Bias in Decision Making in Uncertainty

Strategic Innovation and Artificial Intelligence - Velvet Edition

Dr. Philippe J.S. De Brouwer
Honorary Consul of Belgium in Kraków
guest professor at the UJ, AGH, UEK and UW
board member of AGH and ISK
SVP at HSBC in Kraków

2024-03-12

executive master of business administration
emba@uw
University of Warsaw

Example of a survey

Question: How are you today?

(A) Excellent

(B) Very Good

(C) Good

(D) Not so Good

How do you see yourself?

Question: What describes you best?

(A) Impulsive, biased, judging, and jumping to conclusions

(B) both A and C

(C) Logical, structured, open-minded, and conscious

Table of Contents i

Table of Contents iii

Introduction

Figure 1: The Makapansgat Pebble: 2.5 million years old!

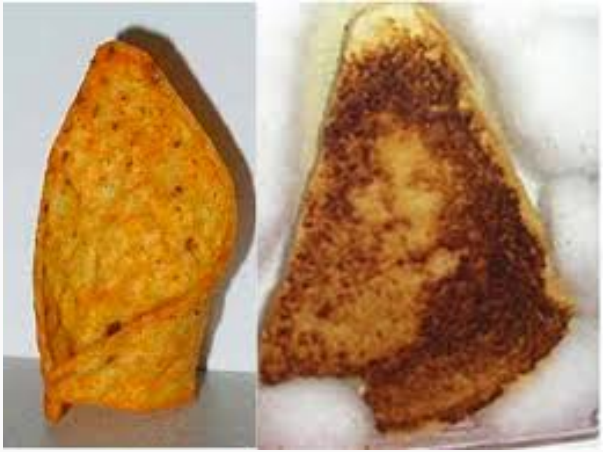


Figure 2: Mary got grilled cheese in 2004 and earned $24'000

Figure 3: Another face that is not.

Behavioural Finance (BF)

Efficient Markets

- **Rational Approach**: people make decisions
  - according to Expected Utility (EUT) or at least Subjective Expected Utility Savage, 1954
  - and apply correctly Bayes Law
- **Friedman, 1953**: rational traders (arbitrageurs) will fast eliminate non-efficiencies created by irrational traders (noise traders)
- **Efficient Market Hypothesis** (EMH)Fama, 1965 and Fama, 1970

Note

The EMH together with EUT is an elegant, appealing, compelling and rational framework

Market Efficiency

- **Behavioural Finance** (BF), is the stance where some financial phenomena can be better understood, assuming that some agents are **not** (fully) rational
- **Examples** of behavioural models:
  (A) Adam Smith's Theory of Moral Sentiments Smith, 1759
  (B) Keynes's beauty contest Keynes, 1936
  (C) Prospect Theory Kahneman and Tversky, 1979
  (D) Behavioural Portfolio Theory Shefrin and Statman, 2000

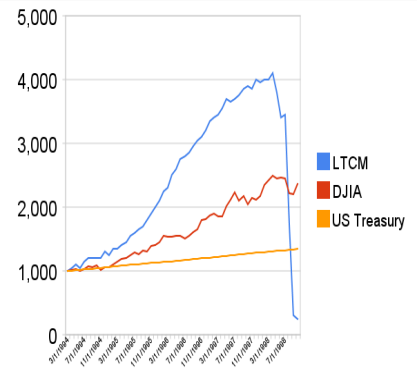
Long Term Capital Management (LTCM)

- LTCM was a well known Hedge Fund with 3 well known partners with excellent reputation:
  - John Meriwether (Salomon Brothers)
  - Myron Scholes (Nobel Laureate)
  - Robert Merton (Nobel Laureate)
- consistent and very good performance between 1994 and 1997
- more than USD 7 Bln. assets by 12/97
- banks eager to lend to LTCM

LTCM in 1998

- NAV: -82%
- 9/98: Federal Reserve Bank of NY organises rescue plan with 14 banks and brokers
- They raise $3.6 bln. in exchange for 90% of LTCM's equity

. . . How was this possible?



LTCM made rational bets

- Royal Dutch Petroleum (RDP) and Shell Transport & Trading (STT) Both owned by Royal Dutch Shell
  - a DLC (Dual Listed Company)
  - 1998: a corporate charter linked the two companies by dividing the joint cash flows between them on a 60/40 basis
  - both shares quoted on the NYSE and the LSE
  - $\Longrightarrow$ Rational expectation: market cap of RDP $= 1.5 \times$ market cap of STT
  - LTCM noticed that STT traded at a 8% discount
  - $\Longrightarrow$ pairs-trade: Long in STT and short in RDP

LTCM made rational bets

- Royal Dutch Petroleum (RDP) and Shell Transport & Trading (STT) Both owned by Royal Dutch Shell
  - a DLC (Dual Listed Company)
  - 1998: a corporate charter linked the two companies by dividing the joint cash flows between them on a 60/40 basis
  - both shares quoted on the NYSE and the LSE
  - $\Longrightarrow$ Rational expectation: market cap of RDP $= 1.5 \times$ market cap of STT
  - LTCM noticed that STT traded at a 8% discount
  - $\Longrightarrow$ pairs-trade: Long in STT and short in RDP
- but, the spread continued to widen ...

LTCM made rational bets

- Royal Dutch Petroleum (RDP) and Shell Transport & Trading (STT) Both owned by Royal Dutch Shell
  - a DLC (Dual Listed Company)
  - 1998: a corporate charter linked the two companies by dividing the joint cash flows between them on a 60/40 basis
  - both shares quoted on the NYSE and the LSE
  - $\Longrightarrow$ Rational expectation: market cap of RDP $= 1.5 \times$ market cap of STT
  - LTCM noticed that STT traded at a 8% discount
  - $\Longrightarrow$ pairs-trade: Long in STT and short in RDP
- but, the spread continued to widen ...
- and LTCM had to close its position at a spread of 22%
- of course there were also the swaps, equity volatility, emerging markets (Russia), etc. ...

Conclusion for Limits to Arbitrage

- Exploiting non-rational pricing can be
  - Risky
  - Costly
- $\Longrightarrow$ non-rationalities **may** persist longer than the rational trader can stay liquid.
- $\Longrightarrow$ markets can during certain periods deviate from what we would expect via the EMH framework

Conclusion for Limits to Arbitrage

- Exploiting non-rational pricing can be
  - Risky
  - Costly
- $\Longrightarrow$ non-rationalities **may** persist longer than the rational trader can stay liquid.
- $\Longrightarrow$ markets can during certain periods deviate from what we would expect via the EMH framework
- $\Longrightarrow$ riding the trend can be the rational thing to do ...
- and ... who knows the real price anyhow?

Further Evidence of Non-Rationalities in Financial Markets

- The **Tulipomania** – Amsterdam, 1637 – Mackay, 1841
- The **South-Sea Bubble** – LSE, 1720 – ibid.
- **Twin Shares** – e.g. Froot and Dabora, 1999: STT and RDS
- **Index Inclusions** – e.g. Harris and Gurel, 1986 and Shleifer, 1986
- **Internet Carve-Outs** – e.g. 3Com and Palm (March 2000) – Lamont and Thaler, 2003

Did we learn something?

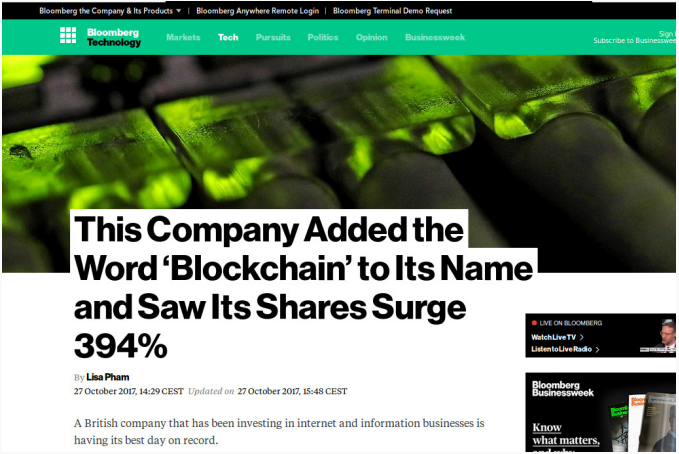


Figure 4: The reaction of the market to the name change of the company On-Line Plc. Source: `https://www.bloomberg.com/news/articles/2017-10-27/what-s-in-a-name-u-k-stock-surges-394-on-blockchain-rebrand`.

