NATIONAL BIOETHICS COMMISSION

REPORT
on the use of genetic fingerprints in criminal procedure

The present report is based on the proposals of the academic associates T. Vidalis and K. Manolakou.

General

The detection of persons who are guilty of criminal acts, to render possible their prosecution on the part of the State, is one of the most sensitive issues within the framework of the rule of law. This is because concern for respect for the value of human beings and the protection of the individual liberties of citizens is at the centre of this approach and requires specific limits to the action of official power.

Thus, the search for evidence for the detection of crimes does not proceed at the hands of the competent police, prosecuting and judicial authorities unchecked, with the discovery of the 'truth' as its sole aim. It proceeds in accordance with strict rules which guarantee the observance of the above 'constants' of the rule of law. These rules are formulated, basically, in the Constitution, in instruments of international law on human rights and in the current criminal case law, and find expression in the familiar principles of modern criminal law, such as, for example, the presumption of innocence or the preclusion of self-incrimination. It is in the light of these observations that any method of collecting evidence in criminal procedure, such as the use of genetic fingerprinting, must be judged.

To the extent that this specific method (a) concerns information which is directly connected with the biological particularity of the person examined; (b) presupposes intervention in the body of the person examined; (c) raises issues over the dangers arising from the keeping of the sample, since access to the DNA of the sample makes possible the collection of other genetic information over and above that required for the verification of the identity, the conditions under which it is applied, its reliability, and the type of information which it provides are serious issues of bioethics and, as such, fall within the competences of the Commission.

Genetic fingerprints

The method of genetic fingerprinting is a way of verifying the identity of individuals used in the absence of physical fingerprints; it does not have the same accuracy as and is not absolutely comparable to traditional fingerprinting.

Fingerprints are a phenotypic characteristic; that is to say, they depend upon the genetic constitution of the individual, but also on the (intra-uterine) environment. It is instructive to note that monozygotic twins have the same genetic fingerprints but different physical fingerprints. Physical fingerprints therefore have greater potential for distinguishing between individuals than their genetic counterparts.

On the other hand, it is a fact that the information contained in the whole of the DNA of an organism is *unique*. Consequently, if the whole of the DNA were to be read base by base, it could serve as an absolute means of establishing the identity of an individual, except in the case of monozygotic twins. In spite of this, the method of genetic fingerprinting is based on an

examination of only certain segments of the DNA, and these are not read base by base, and, therefore, the accuracy of the method in the verification of the identity is relative.

Examination for the determination of the genetic fingerprint presupposes access to the DNA of the sample. This means that much more information can *potentially* be deduced than that required for the determination of the genetic fingerprint. It is likely that some of this information will be more 'sensitive' than that collected by means of physical fingerprinting (e.g., hereditary illnesses). Such 'sensitive' information concerns not only the person from whom the DNA sample comes, but are also hereditary features for his/her blood relatives.

Consequently, the range of genetic information which is to be collected from DNA samples should be determined, the weight to be attached to the evidence obtained by the method of genetic fingerprinting should be evaluated, and the conditions under which the implementation of the method is scientifically valid and ethically acceptable should be defined.

Method

Technique

The method of genetic fingerprinting is based on the technique of PCR (polymerase chain reaction). This is an exceptionally effective technique which permits the multiplication of selected segments of the DNA, starting out from a very small initial quantity. Saliva, hairs (with root), sperm, dried bloodstains, flakes of dandruff, or surfaces on which a person has rested contain a sufficient quantity of DNA for the PCR technique.

Precisely because of the exceptional sensitivity of the technique, possible sources of contamination of the original material can lead to a false diagnosis. Such contamination is usually connected with the conditions of collection (admixture of biological material) and the way in which the sample is handled (laboratory practices).
In order to minimise the possibilities of a false diagnosis, the examination of different samples of the same initial biological material, experimental conditions which preclude contamination, parallel analysis of samples of a known genetic fingerprint, and 'blind' analysis (without the researcher knowing the origin of the sample) are advisable.

DNA analysis

The segments of the DNA which are used to make up the genetic fingerprint are relatively short, are to be found scattered in the genome, and consist of tandem repeats of 2-5 bases. The number of repeats is not constant, but differs significantly among the individuals of a population; they are, as we say, polymorphic markers. By examining a number of STRs (Short Tandem Repeats), we establish the *genetic fingerprint*.

