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TrueAllele Workshop: Unlocking DNA profile interpretation for Africa

6# African Forensic Forum
University of Cape Town
South Africa
March 2026

Mark W Perlin, PhD, MD, PhD
Cybergenetics, Pittsburgh, PA USA


 Cybergenetics © 2003-2026  **JUSTICE
THROUGH
SCIENCE**

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Introduction

Who is Dr. Perlin?
What is Cybergenetics?
Why Africa?



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Scope of the Problem

More than 79 million girls and women—over 1 in 5
(20%)—across sub-Saharan Africa have experienced rape
or sexual assault before turning 18 – UNICEF, 2024

Globally, about 1 in 3 **(30%)** of women worldwide have
been subjected to either physical and/or sexual intimate
partner violence or non-partner sexual violence in their
lifetime – WHO, 2018

In the Republic of South Africa
53,498 sexual offenses:
42,780 rapes + 7,483 sexual assaults
were reported – SAPS, 2023

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SAMPLES TO SOLUTIONS:

Building Forensic DNA Capacity for Conflict Related Sexual Violence



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But most DNA evidence isn't used

As we explain in this workshop

Complex DNA is considered "*uninterpretable*"

So crime labs avoid generating complex DNA data.
Their data analysis *cannot interpret* it.

But faster, better, cheaper computer methods
can interpret complex DNA

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But most DNA evidence isn't used

As we explain in this workshop

Complex DNA is considered "*uninformative*"

Crime labs avoid generating complex DNA data.
Simple analysis *cannot get information* from it.

But faster, better, cheaper computer methods
can get information from complex DNA

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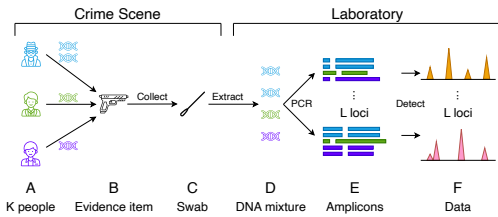
UCT Scientific Research Areas

1. Show sexual violence does exist as a problem in Africa
2. Demonstrate that “uninformative” DNA data can be informative
3. Reveal the presence of multiple perpetrators in DNA rape evidence
4. Find serial offenders by comparing DNA evidence between crimes

Simple Profile Genotyping

| DNA evidence | Simple |
|-------------------------|----------|
| Information | Preserve |
| Use evidence item | Yes |
| Generate DNA data | Yes |
| Infer evidence genotype | Yes |
| Upload to database | Yes |
| Match with reference | Yes |

Generate DNA Data

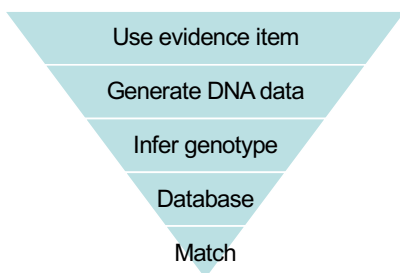


DNA Discarding Genotyping (DDG)

| DNA evidence | Complex | Threshold | Level | Preserve |
|--------------------------------|----------------------|----------------------|-------------|----------|
| Information | Question | | | |
| Use evidence item | Too difficult? | Sample type | Hat, gun | No |
| Generate DNA data | Too little DNA? | qPCR quantification | M:F of 1:10 | No |
| Infer evidence genotype | Too few cells? | Analytic peak height | 175 rfu | No |
| | Too much variation? | Stochastic height | 400 rfu | No |
| | Too many people? | Contributor number | 3, 4 | No |
| | Too few alleles? | Male contributor | All | No |
| Upload to database | Too low match? | CODIS MME | 7 ban | No |
| Match with reference | Too little strength? | CPI level | 3-6 ban | No |