Did we learn something?

Figure 5: chart supplied by Bloomberg. Source: https://www.bloomberg.com/news/articles/2017-10-27/what-s-in-a-name-u-k-stock-surges-394-on-blockchain-rebrand.

ONL today

Figure 6: in R: library(quantmod);loadSymbols('ONL',src='yahoo');lineChart(ONL)

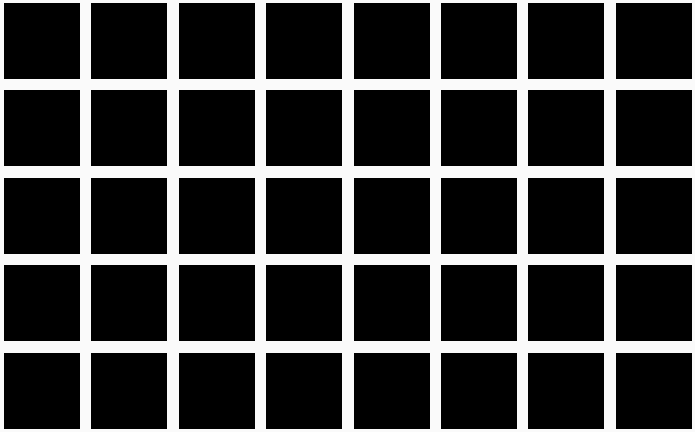


Figure 7: Gray dots appear at the intersection of the black squares (and if you focus on it, then it disappears, but others become visible).

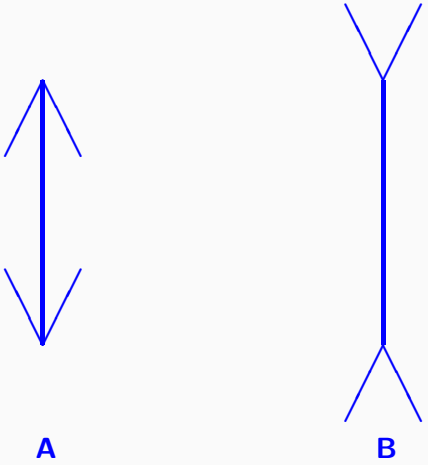


Figure 8: Which vertical line is longer? (only taking into account the vertical lines, not the arrows)

Summary Behavioural Finance/Economics

	Traditional	Behavioural Finance
Investors	rational	cognitive biases
Markets	efficient	not always efficient
Return	driven by risk	driven by risk, greed and fear

Table 1: Behavioural Finance in a nutshell

Some Examples i

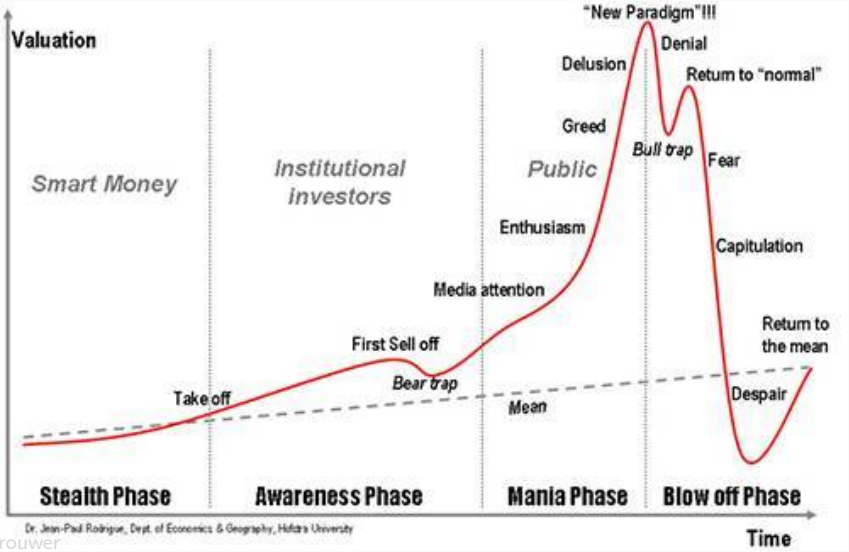
- **buy more after market decline** ("to reduce average purchase price")$\leftarrow$ loss aversion, overconfidence
- a **portfolio of loser stocks** $\leftarrow$ loss aversion, overconfidence, affect heuristic
- **home bias** $\leftarrow$ label effect, prefer the known $\Rightarrow$ suboptimal diversification
- ...or home bias for the location of the private banker
- **exclusive products** for exclusive clients $\leftarrow$ labelling $\Rightarrow$ products that are generally less diversified with higher (fixed) costs and the same MtM
- **bespoke products** $\leftarrow$ labelling, overconfidence $\Rightarrow$ products that are less diversified with higher (fixed) costs and the same MtM

Some Examples ii

- **complicated products** ← labelling, overconfidence, (sometimes) loss aversion ⇒ investments with high costs, and proven mathematical inefficiency (e.g. Bernard, Maj, and Vanduffel, 2010 show that path dependency is not efficient)
- arguments such as "**most people choose option A**" ← works because of herding effect
- **bubbles** ← herd behaviour, greed, overconfidence, etc.
- **crashes** ← herd behaviour, fear, etc.

The Emotional Investment Life Cycle

The Life Cycle of a Bubble



Bitcoin: where are we today?

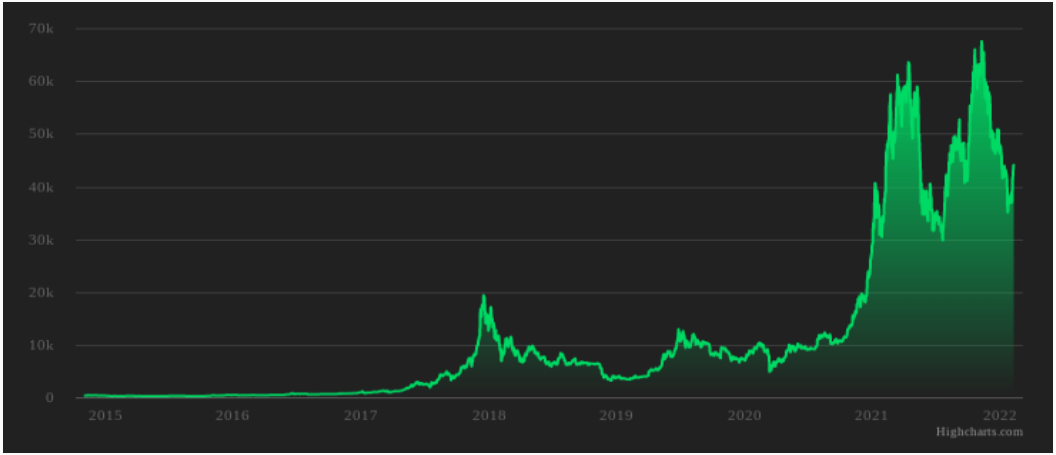


Figure 11: In what phase is Bitcoin? Source: `https://www.coindesk.com/price/`

Bitcoin: where are we today? (latest update)

