How a simple graph improves people' understanding of informed consents and their decision-making in a medical screening setting

Imke Hrycyk, Nicolas Sanchez-Fuenzalida, Esteban Hurtado, Rut Correia & Gorka Navarrete

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"Just a darn minute! — Yesterday you said that $X$ equals two!"
High complexity
Low confidence (<50%)
High accuracy rate (>80%)
RECKONING WITH RISK
GERD GIGERENZER
LEARNING TO LIVE WITH UNCERTAINTY

‘Gigerenzer is brilliant and his topic is fabulous’
STEVEN PINKER
The probability of breast cancer is 1% for women aged forty who participate in routine screening.

If a woman has breast cancer, the probability is 80% that she will get a positive mammogram.

If a woman does not have breast cancer, the probability is 9.6% that she will also get a positive mammogram.

A woman in this age group has a positive mammogram in a routine screening. **What is the probability that she actually has breast cancer? ____ %**
Classical Problem

- Relative Probabilities

High complexity
High confidence (>80%)
Low accuracy rate (~5%)
10 out of every 1,000 women at age forty who participate in routine screening have breast cancer.

8 of every 10 women with breast cancer will get a positive mammography.

95 out of every 990 women without breast cancer will also get a positive mammography.

Here is a new representative sample of women at age forty who got a positive mammography in routine screening. How many of these women do you expect to actually have breast cancer? ____ out of ____
Base Rate Neglect

\[ p(H|D) = \frac{p(D|H)p(H)}{p(D)} \]
Unicorn Test

Hit rate: 100% (sensitivity)
False positives: 0.1% (1 - specificity)
Massive screening
Type 2 diabetes

Population A

Population B
Massive screening

Type 2 diabetes

Population A
Population A

Hit rate: 100%

Prevalence: 1 out of 1000

False positives: 0.1%

\[ p(\text{Disease} | +) \]
Population A

Hit rate
100%

False positives
0.1%

Prevalence
1 out of 1000

\[ p(\text{Disease}|+) \]?

<25% 25-49% 50% 51-75% >75%
1 out of 1000
<table>
<thead>
<tr>
<th>Hit rate</th>
<th>1 out of 1000</th>
<th>False positives</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>1 in 1000</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

PPV = 50%
Hit rate 100%  1 out of 1000  False positives 0,1%

\[ p(H|D) = \frac{p(H) \cdot p(D|H)}{p(H) \cdot p(D|H) + p(\bar{H}) \cdot p(D|\bar{H})} \]

PPV = 50%
Hit rate **100%**

1 out of 1000

False positives **0.1%**

\[ p(H|D) = \frac{p(H) \cdot p(D|H)}{p(H) \cdot p(D|H) + p(\neg H) \cdot p(D|\neg H)} \]

**PPV = 50%**
Hit rate 100%  1 out of 1000  False positives 0.1%

\[ p(H|D) = \frac{0.1\% \cdot 100\%}{0.1\% \cdot 100\% + 99.9\% \cdot 0.1\%} \]

PPV = 50%
Hit rate 100%  1 out of 1000  False positives 0.1%

\[\text{TRUE} + \quad \text{TRUE} + \quad \text{FALSE} + \quad = \quad \text{FALSE} + \]

\[\text{Hit rate} \quad \text{1 out of 1000} \quad \text{False positives} \quad 0.1\%\]
Massive screening

Type 2 diabetes

Population B
Population B

Hit rate
100%

Prevalence
500 out of 1000

False positives
0.1%

p(Disease|+)?

