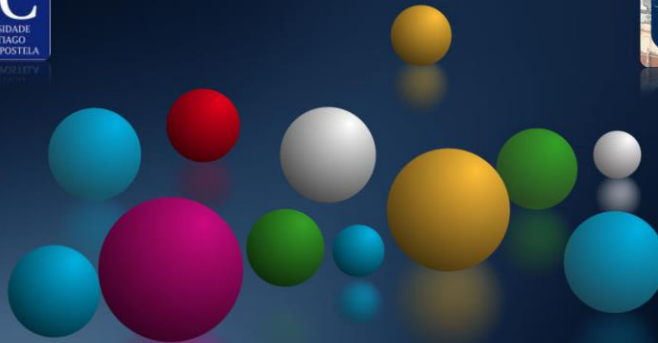
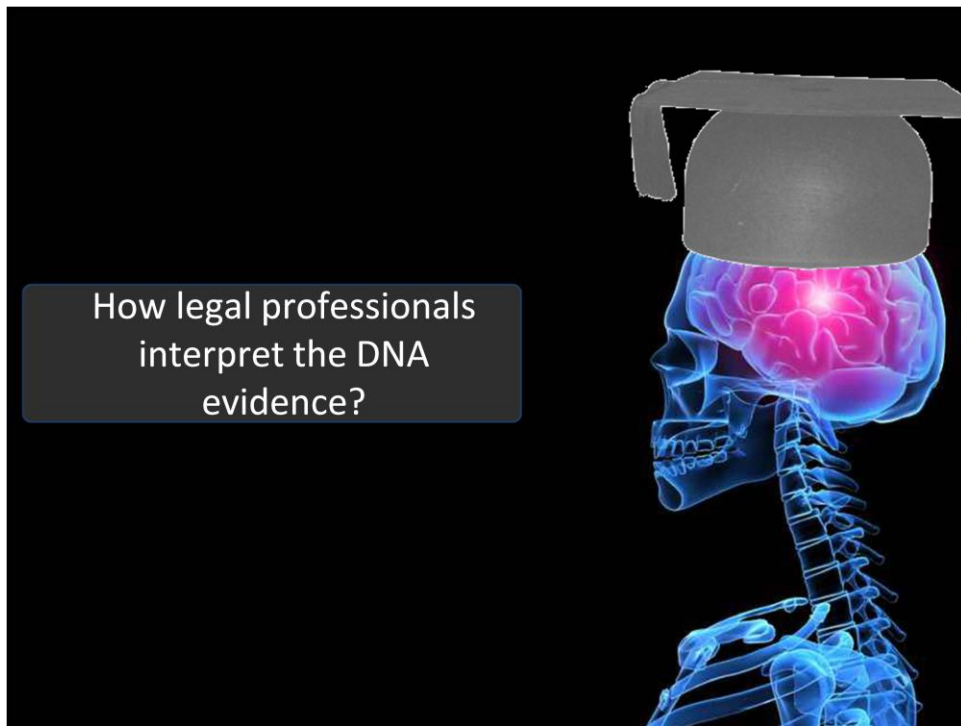


# The impact of the statistical evaluation of the DNA test in judicial sentences in Spain

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More and more frequently, the court requires DNA analysis in order to clarify who committed the crime or how the crime was committed. In Spain, DNA analysis with forensic purposes is widely used in more than 45 laboratories throughout the country, all of which belong either to a university, the government or private companies.



It is not necessary for judicial professionals (prosecutors, lawyers and judges) to perfectly understand the DNA test from a biological point of view, but the understanding of its meaning and limitations is crucial in order to correctly evaluate the biological evidence.

With study, we wanted to know how the legal professionals interpret the DNA evidence in real cases by analyzing real judicial sentences.



# Miscommunication?

- Aim of this study: to test how the meaning of DNA analysis is understood by the legal community
- Compilation of sentences reported by provincial courts in Spain. The content was analysed in order to know:
  - if the statistical interpretation of the DNA evidence is included or not
  - ~~Association fallacies~~



Usually, forensic geneticists statistically evaluate their findings through likelihood ratios (LR). The LR is a concept that is not easily understood by legal professionals and geneticists are not always able to explain it properly. This is the reason why there is frequently some misunderstanding, but the great differences in the language and expertise between both the legal and scientific fields also contribute to this misinterpretation.

We have compiled sentences reported by provincial courts in Spain and their content was analysed in order to know if the statistical interpretation of the DNA evidence is included or not, and if so, if it is understood. We have also paid attention on association fallacies, although we don't have time to discuss them here.

