Forensic apophenia: sensing the bioinformation archive

Investigative and forensic teams working on the prosecution of Stephen Wright, who murdered five women in the Ipswich red light district, in the county of Suffok, England, in 2006, reacted with dismay when the defense presented a plausible justification of the presence of the suspect's DNA on the bodies of three victims. The prosecution had attempted to prove Wright's guilt based on finding his DNA on the victims' bodies; but on the second day of the hearing, Wright admitted having had consensual intimate contact with four of the women, which rendered DNA profiling insufficient to prove his guilt beyond reasonable doubt. Suffolk Constabulary, leading the prosecution investigation, approached the Forensic Science Service to provide new leads and investigative direction. During a 14-month investigation, 100 scientists joined the mobile laboratory that provided specialist adviser support, scene services and DNA profiling. The Forensic Science Service team were able to refocus the investigation opening up new lines of enquiry, eventually concentrating on fibers found on a victim's skull which had been dumped in water in close proximity to the town. The analysis of the fibers involved sorting through more than 100 fluid swabs and 580 exhibits, painstakingly cleaning mud around the skull, and collecting, classifying and analysing thousands of samples in terms of composition, type of dye and weave, then, cross-checking each fiber against furniture manufacturers' historic supply chains. In due course, multiple fibers found on the victims' bodies were matched to Wright's car and sofa. Digital forensic analysis of CCTV tapes placed Wright's car cruising the red light district of the town, and captured Wright cleaning his car at unusual hours. The combined evidence in court secured a sentence of life in prison, against the absence of a confession.

Remembering the complex investigation that secured Wright's conviction, one of the forensic scientists leading the prosecution case lamented during our conversations that the current provision of forensic science in England and Wales no longer pursues unusual tests, such as those undertaken to ascertain the provenance of fibers during the Ipswich enquiry, or support the use of preliminary investigation reports drawn up by forensic scientists to devise investigative directions before selecting the most relevant kinds of forensic evidence to be pursued for analysis in order to secure a conviction.

These wider questions about the relevance of pertinent, if unusual, lines of enquiry are lost in a procurement model of forensic provision which aims to cut costs and lead times, and provide enforcement teams with a promise of certainty which can only be sustained through the fragmentation of the questions to be asked of evidence. The field of forensics entails articulations of what Susan Lepselter has described as 'apophenia', that is, the experiential dimensions and capacities tied to the perception of 'connections between random and unrelated objects' (Lepselter 2016:3). In forensics, this capacity connects knowledge to method and technique as much as to perception. It engages scientific apparatuses and the senses and is explicitly articulated through the analogies of trace and signal. Forensic practitioners describe their activities as the production of information out of inchoate traces, clues or signals, following 19th century pioneer of forensic science Edmond Locard's maxim, 'every contact leaves a trace' (Petherick et al. 2010). The forensic scientists we met in the course of our research had extensive expertise in a range of subfields of technical specialization, having led high-profile investigations such as the one of the five Ipswich murders. Their accounts of forensic practice reflected on their quest to make sense of the multiplicity of elements which appeared at first sight haphazard or fortuitous. Forensic practice was also unequivocally tied to the cultivation of a haptic and practical capacity to sense in order to then 'make sense' out of multiple, fragmentary and contingent traces.

Our interlocutors referred to specific examples, notably blood spatter analysis and fiber identification, to illustrate how, through technoscientific practices of observation and the application of methods of classification and comparison, they were able to 'make sense'. In this article, we consider how forensic experts' accounts of their professional practice and their descriptions of the technoscientific *and* sensory operations tied to deciphering, for example, blood stains or traces of fabric, may be said to directly connect to Lepselter's (2016) conceptual analysis of apophenia as a sensory and analytical operation to establish relations among disparate, otherwise unconnected elements. Forensic practitioners described 'making sense' in forensics as more than 'the scientific practices of upholding or rejecting a given hypothesis in view of the evidence' – a senior forensic scientist explained to us. In our conversation, they noted the seemingly paradoxical discrepancy between the large data outputs produced in forensic labs vis-à-vis the relatively small number of cases that eventually make it to court. They wondered

whether this lack of proportionality might be due to the ways forensic work is tied to the production of *exoneration* and inconclusiveness, 'because, they stated, 'the work was used to either produce, give people exonerations or because it did not help one way or the other'. Bloodstain pattern analysis and forensic fiber analysis are therefore concrete examples of domains of technical specialization of great interest to our interlocutors. They shared reflections on how their activities entailed a reliance on Locard's enduring fundamental principle, 'every contact leaves a trace', but also speculation in that, 'if we accept that [Locard's principle], then how the trace is transferred is actually more relevant and important than whether or not it matches something'. In these accounts, forensic 'sense making' was explicitly tied to the production of complexity and framed as often operating against the calculus of easily quantifiable and incontrovertible 'matching' which might lead to convictions. We read apophenia in this context as the process of enquiry through which forensic scientists generate a wealth of data which might exonerate, rather than securely identify and then convict. Apophenia is tied to a distinct ability to make sense and make space for a calculus of complexity and a determination of the undeterminable which does not align with demands for enumerable identifications and socially and institutionally recognizable 'results'. Forensic apophenia is a speculative practice that foregrounds how capacities for sensing resonances as much as the unconnected are tied to political processes and situated responses to social transformations (Lepselter 2016, Harding and Stewart 2003), responding to social demands that truth is found. For our interlocutors, this form of forensic sense-making was tied to traditions of practice and learning attached to scientific epistemic frameworks, built on long-term forms of enquiry which aimed to formulate one crucial question: the right question that should guide the enquiry. Without it, as an interviewee put it, the technical ability to produce results from small amounts of DNA or the availability or relevance of samples would amount to insignificance, as forensic scientists measured their practice against the possibility of finding relevance out of traces that would not cohere if the question asked 'might not be the right question at all'.

