole would benefit. It follows from this that society would also benefit from the development and deployment of FDP to be embedded in systematic research and evaluation. For more details, see previous answers in this section.

7. **Are there other European societal values that are enhanced by the proposed research, e.g. public accountability and transparency; strengthened community engagement, human dignity; good**

	governance; social and territorial cohesion; sustainable development. If the development and deployment of FDP is embedded in sound research whose findings are made public, then this could help to improve accountability and transparency, as well as good governance. Moreover, effective criminal justice can also serve human dignity. All these benefits, however, would be dependent on the deployment of FDP not creating unintended negative side effects, especially in terms of ethnic and racial discrimination.

4.1 Societal Impact assessment

Drawing upon insights from our interviews with professional and civil society stakeholders, insights from the published (including the grey) literature, and on an analysis of relevant legal and policy documents pertaining to a wide range of societal goods, rights, and entitlements, a Societal Impact Assessment was carried out to systematically examine the actual and potential benefits and risks of FDP on society. Particular consideration was paid to privacy- and other data protection-related aspects, which will be fed into a privacy-by-design strategy for the development of the VISAGE FDP prototype. On the basis of the triangulation of insights from all of these analyses we will summarise key findings in the following sections, and in the subsequent Chapter 5.

4.1.1. Way of life, fears and aspirations

How people live and interact with each other on a daily basis, their perceptions about their safety and that of their communities, and their aspirations for future, including the future of their children.

FDP is related most strongly to one fear and aspiration respectively: The fear that in societies with growing right-wing movements and more blatant racism in public discourse, technology use in the context of criminal justice could reinforce racist, ethnic and religious bias and discrimination. That this is not a far-fetched scenario and has been shown in the way in which

FDP has been linked to anti-immigration political agendas in public discourse in Germany. It is of utmost importance to avoid that FDP as a technology and practice lends itself to such racist and discriminatory practice.

In terms of hopes, the biggest hope in this context is that FDP will lead to more effective criminal justice in the sense that it can (a) help to detect perpetrators in cases where no clues or other methods for the detection of perpetrators are available; and (b) help to exclude (potential) suspects from investigations, thereby reducing burdens on innocent people and on public funds.

If it was possible to realise the benefits without causing undue harms to individuals or groups, then this would be a desirable step forward. Because the risk to individuals and groups being significant some commentators argue that the technology should only be deployed in actual case work if it has been proven that no undue harms will occur. Others argue that in a narrow range of cases where no other clues or technologies are available, not using FDP in case work would in itself represent significant harm.

4.1.2. Culture and community

People's shared beliefs, customs, values and languages, the cohesion, stability and character of their communities.

FDP could have a positive impact on society if, as noted above, it led to more effective criminal justice without leading to any undue harm to individuals and groups. If proven to do so it would help to strengthen trust in the criminal justice system and could have a positive effect on community life and shared values. If, on the other hand, FDP were used in a way that emphasised dividing lines in society, especially dividing lines around ethnic or religious or 'cultural' lines, then this is likely to have a destructive effect on social cohesion. It is also likely to have a disruptive effect on communities and groups that are stigmatised as a crime-prone population. It should be noted that the effect of strengthening divisions and contributing to a stronger fragmentation of society is something that can happen without any intentional or nefarious behaviour on the side of any actors; instead, in societies where there is already a political climate of playing out societal groups against each other, and/or mobilising against migrants, any technology that has any bearing on visible traits or biogeographical ancestry may have this effect.

4.1.3. Political systems

Participation in the decisions and processes that affect people's lives, the nature and functioning of democratic processes, and the resources available to support people's involvement in these.

FDP is relevant to the political system (and in particular also to participation) in connection with transparency and accountability, and with the protection of minority rights. We noted above that FDP could be used in ways that discriminate against, or stigmatise, members of minority populations if no adequate safeguards are in place. To ensure that adequate safeguards can be put in place, and to ensure that the effect of FDP in case work is open to scrutiny, transparency about the use of the technology is paramount (e.g. in the form of the publication of aggregate numbers and analyses). It is also important to provide the public, in an accessible way, information about how FDP works.

As noted above, if robust research shows that the effect of FDP in case work is beneficial - in the sense that it increases detection rates, reduces cost and/or investigation time, saves public resources, and does not lead to undue harms for people or groups, then FDP could also have a positive impact on political systems by increasing trust in, and the trustworthiness of, criminal justice systems.

4.1.4. Environment

Access to and quality of air, water, and other natural resources, the level of exposure to pollutants and harmful substances, adequacy of sanitation.

On the basis of the data available to us FDP is not immediately relevant to environmental concerns.