<25% 25-49% 50% 51-75% >75%
Population B

Hit rate
100%

False positives
0.1%

Prevalence
500 out of 1000

p(Disease|+)

<25%  25-49%  50%  51-75%  >75% (99.8%)
Hit rate 100%

500 out of 1000

False positives 0.1%

PPV = 99.8%
Hit rate 100%  
500 out of 1000  
False positives 0,1%

\[ \text{TRUE} + \text{FALSE} + = \]
Epidemiology 101:
Screening tests, PPV and NPV
Screening tests are to discard healthy people:

- NPV very high
- PPV, … it depends, but who cares?

\[
\text{PPV} = \frac{\text{TRUE} + \text{FALSE} +}{\text{TRUE} +} \\
\text{NPV} = \frac{\text{TRUE} -}{\text{TRUE} - + \text{FALSE} -}
\]
We focus on **PPV**:

- Relevance for the individual
- Massive cost of False Positives
  - (e.g. 4 Billion US$/year Breast cancer)
- Important for the decision:

  screening test? → + → diagnostic test?

\[
\text{PPV} = \frac{\text{TRUE} +}{\text{TRUE} + \ + \ \text{FALSE} +}
\]
Unicorn Test

In the real world

Hit rate: 100% (sensitivity)
False positives: 0,1% (1 - specificity)
Sensitivity = 100%  

1 out of 1000. PPV ~50%  
500 out of 1000. PPV ~99.8%  
1 out of 2000. PPV ~33%  

High prevalence diseases (WHO)
Real world screening tests

In real world diseases

Sensitivity: 100%
False positives: 0 - 10% (1 - specificity)
PPV of Mammogram for Breast Cancer by Age

Prevalence vs. False Positive rate

Sensitivity = 90 %

Legend:
- 100
- 75
- 50
- 25
- 0
Physicians

Probabilities 4 to 21% accuracy
Nat. Frequencies 29 to 67% accuracy

Hit rate 100%

False positives 0,1%
Consent forms

Shared decision making
Would you go through this **screening test**?

Result is **+**

Would you go through a **Follow up test** with 1% chance of a procedure-related miscarriage?

Result is **−**
SHARED DECISION MAKING

Information & Recommendations

Values & Preferences
How people deal with Consent Forms?
Terms of service

Service, and in exchange for service, all users of this site agree to immediately assign their first-born child to NameDrop, Inc. If the user does not yet have children, this
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1.7% complained about the Child clause

Consent forms

Prenatal screening examples

A) Not enough information

B) Too much information

C) Consequences
A) Not enough information

B) Too much information

C) Consequences
Positive Predictive Value (PPV)

90% Hit rate (sensitivity)

1% False positives (1 – specificity)

Prevalence
Hit rate (sensitivity) 90%

False positives (1 – specificity) 1%

Prevalence

Positive Predictive Value (PPV)

\[ p(\text{Down syndrome} | +) = \frac{x \times 90\%}{(x \times 90\%) + ((1 - x) \times 1\%)} = \frac{x}{x + y} = [0 \ldots 100\%] \]
A) Not enough information

B) Too much information

C) Consequences
What is a Trisomy?

Humans have 23 pairs of chromosomes, which are strands of DNA and proteins that carry genetic information. A trisomy is a chromosomal condition that occurs when there are three copies of a particular chromosome instead of the expected two.

TRISOMY 21

Trisomy 21 is due to an extra chromosome 21 and is the most common trisomy at the time of birth. Trisomy 21, also called Down syndrome, is associated with mild to moderate intellectual disabilities and may also lead to digestive disease and congenital heart defects. It is estimated that trisomy 21 is present in 1 out of every 800 births in Canada.¹

TRISOMY 18

Trisomy 18 is due to an extra chromosome 18. Trisomy 18, also called Edwards syndrome, is associated with a high rate of miscarriage. Infants born with trisomy 18 often have congenital heart defects as well as various other medical conditions, shortening their lifespan. It is estimated that trisomy 18 is present in approximately 1 out of every 6,000 births.²

TRISOMY 13

Trisomy 13 is due to an extra chromosome 13. Trisomy 13, also called Patau syndrome, is associated with a high rate of miscarriage. Infants born with trisomy 13 usually have severe congenital heart defects and other medical conditions. Survival beyond the first year is rare. It is estimated that trisomy 13 is present in approximately 1 out of every 16,000 newborns.³

Harmony™ Prenatal Test

Simple, safe and accurate for you and your pregnancy.