Type of information

The biological function of STRs (the parts of the DNA which are examined to make up the genetic fingerprint) is not at present known. They are a class discrete from genes, which codify particles of biological significance, since *genetic fingerprints do not provide information on genetic predisposition or the state of hereditary illnesses*. However, it is not impossible that future

research will show that sensitive information of this kind can also be deduced from genetic fingerprints.

Application

During the course of forensic investigation, the genetic fingerprint of a known sample is compared with the genetic fingerprint of a sample of unknown origin found at the scene of the crime. The expert then pronounces on the probability of the sample of unknown origin coming from the known donor. When the genetic fingerprints of the two samples *match in all the STR loci*, the specialist is called upon to 'evaluate', as it were, the degree to which they match, and usually cites the frequency with which the specific genetic fingerprint is observable in the population - for example, one in 10,000.

In order to determine the frequency of the genetic fingerprint in the population, the frequency of the genotype[1] for each of the STR loci examined is first calculated and then these probabilities are multiplied by one another.[2] [3]

Theoretical prerequisites and practical limitations

For the result of this multiplication - and therefore the frequency of the genetic fingerprint - to be mathematically correct, the population to which

[1] We term 'genotype' the combination of the two alternative forms (alleles) of a genetic locus which have been inherited from each parent.

[2] Risch, N.J., Devlin, B. (1992): On the probability of matching DNA fingerprints, *Science* 255: 717-720.

we refer must consist of randomly mating individuals, what is called a 'panmictic population'.

It is, however, a known fact that the human population is not panmictic, since we do not enter into relationships at random. We select on the basis of certain genetically determined characteristics such as appearance or aroma, and, above all, we use cultural and geographical criteria. Thus, even when we do not choose partners for their genes as such, the population consists in part at least of endogamous groups. If for any reason these groups differ genetically between themselves, certain genotypes will tend to cross with one another and thus the population will not be panmictic. On the other hand, cross-breeding between members of genetically differing groups tends to homogenise the population, but a number of generations is required for this to come about. Until this happens, it is observable that the allele inherited in one locus affects the allele which is inherited in another - there is, that is to say, a correlation between alleles across loci. This correlation remains for many generations in the case of loci borne by the same chromosome.

Check on the theoretical prerequisites[4]

* We choose to study populations whom we regard as *a priori* homogeneous on the basis of racial, national, cultural or geographical criteria.

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[3] Buckleton, J. (1999): What can the 90s teach us about good forensic science, *First International Conference on Forensic Human Identification.*

[4] Lewontin, R.C., Hartl, D.L. (1991): Population Genetics in forensic DNA typing, *Science* 254: 1745-1750. Review.

* Since, however, it is impossible to include all the individuals of the population in the study, the sample of the population which we study is so selected as to consist of persons who are not genetically related.
* We select genetic loci in different chromosomes.
* We select loci which do not affect characteristic such as those of appearance or aroma (the loci which play a part in genetic fingerprints fulfill this condition).
* We check whether there is any correlation between alleles across loci.

If correlations between alleles across loci are detected, this means that the criteria which we used to define the population are erroneous and we can be certain that we are not dealing with a panmictic population. If, however, we do not find these, this does not necessarily mean that the population is correctly defined - simply that we cannot preclude the hypothesis that it is.

It is important that the criterion of the panmixia for the population of reference should be satisfied, because otherwise some genetic fingerprint may in reality be more frequent than we have calculated, so that the probability of it 'matching' by chance that from the scene of the crime while coming from a different person is significantly greater and can mislead us.

Results of the practical limitations

* The frequencies of each genotype have been assessed by means of sampling and thus are not absolutely accurate. By then multiplying the frequencies by one another in order to find the frequency of appearance of the genetic fingerprint, the inaccuracy contained in each of these is also multiplied. Consequently, it is important not only that the frequency of

appearance of a fingerprint should be stated, but also what are the extreme values (upper and lower) which it can take on because of sampling error.

* Whatever is the frequency of appearance of a genetic fingerprint, this does not mean that it is encountered only once. For example, if the frequency is one in a million and the population is eight million, eight different people can be expected to present the specific genetic fingerprint.