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DDG Threshold Funnel

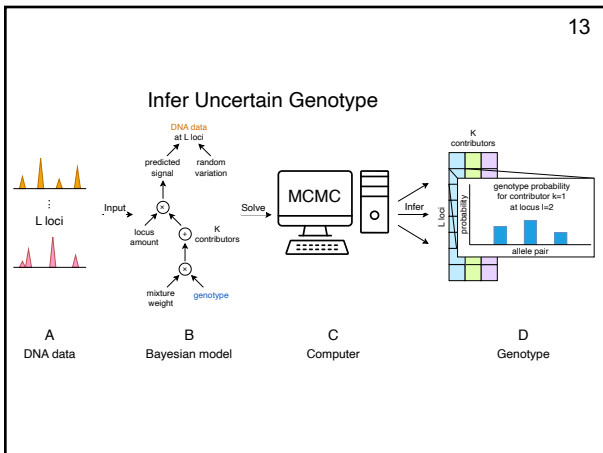


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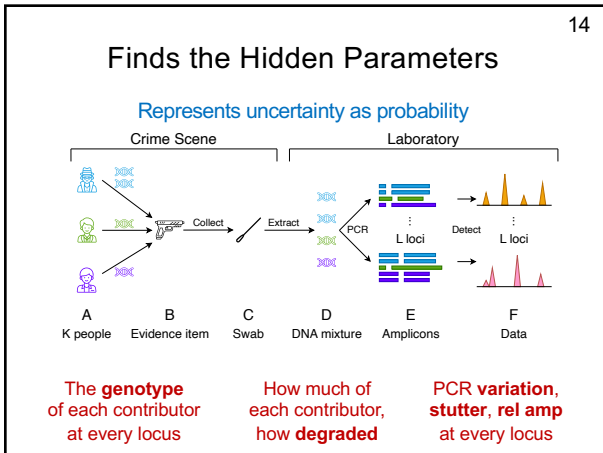
Information Preserving Genotyping (IPG)

| DNA evidence | TrueAllele | | |
|--------------------------------|----------------------|-----------------------|----------|
| Information | Question | Method | Preserve |
| Use evidence item | Too difficult? | Separate genotypes | Yes |
| Generate DNA data | Too little DNA? | Model PCR variation | Yes |
| Infer evidence genotype | Too few cells? | Full Bayesian model | Yes |
| | Too much variation? | Model all variation | Yes |
| | Too many people? | Unmix mixture | Yes |
| | Too few alleles? | Model missing alleles | Yes |
| Upload to database | Too low match? | TrueAllele LR | Yes |
| Match with reference | Too little strength? | LR error rate | Yes |

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Computer Interpretation of Quantitative DNA Evidence

People v Casey Wilson
September, 2014
Elmira, New York

Mark W Perlin, PhD, MD, PhD
Cybergenetics, Pittsburgh, PA

Cybergenetics © 2003-2014

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DNA biology

Cell
Nucleus
Chromosome
Locus

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Short tandem repeat

23 volumes in cell's DNA encyclopedia

DNA locus paragraph

Take me out to the ball game
take me out with the crowd
buy me some peanuts and Cracker Jack
I don't care if I never get back
let me
root root root root root root root root root
for the home team,
if they don't win, it's a shame for it's one, two,
three strikes, you're out
at the old ball game

"root" repeated 10 times, so allele length is 10 repeats

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DNA genotype

Chromosome
locus

mother allele
1 2 3 4 5 6 7 8

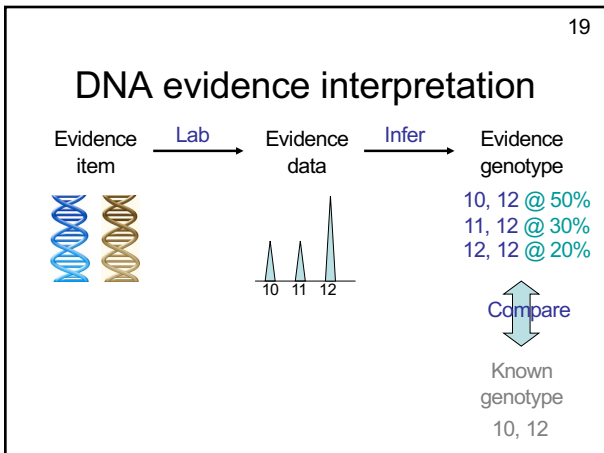
ACGT repeated word

father allele
1 2 3 4 5 6 7 8 9

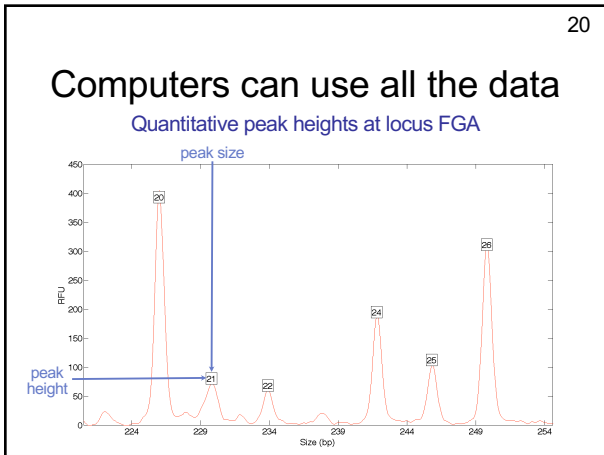
A genetic locus has two DNA sentences, one from each parent.
An allele is the number of repeated words.
A genotype at a locus is a pair of alleles.
8, 9

Many alleles allow for many many allele pairs.
A person's genotype is relatively unique.