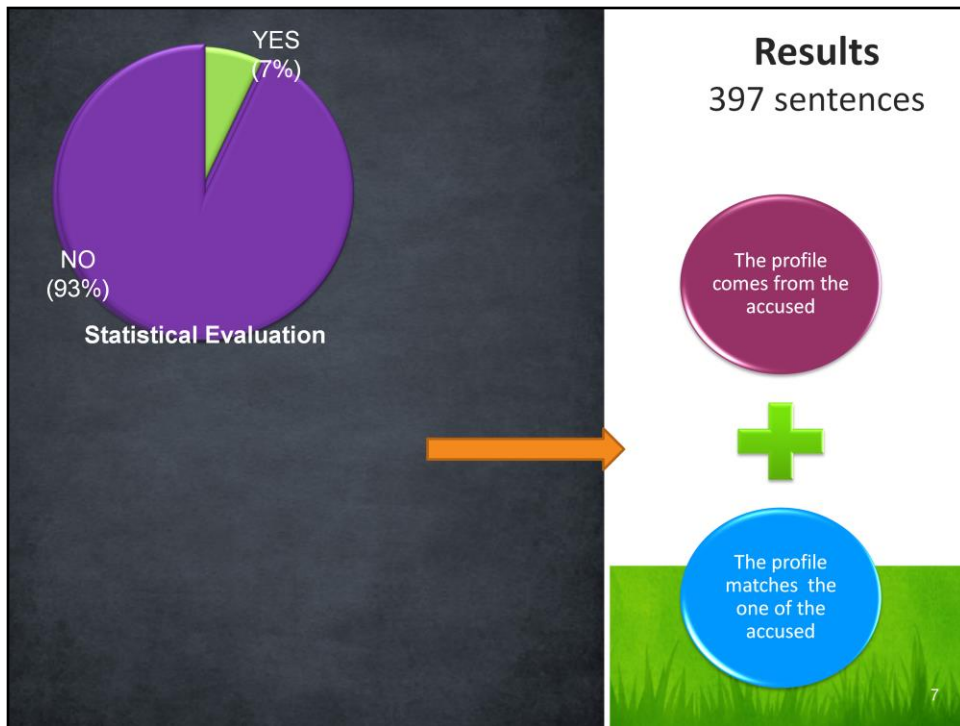
# Materials and Methods

- Search of sentences in the official searcher of jurisprudence (<http://www.poderjudicial.es/search/>), by following searching criteria:
  - Jurisdiction: criminal
  - Type of document: sentence
  - Type of legal body: Provincial Court
  - Date: from January 1st, 2013 to July 7th, 2014
  - Key word: DNA

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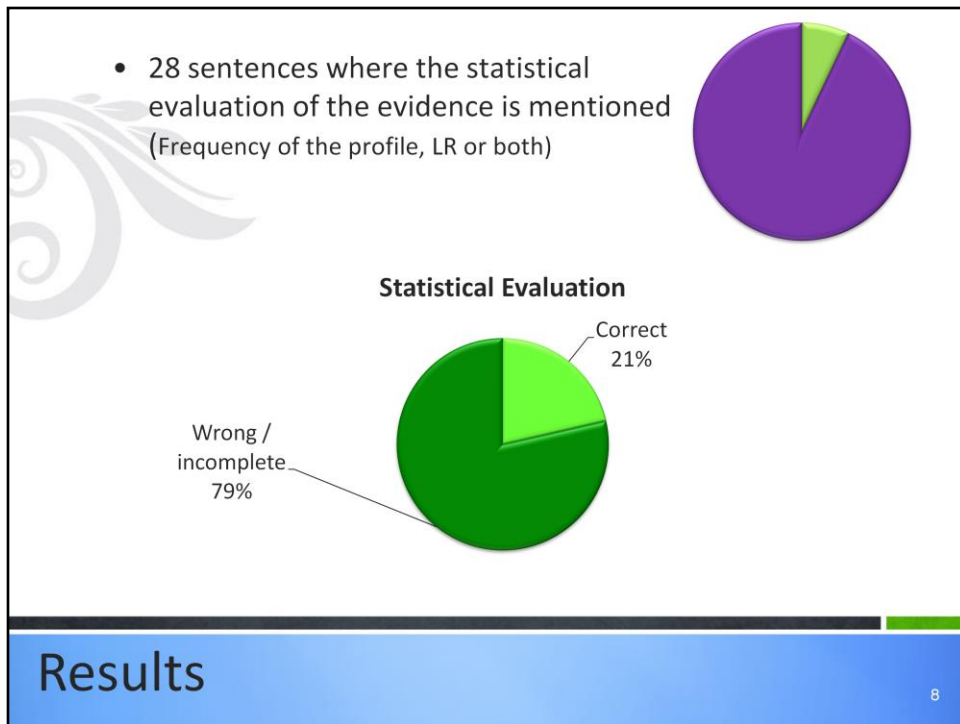
We have carried out a search of sentences in the official searcher of jurisprudence located at the web site of the Consejo General del Poder Judicial (Judiciary Branch of Government): <http://www.poderjudicial.es/search/indexAN.jsp>. We have used the searching criteria of the slide, and we added DNA as a keyword.