However, transformations in state support for forensic science transformed the landscapes of knowledge and practice of forensic services through deep socio-political shifts which transformed the shape and scope of provision in the past two decades. This

article draws on intersecting debates on archives, infrastructures, and science and technology studies to show that forensic science connects sensing practices with a history of sectoral transformation and privatisation which newly engaged science and technology in producing and analysing multiple forms of bioinformation as evidence. For the forensic scientists we spoke to, these shifts catalysed not only the material transformation of data and everyday practices of storage, retrieval and analysis, but also coincided with important structural and institutional shifts which reshaped forensic science as a field.

Indeed, these transitions connected practical, infrastructural and epistemic dimensions, and were led by changing configurations of power, knowledge and expertise tied to collection, storage and analysis of bioinformation. Parry and Greenhough (2018:5) note that "bioinformation" is a particularly opaque term, but at a minimum, it captures derivative and descriptive dimensions that refer to information that is derived from biological organisms or that describes biological processes and lives. Descriptive and derivative designations refer to transitions from body to data, biological substance to information, and archives to datasets. As we laboured to establish a distance from common sense framings of bioinformation that stress the unprecedented character of its analytic potential, we took a detour through a national forensic archive. Our interest in this facility began in 2017. This facility is the only site in England and Wales where biological specimen and bioinformation tied to cold cases are kept for reanalysis, and thus, it remains vital to the resonances and truths claims that forensic scientists can make while attempting to identify individuals from particular assemblages of materials found at crime scenes and analytic information about their broader social context. However, at the time of our fieldwork, this archive was becoming a relic of a fast disappearing recent past. In the article, we use its transformation towards obsolescence as a case study that is illustrative of the changing conditions that shape how facts are made into evidence and how scientists are able to make sense of inchoate fragments and unfitting materials while coping with complex systemic transformations (Jasanoff 2004, 2005). With Hilgartner (2017), we understand these shifts and rearrangements as bringing to the fore distinct knowledge-control regimes, that is, compositions of agents, spaces, objects and relationships which order and control the practice of science. As austerity policies transformed not only forensic provision and the place of

scientific enquiry in the criminal justice process, but also the human practices and technical expertise underpinning forensic science, the archive made explicit the progressive erosion of knowledge and skills that accompanied the dismantling of public service institutions. Since then, our ethnographic practice has focused on piecing together changing epistemic landscapes in forensic science, as scientists and practitioners working in this sector make sense of the implications of a "bioinformational turn" in which ever larger datasets, infrastructures and automation continue to transform the scope of their practice, and the principles they deploy in the field. Forensic scientists grappled with the progressive re-organisations of forensic science as entailing a rearrangement of forensic sociotechnical imaginaries (Jasanoff and Kim 2015) that curtailed the 'future potential' of the physical specimen held in the forensic archive. In the bioinformation age, repositories of the physical debris of crime scenes were being recast as newly obsolete. As the preservation and curation of the forensic archive is jeopardised in the contemporary moment when databases are increasingly ascribed with 'future potential' (Jasanoff and Kim 2015), in opposition to the cost of maintain physical material and collections, capacities for forensic knowledge making out of sociotechnical and sensorial practices tied to the handling of specimen and material objects are also curtailed. In this sense, the progressive destruction of the physical archives and the dissolution of forensic scientist's expertise also mark a narrowing of forensic scientists' capacities for 'planned insight' – that is, for ascribing value to physical collections in the light of their potential future use. Planned insight here is tied to complexity and the possibility of 'widely divergent speculative visions' (Radin 2015:1) inherent in the forensic archive's yet-unrealised and unaccomplished potential for future knowledge that is unobtainable through derivative data.

From biological specimen to bioinformation

Our ethnographic enquiry about the status and purchase of bioinformation started in a secretive government-funded site of storage of forensic casework, the Forensic Archive Limited (FAL). It was difficult to get beyond the bland and unremarkable website at first, as it contained only scant information. A vaguely written mission statement indicated that the FAL emerged as a container for casework files "from all investigation work previously undertaken by the Forensic Science Service (FSS), which on the

direction of the government ceased to provide operational casework services in March 2012" (www.forensicarchive.com). The website did not list the actual location of the archive, or offer a way to contact archive staff. Below a broad statement of purpose – "Preserving forensic archives for the future" – it indicated that only members of the criminal justice system can apply to access casefiles stored in the archive, suggesting indicative time frames needed to locate and access specimen relating to cold cases. The archive hosts casefiles that survive the dissolution of the Forensic Science Service, a much larger public entity, which for decades previously offered a range of integrated forensic services to the Crown Prosecution services, British Transport Police and HM Revenue & Customs. Its laboratory facilities functioned as a forensic science hub and were central to training as well as daily case work. Many forensic scientists who trained in the Forensic Science Service regard themselves as having been a part of an internationally recognized, highly esteemed institution which supported scientific research and trained generations of practitioners under the aegis of directors known for their field-defining vision. Similarly to other scientists whose lives and careers unfolded in powerful institutions (v.g. Gusterson 1996), FSS scientists expressed a sense of a shared history in their conversation with us, while punctuating their accounts with reflections on the visionary, experimental, or autocratic character of the direction of the FSS at different points in its history. On 14 December 2010, however, as part of a new austerity policy spearheaded by David Cameron's newly elected Conservative government, the Home Office announced its intention to 'support the wind down of FSS, transferring or selling off as much of its operations as possible' (FSS, 3). As a government-owned, contractor-operated organization since the 1980s, the FSS worked on over 120000 case files every year, employing over 1300 scientists. It assisted more than 60 countries worldwide on services ranging from consultancy, training, and database development, establishing itself as an international forensic resource, particularly in terms of DNA technology. The FSS was therefore an institution that emerged out of a specific local history vis-à-vis other global locations contributing to the making of what Burney and Hamlin (2019) have aptly named 'global forensic cultures' that are rooted in local contexts and yet transnational and mobile.