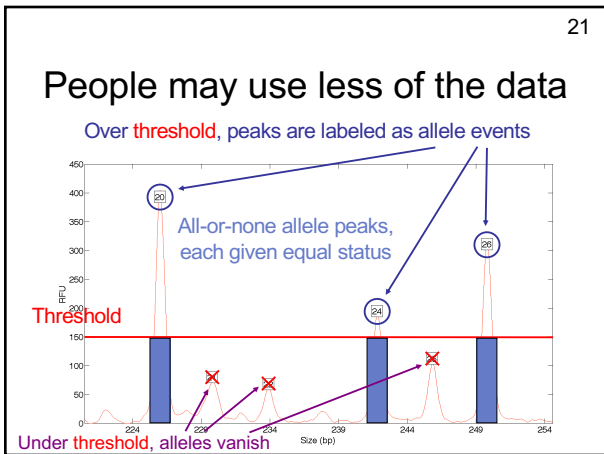
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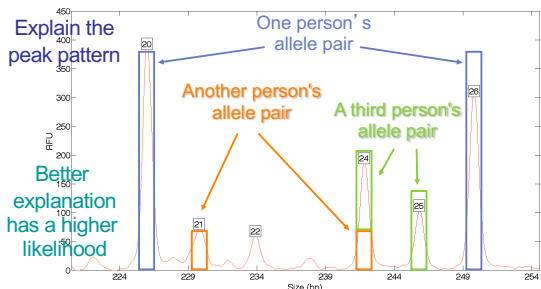


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How the computer thinks

Consider every possible genotype solution

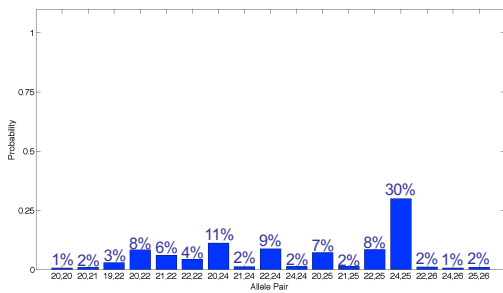


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Evidence genotype

Objective genotype determined solely from the DNA data.
Never sees a reference.

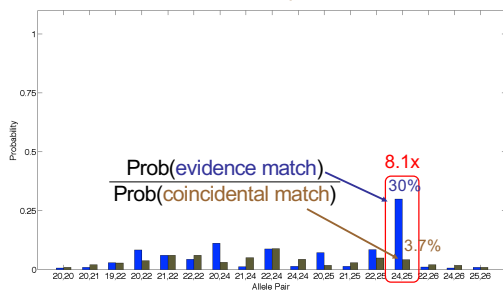


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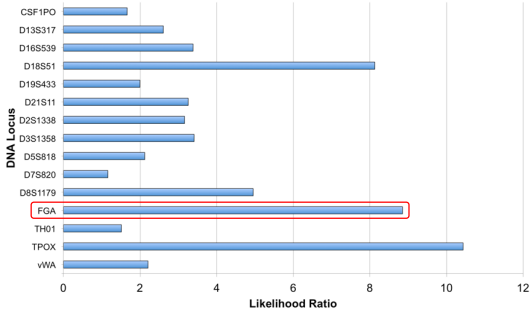
DNA match information

How much more does the suspect match the evidence than a random person?



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Match information at 15 loci



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Is the suspect in the evidence?