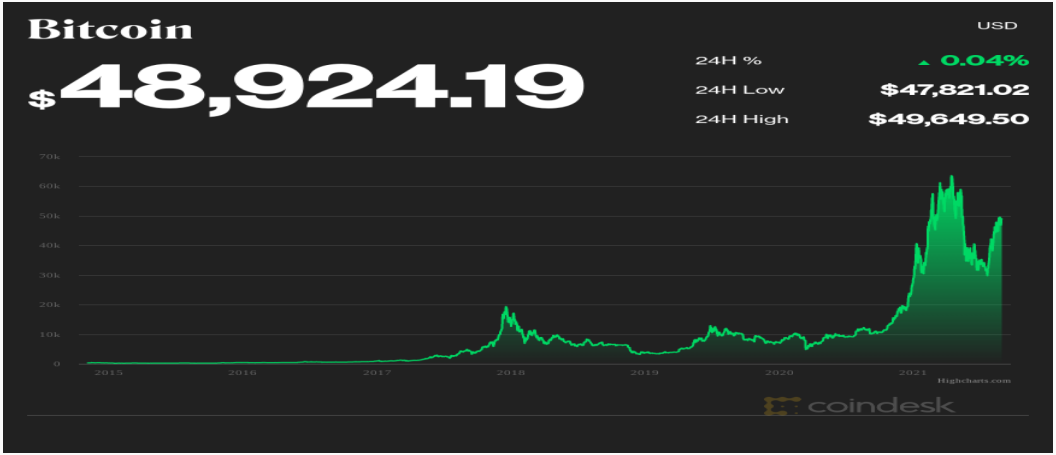


Figure 12: In what phase is Bitcoin? Source: https://www.coindesk.com/price/bitcoin/

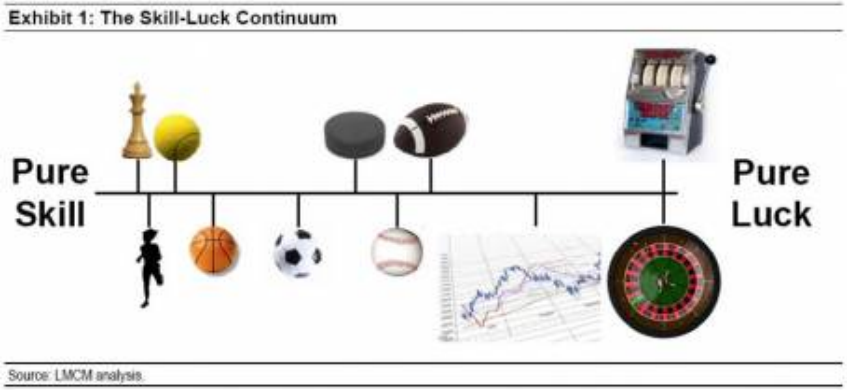


Figure 13: The truth about forecasting power in financial markets.

Selected Behavioural Biases

Warm-up: Math first

Question: what is the next number in the following series: 1, 3, 5, 7, ...

The most complete answer is ...

(A) 9
(B) 11
(C) 217,341
(D) A and B
(E) A, B, and C

Warm-up: Math first

Question: what is the next number in the following series: 1, 3, 5, 7, ...

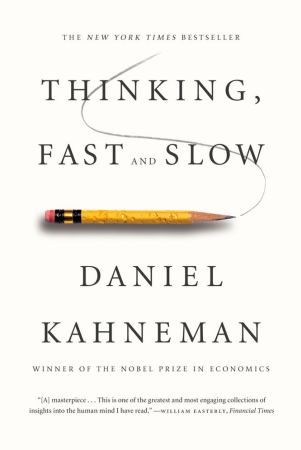
The most complete answer is ...

(A) 9
(B) 11
(C) 217,341
(D) A and B
(E) A, B, and C

Answer/Comment

All of them: A is uneven numbers, B is prime numbers (or the series $\sum_{n=1} \{(-1)^n (x_{n-1} + x_{n-2})\}$, with $x_1 = 1$ and $x_2 = 3$), and C is the function $f(x) = \frac{18,111}{2}x^4 - 90,555x^3 + \frac{633,885}{2}x^2 - 452,773x + 217,331$ for $x = 1$ to 5.

Bias is Rooted in Heuristics for Fast Decisions



Two systems of thinking

(A) **System 1**:

- automatic
- quick
- no sense of voluntary control
- huge processing capacity (11 000 000 bits per second)

(B) **System 2**:

- requires effort and concentration
- slow
- conscious
- limited capacity (40 bits per second)

When we think about "us", we think of System 2, but from others we see more of System 1 (e.g. System 1 is only 7%)

What is Bias Anyhow?

Question:

A golf-club and ball cost together 1,050$. The club is 1,000$ more expensive than the ball.

How much cost the ball?

(A) 0.0$
(B) 25.5$
(C) 50.0$
(D) 75.5$

What is Bias Anyhow?

Question:

A golf-club and ball cost together 1,050$. The club is 1,000$ more expensive than the ball.

How much cost the ball?

(A) 0.0$
(B) 25.5$
(C) 50.0$
(D) 75.5$

Answer/Comment

$1,025.5 + 25.5 = 1,050$

Are you a bad driver?

Question: Suppose that we (with the group in which we are now) would do a driving test and rank all drivers from the best to the worst. Then we split the group in half: group 1: 50% relatively best drivers and group 2: 50% relatively worst drivers. In which group would you end up?

(A) group 1: 50% relatively best drivers

(B) group 2: 50% relatively worst drivers

Overconfidence

Question: Suppose that we (with the group in which we are now) would do a driving test and rank all drivers from the best to the worst. Then we split the group in half: group 1: 50% relatively best drivers and group 2: 50% relatively worst drivers. In which group would you end up?

(A) group 1: 50% relatively best drivers

(B) group 2: 50% relatively worst drivers

Question: **Suppose that we (with the group in which we are now) would do a driving test and rank all drivers from the best to the worst. Then we split the group in half: group 1: 50% relatively best drivers and group 2: 50% relatively worst drivers. In which group would you end up?**

(A) group 1: 50% relatively best drivers

(B) group 2: 50% relatively worst drivers

Answer/Comment

People over-estimate their own abilities.

Question: **The Amazon river is a river in South America. Provide a confidence interval so that you're 90% sure that the real length is in it. (use *km* or *mi*)**

Question: The Amazon river is a river in South America. Provide a confidence interval so that you're 90% sure that the real length is in it. (use *km* or *mi*)

Measurements of the Amazon vary between $6,259$ and $6,800$km ($3,889$ and $4,225$ mi) long

(A) Yes, the real length is in my interval

(B) No, the real length is longer or shorter

Overconfidence

- When people give a 98% confidence interval, it contains only in 60% of the cases the true value – Alpert and Raiffa, 1982
- When they say to be "certain", then the they are about 80% certain – Fischhoff, Slovic, and Lichtenstein, 1977
- Related to:
  - hindsight bias
  - self attribution bias
  - optimism and wishful thinking: 90% of people believe to be over average in many common skills – Weinstein, 1980; and they generally are too optimistic in meeting deadlines – Buehler, Griffin, and Moss, 1994

Overconfidence Examples

Figure 14: In 2011, Aaron Barr, CEO of HBGary Federal, bragged that he could exploit social media to gather information about anonymous. Photo: ©Philippe De Brouwer

Discussion – Overconfidence

Here are some examples of the overconfidence bias:

- Someone tells you "I'm sure."
- An investor tells you "it's different this time."
- 90% of startups fail ... but you will start a new company.

Add some examples yourself.

Overconfidence

Overconfidence

Overconfidence

Question on next slide

Two Gambles

Suppose that you are participating in a game that consists out to two gambles.
Choose an option in gamble 1 and 2

Gamble 1

(A) a sure gain of € 2,400

(B) 25% chance to win € 10,000 and 75% chance to win nothing

Gamble 2

(A) a sure loss of € 7,500

(B) 75% chance to loose € 10,000 and 25% chance to loose nothing

Voting

Question:

Gamble 1 and 2

(A) **1A** and **2A** (sure gain of € 2'400 and sure loss of € 7'500)

(B) **1A** and **2B** (sure gain of € 2'400 and 75% chance to loose € 10'000 and 25% chance to loose nothing)

(C) **1B** and **2A** (25% chance to win € 10'000 and 75% chance to win nothing and sure loss of € 7'500)

(D) **1B** and **2B** (25% chance to win € 10'000 and 75% chance to win nothing and 75% chance to loose € 10'000 and 25% chance to loose nothing)

Framing

Below are the observed probabilities for the question "Suppose that you are participating in a game that consists out to two gambles: A and B, so choose an option in question A and B".