With the dissolution of the Forensic Science Service, concerns emerged among scientists and practitioners about the lack of comparable quality laboratories to be employed in

public service. The FSS had become the main entity to hold criminal case files going as far back as the 1930s, ensuring these remained in a single, accessible resource. In fact, the FSS was at the center not only of court proceedings and police investigations, but became a national database of criminal offences and materials, a unified body tasked with combining case work and advancing scientific research, setting professional standards and developing methods of analysis. In practice, over time, the FSS became a single national interconnected infrastructure, comprising a grid of laboratories, training centers and mobile response units with the mandate to orchestrate and govern a complex system of memory and connection. The role of the FSS, however, was always constrained by the demands of police forces, and by different standards of proof in civil and criminal courts. In court proceedings, as the prosecution holds not only the burden of proof but also the burden of persuasion, forensic evidence entangled police cultures and forensic provision, gradually generating tensions between scientists and police forces about the principles that should guide investigations, specimen storage and handling, and chain of custody procedures.

The forensic scientists we spoke to were acutely aware of disparities between the ways in which prosecution teams and police investigators understood the role of forensic science in criminal procedures – as providing essential evidentiary 'proof'– and the way scientists understood their role in criminal cases – as substantiating the probability that a particular line of evidentiary enquiry may prove more fruitful than another. They were also sensitive to questions about certainty linking the evidentiary status of particular tests as leading to convicting particular individuals. Police forces placed tests such as DNA matching, blood spatter analysis or fingerprinting as core evidence to sustain prosecution cases, while forensic scientists saw testing as a route to assess the likelihood that a particular set of circumstances might hold together, which often demanded that they ask difficult questions towards falsifying, rather than confirming, hypotheses. A forensic scientist with a long career in the field told us that while working for the FSS, she was probed by investigative officers gauging her willingness to rephrase evidentiary reports to provide more certainty than indicated by scientific confidence ratios, or to reframe results in the direction of tipping the balance of probabilities to increase the prosecution's chances to secure a conviction. But, our interlocutor was quick to add, under FSS standards of quality, forensic scientists could refuse to provide

this. The integrity of the scientific process demanded that scientists saw beyond the quest for rapid certainty expected by police cultures, while deploying all available capacities of sense-making. Forensic scientists saw their role as leading investigations by intuition and common sense, using relational thinking to draw up hypothesis-generating scenarios, and finding relevance between inchoate sets of traces that made no sense in isolation, and the wider material, social, and temporal frameworks of the investigation.

Progressively, however, the chasm widened between the Forensic Science Service's investigative process, based on its signature method offering detailed holistic interpretation of evidence in context, and police forces that favoured faster turnarounds. Rather than focusing an enquiry on the broader question of relevance, forensic scientists were no longer in charge of directing the enquiry, but placed on the back seat as technical managers in the analysis of recovered evidence. Their services were now considered too expensive and time consuming, and, in the absence of forensic science standards, police forces could now outsource investigative tests to unregulated laboratories and providers. The forensic scientists we spoke to argued that the emphasis on cost-reduction was underpinned by epistemic and practice cultures driven by an avoidance of complexity, to the point of cognitive closure. In our conversations, forensic scientists often described a sense of incommensurability between their work and that of police forces. They reflected on the difficulties in translating the principles and confidence margins of forensic science to the police, a professional and epistemic community they regarded as fundamentally distinct from their own. In turn, police forces continued to argue that breaking the monopoly of the Forensic Science Service could only bring a positive change to the sector. Their financial calculations favoured contracting specific services over funding a large-scale national infrastructure, and highlighted cost savings made in subcontracting forensic testing to private firms, while storing and handling specimen in-house. At the same time, an unprecedented rise of digital forensics, for which existing forensic laboratories were not equipped, aimed to make sense of digital data from a variety of devices - including mobile phones, CCTV cameras, sensor and digital map data. As demand for digital forensics grew with the digital economy, forensic services were increasingly provided by specialists who were not trained in forensic science, and by firms which could operate while evading the

quality standards and strict regulation that applied to forensic laboratories. While police forces were able to claim that this system led to greater competitiveness and drove down prices, forensic scientists contend that this also resulted in poorer quality testing, the dilution or effacement of quality standards for common procedures, and the proliferation of unvalidated methodologies – sometimes by providers that lacked scientific accreditation or proved experience -, which was soon to foreground the deep rooted problems that have characterized the industry since its privatization[1].

