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Governing Anticipatory Technology Practices. Forensic DNA Phenotyping and the Forensic Genetics Community in Europe

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Abstract

Forensic geneticists have attempted to make the case for continued investment in forensic genetics research, despite its seemingly consolidated evidentiary role in criminal justice, by shifting the focus to technologies that can provide intelligence. Forensic DNA phenotyping (FDP) is one such emerging set of techniques, promising to infer external appearance and ancestry of an unknown person. On this example, I consider the repertoire of anticipatory practices deployed by scientists, expanding the concept to not only focus on promissory but also include epistemic and operational aspects of anticipatory work in science. I explore these practices further as part of anticipatory self-governance efforts, attending to the European forensic genetics community and its construction of FDP as a reliable and legitimate technology field for use in delivering public goods around security and justice. In this context, I consider three types of ordering devices that translate anticipatory practices into anticipatory self-governance.

Keywords

Anticipatory practice, forensic DNA phenotyping, governance, ordering device

Introduction

The management of expectations about new and emerging sciences and technologies through promissory—potentially contested—narratives is an integral aspect of discursive and deliberative governance of research and technology development; it presents a significant avenue via which scientists and practitioners contribute to public and policy deliberations (e.g. Borup et al. 2006; Brown, Rappert, and Webster 2000; Gardner, Samuel, and Williams 2015; Hedgecoe and Martin 2003; Lucivero, Swierstra and Boenink 2011; Selin 2007). The governance discourse has been practically expanded by programmes such as Responsible Research and Innovation (RRI) (e.g. von Schomberg 2011, Owen, Macnaghten, and Stilgoe 2012) as a form of anticipatory governance (cf. Guston 2014). The RRI and other anticipatory governance programmes can be understood as promissory themselves, and they incorporate anticipatory practices such as foresight, public engagement, and knowledge access planning (e.g. Open Access publication strategies), among others. These are *interventionist* activities. Indeed, research on anticipatory practices of technology has been shaped by an understanding of purposeful "problematisation of the future" (Anderson 2010), exploring practices as interventionist programmes in the shape of technology assessment; transition management; modularisation of research and development; socio-technical experiments; the analysis of ethical, legal and social aspects of technology (McGrail 2012). These are all actions that aim to steer technology development by making a specific future present, and by producing logics of legitimation for certain practices (Anderson 2007, 2010). This paper proposes that—next to promissory negotiating of past, present and future, and of the opportunities, challenges and limitations of technology—anticipation in technology development practices is also part of epistemic and operational aspects of technologies, above and beyond expectations that the technology is capable of delivering on certain promises. The analysis in this paper explores anticipatory practices in the context of the concept of "adoption space" which describes

> …a spatial and temporal space…populated by human and non-human actors…where attitudes, practices, interactions and events, together with the technology's material features, shape technology perceptions in ways that are instrumental in decisions about its use. (Ulucanlar et al. 2013, 98)

The adoption space provides a frame for understanding anticipatory practices as contributive to the governance of emerging technologies. One such set of technologies, and the case study for this paper, is forensic DNA phenotyping (FDP). FDP analyses make statistical inferences about what a person may look like, or what biogeographic ancestry—belonging to which larger genetic population(s)—a person may have, on the basis of genetic analyses from traces of unknown donors. Forensic technologies contribute to ordering the past, present and future by constructing states of probable knowledge about a source (a person or a category of person) and an activity (a crime and its narrative) (cf. Innes and Clarke 2009). They offer the dual anticipatory nature of technology: in, both, narratives about technology and the technology itself. As such, they present an ideal case for the study of anticipatory practices. What renders FDP such an interesting case study within forensic science is the fact that although forensic genetics technologies, such as DNA profiling and databasing, tend to enjoy the accolade of representing the 'gold standard' of forensic science, and FDP developers can and do draw on this narrative to bolster technology development and adoption, anticipation about its usefulness and reliability remains a vital, even crucial element of the field and its technologies.