A match between the glove and Casey Wilson is:

31.3 million times more probable than a coincidental match to an unrelated Black person

66.3 million times more probable than a coincidental match to an unrelated Caucasian person

98.1 million times more probable than a coincidental match to an unrelated Hispanic person

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Match statistics

| Item | Description | 15B | 24A | 20A |
|-------|-------------------|----------------|-------------|--------------|
| | | Danielle Brown | Elijah Milo | Casey Wilson |
| 17D-E | Purple knit glove | 17.97 | -0.43 | 5.91 |
| 18D-E | Purple knit glove | 14.72 | 4.16 | 7.50 |

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Match statistics

| Item | Description | 15B | 24A | 20A |
|-------|-------------------|-----------------|---------------|--------------|
| | | Danielle Brown | Elijah Milo | Casey Wilson |
| 17D-E | Purple knit glove | 930 quadrillion | 1/2.72 | 817 thousand |
| 18D-E | Purple knit glove | 520 trillion | 14.6 thousand | 31.3 million |

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Sexual Assault Cases

California v. Billy Ray Johnson

Maryland v. Nelson Clifford

Indiana v. Darryl Pinkins & Roosevelt Glenn

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The Bakersfield Californian NEWS OBITS SPORTS EVENTS

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July & August 2013

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Rapes have east Bakersfield residents on edge

BY JASON KOTOWSKI Californian staff writer jkotowski@bakersfield.com
WEDNESDAY, AUG 21, 2013 6:43 PM

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DNA database hit

Major contributor to DNA
of zip tie in road

Billy Ray Johnson

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Biological evidence

Kern Regional Crime Laboratory

Early October 2013

thirty seven
swabs and cuttings

garments
blankets
apartment surfaces
skin
body cavities
telephones
zip ties

low-level DNA mixtures containing 3 or 4 people

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Informative DNA mixtures

8 mixture items vs. 5 victims + 1 suspect

| Description | Item | C0428X | C0459X | C0460X | C0475X | C0820X | C1147X |
|------------------|--------|--------|--------|--------|--------|--------|--------|
| Purse strap | C0431X | 18.73 | 5.91 | | | | 1.63 |
| Phone cord | C0432X | | | | | | 4.53 |
| Phone | C0984X | 18.74 | 2.06 | | | | 4.62 |
| Stain on pants | C0801S | | | | 16.39 | | 6.24 |
| Stain from pants | C0802S | | | | 17.42 | | 6.73 |
| Back of shirt | C0806S | | | 6.69 | 17.43 | | 8.86 |
| Bathtub handle | C0929X | | | | | 5.80 | 2.74 |
| Zip tie | C0937X | | | | | 4.55 | 20.32 |

BRJ

DNA match statistics
corroborate victim statements

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December 2013: Grand Jury



100 North Craig Street, Suite 210
Bakersfield, CA 93311
Tel: (805) 833-0888
Fax: (805) 833-0885

December 4, 2013

TO: DR. KEVIN MILLER
KERN REGIONAL CRIME LABORATORY
BAKERSFIELD, CA 93301

SUPPLEMENTAL REPORT
Lab # 13-CL-01721, 13-CL-01927,
13-CL-02349

Case 13-CL-01721

Case 13-CL-01927

Case 13-CL-02349



Cybergenetics TrueAllele Report

Arrest

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April 2015

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May 2015

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Maryland serial rapist

Did suspect Nelson Clifford contribute his DNA to the victim's clothing in a fifth case?

Man charged in multiple sexual assault cases acquitted a fourth time

Nelson Bernard Clifford, 35, remains in jail awaiting another set of charges

October 27, 2013 | By Jessica Anderson and Ian Duncan, The Baltimore Sun

A man charged in five sexual assault cases since 2010 based on DNA evidence was acquitted a fourth time Friday in Baltimore City Circuit Court, as prosecutors vowed to continue to try to convict him.

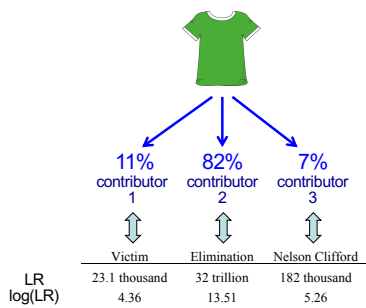
The acquittal is the latest move in a cat-and-mouse game between Nelson Bernard Clifford and the Baltimore state's attorney's office. As Clifford headed to trial on the most recent case, prosecutors refilled charges stemming from 2007 allegations, keeping him locked up without bail despite the result Friday.



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Separated DNA mixture



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Clifford outcome

Jury convicts sex offender in fifth trial

By Justin George and Justin Fenton
The Baltimore Sun
contact the reporters

SHARELINES

- After four acquittals, jurors convicted Nelson Clifford of sex offenses in a fifth trial.
- Nelson Clifford faces life in prison after a jury convicted him of sex offenses Friday.
- Prosecutors view conviction of sex offender as a needed win against predatory behavior.