The bioinformational turn encompassed a shift in scientific research, commercial partnerships, funding opportunities, patents, and new practices of sensing, transforming the practice of forensic science through an ecology of new devices and infrastructures. Bioinformation was embedded in the rise of a data-centric turn in the life sciences, and it became key to the shift from archival infrastructures to post-archival analytics based on digital aggregation, cross-matching and taxonomy-driven computation (Gerards 2018). The availability of ever more granular analyses of genetic bioinformation, led by the development of next generation sequencing technologies, allowed faster turnaround times, while extending the analysis of genetic markers to genome and metagenome level [2]. A new government-led emphasis on compiling national databases enabled the routine deployment of totalising surveillance, normalising forms of bioinformation storage and circulation which responded to governmentality logics, though these remain opaque and out of reach for most citizens (for example, see Machado and Costa 2013). The Police and Criminal Evidence Act of 1984 (PACE) introduced powers for the police alone to regulate aspects of the production and management of bioinformation (fingerprints), producing bioinformation through speculative aggregation and cross-referencing. Amendments to PACE in 1994 (Criminal Justice and Public Order Act), as well as the extension of powers through amendments in 2001 and 2003 allowed police forces to take and retain DNA, without having to destroy files in cases where a resulting conviction did not materialise. Retention of bioinformation data of suspects after the Counter-Terrorism

[1] See, for example, recurrent attempts by the Forensic Regulator to address these problems in a new Code of Practice and Conduct in 2011 (https://www.gov.uk/government/publications/forensic-science-providers-codes-of-practice-and-conduct), as well as in the Forensic Science Strategy of 2016 (https://www.gov.uk/government/publications/forensic-science-strategy) (Last accessed 7 April 2019).
[2] See Mackenzie et al (2016); Richardson and Stevens (2015), Khodakova et al (2014)

Act of 2018 can be undertaken through covert sampling, without the consent of individuals under surveillance, and retained for renewable periods of two years after the Crime and Security act of 2010 (McCartney, Williams and Wilson, 2010:15). The widespread storage and handling of forensic bioinformation led governments and police forces to speculate about the promissory dividends derived from its potential re-analysis, but it had the effect of making physical archives inoperable and obsolete, and raising new questions about who benefits from bioinformation storage and the processes of making 'rights through data' (McCartney, Williams and Wilson 2010). In digital form, bioinformation brought forth new challenges of access and readability[3]. While data infrastructures became essential conduits of relations between enforcement cultures, forensic service providers and the criminal justice system, they also became concrete interfaces that made possible only some forms of access and analysis, limiting how and to what effect forensic bioinformation could be brought to bear on criminal justice proceedings.

In this context, infrastructures of bioinformation aggregation and analysis – such as integrative databases, indexers and case management systems- promised to deliver interoperability between data generated by governments, healthcare service providers and a fragmented network of forensic providers. Straddling the domains of knowledge in science, law, and law enforcement, forensic scientists' capacities for apophenic reasoning now had to confront the making and remaking of 'data' and therefore 'evidence', across domains and technical interfaces. Data, in this context, relates to the larger project determining and producing evidence in relation to the distinct frames of science[4], enforcement and the law (Haas 1992, Longino 1990). Here, just as Lepselter observed, 'sensing' evidence means connecting knowledge practices to social imaginaries and fantasies of power, given that the ability to connect the unconnected and haphazard, be they objects, events, or scenes, is to hold a grip on meaning-making. While in the field of psychology apophenia is 'an error of perception', Lepselter foregrounds instead apophenia's hold on social life through vernacular theories that establish parallels, resemblances and resonances between stories: 'the sense of uncanny

[3] See, for example, Wilson (2019).
[4] We follow Stephen Hilgartner in defining frames in relation to knowledge regimes as common understandings, or "an organized set of schemata that individuals and collectives use to interpret situations or activities as being instances of a particular kind of event or deed" (2017:11).

resonance … becomes both performance and theory, creating a sense of occult design that might someday be apprehended below the jumbled surfaces of the ordinary' (Lepselter 2016:4)[5].

Sensing data, thinking systems

Forensic science, similarly to occult cosmologies (West and Sanders 2003) and conspiracy theories (Harding and Stewart 2003), also relies on the generation of structures of feeling that shape social practices of making sense. Forensic and investigative imaginaries, particularly as they relate to shared social values of life and death, draw on the ability to see through patterns (Fraser 2010). Uncertainty and indeterminacy saturate the field. For example, in the case of bloodstain patterns (blood spatter analysis), forensic experts know that "not all patterns are readily identifiable, and some patterns are fragmentary and difficult to interpret" (Fraser 2010:30). Apophenia is at work in the resonances that enable the making of "just-glimpsed connections" and the distinction of latent and obscured structures or patterns (Lepselter 2016: 4-5) to produce a sense that "it all fits together". Forensic apophenia is, in this sense, an endless bricolage heavily reliant on the promising discourse of science and technics to tease out signal from noise whilst remaining attuned to the possibility that things might in fact *not* fit together. In the everyday practice of forensic scientists, forensic apophenia also entails a sensibility towards registering randomness, the undefinable or disparate. From the 19th century, a wide range of forensic techniques and knowledge practices – e.g. graphology, blood spatter analysis, serology, polygraph measures and "dog tracking", i.e. the use of Doberman dogs' sensoria – have been applied to apprehend and make sense of traces. Forensics as a field is haunted by demands to show scientificity (Burney and Hamlin 2019) through technical solutions. Yet, forensic practices entail apophenic thinking and sensing in the exercise of varied knowledge practices and techniques to grapple with the uncanny and the unfathomable: "since evidence *must* exist, what is found will be evidence" (Burney and Hamlin 2019:

[5] Lepselter argues that "resonance describes the social, affective, and aesthetic dimensions of a perspective based in apophenia, finding connections between signs, and often understanding the process as political. Here those connections are based on resemblance and repetition. This effect entails mimesis, but the resemblance is partial and fluid" (2016: 4).