Academic and policy documents, communication with forensic geneticists, as well as technology deliberations in the wider public domain have provided data for the research presented in this paper. The interpretive analysis is informed by personal experiences in, and academic contributions to, a large pan-European forensic genetics network and project, including project meetings, conferences, ethics advisory group work, and presentations of work, in the period between late 2012 and early 2017. Insights have also been drawn from exchanges with forensic genetics stakeholders (academic and police scientific practitioners, social analysts, judiciary) about social and ethical as well as scientific aspects of their work, and about the policy and societal context of their work. Interview data were generated in one-to-one, semi-structured meetings with respondents in academic or practitioner laboratories, or in offices, in six European countries (Austria, Denmark, Germany, Spain, The Netherlands, UK), and were thematically analysed. One theme of the analysis engaged with anticipation in the development and application of new and emergent forensic genetics technologies, in particular of FDP.

Forensic DNA Phenotyping

Comparing human DNA profiles from crime scene traces with those of suspects or DNA database entries has been the mainstay of forensic genetics uses in investigations since the introduction of the National DNA Database in England and Wales in 1995 (Hindmarsh and Prainsack 2010; Johnson, Williams and Martin 2003). More recently, forensic geneticists have suggested that, as successful as DNA profiling has been in contributing to the conviction, exoneration or identification of suspects and victims, DNA profiling is still limited in situations when comparable profiles cannot be matched or simply do not exist (e.g. Kayser and Schneider 2009). They suggest that forensic DNA phenotyping—among a number of recent technological innovations—may provide additional information in an investigation by inferring the physical appearance of an unknown person from their DNA. The discovery of single nucleotide polymorphisms (SNPs) has considerably pushed the phenotypical analysis of DNA since its modest beginnings in the 1990s, utilising those parts of the genome that are associated with the development of certain visible traits. This research has primarily emerged in the context of clinical genetics, and was quickly adapted by academic forensic geneticists. SNPs challenge a common narrative of criminal justice actors about the limits of personal information gathered via forensic genetic technologies as these loci of minute single-base genetic mutations are the basis for gene expression, a factor phenotyping technologies exploit. Forensic geneticists increasingly argue that, from a scientific point of view, 'it is completely ridiculous to distinguish between coding [and] non-coding' areas on the genome (from a conversation with a senior clinical and forensic geneticist, 2014). Simultaneously, the argument that currently used regions on the genome are actually non-coding but work as FDP markers based on their association with protein-coding regions (Kayser 2015) may be seen as opening an avenue to addressing scientific foundations of current, more restrictive regulation. Both arguments aim at withdrawing the basis for this distinction, which is constitutive of restrictive legislation in some jurisdictions (Murphy 2013). In fact, forensic phenotyping technologies are currently not known to be in widespread use in criminal justice. They have, however, been applied in individual criminal investigations in the Netherlands (e.g. in the detection of the murder of Marianne Vaatstra, cf. M'charek 2008), in Spain (e.g. in the Madrid train bombings of 2004, cf. Phillips et al. 2009, and in the detection of the murder of Eva Blanco Puig in Spain in 2015), and there is some anecdotal data suggesting that in Germany and Austria investigations may already have produced such analyses (such as in the contamination case of the 'Phantom of Heilbronn'). While DNA is increasingly used in cross-border collaborations for state security and public safety such as the investigation of organised and cross-border crime, e.g. via the Prüm Treaty (Council of the European Union 2008; Prainsack and Toom 2013), and in disaster victim identification procedures (Williams and Wienroth 2014), the use and governance of forensic genetics technologies is rarely harmonised across jurisdictions. In Canada, Belgium and, as yet, Germany, for example, regulation expressively permits the use of forensic genetics analyses for identification purposes only. Existing regulation may in time be challenged by scientific discoveries and technological innovations, and likely to undergo further deliberation should policy-makers, law enforcement agencies or forensic practitioners lobby for the use of new and emerging forensic technologies, as is the case in Germany at point of writing (January 2018). In the Netherlands, on the other hand, the application of technologies using coding areas on the genome is precisely legislated (Koops, Prinsen and Schellekens 2006), based on the application rather than on the technical detail of FDP. In France, a recent appellation court decision, from 25 June 2014, has opened the door to the application of DNA phenotyping for crime scene traces (Cour de cassation [Chambre criminelle] 2014) but has not yet made its way into legislation. And the jurisdictions of England & Wales and many states in the USA have no explicit hard law on the use of coding or non-coding areas, enabling the use of related innovations and placing decision-making concerning technology use within the purview of local law enforcement and other forensic users. Diversity in technology governance can present hurdles in cross-jurisdiction or cross-border uses of forensic genetic technologies, at best in the form of uncertainty about managing information that may be permissible in one area and problematic in another, at worst when information used through transnational exchanges turns out to be invalid in court or conflicts with cultural norms leading to potential backlash against technology use or cross-border collaboration. Variations can render the adoption of transnational research outcomes difficult, and they are illustrative of the dual global and local identities of forensic technologies (Lynch and McNally 2009). Global identity draws from shared scientific aspects in the utilisation of DNA methodologies in the criminal justice system. The use of probability and likelihood ratio stand at the heart of epistemic claims to the scientific nature of forensic genetics, and they represent the mathematical reliability of DNA analyses. DNA phenotyping technologies, specifically, have been developed on the basis of human genetic diversity studies and require diverse reference population databases to make predictions, which are part of international scientific efforts. Local identities arise from differences in the use and governance of forensic genetic technologies, dependent on national legislation and regulation, on societal experience and expectations, on cultural norms and values, and on institutional and individual practices.