The Harmony Prenatal Test is a non-invasive test that detects common fetal trisomies in pregnancies of 10 weeks or more, based on directed analysis of DNA in maternal blood.

WHAT WILL THE HARMONY PREGNATAL TEST TELL ME AND MY HEALTHCARE PROVIDER?

The Harmony Prenatal Test assesses the risk of three fetal trisomies by measuring the relative amount of chromosomes in maternal blood.

HOW IS THE HARMONY PREGNATAL TEST DIFFERENT FROM OTHER PREGNATAL TESTS?

The Harmony Prenatal Test is based on the newest advances in non-invasive prenatal testing. It is a simple and safe blood test that has been shown in clinical studies to detect the risk of fetal trisomies with high accuracy.⁴ ⁵

The Harmony Test has been shown to have detection rates of up to 99% and false positive rates as low as 0.1% for trisomy 21, 18 and 13.⁶ ⁷ Diagnostic tests such as amniocentesis or chorionic villus sampling (CVS) are accurate for detecting fetal trisomies, but they are invasive and pose a slight risk for fetal loss.⁸ ⁹

¹Canadian Down Syndrome Society
²Ontario Ministry of Health and Long-Term Care
³U.S. National Library of Medicine

Harmony

Cost* $795.00

*Subject to change without notice.
What is a Trisomy?

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**TRISOMY 21**

Trisomy 21 is due to an extra chromosome 21 and is the most common trisomy at the time of birth. Trisomy 21, also called Down syndrome, is associated with mild to moderate intellectual disabilities and may also lead to digestive disease and congenital heart defects. It is estimated that trisomy 21 is present in 1 out of every 800 births in Canada. 1

**TRISOMY 18**

Trisomy 18 is due to an extra chromosome 18. Trisomy 18, also called Edwards syndrome, is associated with a high rate of miscarriage. Infants born with trisomy 18 often have congenital heart defects as well as various other medical conditions, shortening their lifespan. It is estimated that trisomy 18 is present in approximately 1 out of every 6,000 births. 2

**TRISOMY 13**

Trisomy 13 is due to an extra chromosome 13. Trisomy 13, also called Patau syndrome, is associated with a high rate of miscarriage. Infants born with trisomy 13 usually have severe congenital heart defects and other medical conditions. Survival beyond the first year is rare. It is estimated that trisomy 13 is present in approximately 1 out of every 16,000 newborns. 3

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The Harmony Test has been shown to have detection rates of up to 99.6% for trisomy 21 and 13. 6,7 Diagnostic tests such as amniocentesis or chorionic villus sampling (CVS) are accurate for detecting fetal trisomies, but they are invasive and pose a slight risk for fetal loss. 4,5

---

*The information provided about sensitivity and specificity are probably an overestimation...*
What's the meaning of a + result?

\[ p(\text{Trisomy 21} \mid + \text{test}) = \]

\[
\frac{1 \text{ out of 800 } \times 99\%}{(1 \text{ out of 800 } \times 99\%) + (799 \text{ out of 800 } \times 0.1\%)} =
\]

\[
(B) \frac{0.123}{0.123 + 0.0998} = 0.55
\]

What's the meaning of a + result?
A) Not enough information

B) Too much information

C) Consequences
100,000 pregnant women (30yo)

Prevalence: 1 in 800

Healthy
99,880

False Positives: 5%

Triple screen –
94,886

Triple screen +
4,994

Trisomy 21
120

Sensitivity: 81%

Triple screen –
23

Triple screen +
97

PPV (21): ~1.60%
PPV (18): ~0.48%
PPV (13): ~0.32%
100,000 pregnant women (30yo)