7). However, as one of our interlocutors explained, the most fundamental question has to do what the evidence might be evidence for: 'the real issue is, what does this tell us, how does this shed some light on a past event?'. From this perspective, forensic scientists might in fact appear to be working to *undo* notions of evidence as identification or 'matching'. As it was explained to us, in their scientific work in laboratories, they are effectively engaged in the production of 'too much data' which in practice complicate rather than streamline analysis. Complexity and excess are eventually more likely to exonerate through the production of inclusiveness or lack of determination, rather than to pinpoint to convict through 'a match'. Furthermore, as an enterprise concerned with uncovering what is taken away and what is left behind at a crime scene, forensics does not cohere in a unitary epistemological framework, and thus, the commonsensical principle that process can be traced and reconstructed becomes an axiom surrounded by doubt.

There was general consensus among forensic scientists we spoke to that the dissolution of the Forensic Science Service was catastrophic in terms of loss of expertise, infrastructural capacity and innovation. It generated a severe shortage of laboratory space and specimen retention facilities, which in turn transformed the kinds of questions that could be asked of forensic materials during an investigation. Scientists at FAL told us that the first task they were assigned by the Home Office was to downsize the Forensic Science Service cold case database, as keeping these case files intact incurred significant running costs. The Forensic Science Service held the first and largest national database of forensic specimen and case files[6]. It was highly centralised and practically inaccessible, even for scientists, and our interlocutors told us that, in this context, 'data meant very little'. With the closure of the Forensic Science Service, ideas about how to reorganise this catalogue were lost with the corporate memory of the scientists who lost their jobs. FAL's executive director took on the task of making the archive a custodian of cold cases, integrating files and specimen hosted by 45 police forces about decades-old crimes committed in England and Wales. She impressed on us an urgency to think about these materials as the only existing records of cases – and the only chance that these cases could be reviewed by reanalysing material recovered from

[6] In contrast with others developed later, such as NDNAD and Europol.

examinations. project entailed devising criteria for specimen retention, cataloguing and barcoding samples, and deleting thousands of data points falling outside cold case review timeframes. Strict taxonomic categories divided reconfigured the thousands of records. The newly catalogued materials comprised small samples, such as documents and records from examinations, debris collected of a gun, particles of glass, frozen DNA samples, swabs not previously chosen for examination, stomach contents, body parts. During our research visits, staff at the archive remembered the task of destroying most of those materials and cataloguing eligible samples and records and developing a new barcoding system to significantly reduce the time it took to locate samples. The new database would allow them to search the archive by evidence type and provenance, and to distinguish samples belonging to suspects and victims. The archive contacted police forces offering them a timeframe to decide whether or not to keep their open cases, and to seek any permissions needed to keep them on record.

At the same time, with the wind down of the Forensic Science Service, forensic scientists dispersed into private companies and other research environments looking for new opportunities. We encountered one of these experienced scientists in her new post, working at the US National Institute of Standards and Technology on re-stablishing a scientific basis for forensic science. She noted that the rise of bioinformation infrastructures, particularly those supporting powerful interpretative methods that emphasised 'matching evidence', such as DNA fingerprinting, had the potential to displace foundational epistemologies of forensic science which were instead concerned with 'evidence transfers' and speculative inferences about temporal and circumstantial reconstructions of a crime scene. Reflecting on a system in which the purview of forensic science was progressively reduced to producing the measurements, tests and confirmations demanded by the criminal justice system, other experienced practitioners noted how many providers were oriented towards delivering inclusive or exclusive evidence, producing evidence to uphold or reject a given hypothesis. The procurement system did not prioritise evidence produced in laboratories, which in some cases neither confirms nor denies, and in other cases is not critical enough to the case.

The closure of the Forensic Science Service and the establishment of the FAL archive illustrate how a technocratic attempt to create a market in forensic services effectively undermined a state monopoly which, whilst less cost-efficient than contractors, for many decades sustained a vision of public forensic services, standards, infrastructures and the cultivation of expert practitioners' haptic capacities for forensic 'making sense'. Indeed, for many scientists, the loss of an integrated system of forensic science provision meant losing sight of the broader research questions which could support empirical work towards asking questions about the status of knowledge in an investigation, and an orientation towards a more complex falsifiable notion of truth. Forensic practitioners understood their practice as bound by the exigencies of a community of practice with its own working knowledges, methods and quality standards, while, on the other hand, the transition to post-archival infrastructures demanded new forms of compliance with multiple institutional standards and timeframes, as their results drew data from multiple sources and had to be translatable across investigative problem spaces and court processes. Leading forensic practitioners admitted that quick technological fixes aiming to reduce costs often implied over-relying on unvalidated methodologies, or regarding particular data types as silver bullets, that is, evidence materials that can cut through complexity and yield quick results across contexts. However, as in other contexts (Gusterson 2019, Morozov 2013), in practice, the hasty over-optimistic forecasts offered by management consultants employed to report on the promissory value of forensic markets (detailed for example in the *Forensic Science Strategy* of 2016) did not materialise. Indeed, technological solutions often remained inaccessible, unevenly regulated and disconnected, posing major problems in relation to open investigative processes, regulatory oversight, and sustainability (for example, see Skinner and Weinroth 2019).

In this context, the forensic archive increasingly resembled a repository of obsolescent samples, data and soon to be outdated taxonomic operations. Like 'the database of dreams' that in the mid-1950s aimed to be the largest database of sociological data ever assembled (Lemov 2015), or the once cutting-edge, but now non-operational Readex machine needed to access the records, the Forensic Archive Limited presides over impending anachronism and infrastructural decay. However, its permanence is also a

labour against obsolescence that seeks to ensure records are retained for the future. The archive director impressed on us the urgency to think about these materials as the only existing records of criminal cases – and the only chance for victims or wrongly convicted suspects to review material recovered from examinations. The FAL maintains forensic artifacts and instruments in prospective anticipation that new investigative enquiries open up possibilities of future resonances and new recompositions. However, changing guidelines on retention, handling and disposal of bioinformation in this archive mean that evidence related to cold cases is no longer accessible by the persons whose biological substance and data the archive is entrusted to manage (McCartney and Shorter 2019).