The duality of identity of a forensic technology is a concern which scientists developing technologies aim to address by prioritising the epistemic, that is the scientific dimension of technologies, over the local application. For example, a ‘purpose-led’ approach to regulation has been proposed (e.g. Kayser 2015) to replace the distinction between genetic information about a person (from coding loci) and the comparison of trace and suspect profiles (generally using non-coding loci). Forensic DNA phenotyping uptake by other criminal justice actors may well depend on the persuasiveness of the argument that a change in scientific understanding should be taken into account when considering the fundamental premises of existing regulation (such as privacy concerns and the strict division between criminal justice and biomedical domains), rather than changing regulatory understanding of privacy per se. More recently, news media have reported that commercial forensic stakeholders, such as North America-based companies Identitas and Parabon Nanolabs, offer services that imply the advanced interpretation of phenotypical information into ‘photo-fits’ of persons of interest is already practicable (as reported by, e.g., Cookson 2015; Pollack 2015; Woollaston 2015), services which seem to have been taken up by a small number of US-state law enforcement agencies, exploiting diversity in local governance.

An additional issue for phenotyping technologies and their adoption in criminal justice systems is the general lack of peer-reviewed case work studies—with the notable exception of the use of ancestry-informative markers (AIMs), a type of appearance marker, to predict whether the trace donors are more likely to belong to North-African or European genetic populations in the investigation after the Madrid bombings using (Phillips et al. 2009)—that provide evidence about their practicable usefulness and reliable and substantial contribution to investigations. Instead, invested researchers encourage forensic practitioners (e.g. from police forensic laboratories) and policy makers to accept a stake in the field's application, to articulate interest in its potential uses.

In this context, academic forensic geneticists engage with commissioners and users of forensic science, focusing on utility and added value of emerging technologies in order to emphasise anticipated benefits of FDP to criminal justice and other forensic uses. For the example of biogeographic ancestry, a recent representative review paper provides a comparative rationale for the added value of using this technology whilst also anticipating its utility for a range of investigative purposes and contexts:

> Inference of ancestry in forensic analysis gives possibilities to substitute eyewitness testimony as described above—when descriptions are uncertain, unavailable or may misdirect investigators. Yet in forensic analysis, ancestry inference offers many other applications, including: (i) aiding cold case reviews with additional data on linked profiles; (ii) achieving more complete identifications of missing persons or disaster victims; (iii) confirming donor's self-declared ancestry and therefore maintaining the accuracy of databases for STRs [Short Tandem Repeats], Y-markers and mitochondrial variation (mtDNA); (iv) refining familial search strategies highly dependent on STR allele frequency assumptions made prior to searching; (v) assessing atypical combinations of physical characteristics in individuals with admixed parentage, e.g., using IrisPlex; (vi) enhancing genetic studies where forensic sensitivity is necessary, e.g., testing medical archive material or archaeological DNA. (Phillips 2015b)