1 Choose an option.
   (A) a sure gain of € 2'400 [84%]
   (B) 25% chance to win € 10'000 and 75% chance to win nothing [16%]
2 Choose an option.
   (A) a sure loss of € 7'500 [13%]
   (B) 75% chance to loose € 10'000 and 25% chance to loose nothing [87%]

$\longrightarrow$ risk aversion when profits are involved and loss aversion when losses are involved

Framing ii

the results:

1. (1A + 2A) = 100% sure € 5'100 loss
2. (1A + 2B) = 75% chance to loose € 7'600 and 25% to win € 2'400
3. (1B + 2A) = 25% chance to win € 2'500 and 75% chance to loose € 7'500
4. (1B + 2B) = 37.50% chance on zero, 6.25% chance to win € 10'000, 56.25% chance to loose 10'000

$\longrightarrow$ In order to solve a problem, people break it down to small units and solve each of them overlooking correlations and interconnections – Tversky and Kahneman, 1981

Framing iii

Framing is a strong heuristic and leads to different other biases

- mental accounting
- consider gains and losses in stead of total wealth (consider each gamble separate)
- (and as a consequence) **loss aversion** (in stead of volatility aversion)
- labelling
- sunk cost fallacy
- loss aversion
- anchoring

Figure 15: The pyramids are in the middle of the desert, isn't it? Pictures `pixabay.com` and `twitter.com`.

Discussion – Framing

Here are some examples of framing:

- Sunk costs.
- Replace a fixed premium/bonus of \$1000 with a variable one (even if the expected average is equal or higher).
- Loss aversion (not seeing the bigger frame: total wealth).

Give an example about framing from your experience

Framing

Figure 15: The pyramids are in the middle of the desert, isn't it? Pictures `pixabay.com` and `twitter.com`.

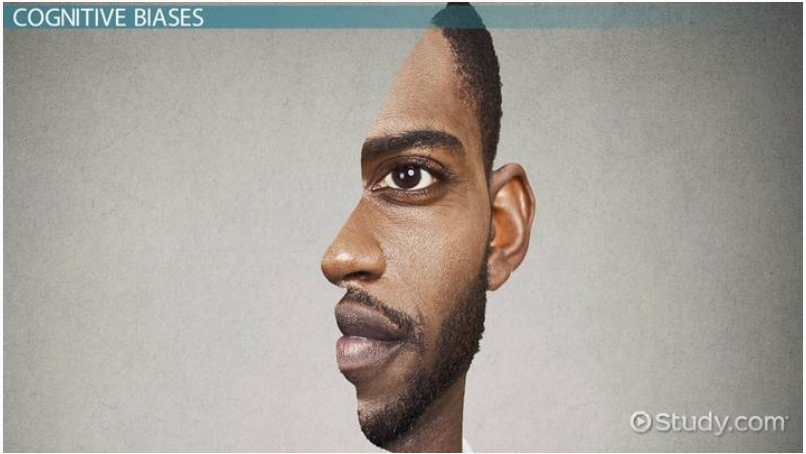
Discussion – Framing

Here are some examples of framing:

- Sunk costs.
- Replace a fixed premium/bonus of $1000 with a variable one (even if the expected average is equal or higher).
- Loss aversion (not seeing the bigger frame: total wealth).

Give an example about framing from your experience

Framing



Framing


Shaken, and a little scratched, the zebra manages to escape his fate
The exhausted and hungry lioness returns home.
Not all her cubs are likely to survive the season


Cops beat Chinese man after asking for his name
"I've lost all faith in our police" says Fuk Yu
By Chief Editor Danny Soz
FULL STORY Page 5


Bullshit
meeting

Framing

Framing


Sometimes the thing that is holding you back...
...is all in your head.

Question: Linda is thirty-one years, single, outspoken and very bright. She majored in Phylosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti nuclear demonstrations."

What is most probable:

(A) Linda is a bank teller

(B) Linda is a bank teller and is active in the feminist movement

Question: Linda is thirty-one years, single, outspoken and very bright. She majored in Phylosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti nuclear demonstrations."

What is most probable:

(A) Linda is a bank teller

(B) Linda is a bank teller and is active in the feminist movement

Representativeness

- People tend to confuse "sounds like" with "is proof for". Generally people act here in contradiction with Bayes' law.
- Related to:
  - sample size neglect
  - hot-hand fallacy – Gilovich, Vallone, and Tversky, 1985
  - the Law of Small Numbers – Rabin, 2002
  - gamblers' fallacy

Belief Perseverance

- Once people have formed their opinion, they stick to it too tightly and too long – Lord, Ross, and Lepper, 1979
- Two effects:
  - (A) people do not search for disconfirming evidence
  - (B) if they find it anyhow, they treat it with excessive scepticism (i.e. they underreact to it)
- Related to:
  - Confirmation bias: people misinterpret disconfirming evidence as if it would support their beliefs
  - overconfidence
  - self-serving bias

Your and Your Parent's Worldview

Question: Compare your religious beliefs or the lack thereof with your parents.

(A) I am less religious (same religion) or have no religion

(B) I have the same religion, similar level

(C) I am more religious (same religion)

(D) I have a different religion

Your and Your Parent's Worldview

Question: Compare your religious beliefs or the lack thereof with your parents.

(A) I am less religious (same religion) or have no religion

(B) I have the same religion, similar level

(C) I am more religious (same religion)

(D) I have a different religion

Your and Your Parent's Worldview

Question: Compare your religious beliefs or the lack thereof with your parents.

(A) I am less religious (same religion) or have no religion

(B) I have the same religion, similar level

(C) I am more religious (same religion)

(D) I have a different religion

Answer/Comment

If you belief in something, logic will not help you to change your mind. People tend to stick to beliefs way too long.

Confirmation Bias / Conservatism Bias / Information Bias

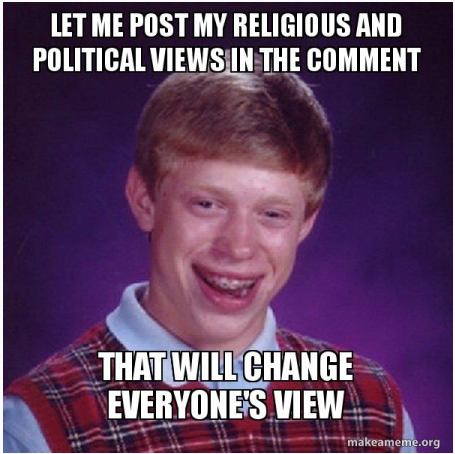
Discussion – Confirmation Bias

People tend to listen only to news that corroborates their beliefs or preconceptions.
Examples:

- Political and religious views.
- Flat Earthers.
- Information Bias: If you are convinced of something, then you will search for confirming information.
- Conservatism Bias: slow to accept new evidence that does not corroborate one's preconceptions.
- Ostrich Effect: Ignoring disconfirming evidence.
- Outcome Bias: judging a decision based on its outcome.
- Attribution bias: my investments performed well so I'm a good investor; last month it was not good because the Fed raised the interest rates.
- Placebo Effect: e.g. in medicine

Can you find other examples of the belief and preconception related biases?

Sticking to Beliefs / Confirmation Bias



Discussion – Choice Supportive Bias

People tend to support a choice once made or an opinion once formed and overlook its weaknesses.

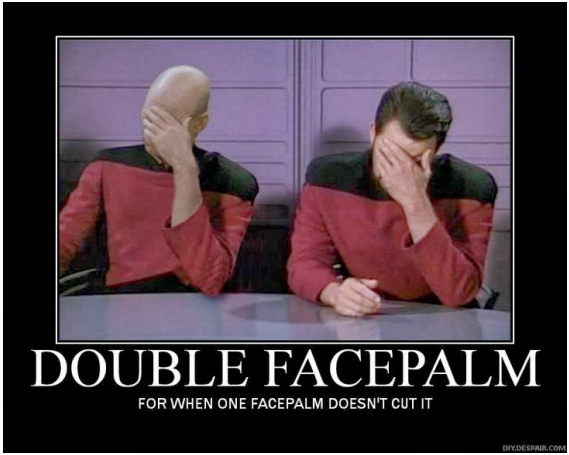
Examples:

- My child, beautiful child.
- My dog is the best, even if it bites from time to time
- I have chosen for SAS/IBM/xxx, it is *my* project, I support it

Can you find other examples of the Choice Supportive Bias?