Prevalence: 1 in 800

Healthy
99,880

False Positives: 5%

Trisomy 21
120

Sensitivity: 81%

Triple screen +
4,994

Amniocentesis

Miscarriage rate: 1%

Miscarriages
50

Triple screen +
97

Amniocentesis

Miscarriage rate: 1%

Miscarriages
~1

OLD RESEARCH!
Cognitive mechanisms behind the comprehension of Bayesian reasoning problems

Arithmetic complexity
Individual differences
Reference class
Arithmetic complexity
Classical Problem

- Relative Probabilities
- Absolute Frequencies

Accuracy

Y-axis: 50
38
25
13
0
Take, for example, a sample of women who have positive mammograms. How many of these women actually have breast cancer?

\[
p(\text{Disease}|\text{Symptom}) = \frac{\text{99+}}{\text{99+} + \text{8+}}
\]
Take, for example, a sample of women who have positive mammograms. What is the probability that she actually has breast cancer?

\[ p(\text{Disease}|\text{Symptom}) = \]
PROBABILITIES

80% + * 1% BC

10% + * 99% no BC + 80% + * 1% BC

NATURAL FREQUENCIES

8+

95+ + 8+
Individual differences

Cognitive Reflection, Numeracy, WM
Cognitive mechanisms behind the comprehension of Bayesian reasoning problems

Improve medical risks communication
Presentation format

University students

Presentation format x Response type

Vulnerable population
Presentation format

University students
Imagine that a group of 1000 people have participated in a medical screening to detect disease A. The following information is available about the screening.

4 in every 1000 people actually have the disease A.
3 in every 4 person with the disease A has received a positive screening test result.
27 in every 996 people without the disease A have also received a positive screening test result.

Of the people who have received a positive screening test result, how many would you expect to have the disease A? ____ out of _______
Presentation format x Response type

Vulnerable population
Imagine that a group of 1000 people have participated in a medical screening to detect disease A. The following information is available about the screening:

4 in every 1000 people actually have the disease A.
3 in every 4 person with the disease A has received a positive screening test result.
27 in every 996 people without the disease A have also received a positive screening test result.

Of the people who have received a positive screening test result, how many would you expect to have the disease A?

_____ out of _______

Very few   Few   Half   Quite   Many
(0-20%)   (21-40%)   (41-60%)   (61-80%)   (81-100%)
Accuracy by response type and presentation format

±10% of correct response
Accuracy by response type and presentation format

±10% of correct response
New research
Imagine that a group of 1000 people have participated in a medical screening to detect disease A. The following information is available about the screening.

4 in every 1000 people actually have the disease A.
3 in every 4 person with the disease A has received a positive screening test result.
27 in every 996 people without the disease A have also received a positive screening test result.

~5-10% correct responses

_____ out of _______

Very few  Few  Half  Quite  Many
(0-20%) (21-40%) (41-60%) (61-80%) (81-100%)
What is a Trisomy?

Humans have 23 pairs of chromosomes, which are sets of DNA and proteins that carry genetic information. Trisomy occurs when there are three copies of a particular chromosome instead of the expected two.

TRISOMY 21

Trisomy 21 is due to an extra chromosome 21 and is the most common chromosome anomaly at the time of birth. Trisomy 21, also called Down syndrome, is associated with mild to moderate intellectual disability, characteristic facial features, heart defects, and a high risk of leukemia. It is estimated that trisomy 21 is present in 1 out of every 800 births in Canada.

TRISOMY 18

Trisomy 18 is due to an extra chromosome 18. Trisomy 18, also called Edwards syndrome, is associated with a high risk of miscarriage, intellectual disability, heart defects, and a variety of other medical conditions. It is estimated that trisomy 18 occurs in approximately 1 out of every 10,000 births.

TRISOMY 13

Trisomy 13 is due to an extra chromosome 13. Trisomy 13, also called Patau syndrome, is associated with a serious of birth defects, intellectual disability, heart defects, and a high risk of miscarriage. It is estimated that trisomy 13 occurs in approximately 1 out of every 10,000 births.

