Sexual assault offenders can be convicted more easily with Danish researcher's method

Based on the Danish article at Videnskab.dk "Voldtægtsforbrydere kan nemmere dømmes med danske forskeres metode"

Now it is possible to see how much a DNA match between a suspect and a perpetrator should weight by means of knowledge about the suspect's male relatives.

A match between DNA profiles at a crime scene and a suspect is not always convincing evidence. A new mathematical method helps the court to calculate the evidential weight of the match. (Photo: Shutterstock)

When the court gives their verdict of someone accused of murder or rape, the evidence must be reliable and assessed correctly so that innocent people are set free, and criminals are sentenced.

In recent years, the discovery and our understanding of DNA has made that task easier.

For example, DNA profiles are very useful in release a suspect (if the suspect's DNA profile is not consistent with the DNA-profile found on the crime scene).

In cases where DNA matching the suspect has been found, there may still be doubts (more about why in a moment).

How much weight should DNA evidence be given? That is exactly what Mikkel Meyer Andersen is researching. And together with his colleague from Australia, he has developed a mathematical method that can help solve murder cases and sexual assault crimes among others.

Their method is better at interpreting and presenting the information in DNA profiles than the methods that have been used so far.

This means that experts better can explain the court what it means and how much weight it has when a suspect has the same DNA profile as was found at the crime scene.

What do you do when several people have the same DNA profile?

Before explaining the method, we have to explain a bit about the background. There are several types of DNA profiles that can be used in different situations.

What they have in common is that they are both only looking at a small part of the DNA – and these are places where people often differ (and technically behave nicely so one can get robust results).

Because one only looks at part of the DNA, it means that several people, in principle, can have the same DNA profile .

So just because a suspect's DNA profile matches the DNA profile found at the crime scene, it does not mean that it was necessarily left behind by the suspect.

This is quantified through an evidential weight of a match between the suspect's DNA profile and the DNA profile from the crime scene.

Slightly simplified, this weight measures how frequent the DNA profile is in the population in relation to how likely it is that a random person has the same DNA profile.

If the profile is frequent, it is not as incriminating as if it is very rare.

The evidential weight is the probability of seeing the DNA profile in question if the suspect is guilty (that is, the DNA profile is left by the suspect) divided by the probability of seeing the DNA profile in question if the suspect is innocent (i.e., the DNA profile is left by someone else).

Notice that the evidential weight does not state probability of guilt – it measures the ratio between the probability of observing the evidence in two scenarios (here guilt or innocence).

It is not uncommon to get an evidential weight of one million. It must then be presented as being one million times more likely to see a DNA match if the suspect is guilty than if the suspect is innocent (see the fact box).

How to use DNA profiles in practice

For many types of crimes, a so-called autosomal DNA profile can be obtained from the perpetrator (one, which is based on the first 22 pairs of chromosomes that are not sex chromosomes).

Such a DNA profile can help link crimes with the same perpetrator or perhaps even find the perpetrator in the DNA register.

If one already has a suspect, one can calculate the evidential weight of a match between the suspect's DNA profile and the DNA profile of the perpetrator (as described above).

In the case of sexual crimes, one can only sometimes obtain a traditional DNA profile from the perpetrator, for example from a stain of semen and then calculate the match.

However, this is not always possible. Instead, one can sometimes collect a mixture of the victim's cells and the perpetrator's cells (for example skin from under the victim's nails or from a vaginal swab).

Facts

Guilt is not calculated

Unfortunately, a mistake called "Prosecuter's fallacy" is sometimes made, and the evidential weight are falsely presented as being one million times more likely that the suspect is guilty given the DNA match than the suspect being innocent given the DNA match.

But one cannot put it this way.

To convert the evidential weight into probability of guilt, one must use prior odds that the suspect is guilty (from before looking at the DNA evidence), which is something the court needs to consider.

As an expert one must consider the evidential weight – not the question of guilt.

But this creates another problem: The cell mixture will often have many, many times more of the victim's cells than the perpetrator's.

This means that if one does autosomale DNA profiles based on the cell mixture, the victim's DNA profile will drown out the perpetrator's DNA profile completely, and one will only get the victim's DNA profile.

The solution to this problem is to take advantage of the fact that victims of sexual crimes often does not have a Y chromosome, while the perpetrator typically has a Y chromosome.

Then one can make a Y-DNA profile instead of an autosomal DNA profile, and because the victim does not have a Y chromosome, one will only get the perpetrator's Y-DNA profile. That is smart.

However, the assessment of the evidential weight is more difficult than with autosomal DNA profiles.

So, what do one do then?

How do we find the evidential weight for Y-DNA profiles?

Y chromosomes are inherited as a unit from father to son, except from some mutations. That is why Y-DNA profiles are a lineage marker – it tells us which male lineage you are part of.

For many years, however, there were doubts about how many generations away from a man the same Y-DNA profile could be found.

Some of the research that Mikkel and his colleague have done is precisely to figure this out. This is because it is important for the calculation of the evidential weight.

Due to other genetic and thus statical properties, the methods from the autosomal DNA profiles cannot be used to assess how much weight to ascribe a match (between the suspect's DNA profile and the perpetrator's DNA profile) of Y-DNA profiles.

However, Y-DNA profiles can still be used to rule out a suspect in the same way as autosomal DNA profiles can.

How many have the same Y-DNA profile?

For a long time, there have not been any methods to assess and calculate how much weight to ascribe a matching Y-DNA profile.

In 2017, a research colleague and Mikkel published a scientific paper proposing a way to assess the evidential weight for match of Y-DNA profiles.

You can read much more about this method in the Videnskab.dk article 'Researchers will help the court rule rape cases' (in Danish).

In the method they estimated how many in the world that could have the same Y-DNA profile.

They argue that it is only in the relatively close male lineage that one will find men with the same Y-DNA profile.

And what does 'relatively close' mean? It is of course father/son, uncle/nephew, grandfather/grandson, cousin, but also great-cousin and further out.

In other words, the relatively close male line can also include relatives that one does not even know exists.

Does this mean that the method is not specific enough?

In no way. It helps narrowing down the field of possible perpetrators to under 50 worldwide – and often less.

In addition, the suspect must have been close to the crime scene at the given time which reduces the number of suspects even further.

Mutations in the family's DNA are bad for the suspect

In 2019, Mikkel and his colleague made an extension of the method, so that knowledge about the male relatives can be taken into account, such as number of brothers, and whether some close relatives have the same or different Y-DNA profile (i.e., whether a mutation has occurred or not).

This can be essential, as they in 2017 showed that it was only relatively close male relatives that would have the same Y-DNA profile.

For example, if it is known that the suspect's grandfather does not have the same Y-DNA profile as the suspect, a mutation has occurred either between the suspect's grandfather and father or between the suspect's father and the suspect.

Specifically, this means that one expects fewer people to have the same profile than if one does not take this knowledge into account.

In other words, it is incriminating for the suspect if any close ancestors do not have the same Y-DNA profile.

In the work, they quantified how the evidential weight changes in different situations (for example if father/brother/grandfather does not match).

Here their method can be used

What can this be used for in practice? A great deal.

In fact, the method is being used in an ongoing murder case in Norway that you can read about right here.

Furthermore, it is mentioned in the widely recognized guidelines from International Society for Forensic Genetics (ISFG), which means that it is one of the methods that forensic geneticists can use worldwide.

Thus, the method helps the court determining how much weight they should ascribe a match between DNA found at the crime scene and the suspect.