Choice Supportive Bias

Choice Supportive Bias



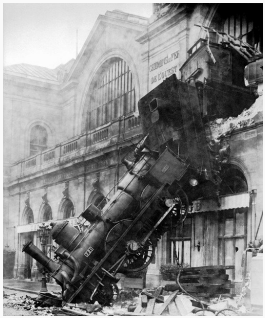


Figure 16: Train accident in Gare de l'Ouest (22/10/1895) – source: `pixabay.com`.

Discussion – Selective Perception

Our expections and point of view influence what we see.

- Football players see more mistakes of the other team when the movie is played.
- We judge ourselves on our intentions and others on the outcome of their intent.

Can you find other examples of the selective perception bias?

Perception and Perspective Matter

Perception and Perspective Matter

Framing / Perception and Perspective Matter

Question: Assume that you're hungry and find two restaurants that only differ in name and in the number of guests: one is empty and the other is half full.

Which restaurant would you choose?

(A) the empty restaurant

(B) the half full restaurant

Question: Assume that you're hungry and find two restaurants that only differ in name and in the number of guests: one is empty and the other is half full.

Which restaurant would you choose?

(A) the empty restaurant

(B) the half full restaurant

Herding Behaviour

- How hard is it to be the first to stand up and applaud after an opera that you particularly liked, or to remain seated when all are standing?

Herding

Humans feel safe in bigger crowds. We tend to see it as the natural choice to follow the herd.

Availability Bias

Question:

Who kills most people per year?

(A) dogs

(B) crocodiles, sharks, tsetse fly (carries malaria virus), and hippopotamus combined

see: Tversky and Kahneman, 1973

Availability Bias

Question:

Who kills most people per year?

(A) dogs

(B) crocodiles, sharks, tsetse fly (carries malaria virus), and hippopotamus combined

see: Tversky and Kahneman, 1973

Availability Bias

Question:

Who kills most people per year?

(A) dogs

(B) crocodiles, sharks, tsetse fly (carries malaria virus), and hippopotamus combined

Answer/Comment

Dogs kill ca. 25,000 people per year, crocodiles 1,000, sharks 150, hippopotamus 500, and the tsetse fly 10,000 – (source BBC and WHO).

see: Tversky and Kahneman, 1973

Pictures

Figure 17: Nice portraits

Availability Bias – II

Question:

Were there more man or more women in the picture? (not counting Harambe, the gorilla)

(A) more women

(B) more men

Anchoring

Question: Paul is told by the car dealer that the car is $20'000 and next week the price is $25'000
Peter is told that the car costs 30'000 and a week later it is $25'000.

Who is most happy?

(A) Paul

(B) Peter

Anchoring

Question: Paul is told by the car dealer that the car is $20'000 and next week the price is $25'000
Peter is told that the car costs 30'000 and a week later it is $25'000.

Who is most happy?

(A) Paul

(B) Peter

Divide in 2 groups

Divide the audience in 2 groups

Voting for group 1

Question: group 1

multiply: $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$

The answer is ...

(A) less than 100

(B) between 100 and 1'000

(C) between 1'000 and 10'000

(D) between 10'000 and 30'000

(E) above 30'000

Voting for group 2

Question: group 2

multiply: $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$

The answer is ...

(A) less than 100

(B) between 100 and 1'000

(C) between 1'000 and 10'000

(D) between 10'000 and 30'000

(E) above 30'000

Voting for group 2

Question: group 2

multiply: $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$

The answer is ...

(A) less than 100

(B) between 100 and 1'000

(C) between 1'000 and 10'000

(D) between 10'000 and 30'000

(E) above 30'000

Answer/Comment

The median in group 1 is 512 and in group 2 is 2'250 ... while it should be 40'320

Anchoring

- When forming an estimate, people start from an initial (possibly) arbitrary value and then adjust . . . but not enough – Kahneman and Tversky, 1974
- Related to:
  - Availability Bias: people overestimate the value of the available information – ibid. Tversky and Kahneman, 1973

Anchoring

Figure 18: People are over-reliant on the first piece of information they get. For example in salary negotiations, the first person to speak sets a range of possibilities in the other person's mind.

Discussion – Anchoring

Give an example of your personal experience that illustrates the anchoring bias.

Anchoring Meme

Discussion – Availability

People overestimate the probability of something based on anecdotal evidence (e.g. waiving climate change after one cold winter).

- The pictures with Harambe, men and women.
- Recency Bias: annual performance review in your company: does it really cover one year or just one month?
- Salience Bias: focus on the most easily recognizable features (e.g. crocodiles/dogs)
- Survivorship Bias: belief that starting a new company is easy because only the people that succeeded talk about it.

Can you find other examples of the availability heuristic?

Example of Availability Heuristic

Figure 19: D. Trump on climate change – Source: `twitter.com` .

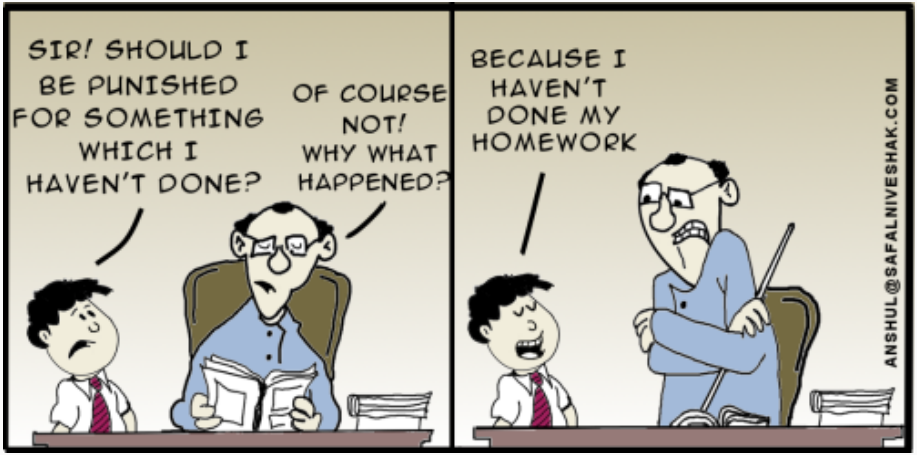
Availability Heuristic: Consequences

70 Years Later, Florida Posthumously Pardons the "Groveland Four"

On January 11, 2019, the Florida Clemency Board unanimously granted posthumous pardons to the "Groveland Four," four young African-American men falsely accused of raping a young white woman in Lake County, Florida in 1949. During the racist hysteria following the accusation, white mobs burned down black residences, a massive white posse lynched a black suspect, all-white juries condemned two innocent men to death and an innocent teen to a life sentence, and a racist sheriff murdered one of the men and attempted to kill another.

Figure 20: From `www.deathpenaltyinfo.org`.

Availability, Framing and Anchoring



Availability, Framing and Anchoring

Discussion – Group-think

People feel safe in the group. In a meeting, the first speaker sets the frame in which others will form their beliefs . . . often corroborating.

Examples:

- People hold generally similar belief frameworks as their parents.
- The influence of polls on elections
- Did you foresee the global meltdown in 2008?
- Did you expect D. Trump to win the election in 2016?
- Did you expect Russia to attach Ukraine in February 2022?
- Pro-innovation bias (e.g. Bitcoin)

Can you find other examples of Group-think?

Herd Effect and Group-think

Hot Hand Fallacy

Figure 21: People tend to "see" patterns, even where there are none. Image from pixabay.com

Discussion – Hot Hand Fallacy

Examples:

- The Makapangsat pebble, washing machine, and Mary's cheese.
- The "Hyperactive Causal Agent" and belief.
- Madoff, Enron, etc.