MAY 8, 2015, 9:42 PM

A Baltimore jury convicted a man Friday who had been acquitted in four previous sexual assault trials, a win for prosecutors who revived the discarded case in a bid to secure an elusive conviction.

Nelson Bernard Clifford, a convicted sex offender, was found guilty of two counts of third-degree sex offense. While the counts individually carry a maximum sentence of 10 years, prosecutors say Clifford faces an enhanced penalty — up to life in prison — because of prior convictions.

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Darryl Pinkins imprisoned

1989 – 5 men raped an Indiana woman
Darryl Pinkins and 2 others misidentified
1991 – wrongfully convicted, 65 year sentence

2001 – DNA mixture evidence
2 contributors found, not the accused
but 5 were needed, post-conviction relief denied

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TrueAllele Pinkins findings

1. compared *evidence with evidence*
2. calculated *exclusionary match statistics*
3. revealed 5% *minor mixture contributor*
4. *jointly analyzed* DNA mixture data
5. showed three perpetrators were *brothers*

found 5 unidentified genotypes,
defendants not linked to the crime

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Pinkins exonerated



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Homicide Cases

Pennsylvania v. Allen Wade

Northern Ireland v. Brian Shivers

Australia v. Robert Xie

Wolfe sisters homicide



On February 6, 2014, Susan Wolfe (44) and her younger sister Sarah (38, left) were killed in their East Liberty home in Pittsburgh.

Pennsylvania v. Allen Wade

Thresholds failed to interpret most DNA mixtures

| | |
|-------------|----------------------------------|
| Hat | No conclusions |
| Cup | Insufficient data |
| Fingernails | Contamination, insufficient data |
| Gear shift | Insufficient data |
| Seat lever | Cannot be excluded |
| Knit hat | Insufficient data |
| Sock | Too complex, no conclusions |

Pennsylvania v. Allen Wade

The crime lab reported 5 DNA mixture matches
TrueAllele found 17 matches on the same data

| | | |
|-------------|---------------|-------------|
| Hat | 65.3 thousand | Allen Wade |
| Cup | 20.5 thousand | Susan Wolfe |
| Fingernails | 6.06 trillion | Allen Wade |
| Gear shift | 9.37 million | Sarah Wolfe |
| Seat lever | 385 billion | Sarah Wolfe |
| Knit hat | 25.7 thousand | Allen Wade |
| Sock | 300 | Sarah Wolfe |

Allen Wade Found Guilty On All Counts In East Liberty Sisters' Slaying

CBS News, May 23, 2016

PITTSBURGH (KDKA/AP)

- A man accused of killing two sisters who lived next door to him in East Liberty has been found guilty on all counts.
- Allen Wade was accused of shooting Sarah and Susan Wolfe after they returned from work on Feb. 6, 2014, apparently to steal a bank card.
- On Monday morning, a jury found Wade guilty of first-degree murder, robbery, burglary and theft by unlawful taking.

Pennsylvania v. Allen Wade

Thresholds failed to interpret DNA mixture
TrueAllele succeeded on the same data

A hat left from a burglary of the Wolfe sister's home
six weeks before the murder matched
Allen Wade with a 65.3 thousand statistic



Preventable Crime

Statistics lack scientific basis

CPI (RMNE) misled courts on countless DNA mixtures

J Pathol Inform

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HTML format

Research Article

Inclusion probability for DNA mixtures is a subjective one-sided match statistic unrelated to identification information

Mark William Perlin¹

¹Cybergenetics, Pittsburgh, USA

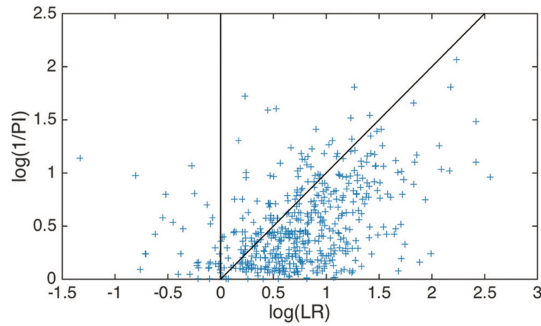
E-mail: MarkWilliam.Perlin@cybgen.com

*Corresponding author

Received 14 July 2013 Accepted 21 September 2013 Published 28 October 2013

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Uncorrelated with information