International and Greek realities

In spite of the fact that the use of genetic fingerprinting in criminal procedure is already implemented in Greece and in many other countries (see *comparative legislative data*) and several countries have in the last three years begun population studies with a view to being able to incorporate the method of genetic fingerprinting into their legislation, no international criteria have emerged as to the number of loci which are examined. The European Network of Forensic Science Institutes (ENFSI, http://www.ensfi.org) defines an optional operational framework for the contracting states and provides the member-states (25, including Greece) with know-how. In this context, the use of 13 genetic loci in the determination of the genetic fingerprint is recommended.

Member-states such as Japan, Portugal, Italy, and Slovenia, who are, apparently, at the stage of population studies, have published certain data in international forensic science journals during the last decade, reporting that they use between nine and 13 loci.

In Greece, the method of fingerprinting for the detection of crime is already used, but we are unable to find published studies in international journals dealing with population data.

It is stated in the web page of the Ministry of Public Order (http://www.ydt.gr) that five loci are used; only two of these are among the 13 recommended. The population study for the calculation of the frequencies of genetic fingerprints is based on random sampling of 300 individuals (personal communication).

However, within Greek territory various indigenous languages[5] and religious groups, as well as aliens of various national origins co-exist. As to the indigenous groups, some of these in all probability constitute endogamous communities and it has yet to be clarified whether they are genetically differentiated, while it is certain that data are also required on the foreign resident populations.

According to the information supplied by the Ministry of Public Order, thanks to the genetic fingerprinting method, one convict has been cleared of charges by the courts and another suspect has been charged (in the same case).

At an international level, the use of the method has undoubtedly helped in the investigation of many crimes, as can be seen from the annual reports of the American and European prosecuting authorities. At the same time, the method of genetic fingerprinting has won fervent supporters in the circles of organisations opposed to the death penalty, who have sought the re-examination of evidence and have demonstrated in a number of instances the innocence of those sentenced to death. Action of this kind led the Governor of Illinois, George Ryan, on 30 January 2000, to suspend all executions in that state, given that in the majority of cases the innocence of those sentenceded to death had been proved.[6] The method of genetic fingerprinting

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[5] *The minority question in Greece*, Kritiki publications, 1997, pp. 349-414.

[6] Reilly, P.R. (2000): Capital Errors, *Nature Genetics* 24(3): 219.

has, however, also led to wrongful arrests. The example of a Briton who was arrested because his genetic fingerprint 'matched' that found at the scene of the crime but who had an alibi, while there was no other evidence apart from the genetic fingerprint, is instructive. When the same samples were analysed for four additional loci, it was shown that the fingerprint which had been found could not have come from this individual.[7] Re-examination of genetic fingerprints is more or less standard practice. This has led to the development of a whole labour market for experts who testify either for the defence or the prosecution. Nevertheless, it has been observed that strict scientific and ethical criteria are often lacking in practice.[8]

Comparative legislative data[9]

Apart from its use in other procedures (for example, within the context of family law for affiliation procedure), the DNA test can also be applied in penal procedure to verify the identity of an individual, as a particular method of 'autopsy on the person'.

Unlike the case of Greece - where the method already seems to be applied, on the authority, apparently, of the general provisions of penal procedure[10] - in a number of countries now, specific laws are either already in force or are being prepared (e.g., *USA, Canada, Netherlands*), or specific regulations are

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[7] Moenssens, A.A.(2000): A mistaken DNA ientification? What does it mean? (http://www.forensic-evidence.com).

[8] Erzinclioglu, Z. (1998): British forensic science in the dock, *Nature* (392): 589-860.

[9] See, indicatively, Crosby, D.: Protection of Genetic Information: An International Comparison, on www.hgc.gov.uk, 2000, particularly pp. 9-26, 51-80, 80-88; Kimmelman, J.: The Promise and Perils of Criminal DNA Databanking, *Nature Biotechnology* 18, 2000, pp. 695-696; Tak, P.J-P. - Van Eikema Hommes, G.A.: Le test AND et la procédure pénale en Europe, *RSC*, 1993, pp. 679-693.