Harmony®** Prenatal Test

Simply, safe and accurate for you and your pregnancy.

The Harmony Prenatal Test is a non-invasive test that targets common fetal chromosome imbalances of 16 weeks or more, based on targeted analysis of DNA in maternal blood.

WHAT’S THE HARMONY PREGNATAL TEST TELL ME AND MY HEALTHCARE PROVIDER?

The Harmony Prenatal Test identifies the risk of three fetal chromosome imbalances to measure the relative amount of abnormal DNA in maternal blood.

How is the Harmony Prenatal Test different from other prenatal tests?

The Harmony Prenatal Test is based on the same test utilized in your carrier prenatal testing. A simple blood test of maternal blood is used to identify the risk of fetal aneuploidy with high accuracy.

The Harmony Test has been shown to have detection rates up to 99% for trisomy 13, 18, and 21, and 99.5%**. Diagnostic tests such as amniocentesis or chorionic villus sampling (CVS) are accurate for detecting fetal aneuploidies, but they require a patient to undergo an invasive procedure.

Harmony Prenatal Test is a registered trademark of PerkinElmer Health Sciences. Harmony Prenatal Test is available in the United States. **99.5% accuracy for trisomy 13, 18, and 21. **99.5% of Anomalies detected. 

An advance in non-invasive fetal trisomy testing

Integrated Genetics is the leader in non-invasive fetal trisomy testing.
What's the meaning of a + result?

\[
p(\text{Trisomy } 21 \mid + \text{ test}) =
\]

\[
\left(\frac{1 \text{ out of } 800 \times 99\%}{(1 \text{ out of } 800 \times 99\%) + (799 \text{ out of } 800 \times 0.1\%)}\right) =
\]

\[
\frac{0.123}{0.123 + 0.0998} = 0.55
\]

What's the meaning of a + result?
New paradigm

Ask questions people know how to answer
What is your age?

\[
p(\text{Trisomy 21} \mid + \text{test}) =
\]

\[
\frac{1 \text{ out of 800} \times 99\%}{(1 \text{ out of 800} \times 99\%) + (799 \text{ out of 800} \times 0.1\%)} =
\]

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\]
Ask questions people know how to answer

Would you recommend this **screening test**?

Imagine the result is +

Would you recommend a **Follow up test** with 1% chance of a procedure-related miscarriage?

**YES** / **NO**
Do people know the information they need?

Can we improve calculation/comprehension?

Can we improve decisions?
Do people know what they need?

All vs Missing information
What is a Trisomy?

Humans have 23 pairs of chromosomes, strands of DNA that carry genetic information. A trisomy is a chromosomal condition that occurs when there are three copies of a particular chromosome instead of the expected two.

Down syndrome

Trisomy 21, also called Down syndrome, is caused by a third copy of chromosome 21. It is the most common trisomy at time of birth. Down syndrome is associated with mild to moderate intellectual disabilities and congenital heart defects.

It is estimated that, when a mother is aged 40, Down syndrome is present in 1 out of 60 births.

Prenatal Test

When you are pregnant, your blood contains fragments of fetus DNA. A Prenatal Test is a new type of test that samples your blood and analyzes the fetus DNA to determine the risk of Down syndrome. It is used for early detection of Down syndrome in all pregnant women.

Clarity Early

The Prenatal Test requires a single blood sample and can be done as early as 10 weeks or later in pregnancy. Results are available within one business day.

A More Accurate Test

The Prenatal Test, a new DNA-based blood test, has been extensively tested. It was developed to be a more accurate prenatal screening. The Prenatal Test has been shown in clinical testing to identify 90% of Down syndrome cases and to have a false-positive rate of less than 0.4%.

A positive result does not necessarily mean that Down syndrome is present.