By using these searching criteria, a total of 397 sentences were found. And we can classify these sentences in 2 groups: the ones where the statistical evaluation of the evidence is mentioned and the ones where it is not. As you may have guest, the purple portion are the sentences without (369, 93%) statistical interpretation, and the green portion are the ones where the evaluation of the DNA test is mentioned. At the same time, these purple sentences can be grouped in 2 categories:

Group 1: sentences where it is directly stated that the genetic profile found in the evidence belongs to or comes from the accused (or the victim); several of them even assure this fact with “scientific certainty” or “certainty of 100%”.

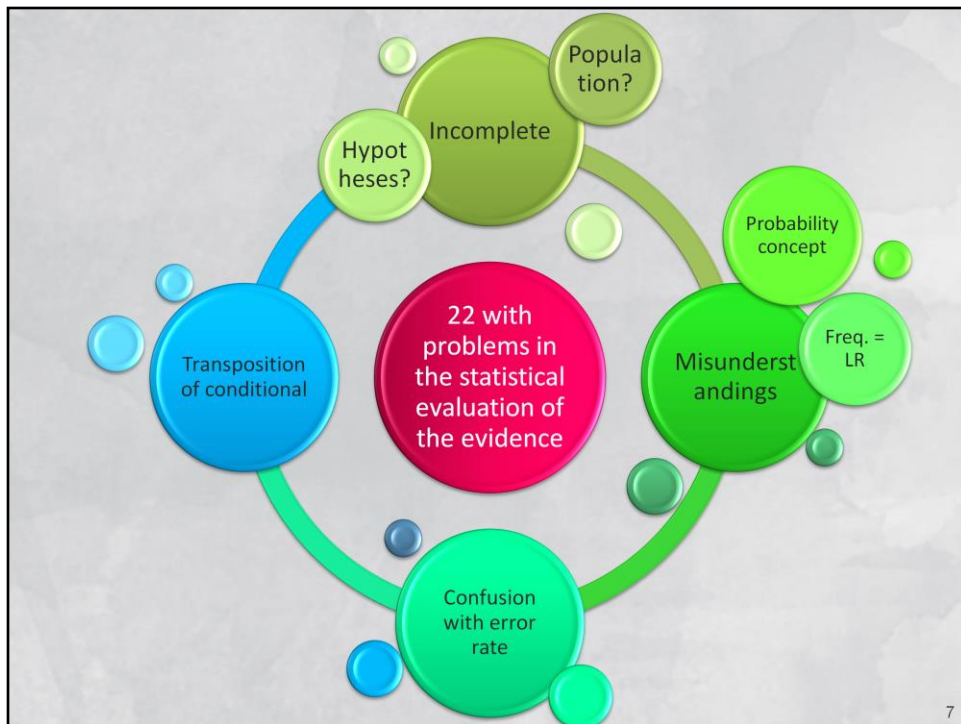
Group 2: sentences where it is stated that the profile in the evidence “match” (or “is compatible with”) the profile of the accused (or the victim), that is to say, words such as “belongs to” or “come from” are avoided, but the value of the DNA match is not included. In this way, a partial profile would have the same strength as a complete profile, which it is not true.



Regarding to the rest of sentences, the remaining 7%, they are 28 sentences where the statistical evaluation is mentioned.

Only 6 of these 28 sentences correctly outline and interpret the meaning of the statistical evaluation of the evidence. The rest, almost 80%, are sentences with wrong or incomplete statements.

Most of the correct sentences limit themselves to reproducing the conclusions of DNA reports. Nonetheless, we also have to say that we've detected some errors in the conclusions of some DNA reports such as not using the proper reference population.



22 out of the 28 sentences which included the statistical evaluation of the test show problems. And you can see here the four main types of problems. Some of them include incomplete statements such as a lack of definition of the reference population that was taken into account, or the lack of definition of hypotheses to be compared with when LR's are used to evaluate the evidence.