[10] See the official web page of the Ministry of Public Order (www.ydt.gr/minist4.htm)

being formulated within the general framework of penal procedure (e.g., *Australia, Great Britain, Germany, France, Denmark, Norway*, etc.) to cover this field.

Six basic categories of issues which are of concern to the legislator in this area can be distinguished; these relate to: (a) the nature of the sample for the application of the method; (b) the seriousness of the crime being investigated; (c) the part played by the individual examined; (d) additional restrictions on the carrying out of the test; (e) those responsible for the application of the method; (f) the fate of the sample and of related information following the specific use. These categories are examined in detail below.

The nature of the sample

In certain Anglo-Saxon legislations (*Great Britain, Australia, Canada*), samples are divided into those of an 'intimate' or 'non-intimate' character, depending upon the part of the body from which they have been taken. The former include, for example, blood, saliva, pubic hairs, or secretions from the genitals or the female breast. 'Non-intimate' samples are, for example, hairs from other parts of the body, nail clippings or other bodily secretions. The distinction is of importance particularly when there is provision for fewer guarantees in favour of the person examined in the case of 'non-intimate' samples (see in greater detail below).

The seriousness of the crimes

In most legislations, the application of the method is not provided for in every case, but only for the investigation of the most serious crimes. Thus, in *Germany* and *Ireland* there is a general clause in this connection (without further determination of these crimes), in *Denmark* it is prescribed in the case of crimes which entail imprisonment of at least 18 months, and in *Australia* for crimes which entail imprisonment of at least 12 months. In the *United States*, the legislations of the different states vary widely, usually using as a criterion the nature of the crime (ranging from sexual or 'violent' crimes to any crime).

The role of the individual examined

The free consent of the individual examined to the application of the method is the general norm. The principle of consent of a person who undergoes interventions of any kind in his/her organism is stipulated both in the *UNESCO Declaration on the Protection of the Human Genome* (Article 5) and in the *Convention of the Council of Europe on Human Rights and Biomedicine* (Article 10). In certain legislations there is provision for the taking of the sample even by the use of force on the part of those competent ("reasonable" force in the case of *Australia*, "necessary" force in that of *Canada*). In others (*Great Britain, Ireland*), though there is no provision for the use of force, refusal of consent may be freely evaluated by the judge, who may deem such refusal sufficient to conclude that the individual examined is guilty. In *Germany*, however, an individual may refuse consent on the same grounds as he/she can refuse to testify.

An exception to the rule of free consent can usually be identified in the case of minors and those lacking the capacity to consent. Here consent of the

lawful representative and/or an order of the court for the application of the method is stipulated (*Germany, Australia*).

In some cases there has been provision for the prior briefing of the individual examined, so that he/she is properly informed before consenting. The information concerns chiefly the procedure for the carrying out of the test, its purpose, the need for consent, and the consequences of refusal (*Australia*, *Denmark*).

In some cases (*Great Britain, Ireland*), it is provided that consent is to be written.

Additional restrictions on the application of the method

In all legislations there are certain additional restrictions on the application of the method, as guarantees of the rights of the individual examined. Such restrictions are, more particularly, the necessity for the test (as opposed to its application in every case - *Denmark, Norway, Great Britain, Netherlands, Germany*), the observance of the principle of proportionality (so that it should not entail harm to the individual examined - disproportionate to the aim pursued - *Australia, Canada, Denmark, Norway*), and other guarantees of the protection of the personality, such as, for example, the taking of a sample by a person of the same gender or the prohibition of the putting of questions in parallel with this procedure (*Australia*).

Those responsible

The judge/examining magistrate, as the *par excellence* independent factor in the penal procedure, gives orders for the carrying out of the test. There are,

however, exceptions in the various legislations. Thus, in *Sweden* the order may be given by the public prosecutor, as it may in Germany (in urgent cases), while in *Norway* in urgent cases, police officials also possess such powers. The same is true in *Australia* and *Great Britain* when the individual examined refuses to consent to the examination of 'non-intimate' samples (see A above).