4.1.5. Health & well-being

Physical and mental wellbeing, not just an absence of infirmity.

Based on the data available to us, FDP is not immediately relevant to health and wellbeing, apart from the health-related aspects of stigma and discrimination that could result from FDP. Studies empirically exploring the health-related impacts of discrimination and stigma show these factors to be associated with adverse psychological and physical health outcomes (Paradies et al. 2015; Schmitt et al. 2014b; Pascoe and Smart Richman 2009; Pieterse et al. 2012). Hatzenbuehler and colleagues (2014), for example, have shown that sexual minority groups living in highly prejudiced areas have a higher hazard of mortality than those living in low-prejudice communities (Hatzenbuehler et al. 2014). Pascoe and Richman (2009) explain that such negative health outcomes relate to the production of significantly heightened stress responses as well as being related to participation in unhealthy, and nonparticipation in healthy, behaviors (Pascoe and Smart Richman 2009). In fact, Hatzenbuehler and colleagues (2013) argue that in this way stress caused by stigma has a substantial effect on population health to such a degree it warrants being considered as a social determinant of health, alongside other factors such as socioeconomic status (Hatzenbuehler et al. 2013). Pascoe and Richman (2009) note that social support, active coping styles, and group identification most likely serve a protective function in these pathways (Pascoe and Smart Richman 2009).

4.1.6. Personal and property rights

Economic effects, civil rights and liberties, personal disadvantage.

As noted above, FDP is relevant to personal liberty and freedom, and the right to non-discrimination. If used appropriately, FDP could help to enhance societal security, civil rights and liberty (as the right to be protected from harms by third parties is seen as inherent in the right to security and freedom, see above). If used in problematic ways, FDP has the potential to unduly discriminate against persons and groups, which would affect their civil rights and liberties and amount to personal disadvantage.

5. Conclusion: triangulation of findings

Supporters of FDP hold that this technology is uniquely placed to provide leads in cases where no other leads are available, and that as long as the use of FDP, which can be analogised to a "biological eyewitness", is paired with suitable safety and accountability measures, ethically we should honour our commitment to try to solve crimes and enhance security.

FDP could indeed have a positive impact on society if it turns out to be an adequate tool to increase security such that it leads to more effective criminal justice without leading to any undue harm to individuals and groups. Societies - and particularly those members of society whose friends and family were affected by serious crimes that may previously not have been solved - will benefit from criminal investigations of these crimes' progress which may even be solved. They may also benefit from cases being solved faster, and/or investigations being more efficient. It would also be a clear benefit for society as a whole if perpetrators who may commit additional crimes could be apprehended. Finally, the use of FDP could help to strengthen trust in the criminal justice system and could have a positive effect on community life and shared values.

In contrast, key arguments against FDP are that, given (a) the risks of FDP infringing privacy rights and supporting discrimination along racial, ethnic and/or religious lines, (b) that the effectiveness of FDP in addressing the risk of crime is not certain, and (c) that there are other ways of addressing the threat of crime, FDP should not go ahead. This argument could also be made on the basis of the responsibility to use public funds prudently. Following this line of reasoning it could be argued that it would be more prudent to invest in measures and technologies that are known to be effective in solving or reducing crime.

To ensure the implementation of FDP is achieved in an ethically and societally responsible manner, below we map out the issues and concerns which need addressing. We note that it is the explicit aim of this Report to map and analyse these issues, with a special focus on privacy- and other data protection-related aspects; our VISAGE year 3 Deliverable will provide Recommendations on the implementation of FDP based on the findings of this Report.

5.1 Privacy

Most scholars do not view FDP predictions for age, appearance and BGA as infringements of people's privacy or their Right not to Know. However, when used in actual casework, FDP could interfere with people's privacy by including people in the investigation (as suspects, witnesses, or family members or friends of suspects) who would otherwise not have been included. Such inclusions of innocent people into criminal investigations are a routine occurrence in the criminal justice system that cannot be abolished entirely. This, therefore, is not necessarily disproportional or otherwise undue. However, if FDP were to increase the number or scope of innocent people who are included in investigations, then this may have a negative impact not only on privacy but also on people's family lives. What effect FDP has in this respect would need to be assessed by monitoring FDP in practice wherever it is used. It should also be noted that, following a perspective of proportionality, where risks to privacy exist, these are more acceptable in connection with serious crimes than in the context of volume crime.