Other very common and well known problems are the transposition of conditional or the misunderstanding of the concept of frequency, probability and the confusion between the frequency and the LR. Finally, we have found several sentences where there is a confusion between the reliability of the test (the error rate) and the evaluation of the results of the test (RMP/LR)

## Results: incomplete

Lack of hypotheses when LR is used to evaluate the evidence. Sentence 2806/2013 - Bilbao:

- “The DNA report concludes that the genetic profile of the accused matches the one of the 2 cigarette butts collected from the hall of the crime scene, being the forensic index named “likelihood ratio” equal to 282 trillion.”



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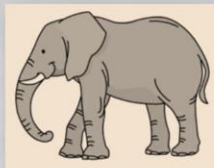
Now let's see some examples of each of these types of errors. Firstly, the incomplete ones. Let's see only an example of a sentence with lack of hypotheses when LR is used to evaluate the evidence, although we can imagine them. In this sentence of the Bilbao Court you can find the following paragraph....



## Results: transposition of conditional

Gender violence case where a pregnant woman was presumably killed by her husband (determining the paternity of the fetus was relevant for the case)

- “... according to the declaration of one of the DNA experts during the trial , this result means about 24 million times more likely that the accused is the biological father than the father being another individual of the population” (Sentence 20461/2013 – Madrid)



$P(E|H) = P(4 \text{ legs} \mid \text{it's an elephant})$



$P(H|E) = P(\text{being an elephant} \mid 4 \text{ legs})$

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Transposition of conditional is one of the most famous errors when statistically evaluating the DNA evidence. This is a gender violence case where a pregnant woman was presumably killed by her husband and where determining the paternity of the fetus was relevant for the case since the punishment is higher if aggravating circumstances such as a family relationship are proven.

And you can see the following statement in the sentence. You see that in this sentence the judge is exchanging these 2 probabilities ( $P(E|H)$  and  $P(H|E)$ ), and you see that both are different.

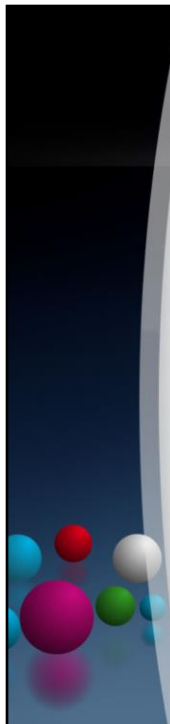
## Results: missunderstandings

- Sentences with statements reflecting that the Court does not understand the evaluation. Examples:
  - 556/2014 - Tarragona: “...with a probability greater than 5 million”
  - 8059/2013 - Madrid: “...the genetic profile appears in the Spanish population with a proportion of 1 person in 260.379 to the square 290.000 possibilities not related genetically”.
  - Sentence 19031/2013 - Madrid: “The DNA report (pages 79-81) has been confirmed during the trial and concludes that the DNA profile obtained from the sample belongs to the accused, adding that the profile is repeated in the Spanish population with a frequency of 25.000 trillion individuals”.

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In the case of sentences with misunderstandings, we have a plethora of different types, ranging from basic errors such as reflecting values of probability greater than 1 to nonsense. But look at the last judicial sentence of the Madrid Court: ... that is to say, the profile is really frequent since all the individuals in the Spanish population show this profile, the judge is understanding the opposite.



## Results: confusion with error rate

- 58/2013- Ibiza: "...the DNA profile of the accused detected in the bed sheet is an indisputable proof of the guilt of John Doe since the identification through the DNA test enjoys a great prestige. The DNA experts, authors of the identification report that was confirmed during the plenary, even stated that the margin of error is 1 in 3 trillion".

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Finally we'd like to show you an example of a sentence reflecting confusion between the evaluation of the test and the error rate of the DNA test. This is only one example, but there are several in the wrong sentences.


I'm sure the DNA experts were refereeing to the RMP when they gave the value 1 in 3 trillion.

## Results: confusion with error rate

- Errors occur, and usually with a frequency several orders of magnitude higher than the chance of a coincidental match.
- Errors: sample switches, contamination, clerical errors in the reports...
  - NFI: Kloosterman A. et al., Error rates in forensic DNA analysis: Definition, numbers, impact and communication. FSIGen 12 (2014): 77-85
- Currently, when DNA evidence is being statistically evaluated, an error rate = 0 is being supposed
  - Error rates could be included in LR's (Gill P., Misleading DNA evidence, 2014, Academic Press)

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Obviously thinking that errors are impossible to occur during the DNA test is naïve. Errors do occur, and usually with a frequency several orders of magnitude higher than the chance of a coincidental match. These errors can include sample switches, contamination, malfunctioning equipment or reagents, clerical errors in the reports, etc. Although it is difficult to estimate the error rate of a Laboratory we can find some good examples in literature (Kloosterman). And it is very important to clarify to the Court that when we are evaluating the evidence we are supposing an error rate of zero, unless we are including the error rate in the LR, as some authors suggest (Gill)



## Our conclusions

- Statistical evaluation of DNA results is not usually included in the judicial sentences in Spain
- Although some sentences include the evaluation, the legal community doesn't seem to understand the real probative value of this piece of evidence.