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\[
p(\text{Down syndrome} | +) = \frac{1 \text{ out of 60} \times 90\%}{(1 \text{ out of 60} \times 90\%) + (59 \text{ out of 60} \times 0.4\%)} = \frac{0.9}{0.9 + 0.236} = 79\%\]
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p(\text{Down syndrome}|+) = \frac{x \times 90\%}{(x \times 90\%) + ((1-x) \times 0.4\%)} = \frac{x}{x+y} \approx [0..100]\%\]
Did the brochure include enough information to solve the problem?

YES!

\[
p(\text{Down syndrome}|+) = \frac{1 \text{ out of } 60 \times 90\%}{(1 \text{ out of } 60 \times 90\%) + (59 \text{ out of } 60 \times 0.4\%)} = \frac{0.9}{0.9 + 0.236} = 79\%
\]

NO

\[
p(\text{Down syndrome}|+) = \frac{x \times 90\%}{(x \times 90\%) + ((1 - x) \times 0.4\%)} = \frac{x}{x + y} = [0..100]\%
\]
89% of those without Enough info said YES
Can we improve calculation/comprehension?

OLD vs NEW paradigm
OLD paradigm
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\]
NEW paradigm
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Humans have 23 pairs of chromosomes, strands of DNA that carry genetic information. A trisomy is a chromosomal condition that occurs when there are three copies of a particular chromosome instead of the expected two.

Down syndrome

Trisomy 21, also called Down syndrome, is caused by a third copy of chromosome 21. It is the most common trisomy at time of birth. Down syndrome is associated with mild to moderate intellectual disabilities and congenital heart defects.

It is estimated that, when a mother is aged 40, Down syndrome is present in 1 out of 60 births.

Prenatal Test

When you are pregnant, your blood contains fragments of fetus DNA. A Prenatal Test is a new type of test that samples your blood and analyzes the fetus DNA to determine the risk of Down syndrome. It is used for early detection of Down syndrome in all pregnant women.

Clarity Early

The Prenatal Test requires a single blood sample and can be done as early as 10 weeks or later in pregnancy. Results are available within one business day.

A More Accurate Test

The Prenatal Test, a new DNA-based blood test, has been extensively tested. It was developed to be a more accurate prenatal screening. The Prenatal Test has been shown in clinical testing to identify 90% of Down syndrome cases and to have a false-positive rate of less than 0.4%.

A positive result does not necessarily mean that Down syndrome is present.

In the graph below, you can see the probability that a positive prenatal test result actually means the presence of Down syndrome. This probability is derived from risk factors associated with age in women.
What is a Trisomy?

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Old vs New

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Positive Predictive Value (PPV)

Estimate the probability that a positive result in the Prenatal screening test means that her child has Down Syndrome.
Good vs bad test

40 years old
Prevalence 1 out of 60
PPV~75%

Good test

20 years old
Prevalence 1 out of 900
PPV~25%

Bad test
40 years old

Prevalence 1 out of 60

PPV~75%

Good test
20 years old
Prevalence 1 out of 900
PPV~25%
Bad test
16% average absolute error

40% average absolute error

\[ p(\text{Down syndrome} | +) = \]
\[ \frac{1 \text{ out of } 60 \times 90\%}{(1 \text{ out of } 60 \times 90\%) + (59 \text{ out of } 60 \times 0.4\%)} = \]
\[ \frac{0.9}{0.9 + 0.236} = 79\% \]
Can we improve decisions?

OLD vs NEW paradigm
Would you recommend this **screening test**?

Imagine the result is **+**

Would you recommend a **Follow up test** with 1% chance of a procedure-related miscarriage?

**YES / NO**

**YES / NO**
Imagine the result is +
Imagine the result is +
20 years old
Prevalence 1 out of 900
PPV~25%

Bad test

Bad test

Vs

Good test

40 years old
Prevalence 1 out of 60
PPV~75%

Good test
20 years old
Prevalence 1 out of 900
PPV~25%

Bad test

77% vs 84%

40 years old
Prevalence 1 out of 60
PPV~75%

Good test
Screening test

Follow-up test

20 years old
Prevalence 1 out of 900
PPV~25%

Bad test

47% vs 89%

40 years old
Prevalence 1 out of 60
PPV~75%

Good test
Would you recommend this screening test?