Can you find other examples of the Hot Hand Fallacy?

Choice Supportive Bias

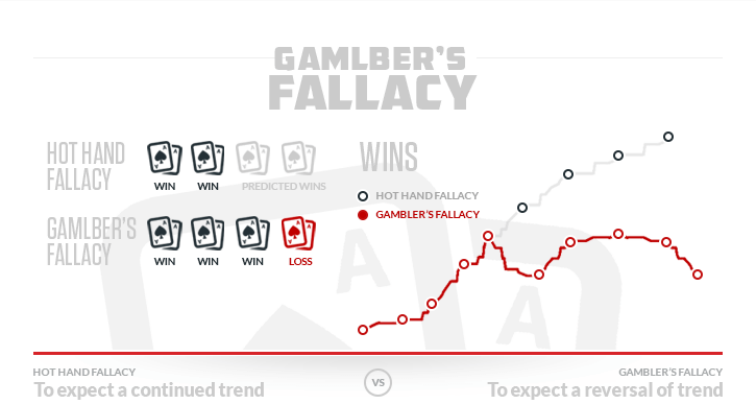


Figure 22: Image from `https://cdn.sportsbettingdime.com`

Figure 23: Stereotypes. Source: Isaac Cruikshank, Wikimedia, A Man-Mid-Wife, or a newly discovered animal not Known in Buffon's time"

Discussion – Stereotyping

Our capability to recognise fast friend or foe (other tribes), creates the tendency to be able to attribute characteritics to an individual based on the group to which he or she belongs.

Examples:

- Racism (crime, good at math)
- The differences in gender and the MBTI profiles.

Can you find other examples of stereotyping?

Blind Spot Bias

People tend to see themselves as unbiased, leaving massive room for judgement error and inferior decisions.

Bible

> *'You hypocrite! First, remove the beam out of your own eye, and then you can see clearly to remove the speck out of your brother's eye.'* Matthew 7:5

Blind Spot Bias / Matthew 7:5

Question:

Assume that you have bought a bond for your portfolio. Which one would be the most acceptable for your boss?

(A) a junk-bond

(B) a high-yield bond

Question:

Assume that you have bought a bond for your portfolio. Which one would be the most acceptable for your boss?

(A) a junk-bond

(B) a high-yield bond

Preferences – Labelling

Which do you prefer?

(A) a junk bond

(B) a high-yield bond

Other biases:

- hyperbolic discounting
- money illusion

Forms of Bias Hindering Inclusion

Forms of Bias Indirectly Hindering Inclusion i

- **Overcondidence on own ability and own judgement**: we systematically over-estimate our own abilities (e.g. After the failure of LTCM the owners tried many more hedge funds that equally failed) – typically people use the wording "to be sure" when they are actually 85% sure — See: Camerer and Lovallo, 1999; Daniel, Hirshleifer, and Subrahmanyam, 2001.
- **Framing** we systematically fail to consider problem from multiple points of view (frames), more in particular we tend to focus on a small frame (e.g. profit and loss of an investment) and fail to see the bigger frame (total wealth) — See e.g. Tversky and Kahneman, 1981
- **Confirmation Bias**: we tend to neglect information that dis-confirms our beliefs and overweight information that confirms our beliefs —

- **Information Bias**: the more information we have, the more confident we get; however, in reality too much information is basis for a weaker decision process. This overconfidence translates in believing that we can "win it" and we fail to follow a process —

Bias Directly Influencing Inclusion i

- **Groupthink**: we have the innate need to conform (e.g. notice how hard it is to remain seated when everyone else is going for a standing ovation), this results in the belief that the majority is right —
- **Shortsighted Shortcuts**: this leads to underestimating the risk of a viral outbreak or interest rates. It also results in trusting that our brain has an unbiased view on the world. Instead our brain will typically use the most readily available information as an anchor and extrapolate from there (but not enough – aka Anchoring) —

Bias Directly Influencing Inclusion ii

- **Attribution Bias and Failure to Seek Feedback**: when a decision is successful then we tend to attribute the success to our own abilities (e.g. "I'm a good investor since the stock that I bought is up") and failures to external circumstances (e.g. "the stock that I bought is down, because of an unfortunate decision of the FED") —
- **Tribal Thinking**: we tend to use ourselves as the norm to judge others and tend to see what our tribe does as normal. An interesting example are the Latin words "dexter", and "barbarus"[1] Obvious examples are wars between tribes, nations, or within nations: almost without exception the rivalling party is portrayed as barbarian.

Bias Directly Influencing Inclusion iii

- **Failure to Learn**: even when we get the feedback, it seems hard to adjust our decision process or understand the biases and heuristics that govern our decision process —
- **Herd behaviour**: our innate drive to conform to the group to which we belong, to fit and to be part of a group (in a way, group-think is a special case of this bias) – Banerjee, 1992; Nosfinger and Sias, 1999
- **In-group favouritism**: related to the previous, and also known as in-group–out-group bias, in-group bias, intergroup bias, or in-group preference, is the bias to favour members of one's in-group over out-group members. This results in an automatic bias for own gender (Rudman and Goodwin, 2004) and race (Fershtman and Gneezy, 2001). We have the tendency to self-identify with

groups and favourise members of them in many ways –
Oklahoma. Institute of Group Relations and Sherif, 1961; Sumner, 2007

[1]The word "dexter" means left, wrong, unfavorable, on the left hand, perverse, harmful: it was indeed the norm to write with the right hand. Also in English "right" revers to the direction on the right but is also the word to indicate what is fair according to the judicial system. "Barbarus" referred originally to foreigners but soon became a word that indicates uncultivated, savage, uncivilized, wild, cruel, etc.

Places to Start Understanding Own Bias

- tolerance.org
- Harvard University

Deep Dive: Gender Bias

EU Definition

'Any discrimination based on any ground such as sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation shall be prohibited.'

article 21 of the Charter of Fundamental Rights

Gender stereotypes and bias

doctor nurse police officer

Gender stereotypes and bias

doctor

nurse

police officer

Gender stereotypes and bias

doctor

nurse

police officer

Gender stereotypes and bias

doctor

nurse

police officer

Gender stereotypes and bias

doctor

nurse

police officer

Gender stereotypes and bias

	doctor	nurse	police officer
female			

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%		

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	17%

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	17%

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	17%
male			

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	17%
male	55%		

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	17%
male	55%	10%	

Gender stereotypes and bias

	doctor	nurse	police officer
			
female	45%	90%	17%
male	55%	10%	83%

The data behind car accidents

multiple sources: Hailemariam et al., n.d., Eustace and Wei, 2010, Kouabenan et al., 2001, Obeng, 2011, Szumska, Frej, Grabski, et al., 2020, EU, IIHS, NHSA, Insurance information institute, etc.

All agree:

- men cause around 70% of car accidents in the EU

[2] EU data from: https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/statistics/dacota/bfs2018_gender.pdf

The data behind car accidents

multiple sources: Hailemariam et al., n.d., Eustace and Wei, 2010, Kouabenan et al., 2001, Obeng, 2011, Szumska, Frej, Grabski, et al., 2020, EU, IIHS, NHSA, Insurance information institute, etc.

All agree:

- men cause around 70% of car accidents in the EU
- 20,000 male fatalities p.a. vs. 6,000 female in the EU (3 times more men die on the road – 76% of road fatalities are men)[2]

[2] EU data from: https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/statistics/dacota/bfs2018_gender.pdf

The data behind car accidents

multiple sources: Hailemariam et al., n.d., Eustace and Wei, 2010, Kouabenan et al., 2001, Obeng, 2011, Szumska, Frej, Grabski, et al., 2020, EU, IIHS, NHSA, Insurance information institute, etc.