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After showing you all this problems, you may guest that our conclusions are really simple.

Statistical evaluation of DNA results are not usually included in the judicial sentences in Spain

Although some sentences include the evaluation, the legal community doesn't seem to understand the real probative value of this piece of evidence.

# Why?

Judges and prosecutors are civil servants that have passed a competitive state exam and then enter the Judiciary School where they take mandatory courses over a year.

Interpretation of scientific evidence is not included in the curriculum

## FAQs:

What is the reliability of the DNA test?

But... did he do it or didn't he?

But in common speak, is that a lot or isn't it?

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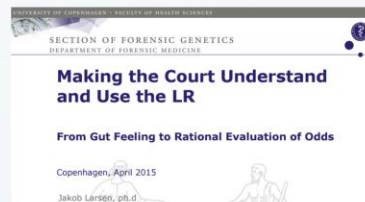
Why is this happening?

In Spain, Judges and prosecutors are civil servants that have passed a competitive state exam and then enter the Judiciary School where they take mandatory courses over a year.

But, interpretation of scientific evidence is not included in the curriculum at all. And this is the reason why we hear these FAQs on trials...

# Solutions: Education

- Why is it necessary to weight the DNA evidence.? Different DNA matches have different meanings:
  - single source match vs DNA mixture
  - partial profile match vs complete profile match
  - mtDNA match vs autosomal markers
  - Database match vs. pairwise match
- Be aware of risks (sample switches, contamination, secondary transfers, close relatives)
- Avoid: 'Oh, Is it DNA? Does it match? Guilty



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Then, there is only one solution to this problem: education. Not only for the legal community, but also for the DNA experts, to help them to explain these difficult concepts to the court and to avoid mistakes.

First of all we have to explain the legal community why is it necessary to weight the DNA evidence. We have to clarify that different DNA matches have different meanings.

And also the legal community should be aware of risks such as sample switches, contamination, second transfers ad close relatives

To avoid this way of thinking: 'Oh, Is it DNA? Does it match? Guilty

In other countries some efforts have began. Let see if we are able to do the same in Spain



There is light at the end of the tunnel...

Sentence 19478/2013 - Madrid:

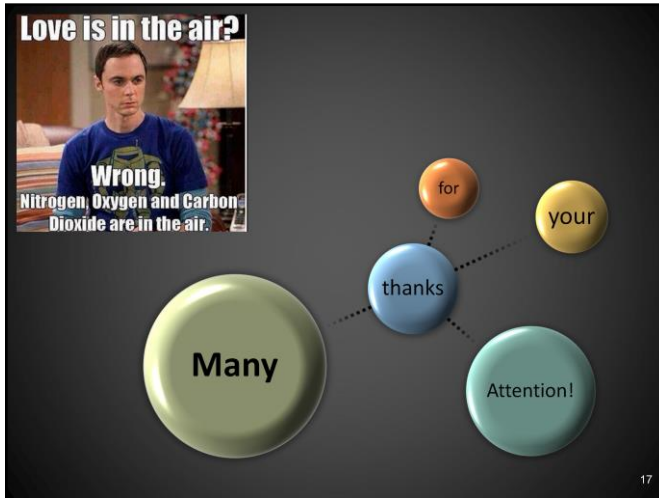
COMPARING DNA TEST WITH HANDWRITING TEST:

“The results of DNA test are usually supported by probabilities” ...“A forensic report can be sustained with difficulty if a condition of infallible is stated on it, as in the handwriting report, where the experts stated a 100% of certainty regarding their conclusions”

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Fortunately, there is light at the end of the tunnel. Look at this sentence about the handwriting test: The results of DNA test are usually supported by probabilities ...A forensic report can be sustained with difficulty if a condition of infallible is stated on it, as in the handwriting report, where the experts stated a 100% of certainty regarding their conclusions. This judge is aware of the importance of qualify probabilistically the conclusions of the reports.





We cannot be very romantic when interpreting evidence, we have to be as accurate and impartial as possible; although it is difficult to do it. I really think that love is in the air, but that's just an opinion, not scientific evidence.