In contrast, little is known about repositories held by private providers and police forces of varying size, complexity and infrastructural sophistication. A report by the National Audit Office (2015) identifies a lack sustained of monitoring by the Home Office through the national forensics network, and illuminates that little or no of data about the forensic services police forces undertake internally is publicly available. Guidelines are more difficult to track than ever before, as multiple biorepositories may be dispersed geographically and respond to commercial interests. The terms and parameters of custodianship of these archives are particularly nebulous, though the Forensic Regulator (Tully 2019) admits that infrastructures, analysis, retrieval and storage are piecemeal and discontinuous. Often archives disappear with the companies that once held them for analysis, making unclear how claims to ownership can be dealt with in practice, and who should adjudicate over conflicts concerning rights of bioinformation access and erasure. In this context, in a market characterised by unregulated service provision, fast changing contracts, and race to the bottom prices, the proliferation and disappearance of archives is posing new problems for public prosecutors and for the public accountability of forensic services. Although the Government only funded the FAL facilities initially for two years, the collapse into administration of private forensic providers (Key Forensic Services) allowed the FAL director convert the archive into "an archive of last resort", where materials of interest in public prosecutions that would disappear as private providers go into administration could be stored according to approved retention timelines.

The matter of apophenic reasoning

The closure of the FSS and the establishment of the FAL archive illustrate how a technocratic attempt to create a market in forensic services effectively undermined a state monopoly which, whilst less cost-efficient than service contractors, for many decades sustained a vision of public forensic services, standards, infrastructures and the cultivation of expert practitioners' haptic capacities for forensic 'making sense' in England and Wales. In this broader context, the project of collecting, storing and analysing bioinformation in large databases was a result, in part, of changes in the functioning and delivery of forensic science, which progressively centred machine learning as a key investigative technology for criminal investigations. Governments took a leading role in funding and developing infrastructures, promising wide-ranging changes to policing and crime scene investigation management as a result. In practice, databases transposed the site of evidence production in forensic practice from the collection, handling and retrieval of specimen to be analysed to produce a suspect match, to the automated production of suspect identities through algorithmic sorting of profile populations. These profiles store demographic background information about individuals. which researchers have tied to multiple processes of profiling, notably racial profiling (Plájás, M'charek, and van Baar 2019), and are then used to make decisions about bail and sentencing, population management, and crime prevention. Our interlocutors often described databases, including NDNAD (National DNA Database) in the UK, and international databases such as ECRIS (European Criminal Justice Records Information Exchange System) as determining the work of forensic scientists, yet producing operations out of view, in the back end of infrastructures. As one put it, databases 'have consequences without human intervention', generating connections that lead to the profiling of individuals, as well as to inferences about global populations. A researcher and civil servant involved in the development of regulatory frameworks for international databases highlighted the implications between increasing contrasting automated data flows and forensic practice:

> "Human intervention is quite important, but it happens in a small stage in data flows. When it comes to criminal justice proceedings, human intervention is much more

> important and people are scrutinising the potential identifications, potential links between something recovered at a crime scene, and something compared that seems to match from a database in much more detail. That raises very interesting epistemological questions".

Indeed, general descriptions aimed at promoting public trust in infrastructures recast bioinformation as an index of a body and its social context (for example, its DNA fingerprint or its history of previous convictions). Forensic scientists, whilst not averse in principle to the scientific use of data infrastructures to aid crime scene investigations, on the whole concur that there is a fundamental epistemological shift with machine learning which undermines their core scientific ambitions, jeopardising their contribution by seeking certainty at the expense of complexity.

A recently retired forensic scientist with experience in multiple jurisdictions in the UK and internationally, told us that in an ideal approach to forensic science, "the issue is the crime and not necessarily the scientific discipline that is applied to the crime. It goes from the point of view of the problem or the issue' instead of, as in the current spaces of forensic provision, the idea that 'here we have a tool, how can we apply the tool to anything we find?". She added:

> "Identifying the issue, identifying what questions need to be addressed is probably one of the more critical aspects of forensic science and it gets very little recognition, and at the moment, it is almost exclusively a police function. I think that is possible as long as there is a very close partnership with the police and the scientists, but if there is a kind of 'throw over the wall' approach to the service, the police are raising questions, the scientists are producing what they think are the answers … with problems floating around in the hope that, somehow, they will tie on to each other, as opposed to the answers being produced for specific questions. DNA is a classic example of that mode: we have the ability technically to produce results from really small amounts of DNA and almost because we can do what we do, without enough thought at all about the relevance of those samples and whether or not they are the right samples, we need to address what we need to know in this particular case, so

these high numbered solutions are there and there is a swamping effect, because they are so impressive, and it might not be the right question at all."