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Inclusion just counts tests

- 1 One-sided Match Statistic
- 2 Truncated Normal Distribution
- 3 Positive Tail Centered at Zero
- 4 Uncorrelated with Identification Information
- 5 Inclusion Distribution Has a Positive Mean
- 6 Law of Large Numbers
- 7 Why CPI is Always a Million

A subjective one-sided match statistic
unrelated to identification information

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Massereene Barracks Attack

March 7, 2009 in Antrim, Northern Ireland



Homicide victims



Patrick Azimkar Mark Quinsey

Real Irish Republican Army claimed responsibility

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Abandoned Burned Car



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Touch DNA Evidence



passenger side safety belt buckle

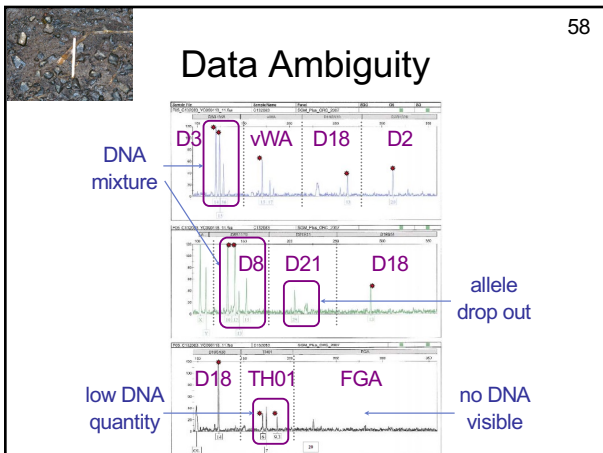


cell phone in center console

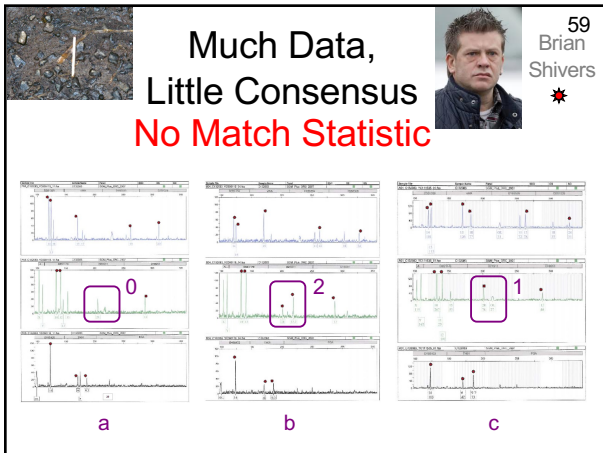
match stick at side of road



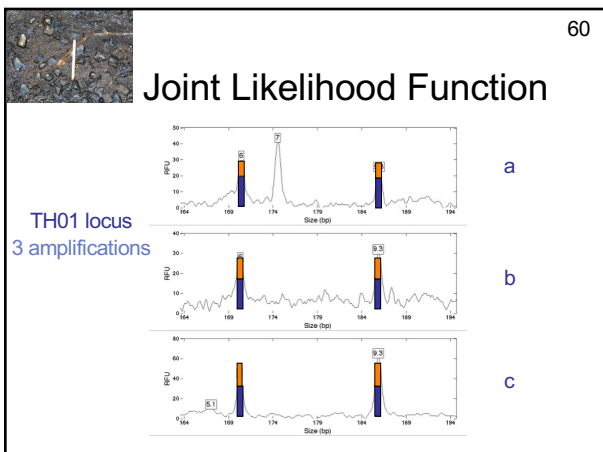
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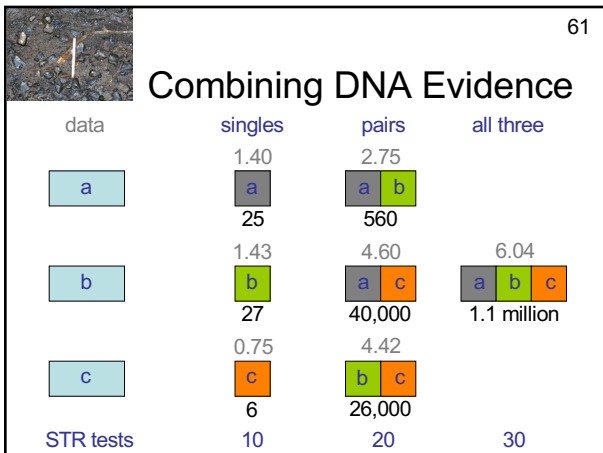
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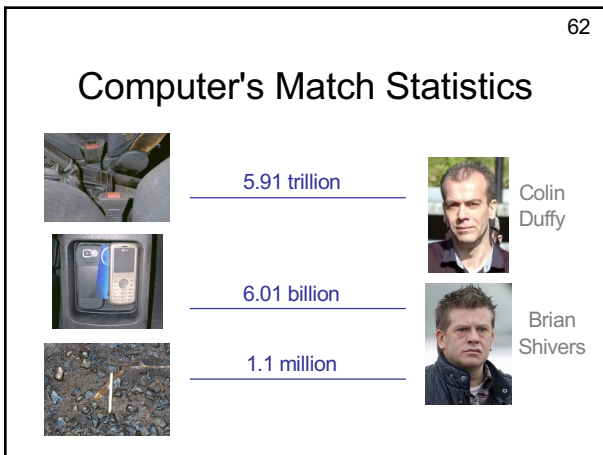
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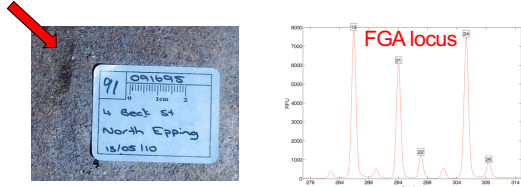
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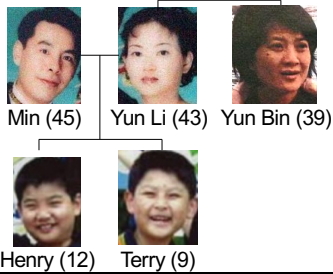
Blood stain 91

Suspicion fell on the wife's brother-in-law, Robert Xie.
 Xie had cleaned his garage floor that morning.
 Police examined the garage floor stains.



A family question

Forensic question #1: Is there DNA from the Lin family in the garage floor mixture?