The taking of the sample is usually entrusted to a doctor (*Denmark, Norway, Sweden* and *Great Britain* in the case of certain samples) and its examination to a specialist. In *Germany* the specialist must not belong to the investigating authority and the sample which he/she examines is anonymous. In the *Netherlands* there is a right for the person involved to be present at the examination of the sample, together with a specialist of his/her choice, as well as a right to seek the appointment by the examining magistrate of another specialist for this examination.

The fate of the sample and of the information

After the information on the identity of the individual has been obtained, certain legislations expressly provide for the destruction of the sample (*Australia, Netherlands*). In *Australia*, the sample must be destroyed at the latest within six months from being taken (but with certain scope for the extension of this period), after the person examined has been provided with a copy of the analysis. In 29 states of the United States, a prior application for the sample to be destroyed is required.

In *Germany*, the penal procedure provision which provides for the keeping of the sample of the same person for future use where there is evidence of new, serious offences has recently been held to be in accordance with the

Constitution.[11] There is a similar regulation as to the collecting and use of samples in Canada.

In *Australia* the creation of personal files containing the information from the examination of samples is prohibited; it is, nevertheless, possible for a file to be created for statistical reasons provided that it is ensured that individual identification on the basis of it is not possible. In *Canada*, on the other hand, there is provision for the keeping of a file with a special service unit, the National DNA Data Bank, for the prevention of serious crimes. This legislation has, however, been called into question and strongly criticised, in view of the risks for citizens' rights involved. In the federal legislation of the *USA* the operation of a data bank of the FBI for DNA of persons convicted of certain crimes (sexual, against minors, etc.) is provided for. This bank has links with similar banks operating locally and at state level.

It should be noted, however, that in most legislations there are no specific provisions on the protection of genetic information, as to which the general provisions concerning the protection of medical data, as a part of personal data, are in force. By way of exception, a special provision on "hereditary characteristics data" is to be found only in the *Netherlands* law on personal data. There is also such a provision in the *UNESCO* Declaration referred to above (Article 7).

Twenty-three states of the USA permit access to the files for the purposes of research which could in the future assist the work of the prosecuting or judicial authorities and one state permits the use of genetic fingerprints in medical research. The condition of the anonymity of the genetic fingerprint is statutorily safeguarded in most cases of its use for research purposes.

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[11] BVerfG/14.12.2000.

Findings

The above data are of use in drawing certain conclusions in connection with the reliability and the conditions of the employment of the method of genetic fingerprinting, in accordance with the fundamental values of the rule of law.

1. When the genetic fingerprints of a sample found at the scene of the crime do not 'match' absolutely those of a suspect, it is certain that they cannot come from one and the same person and thus this is an absolute presumption of innocence.
2. When the genetic fingerprints of a sample found at the scene of the crime absolutely 'match' those of a suspect, this should not be taken to be, independently and in itself, a sufficient presumption of guilt, given that the method gives expression to the probability of their coincidence by chance. The more common a genetic fingerprint is in the population, the greater is the probability of chance coincidence and the greater the sampling error involved. The probability of chance coincidence can be reduced - and thus the weight of the presumption of guilt be increased - if a large enough number of loci is examined and appropriate statistical processing is employed.
3. The use of genetic fingerprints in penal procedure presupposes authoritative population studies on the STR loci which are used for their determination so that the method can be practised with reliability.
4. The introduction of special regulations on the use of genetic fingerprints in penal procedure is a substantive guarantee of the protection of the individual examined. That the specific method should be covered by the

general provisions of penal procedure - a practice followed today by the prosecuting authorities - *is not sufficient* to ensure, preventively, respect for the value of human beings and fundamental rights, because of the particularly sensitive texture of the issue.

5. By its very nature, the whole procedure (taking and examining of a sample) is carried out in conditions of *increased risk* both to respect for the value of human beings and to certain individual freedoms of the individual examined. Thus, regardless of whether there are the means available of ensuring that these goods are not adversely affected, *the very fact that they are put at risk* is a deterrent to the indiscriminate use of the method.

This risk consists, as such, in the *disproportionate restriction* of individual autonomy, particularly when the detection of less serious crimes is the objective. However, the carrying out of the test on the initiative of the individual involved in order to prove his/her *innocence*, regardless of the seriousness of the crime, must constitute an exception. That is, it is correct that a *right* of the individual in this connection which could be exercised in every case of the investigation of a crime should be recognised.