All agree:

- men cause around 70% of car accidents in the EU
- 20,000 male fatalities p.a. vs. 6,000 female in the EU (3 times more men die on the road – 76% of road fatalities are men)[2]
- men are more in fatal accidents (speed and misjudgement), women in minor accidents (distraction, information failure)

[2] EU data from: https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/statistics/dacota/bfs2018_gender.pdf

The data behind car accidents

multiple sources: Hailemariam et al., n.d., Eustace and Wei, 2010, Kouabenan et al., 2001, Obeng, 2011, Szumska, Frej, Grabski, et al., 2020, EU, IIHS, NHSA, Insurance information institute, etc.

All agree:

- men cause around 70% of car accidents in the EU
- 20,000 male fatalities p.a. vs. 6,000 female in the EU (3 times more men die on the road – 76% of road fatalities are men)[2]
- men are more in fatal accidents (speed and misjudgement), women in minor accidents (distraction, information failure)
- In USA: Men drive ca. 30% more miles than females, and cause 6.1 mln accidents vs females 4.4. (IIHS)

[2] EU data from: https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/statistics/dacota/bfs2018_gender.pdf

The Gender of Personality: MBTI

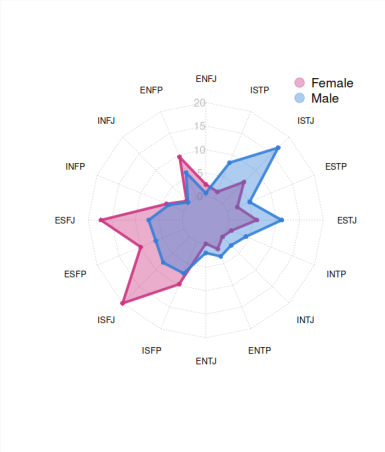


Figure 24: Gender differences in the MBTI profiles.

Table 2: Gender differences in personality. Data from www.statisticbrain.com/myers-briggs-statistics and https://personalitymax.com/personality-types/population-gender/.

Dimension	Male	Female	Δ
Introversion/Extrav.	5% more Introvert	3% more Extravert	8%

The Gender Differences in the MBTI Dimensions

Table 2: Gender differences in personality. Data from `www.statisticbrain.com/myers-briggs-statistics` and `https://personalitymax.com/personality-types/population-gender/`.

Dimension	Male	Female	Δ
Introversion/Extrav.	5% more Introvert	3% more Extravert	8%
iNtuition/Sensing	22% more Sensing	25% more Sensing	3%

Table 2: Gender differences in personality. Data from www.statisticbrain.com/myers-briggs-statistics and https://personalitymax.com/personality-types/population-gender/.

Dimension	Male	Female	Δ
Introversion/Extrav.	5% more Introvert	3% more Extravert	8%
iNtuition/Sensing	22% more Sensing	25% more Sensing	3%
Thinking/Feeling	7% more Thinking	26% more Feeling	33%

Table 2: Gender differences in personality. Data from www.statisticbrain.com/myers-briggs-statistics and https://personalitymax.com/personality-types/population-gender/.

Dimension	Male	Female	Δ
Introversion/Extrav.	5% more Introvert	3% more Extravert	8%
iNtuition/Sensing	22% more Sensing	25% more Sensing	3%
Thinking/Feeling	7% more Thinking	26% more Feeling	33%
Judging/Perceiving	2% more Judging	7% more Judging	4%

Table 2: Gender differences in personality. Data from www.statisticbrain.com/myers-briggs-statistics and https://personalitymax.com/personality-types/population-gender/.

Dimension	Male	Female	Δ
Introversion/Extrav.	5% more Introvert	3% more Extravert	8%
iNtuition/Sensing	22% more Sensing	25% more Sensing	3%
Thinking/Feeling	7% more Thinking	26% more Feeling	33%
Judging/Perceiving	2% more Judging	7% more Judging	4%

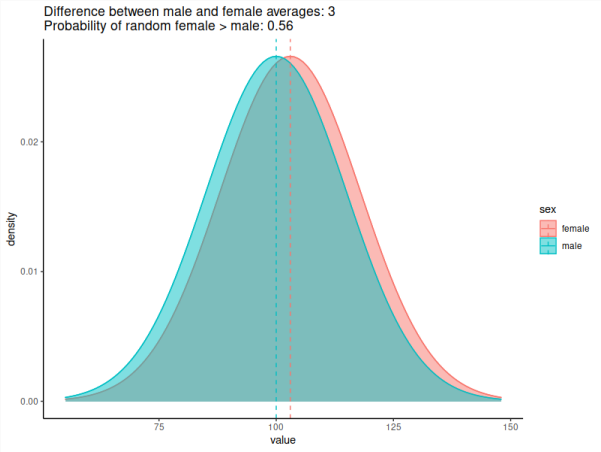


Figure 25: When the differences are small (e.g. 3% or 4%, then the probability that in a random pair men score lower is roughly 50%.

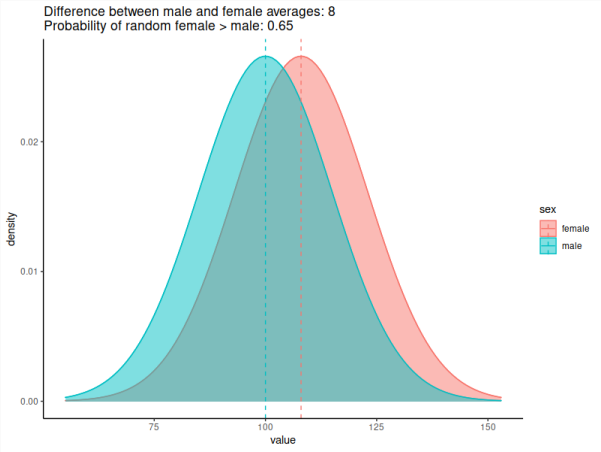


Figure 26: With 8% difference, the probability that in a random pair the woman scores higher/lower is 65%.

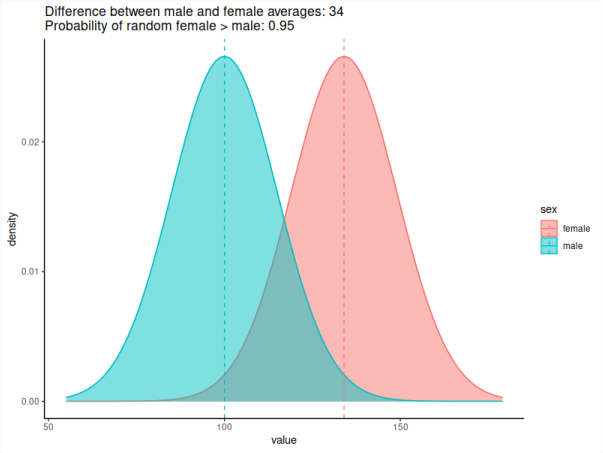


Figure 27: With 34% difference, the probability that in a random pair the woman scores higher is 95% – almost always.

The Big 5

- **Neuroticism** – experience negative emotion in response to perceived threat and punishment (e.g. anxiety, depression, anger, self-consciousness, and emotional lability) — women score higher (except anger)

The Big 5

- **Neuroticism** – experience negative emotion in response to perceived threat and punishment (e.g. anxiety, depression, anger, self-consciousness, and emotional lability) — women score higher (except anger)
- **Agreeableness** – cooperation, social harmony, and consideration of others — women score significantly higher

The Big 5

- **Neuroticism** – experience negative emotion in response to perceived threat and punishment (e.g. anxiety, depression, anger, self-consciousness, and emotional lability) — women score higher (except anger)
- **Agreeableness** – cooperation, social harmony, and consideration of others — women score significantly higher
- **Conscientiousness** – self-discipline, organization, and control of impulses (linked to the ability to exert self-control in order to follow rules or maintain goal pursuit) — women score a little higher

The Big 5

- **Neuroticism** – experience negative emotion in response to perceived threat and punishment (e.g. anxiety, depression, anger, self-consciousness, and emotional lability) — women score higher (except anger)
- **Agreeableness** – cooperation, social harmony, and consideration of others — women score significantly higher
- **Conscientiousness** – self-discipline, organization, and control of impulses (linked to the ability to exert self-control in order to follow rules or maintain goal pursuit) — women score a little higher
- **Extraversion** – sociability, assertiveness, and positive emotionality (linked to sensitivity to rewards) — women score a little higher

The Big 5

- **Neuroticism** – experience negative emotion in response to perceived threat and punishment (e.g. anxiety, depression, anger, self-consciousness, and emotional lability) — women score higher (except anger)
- **Agreeableness** – cooperation, social harmony, and consideration of others — women score significantly higher
- **Conscientiousness** – self-discipline, organization, and control of impulses (linked to the ability to exert self-control in order to follow rules or maintain goal pursuit) — women score a little higher
- **Extraversion** – sociability, assertiveness, and positive emotionality (linked to sensitivity to rewards) — women score a little higher
- **Openness/Intellect** – imagination, creativity, intellectual curiosity, and appreciation of esthetic experiences — no diff.