In this excerpt, the technologies' practical utility is negotiated in part in the prospective imagining of the reliability and informativity of their applications, and is representative of wider efforts to link the inherently anticipatory nature of the technology to its promissory value for investigative adoption (see, e.g., Kayser and Schneider 2009; Liu et al. 2009). Other scientists refer to 'predicting human appearance' as a form of 'biological witness' (Kayser 2015), or even a 'snapshot' of facial features (Parabon Nanolabs 2015), referencing established sources of visual information such as eyewitnessing and photo-fidelity—but also suggesting that DNA information can be more reliable than such accounts, especially in the context of more comprehensive genetic analyses. Many forensic geneticists increasingly emphasize the link between FDP and the development of next generation sequencing technology as a less material and time-consuming analysis approach in which a small DNA sample can simultaneously be submitted to a whole range of biomarkers from STRs, miniSTRs and SNPs on nuclear and mitochondrial DNA to RNA.

> [C]urrently, we are targeting our nuclear DNA typing approach to the question at hand. We use mitochondrial DNA if we don't have enough nuclear DNA. We use autosomal STRs if we want to identify an individual. We use Y-chromosome STRs when we have a male contribution that we would like to identify. We use predictive SNPs if you want to learn about geographic ancestry, or phenotype. [In massively parallel sequencing] that can all be run in one reaction. […] So we make more use of existing DNA than we are currently able to. (from an interview with a forensic geneticist, 2014)

While embedding FDP within a 'package' of STR and SNP markers combines 'identification' with 'attribution' aspects of investigations, with significant implications for the types of data made available to an investigation, the commercial Next Generation Sequencing (NGS) kit offered by Illumina Inc., for example, responds to such concerns by offering the option to operatively be divided into identification and attribution sections, thus enabling the independent use of STR assays for cases and jurisdictions in which attribution is not permitted and in this way pre-empt potential concerns about the universal usability of the kit.

> Several academic institutes like ours in Santiago have been working towards adding predictive tests for physical characteristics using DNA as a proxy for eyewitness, when this is unreliable or not available to investigators. These tests have reached an advanced stage in development just as the NGS technology has arrived and is already offered in two NGS systems for ancestry, as well as eye and hair colour. … I'm not wholly convinced [NGS] will replace existing DNA regimes in the medium term but the technology can swing certain cases and that will be important to investigators lacking strong leads or having to reliably identify the suspect's DNA in a complex mixed profile. (Phillips 2015a)

Enhancing investigations by widening available sources of information—rather than challenging or changing the way DNA is currently utilized in investigations—is a central argument in the discursive work in the shaping of the 'adoption space' (Ulucanlar et al. 2013) for the technologies: FDP and NGS are 'as good as the gold-standard DNA profiling technologies currently in use worldwide'(Phillips 2015a), the type of information that phenotyping is expected to provide for investigations is contextualised in terms of vital intelligence (Liu, Wen and Kayser 2013; Walsh et al. 2011). Rather than useful as evidence in court, intelligence is understood to be indicative rather than substantive, and is posited by proponents of the technology as supporting on-going investigations by 'narrowing' the pool of unknown persons of interest towards identifying suspects, utilizing more trace material than usually makes its way into the laboratory, and thus widening the techniques and types of information drawn upon in policing. Some forensic scientists point out that FDP can never speed up an investigation, but it can help set priorities (rather than 'narrow down') where to focus the investigation next based on DNA-based intelligence. Intelligence as a form of investigative information presents an additional anticipatory element in the self-governance of phenotyping technologies, albeit at a different—the investigative—level: it not only presents an expectation that further information will become available and form an assemblage with actors, agents, and forensic tools to translate into reliable and convincing evidence, but it also represents a framing for the use of DNA phenotyping technologies that enables its adoption, and its governance. When academic geneticists frame emergent phenotyping technology outcomes as useful intelligence, they provide an imaginary of the technology as being responsive to problems in the practices of policing, disaster victim identification, and related areas of potential technology uptake. In this exploration of the technology field I have identify three types of 'anticipatory' practices of technological innovation.