Furthermore, issues arise if an FDP finding can also provide information about a health condition, which - in contrast to appearance, age or biogeographical ancestry - is likely not to be known to the person if the disease has not (yet) caused specific symptoms. In cases where it is known that information about a trait also discloses (probabilistic) health-related information that is unlikely to be known to the affected person, scholars suggest refraining from making predictions about that trait. Others suggest an approach which asks an apprehended suspect if they would like information about any incidental health findings which might have emerged during DNA analyses in the investigative process.

If FDP is to be implemented, adequate safeguards must be in place to minimise any harms as laid out above. In short, to minimise the risk that FDP unduly interferes with the right to privacy, public authorities need to be transparent about its use in casework. This could be achieved such that in countries where FDP is used in casework, there is a duty for legislators to explicitly regulate its use. This would also address the potential for misuse of FDP, which can manifest in terms of excessive surveillance whereby security services or civil society use FDP in circumstances that may not be illegal but ethically or politically problematic. These issues will be explored further in our VISAGE year 3 Deliverable, which will provide detailed Recommendations on the implementation of FDP.

5.2 Data protection

It is not clear whether FDP information obtained from an unknown crime scene sample falls under the remit of personal information. It is arguable that it is not, because it is not at that time relatable to an identified or identifiable person. Even if FDP information were treated as personal information, because the data are processed by “competent authorities” for law enforcement purposes they are governed by Directive 2016/680 on the protection of natural persons with regard to the processing of personal data by competent authorities for the purpose of law enforcement (the Police Directive) which grants limited rights to subjects´ regarding notification, consent, erasure, etc.

Either way, an ethical imperative remains to safeguard any FDP data or findings against misuse or abuse. A some stand alone strategies have been suggested in the literature and by stakeholders to achieve this, including keeping the genetic findings from an FDP test within the laboratory and only providing the police with the narrative descriptions of the findings, and deleting narrative FDP information once a criminal case has been closed. However, a wide number of questions still remain regarding:

1. how findings can be accurately interpreted and checked by specialist police officers if they do not have access to the genetic data;
2. what systems are in place to ensure all data is deleted once a case is closed (there seems to be a near consensus for deleting the files) ;
3. how long FDP findings should be stored in the laboratory in instances where a case is not closed (and even if it is);
4. whether current measures of data protection are sufficient to protect the needs and interests of individuals and groups; and
5. whether current practices within laboratories are set up for deleting and encrypting FDP data.

5.3 Discrimination

If no adequate safeguards are in place, FDP could be used in ways that discriminate against, or stigmatise, persons and groups. This would affect people’s civil rights and liberties as well as their culture and community. One example of this is related to ethnic minority populations. For instance, if FDP were used in such a way that emphasised dividing lines in society, especially

around ethnic or religious or ‘cultural’ lines, such that certain people were set apart from others in a public-facing manner (e.g. people with genetic ancestry from certain world regions) then this is likely to have a destructive effect on social cohesion and could have the effect of introducing new, or reinforcing existing, divisions in our society - especially if these groups were associated with a higher prevalence of crime. Here, this does not imply that FDP will be used with the intent of being racist or discriminatory, or that the person or institution doing so has a conscious dislike of certain groups of people. Instead, these risks relate to the context of structural racism, which does not require intent but is rather embodied by, and inscribed in, our societal and political institutions and shared practices. This discrimination could happen at a number of levels.

- Because the FDP technology only has use to implicate or rule out minority populations.
- Bias inherent in the algorithms and data sets used in FDP may lead to discriminatory practices.
- Police misinterpretations of FDP findings could lead to racial profiling.
- The use of FDP may lead to reification of the belief of the biological basis of race and may lead the public to interpret that racial differences are a “hard” biological given, which might, in turn, deepen the social divide between different groups or individuals, and lead to discrimination.
- In the case of releasing FDP findings to the public (though most consider it best if FDP findings are not released to the public), it could upset community and social relations. (As a side note, whilst not the aim of VISAGE, the publication of any visual images constructed by the police on the basis of FDP findings could be seen as potential infringements of privacy, meaning they would require an assessment of proportionality.)

5.4 Over-interpretation of FDP findings

There are concerns that the over-interpretation of FDP findings (because of difficulties interpreting probabilistic findings, the presence of stereotypes in European societies that could influence this interpretation, and the trust people often place in DNA findings) could lead the police to follow false leads. And even though some remind us that FDP findings should never be used to follow leads without other corroborating evidence, if FDP is used as a last resort, there may be very little corroborating evidence available.

Education and communication approaches have been called for to address these issues, though these approaches are problematic for a number of reasons, including issues of capacity, and issues relating to ineffective strategies which cannot overcome deep-seated bias.