6. On the taking of the sample from specific areas of the body of the individual examined, particular care should be taken *not to infringe the personality*. Regardless of the nature of the sample, respect for human value demands that when a sample is taken, methods should be used which preclude pain being caused.

7. The prerequisite of *free consent* of the individual to the application of the method, and, moreover, after he/she has been *fully informed* of the conditions in which the test is carried out and of the consequences of its results, is a factor which guarantees par excellence respect for the value of human beings; the absence of this factor would turn the individual examined

into a simple 'means' for the discovery of the 'truth'. An additional guarantee for the protection of the individual examined would be the provision that consent should be given *in writing* and that it should be certified in the same way by the person examined that full information has been ensured.

In the face of the possibility of the individual examined not consenting, there are, basically, two approaches (in accordance with the legislations of other countries). The first, that of the use of force in obtaining a sample, would seem to correspond to familiar regulations of penal procedure on the collecting of evidence (e.g., enforced attendance of a witness). However, it should not be overlooked that forcible *intervention in the body* of a person differs qualitatively from other restrictions of his/her fundamental rights, since the possibility of turning the individual into a 'means' again presents itself (protection of human value). For this reason, in any event, the extreme form of such interventions - the infliction of torture in the search for truth - has long been condemned, a fact which is specifically expressed in most constitutions and international legal instruments. The adoption in this instance of the other approach, which accepts the *free drawing of conclusions by the judge as to an individual who refuses the test*, would thus appear to be more correct. Such a practice will perhaps be regarded by some as 'blackmailing the will' of the individual and so forcing him/her, in the end, to accept the test. Nevertheless, on the one hand, it cannot be assumed that the judge will necessarily arrive at unfavourable conclusions - when, moreover, the reason for refusal relates in a direct way to the dignity of any individual and not only of the person involved - and, on the other, this solution does not go so far as to infringe lawful goods of the person involved, as the first does.

8. The method should be employed: (a) *On the initiative of the competent authorities*, only when other lawful means of collecting the specific evidence have not produced results or when they provide completely unclear information which requires supplementation. *Recourse to this method without investigation by other means having been carried out exhaustively gives rise, because of its* sui generis *nature, to disproportionate risk to the rights of the individual and of his family*; (b) *On the initiative of the individual involved in order to prove his/her innocence*. Furthermore, in the carrying out of the test, the principle of *proportionality* must be observed (e.g., a quantity of the sample greater than that which is, in the particular case, absolutely necessary on generally accepted scientific criteria should not be taken).

9. Because of its gravity for the state of the rights of the person examined, the method should be employed on the *order* and under the *constant monitoring of a judge*. In urgent cases, this power may be entrusted to a public prosecutor, but not to the police authority. The taking of the sample should be entrusted to a *suitably trained person* and its examination to a *specialist*, who should not have been involved in other acts of investigation of the same case. It would be correct to provide for rights of the interested party to be represented by a technical adviser at the examination of the sample and to seek *re-examination* of the sample by another expert.

10. The carrying out of the test in penal procedure is of interest only in order to establish the *identity* of the individual. The collection and storing of samples which have been analysed is not justified in the pursuit of the specific aim. This is justified only if the collection of other information (e.g., on the hereditariness of diseases) is sought, irrelevant to the penal procedure, the unchecked use and dissemination of which may infringe fundamental

rights of the person involved. Furthermore, even if a 'samples bank' is of assistance to statistics on criminality, what is being risked, in every case, is the dissociation of the crime from the specific act and its association with 'types' of criminality, in a way entirely at odds with the logic of criminal law under the rule of law. These risks, in the last analysis, call for the provision of the *destruction of the samples* immediately after their use in the specific cases.

The keeping of files containing *information on the identity* of the persons who have been examined is, however, a different question. For the prosecuting authorities such a file would be of use only if the name of the individual who had been examined continued to appear next to the specific information from the genetic fingerprint. In this event, the usefulness of the file would be comparable with that of physical fingerprint files. Viewed from a different angle, however, if the *anonymity* of the files were ensured (e.g., under the control of the Authority for the Protection of Personal Data), the information derived from the application of the method could be of use to other service units for scientific purposes, on condition of the special consent of the subjects of the relevant research.