1. Promissory

Promissory practices have been widely discussed in the literature as promissory narratives and management of expectations. In the case of FDP, published scholarship on its application in actual criminal investigations is lacking which means that their practical usefulness in criminal investigations remains presumptive. Many researchers and practitioners expect FDP technologies to be used in very difficult to solve cases, suggesting rare but high value use. Nonetheless, in some public discourses, such as in the political debate about expanding the repertoire of forensic DNA analyses to include FDP in Germany since November 2016, expectations about investigative contributions ride particularly high. These expectations are in part nourished by a long history of researchers associating FDP technologies with applications such as composite sketches of faces of unknown persons, asserting that while current technological capacity cannot deliver reliable 'mug shots' or composite sketches from DNA, they are likely to do so in the future (e.g. Karberg 2017; Pennisi 2012; Prugger 2016). Such proposals, while seemingly scientifically acceptable, ignore that futured technological capacities can, and are, perceived as temporally neutral by some who are not familiar with the underlying science: what may be possible in the future is already cited as desirable, and also utilised as argument for adoption now, fuelling the anticipatory nature of the technology (as visible in several German media reporting about political decision-makers' push for immediate use of such technologies, e.g. Arte 2016; MDR Aktuell 2017; Schwäbische 2017).

2. Epistemic

Epistemic anticipatory practices describe the ontological imaginary—the understanding of the inherent nature of DNA phenotyping technology—in the shaping of technology capacity, and the epistemological foundation for both claims and use of the technology. FDP offers to provide indicators and pheno-*types* (see also: Amorim 2012), it is anticipatory in its analysis based on probabilistic inference of what phenotypical or genetic ancestry groups an unknown person may belong to. It is not lack of data that plays a role in this epistemic anticipation but the reliance on broad categories and the assumption that phenotypes can be inferred from genotypes. Furthermore, much statistical genetic data as well as genomic knowledge is still required to render FDP technologies reliable and viable for operationalisation for investigative purposes (Gannett 2014; Kayser 2015; Phillips 2015b). Linked to this are efforts by forensic geneticists to manage expectations by potential commissioners and users of FDP technologies (e.g. Phillips 2015b; Sense about Science and EUROFORGEN 2017) in order to delineate epistemically feasible intelligence from aspirations.

3. Operational

Third, the operational dimension of anticipatory practices is particularly important in the context of forensic science, but can also be more widely interpreted as adoption practices. With responsiveness to local jurisdictional concerns, stakeholders aim to perform legitimacy and social safety of using such technologies by using technologies in test cases, and by linking to existing technologies already in operation that they can either enhance or replace. Adoption or anticipatory application practices create operational facts, by integrating new into existing technologies and by applying technologies in test cases before they are more widely adopted into practice, or even regulated or legislated for, and as such go beyond the promissory element of expectation or anticipation.

The negotiation of likely technology uses and users is an aspect of anticipation; of identifying and addressing a variety of non-technical aspects of research and development (from pragmatic applicatory to wider social, ethical, legal and other aspects) that impact on the eventual use of technologies (aiming to enable their routine use in many cases); and to engage with public governance representatives in the negotiation of the technologies' place and role within national regulatory frameworks. Anticipatory practices have been discussed here as performative action: They make the technology field matter by generating concern (the utility of added value, and legitimacy) and fact, expressed in terms of scientific reliability, utility in the context of identification, and by creating anecdotal precedence. Epistemic and operational anticipatory practices emerge from and contribute to the epistemic culture (cf. Cole 2013) of forensic DNA phenotyping. These anticipatory practices are reflected in self-governance efforts by an emerging forensic DNA phenotyping community.

Anticipatory Governance of FDP

Some of the anticipatory practices discussed for forensic DNA phenotyping evidence close attentiveness to legislation and regulatory frameworks in various jurisdictions and the ways these may impact on adoption and operationalisation of FDP. Furthermore, they attend to scientific and operational issues and requirements in the criminal justice system. These combined efforts reflect the Council of the European Union's 'vision for European Forensic Science 2020,' laid out at their Justice and Home Affairs meeting in December 2011 with the aim to developing a 'European Forensic Science Area' with its own infrastructure and the harmonisation of producing, sharing and using forensic data, and training for stakeholders involved in the forensic space (The Council of the European Union 2011). Similarly, the 2009 report of the US-American National Academy of Sciences (NAS) attested forensic genetics to adhere most to scientific practices of all forensic sciences, and more widely encouraged all forensic sciences to develop a *scientific* culture in order to strengthen the authority and reliability of forensic data, its evidentiary status, and the strength of judicial decisions based on such evidence (cf. Cole 2013). In effect, the NAS report exhorts greater capacity building for self-governance of these fields, just as the UK House of Commons Science and Technology Committee did in 2013, so that future interventions by a policy intermediary would be less necessary.