A peeling answer

Without peeling, all five relatives look associated.
 Kinship allele sharing? Or is their DNA truly there?

Item 550, garage floor

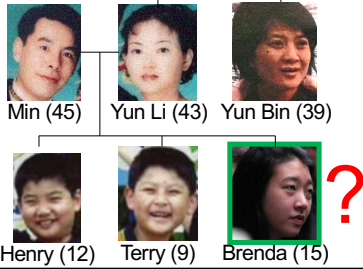
| Assumed Contributors | Total | 142 Terry | 127 Henry | 108 Min | 88 Yun Li | 70 Yun Bin |
|---------------------------|-------|-----------|-----------|---------|-----------|------------|
| None | 5 | 13.11 | 6.80 | 9.04 | -0.61 | -5.37 |
| Terry | 5 | | 6.90 | 5.27 | -16.33 | -24.82 |
| Terry, Henry | 5 | | | 9.37 | -15.67 | -18.61 |
| Terry, Henry, Min | 5 | | | | 0.19 | -0.11 |
| Terry, Henry, Min, Yun Li | 5 | | | | | 3.95 |

With peeling, four of them are clearly there.

The missing sister

Forensic question #2:

Is Brenda Lin's DNA in the garage floor mixture?



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Peeling reveals the truth

Without peeling, Brenda Lin might be present. Sibling allele sharing? Or is her DNA truly there?

Item 550, garage floor

| Assumed Contributors | Total | 142 Terry | 127 Henry | 108 Min | 88 Yun Li | 70 Yun Bin | 63 Brenda |
|------------------------------------|-------|-----------|-----------|---------|-----------|------------|-----------|
| None | 5 | 13.11 | 6.80 | 9.04 | -0.61 | -5.37 | 3.47 |
| Terry | 5 | 6.90 | 5.27 | -16.33 | -24.82 | -6.37 | |
| Terry, Henry | 5 | | 9.37 | -15.67 | -18.61 | -8.26 | |
| Terry, Henry, Min | 5 | | | -0.19 | -0.11 | -3.59 | |
| Terry, Henry, Min, Yun Li | 5 | | | | 3.95 | -5.59 | |
| Terry, Henry, Min, Yun Li, Yun Bin | 6 | | | | | -6.68 | |

With peeling, Brenda's DNA clearly isn't there.

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