While automation delivered avenues for crime prevention that relied on the consolidation of large datasets to identify individuals and populations (for example, through biometric data), its effectiveness in criminal processes not only rests on by the availability of samples, their quality and level of contamination, but also on processes of data handling and storage. These involve contingent processes organised by local rules, involving different facilities, handling and subcontracting policies, as well as different practices of care of the data and standards of analysis, making sense of data leading to the conviction of an individual involves a process of connecting dots which "opens up the more general process of how narrative exceeds its literal, referential function to tell a 'something more'" (Lepselter, 2016, 22). The emerging automated predictive future renders not only of the Forensic Science Service archive, but also of the once-futuristic United Kingdom National DNA Database (NDNAD) imminently obsolete[7]. In the context of the UK Parliament Lords Science and Technology Forensic Science Enquiry, expert testimonies from the forensic science field construed the Forensic Science Service archive and the NDNAD as tied to outmoded, inadequate outcomes. Instead, the Forensic Science Enquiry offered an insight into a predictive future through promises of increased integration and interoperability. A key example of this strategy is the Home Office Biometric Strategy, which aims to combine fingerprints, DNA and facial images, in integrative vision of post-archival data consolidation. Secondly, a fully automated forensic science relies on open source expert systems (Prieto et al. 2019) which promise to process ever-increasing volumes and types of data, including biometrics, facial recognition, retina scans, and behavioural patterns alongside fingerprint capture, photo matching and a plethora of context-specific operations of data capture and processing. These systems purport to combine forensic practices of matching and interpretation. However, unlike open source automated systems advocated by practitioners located in the forensic cottage industry emerged after privatisation (Authors, 2021), the distinctive capacity to 'make sense' which the forensic scientists

[7] In the context of the UK Parliament Lords Science and Technology Forensic Science Enquiry, expert testimonies from the forensic science field construed the Forensic Science Service archive and the NDNAD as tied to outmoded infrastructure, which was inefficient to use and produced inadequate outcomes.

we spoke to saw as the distinctive capacity of their profession, was developed by practitioners through training and experience in their respective fields of forensic expertise, and could not be easily or fruitfully operationalised through automated systems.

The transformations of forensic science provision in England and Wales foregrounds questions concerning the frictions that arise between ways of making knowledge in scientific cultures, law enforcement institutions, and legal systems focussed on stabilising narratives to create facts and certainty, against the fundamentally relational knowledge practices and processual insights offered by forensic practitioners through their emphasis on sensing and engaging complexity. From the perspective of forensic scientists, epistemologies grounded in tests, measurements and outputs are fundamentally partial and ultimately insufficient in the face of the intertexuality and complex composition of evidence. In this context, the epistemic and normative differences between scientific research and criminal justice process often take researchers and practitioners in diverging directions, as the object of the analysis supports different forms of authority and normative practices. Against the ontological indeterminacy of samples, which are often inconclusive beyond theoretical speculation, epistemic cultures determine which claims to truth and ancestry are associated with bioinformation through, for example, DNA (TallBear 2013, Bolnick et al. 2016) or fingerprinting (Michael 2010)[8]. Tracing the emergence of new forms of 'forensic positivism' to the unregulated development of digital technological applications prevalent particularly after the dissolution of the Forensic Science Service, lead forensic scientists to pit new vocabularies of technological agency *against* the capacity of forensic science to provide forms of analysis relevant to particular criminal investigations. They note difficulties in translating legal and scientific discourses, and stress inappropriate uses of specific technologies that fail to lead to convictions in court processes (Fraser 2009, 11). In England and Wales, the political logic behind the storage of bioinformation on this scale relied on the promise of a seamless infrastructural future

[8] For instance, computational analyses based on admixture data - which estimate proportions of alleles in individuals or populations, have produced forms of demographic modelling and new speculations that link historic genetic diversity, population structures and migration histories (Achilli et al 2013; Verdu et al. 2014).

where a number of possible operations, such as searches, aggregation and cross-checking may produce 'the difference that makes a difference' (Bateson 1972). This was particularly important in terms of securing convictions through DNA matching, because data aggregation was seen to boost confidence thresholds and yield quicker results. In practice, however, as illustrated in the case of the Ipswich murders, a DNA match can simply be the wrong test given the particulars of the enquiry, leading to a wrong conviction or a match that is of no consequence. These capacities for forensic sensing are viewed as being undermined and imperilled in forensic scientists' experience of the bioinformational turn and the projections of a data-centric future where notions of the public interest are also redefined.

An anthropological perspective on bioinformation might also suggest that normative frames relating to individual rights and normative understanding of the public interest, as well as principles such as proportionality, have to be first contextualised as artifacts of specific institutional, governmental and cultural logics. Through the relations that sediment in the forensic bioinformation archive, questions emerge out of the capacity for identification of the bioinformation repository, where data has the potential to hold or 'reveal' information about persons and their relations. Liberal framing in terms of individual rights (Parker and Lucassen 2004) are an extension of this and fail to address the more fundamental problem at the heart of forensic science's apophenic reasoning, that is, its production of connections among the speculative, the haphazard and random, which can have very concrete effects for individuals.

Coda

In Lepselter's analysis (2016), alien abduction stories and related conspiracy theories in late-twentieth century United States are tied to broader anxieties about downward class mobility and deepening social marginality. Apophenia in UFO abduction narratives relates to the instantiation of patterns and structures to make sense of the present, as the reverberation of multiple imaginaries of captivity that conjure up settler colonial histories and violent experiences tied to ongoing Native American colonization. In our work on forensic biorepositories and archives, forensic science practitioners' perspectives and experiences bring into view forensic sensoria and skills in the process

of erosion and decomposition, in the context of a fragmentation of the sector that instantiates the disassembling of public institutions. Forensic apophenia, like the biological specimen and bioinformation archive, are remnants that stand for capacities of sensing and making sense patterned by dissolution, crisis and loss. Our reference to Bateson's abstract notion of difference is relevant to the way in which frictions (cf. Tsing 2004) between epistemological frameworks function in the process of making information into evidence. Both scientific and legal contexts imply the narrativization of bioinformation in order to enable evidence to travel and turn to linear form at the time of being rendered into facts. But whereas the concern with truth in scientific communities informs methodological development, in law, 'the difficult relation between "truth" and "common understandings" is compounded by concern with "justice"' (2009, 9; see also Willis 2009). Legal practitioners establish truth dependent on organic, variable, sometimes contradictory contexts and normative rules (Valverde 2003). Unlike machine learning, practices of sensing and sense-making that forensics scientists rely on do not always align with the certainties or narratives demanded by police forces, nor do confidence intervals and ratios instead always offer clear-cut certainties when it comes to matching evidence to individuals.