Self-governance presumes the capacity, responsibility and legitimacy to make regulating decisions for a certain institution, within the parameters of a larger social organisation that delegates responsibility for such competencies. The process of self-governance comprises efforts of enrolling policy interest in permitting delegation of such competencies; enrolling other stakeholders; and the processes of negotiating, implementing and adhering to principles, guidelines, and rules. Scientific self-governance rests on the ability of scientists to coordinate research activities, to learn from experiences with technology uptake and its regulation and legislation, and from there to anticipate policy and wider expectations of the trajectory of research and development. Key here is the alignment of the research community's framing of the technology and its understanding by policy makers, budget controllers and legislators, but also by potential end-users (e.g. law enforcement and the judiciary). The concept of anticipation in self-governance extends the conceptualisation of anticipatory governance (Barben et al. 2008; Guston 2014; Karinen and Guston 2010) by focusing on the role which researchers and users of technologies have in the framing of emerging technologies as responsive to specific operational challenges, and eventually the adoption of a technology into practice. Community building is an integral aspect of self-governing a research field (cf. Pickering 1992), based on shared interests and a recognition that practice can benefit from mutual and coordinated learning (cf. Wenger 2000), ideally leading to the development of standards of work, and the harmonization of methods and interpretative frameworks.

The forensic DNA phenotyping community emerges within a network of forensic genetics institutions, including the European Network of Forensic Science Institutes (ENFSI), the European DNA Profiling Group (EDNAP, part of the International Society of Forensic Genetics, ISFG), and networking projects, such as the FP7-funded European Forensic Genetics Network of Excellence (EUROFORGEN-NoE). These share a large proportion of their members, mainly from academia but also from forensic laboratories, and they operate at the interface of academic genetic research, public and private forensic services, consumerism, and regulatory frameworks. They work towards building a coherent infrastructure and programme for European forensic genetic research, aiming to strengthen such a community's standing with commissioners and users of forensic genetics. Securing a visible and strong exploitation basis for future funding and technology adoption by law enforcement and other agencies is part of this. They share problems such as deliberations around the adoption and use of new forensic DNA innovations, and its members employ epistemic, operational and promissory anticipatory practices with community-building being the key institutionalisation process invested in strengthening these anticipatory practices. The various efforts of the community can be understood along the lines of what are in this analysis termed anticipatory ordering devices.

1. Aspirational Regimes

At the European level, aspirational regimes include the Prüm Treaty of data sharing across member states including that of DNA information; the EU common area of "freedom, security & justice" coordinating policies, tools and practices (which, incidentally, has been described by Balzacq et al. [2006] as being threatened by the Prüm Treaty); and funding policies of the European Commission for security and justice related research and development, among others. These regimes provide context to the development and application of forensic genetic innovations by materially and discursively rationalizing and operationalizing research and technology uses at the transnational level. They are 'aspirational' since their rationales and objectives are future-orientated: to develop technologies and techno-legal systems that can solve or prevent crimes, produce state security and public safety. The aim of the EUROFORGEN Network to develop a macro-level training programme for the use of forensic genetics technologies is an example of an aspirational training regime, as is the role of the European DNA Profiling Group (EDNAP) in what has been described by these groups as the harmonization of DNA typing technology for crime investigations.