47% Bad test
89% Good test
77%
Imagine the result is +

Would you recommend a **Follow up test** with 1% chance of a procedure-related miscarriage?

73% Bad test

83% Good test
Overview of results

Do people know the information they need?

Can we improve calculation/comprehension?

Can we improve decisions?
Overview of results

Do people know the information they need?

Can we improve calculation/comprehension?

Can we improve decisions?
Overview of results

Do people know the information they need?

Can we improve calculation/comprehension?

Can we improve decisions?
YES!
Overview of results

Do people know the information they need?

Can we improve calculation/comprehension?

Can we improve decisions?
Would you recommend this **screening test**?

YES / NO

Imagine the result is +

Would you recommend a **Follow up test** with 1% chance of a procedure-related miscarriage?

YES / NO
Take home message

We can do better! And it matters...
We can do better! And it matters...

Patients
\[ p(\text{Trisomy 21} \mid + \text{test}) = \]

\[
(A) \quad \frac{1 \text{ out of 800} \times 99\%}{(1 \text{ out of 800} \times 99\%) + (799 \text{ out of 800} \times 0.1\%)} =
\]

\[
(B) \quad \frac{0.123}{0.123 + 0.0998} = 0.55
\]

Reliability of a positive test result depending on the mother's age.
Would you go through this **screening test**?

Result is +

Would you go through a **Follow up test** with 1% chance of a procedure-related miscarriage?

Result is -

GOOD test

BAD test
We can do better! And it matters…

Many **false positives** in low prevalence conditions / populations

This leads to:

- unnecessary tests ($$$)
- overdiagnosis (loss of health)
- miracles!
We can do better! And it matters...

When people understand: they may avoid entering the tunnel!

less bad tests → less false positives

This would lead to:

less unnecessary tests
less overdiagnosis
less miracles
We can do better! And it matters...

This is only the first step, but we must be careful
Next steps…

Registered report extending results to different risk levels: 1% vs 10%
Next steps...

Help the ones helping

Screening versus Diagnostic tests

Gender
Next steps…

Help the ones helping

Screening versus Diagnostic tests

Gender
\[ p(\text{Trisomy 21} \mid + \text{test}) = \]

\[ (A) \quad \frac{1 \text{ out of 800} \times 99\%}{(1 \text{ out of 800} \times 99\%) + (799 \text{ out of 800} \times 0.1\%)} = \]

\[ (B) \quad \frac{0.123}{0.123 + 0.0998} = 0.55 \]

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**Prenatal screening for Down Syndrome by Age**

- **Prevalence**:
  - 1 out of 1200
  - 1 out of 1080
  - 1 out of 960
  - 1 out of 840
  - 1 out of 720
  - 1 out of 600
  - 1 out of 481
  - 1 out of 361
  - 1 out of 241
  - 1 out of 121
  - 1 out of 1

- **False Positive rate**:
  - 0% - 6%

- **PPV (%)**:
  - 100
  - 75
  - 50
  - 25
  - 0

**40 y.o.**
- 1 out of 66
- FP = 4.5%
Reliability of a positive test result depending on the mother's age.
Next steps...

Help the ones helping

Screening versus Diagnostic tests

Gender
Screening tests
NPV very high
PPV, ... it depends

Diagnostic tests
NPV, ... it depends
PPV, very high
Next steps…

Help the ones helping

Screening versus Diagnostic tests

Gender

Towards a more integrated model of Bayesian reasoning: calculation, understanding and decision making in medical contexts (2017-2019) Fondecyt Regular 1171035.
16% average absolute error

Screening - PPV calculation

NEW

OLD

40% average absolute error