Severing relations between data and persons, datasets in post-archival times are figured as impersonal artifacts which can erase individuality while offering a future promise of predictive insight. The difficulties that emerge from the shift from archive to dataset encompass issues of access, interpretation and transparency with respect to governance and explainability, particularly in terms of the hidden values inscribed in algorithmic operations. Campaigns for new forms of community-led accountability focus on popularising forensic knowledge and expertise, and engage publics in becoming 'donors as governors of their own data' (Parry and Greenhough 2018, 143). Forensic scientists and the communities that are exhuming remains from acts of genocide may also be useful for thinking about the public rights and engagement, notably when the identification of human remains becomes a path to healing families and communities (Duterme 2016). Sense-making, in this context, encompasses 'making sense' of disparate pieces of knowledge, which can potentially include the senses of the communities from which they originate thus creating novel convergence between constituencies with a range of sociotechnical and political imaginaries and sets of

expertise. These experiments and alignments have emerged in contexts where, for instance, communities organise to initiate investigations into human rights violations, political violence and cases of forced disappearance (Schwartz-Marin and Cruz-Santiago 2016 a, 2016b). However, the extent to which donor-led forensics and "forensic civism" can gain control over biorepositories is unclear when data infrastructures elude direct donor or community oversight and are in fact transnational, highly mobile and fundamentally elusive. In practice, not owning sequencing and forensic analysis macro-infrastructures means community projects rely on international commercial providers which operate as non-governmental organisations across jurisdictions with little, if any, regulatory or public scrutiny. Forensic bioinformation therefore remains closely tied to problems with apophenia and individuation, insofar as the projection of a positivist forensic science aims to create connections and resonances between multiple registers, infrastructures and forms of data, with the aim to generate fictions of individuality increasingly linked to aggregation practices and analytic scores across fragmented providers.

Bioinformation brought forward the ability to detach biological substance and information, enabling new procedures and techniques of individuation, through technical measurement, aggregation, analysis and comparison in the production of evidence. However, the processes of creation or fabrication of relations between specimen and person nestled under the term 'forensic bioinformation' are occluded from view as a result of systemic and infrastructural transformations shaping forensic science provision, and not adequately accounted for in the ethical frameworks that govern the field. Thus, the bioinformational turn in forensic science orients the anthropology of bioinformation towards different types of archival forms and materialities that encompass, inter alia, repositories of paper-based health records, human remains in forensic archives of human rights violations, and the seemingly less tangible medical and forensic digital archives that often include biological samples as well as DNA sequencing information.

As anthropologists, we grapple with the accounts of those whose lives are enmeshed in these infrastructural transformations, making sense of epistemological shifts and new

knowledge configurations, as well as the potential resonances and possibilities of sense making that linger in the bioinformation archive. We reflect on the place of apophenia in anthropology's knowledge practices, as anthropological practices of 'making sense' are tied to the complex temporality of ethnography that is grounded in the lived experience of fieldwork as much as in historical temporalities (Fabian 2014, Trouillot 1995) and the temporal frameworks of anthropological analysis and writing (Strathern 1999, Hastrup 1990). In an incisive analysis of anthropology's investments in practices of documentation, Riles argues that "ethnographic response is part art and part technique, part invention and part convention, part the ethnographer's own work and part the effect of allowing others to work upon the ethnographer" (2006:5). Ethnographic response is a starting point to engage with questions regarding the status of knowledge and its relations to power and authority, memory and subjectivity (Strathern 1999; Verdery 2014, 2018; see also Derrida 1996). Ethnographic accounts stress that the archive does not record, but rather produces knowledge and durability, as a space of production of social epistemologies that have profound political consequences (Stoler 2008). Reflecting on anthropology's own archival impulse, Zeitlyn offers the image of the surrogate to suggest that 'archival materials are surrogates of the events that created them (and digitized records are surrogates of physical originals)' (Zeitlyn 2012:469).

The surrogate status of the archive and its materials relies on a conceptual apparatus of alternation, substitution, supplementation and reproduction. The relations between record and event, trace and impression, digital and physical form, surrogates and originals, and the ways they relate to the production of data and evidence in the anthropological enterprise and beyond it, become fundamental, particularly as a result of the entanglement of infrastructures and scientific practices. However, in the "bionformation turn" which has transformed forensic science over the past two decades, the image of the surrogate invoked by Zeitlyn (2016) is no longer sufficiently capacious to figure the complexities inherent in the relations between "digitized records" and "physical originals". Forensic bioinformation is re-configured through sequencing, aggregation and cross-reference, detaching bioinformation from the "physical original" in an unprecedented way. In the process, bioinformation becomes increasingly distant from individuals as it is tied to techniques of automated calculation

that elude public scrutiny, posing urgent questions about the connection between evidence and public interests. If anthropology is relying on a view of the archive and its own practice as one grounded in surrogates, how can it grapple with the transformations in the field of forensics we have described? The article approached questions about ways of knowing in forensics as also having a bearing on ways of knowing in anthropology.

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