2. Standard Setting

A second set of anticipatory ordering devices represents analytical and interpretative tools and standards that aim to encourage technology uptake by producing usability, compatibility and reliability of analysis and interpretation across different users. These include efforts to harmonise training and methodologies for testing, analysis and interpretation of specific phenotyping technologies (e.g. Branicki et al. 2014). Other examples include the development of phenotyping genetic marker sets for the inference of externally visible characteristics (such as IrisPlex and HIrisPlex, see: Walsh et al. 2011; Walsh et al. 2013) and NGS kits such as Illumina's ForenSeq DNA Signature Library which hosts two primer sets enabling analysis either with or without FDP markers that infer visible traits and those that predict biogeographic ancestry (Børsting and Morling 2015) in order to comply with local regulations; and emerging analysis software such as EuroForMix aiming to incorporate SNPs in existing STR-focused software LRmix (Prieto et al. 2015) and Illumina's ForenSeq Universal Analysis Software, both of which enable the utilization of specific forensic genetic innovations. Different assays of markers and analysis software vie for preference, and even after validation can still be contested when results between two different analyses do not seem to match. An example are controversies over different analysis tools for 3+ person mixes of DNA (Murray 2015; Rudin and Inman 2015). The announcement of work at the validation stage, and validation as a process towards recognition of the reliability of a technology, can therefore also be understood as anticipatory ordering devices. Information drawn from a variety of research on gene expression and population studies is inscribed into these analytical and translational devices, offering access to genetic information through inference and enabling its transformation into investigative leads.

3. Applications and Training

These tools and processes are co-produced with the third type of anticipatory ordering device, that of projected applications and the training for such applications. Emerging forensic technologies are deployed in exceptional cases towards validation, scoping the utility of such technologies and introducing it to criminal justice stakeholders in police work or on request by prosecutors or judges. In particular, work with police forensic laboratories on developing applications is seen as useful in shaping the technology adoption space. The development of the community (including its training in relevant competencies and skills), and its efforts to render the emergent technologies of phenotyping comparable and reliable whilst anticipating applications in criminal justice and disaster victim identification contexts present a bottom-up approach to anticipatory governance that includes aspects of self-governance an emergent research and application field. Academic scientists collaborate with commissioners and users of forensic technologies in the development of phenotyping technologies, specifically in its validation and the narrative of its utility for addressing societal problems.

These devices represent efforts of self-governance and are constitutive of the forensic DNA phenotyping community. They form a layer of the adoption space for new and emerging technologies. In effect, they help translate anticipatory practices into anticipatory self-governance, and operate as a means of preparing the adoption space for uptake of technologies into governmental practice in the criminal justice system.

Concluding Remarks

Forensic DNA phenotyping (FDP) presents a case study of anticipatory practices for which the proactive shaping of the adoption space emerges as a vital element in the uptake of innovation. Simultaneously, as FDP emerges as a research and application field in its own right, anticipation can help in making order towards the consolidation of the technology field as a community. FDP's adoption space is shaped via a transnational network of academic and practitioner groups, and is an element of the development of a European forensic genetics research programme. This programme is shaped in cross-border collaborations working on defining the research field and building a community as a field of practice corresponding with European priority areas of security and justice. The performance of a forensic genetics research community, the engagement with addressing potential hurdles such as legislative barriers, as well as anticipated application fields for technology are efforts at self-governance of the research field with the aim to shaping national adoption of these technologies. The community taps into the persuasiveness and ubiquity of genomic narratives, emphasising the expectation that knowing more about the way the human body is materialized through the genome will improve social life and create desirable social order. Furthermore, the example of FDP shows that anticipatory governance is reflected in the way that technologies are conceptualised in design and use, and applied in existing operational structures and practices: anticipation is an integral part of epistemic and operational aspects of technologies. Recognising the interplay of different anticipatory moments—epistemic, operational, promissory—and a research community's ordering devices contribute to a better understanding of technology adoption and governance. Tracing lines of practice provide the social analyst with an understanding of how technologies are imagined and developed to be implemented, and how they are invested epistemically and operationally in their respective research and application system. Ordering devices and anticipatory practices mutually enable and channel their translation into anticipatory self-governance.

This paper approaches anticipatory practices by understanding these as constituted by both technological innovation practices and socio-ethical engagement about technologies, adding the former to the repertoire of what are described as anticipatory practices and expanding the analytical view towards paying attention to the mundane details of technology. The contribution of this paper's analysis of FDP shows the role that technology developers themselves play in anticipatory governance, and how community building contributes to the process of focusing and enacting anticipation that is inherent to the technologies both epistemologically and ontologically.

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