5.5 Summary

A typical conflict that arises when considering the implementation of FDP is between public security on the one hand, and the privacy of people who may be implicated in criminal investigations or even become the target of discrimination on the other. Rather than trying to weigh up one against the other, we fully support the view of scholars who argue that the relationship between security and privacy/discrimination, for example, is not a zero-sum game where one can be “traded” for a bit of the other; instead, we need to explore whether security technology actually address security needs. Robust research must show that the effect of FDP in case work is beneficial - in the sense that it increases detection rates (and does not lead to false leads), reduces cost and/or investigation time, saves public resources, and does not lead to undue harms for people or groups such as those related to discrimination or bias. Though it is difficult to evaluate this in practice, and questions such as how to evaluate; what to evaluate; and by whom all need answering. Given that the expectations and interests attached to FDP - whether that be from the market, the public, the media or the professional stakeholders themselves - likely play more of a role in shaping the development, application and implementation of FDP than a rigorous evaluation, there are many unresolved questions about how such an assessment can be performed in practice.

Glossary

Amsterdam Treaty: an update and clarification of the Maastricht Treaty, which created the EU.

Autosomal chromosome: any chromosome which is not a sex-linked (X or Y) chromosome (termed gonosome).

Charter of Fundamental Rights of the European Union: sets out the full range of civil, political, economic and social rights of citizens and residents of the European Union (EU) and enshrines them into EU law. It was introduced in 2000 to bring consistency and clarity to the rights established at different times and in different ways in individual EU Member States.

Council of Europe: an international organisation founded in 1949 whose stated aim is to uphold human rights, democracy and the rule of law in Europe

DNA: more formally known as deoxyribose nucleic acid, DNA is the self-replicating genetic material found in all living organisms. DNA is located on chromosomes in the cell nucleus, but a small amount can also be found in the mitochondria (mitochondrial *DNA* or mtDNA).

European Charter of Human Rights: enshrines political, social and economic rights for EU citizens and residents into EU law.

European Convention on Human Rights: an international convention issued in 1953 to protect human rights and political freedoms in Europe.

European Court of Human Rights: an international court established by the European Convention on Human Rights to hear appeals from individuals and States regarding alleged breaches of human rights provisions by all states that signed the Convention.

European Union (EU): an economic and political union between (currently) 28 *European* member countries that together cover much of the continent.

European Pillar of Social Rights: launched in 2015 by President of the European Commission, Jean-Claude Juncker, the Pillar of Social Rights is about delivering new and more effective rights for citizens. It builds upon 20 key principles, structured around three categories, including equal opportunities and access to the labour market, fair working conditions, and social protection and inclusion.

Equality of arms: a principle that requires that there be a fair balance between the opportunities afforded the parties involved in litigation.

Externally visible characteristics (EVCs): are a person's visible traits i.e., their external appearance.

Familial searching: law enforcement using a DNA profile from an unknown person (obtained from a crime scene trace) to search against a national forensic DNA database to gain genetic information which indicates any relatives within the database of the person they seek to identify (i.e., a partial match of genetic information).

General Data Protection Regulation (GDPR): is the European Union's data protection framework which is directly enforceable in all member countries.

Police Directive: The "Directive 2016/680 on the protection of natural persons with regard to the processing of personal data by competent authorities for the purpose of law enforcement". It is a *lex specialis* to the more general EU Data Protection Directive entered into force in May 2016, and replaced the data protection rules based on the Framework Decision 2008/977/JHA for the police and criminal justice sector, with the aim of removing barriers to information exchange for law enforcement purposes between member countries by harmonising and simplifying rules.

Race Equality Directive: is an Act of the European Union, concerning European labour law. It implements the principle of equal treatment between persons irrespective of racial or ethnic origin.

Short tandem repeat (STR): a short sequence of DNA, normally 3-5 base pairs in length and typically positioned in the non-coding region of the genome, that are tandemly repeated numerous times. Individuals will vary with regard to how many times each of their STR motifs are repeated. STRs used in forensics are located in non-coding regions of DNA.

Single nucleotide polymorphism (SNP): a DNA sequence variation occurring when a single nucleotide in the genome differs between members of a species or paired chromosomes in an individual. For FDP, SNP markers are typically, but not necessarily, within coding regions of DNA.

Treaty of the Functioning of the European Union (TFEU): one of two primary Treaties of the European Union, alongside the Treaty on European Union. Formerly known as the EC Treaty, the Treaty of Rome or the Treaty establishing the European Community, the TFEU forms the detailed basis of EU law, by setting out the scope of the EU's authority to legislate and the principles of law in those areas where EU law operates.

UN Declaration of Human Rights: proclaimed by the United Nations General Assembly in Paris in 1948 it sets out fundamental human rights to be universally protected.

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