First Impressions Matter (System 1)

Figure 28: System 1: First impressions matter

First Impressions Matter (System 1)

Figure 28: System 1: First impressions matter

Discussion – Recruitment

How can we get System 1 under control for recruitment?

Discussion – Recruitment

How can we get System 1 under control for recruitment?

Answer/Comment

- Have a process and stick to it
- Select CVs based on quantifiable criteria
- Interview with 2 people (ideally different backgrounds, gender, age, character (MBTI), seniority, . . .)
- Decide in advance what questions to ask
- Score answers (from 1 to 5), based on quantifiable aspects of the answer
- Decide on beforehand how you will calculate a total score

Is this enough to get to equal chances

Question: Assuming that our method is sufficient to tame System 1 in the recruitment process, are the previous rules enough to provide equal and fair chances to everyone?

(A) Yes

(B) No

Is this enough to get to equal chances

Question: Assuming that our method is sufficient to tame System 1 in the recruitment process, are the previous rules enough to provide equal and fair chances to everyone?

(A) Yes

(B) No

Answer/Comment

No, equal chances to get through the CV selection does not provide fair chances to submit the CV, nor does it guarantee equal pay.

Discussion ?

Is de-biasing recruitment enough to get equal pay for equal work?

See the paper "Reporting about Diversity and Inclusion that Inspires to Action" – `http://www.de-brouwer.com/assets/div/div-white-paper.pdf`

Question: What mechanisms can lead to lower pay for women?

What mechanisms can lead to lower pay for women?

(A) biases like over-confidence, availability heuristic etc

(B) biases like framing, groupthink, in-group favouritism, etc.

(C) prejudice / conscious bias

(D) unconscious bias

(E) all of the above

Question: What mechanisms can lead to lower pay for women?

What mechanisms can lead to lower pay for women?

(A) biases like over-confidence, availability heuristic etc

(B) biases like framing, groupthink, in-group favouritism, etc.

(C) prejudice / conscious bias

(D) unconscious bias

(E) all of the above

Answer/Comment

Indeed most biases can –depending on the circumstances– act against a certain group.

Conclusions

Conclusions

- Behavioural biases are deeply rooted in the unconscious part of the brain $\leftarrow$ it is not possible to get "unbiased", being aware of your bias is key on counteracting.

Conclusions

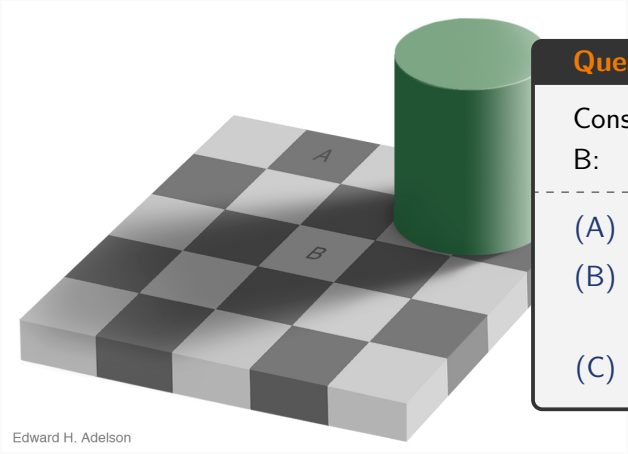
- Behavioural biases are deeply rooted in the unconscious part of the brain $\leftarrow$ it is not possible to get "unbiased", being aware of your bias is key on counteracting.
- Understanding Behavioural Biases is understanding yourself and others.

Conclusions

- Behavioural biases are deeply rooted in the unconscious part of the brain $\leftarrow$ it is not possible to get "unbiased", being aware of your bias is key on counteracting.
- Understanding Behavioural Biases is understanding yourself and others.
- . . . we can make better decisions by consciously engage our rational (aka. slow or System 2) thinking process.

Conclusions

- Behavioural biases are deeply rooted in the unconscious part of the brain $\leftarrow$ it is not possible to get "unbiased", being aware of your bias is key on counteracting.
- Understanding Behavioural Biases is understanding yourself and others.
- ...we can make better decisions by consciously engage our rational (aka. slow or System 2) thinking process.
- We all have multiple biases.



Edward H. Adelson

Question:

Consider the shade of grey in A and B:

(A) A is darker than B

(B) A and B have the same shade of grey

(C) B is darker than A

Can we learn to de-bias?

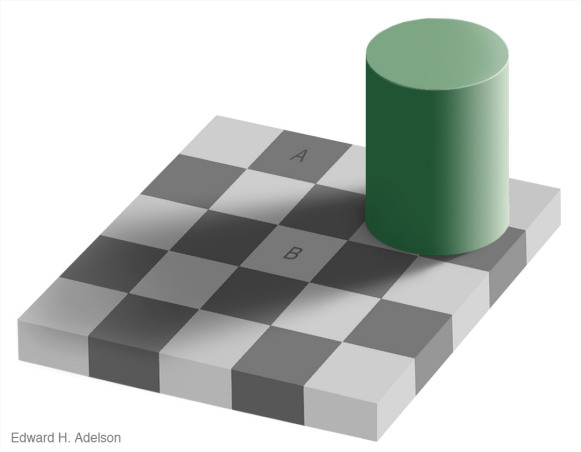


Figure 29: Are A and B of the same shade of grey? – Source: Edward H. Adelson http://web.mit.edu/persci/people/adelson/checkershadow_illusion.html

Can we learn to de-bias?

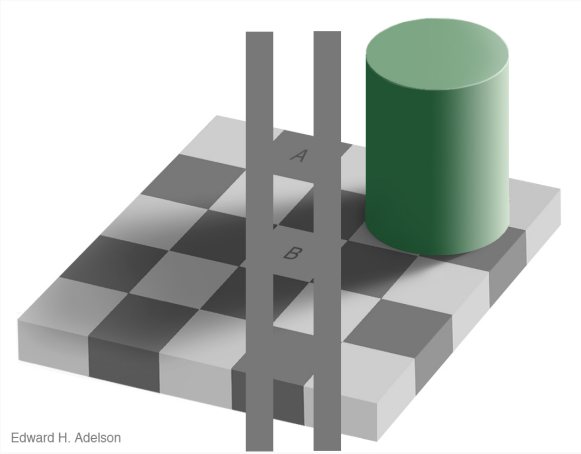


Figure 29: Are A and B of the same shade of grey? – Source: Edward H. Adelson http://web.mit.edu/persci/people/adelson/checkershadow_illusion.html

How do you see yourself?

Question: What describes you best?

(A) Impulsive, biased, judging, and jumping to conclusions

(B) Both A and C

(C) Logical, structured, open-minded, and conscious

Course assesment

Question: Please rate this presentation

(A) Not good – needs replacement

(B) mediocre – needs improvement

(C) good – is ok, but could be improved

(D) very good – difficult to find improvements

(E) top

Thank You!

References

- Alpert, M. and H. Raiffa (1982). 'A progress report on the training of probability assessors'. In: *Judgement Under Uncertainty: Heuristics and Biases*. Ed. by P. Slovic and A. Tversky. Cambridge University Press, pp. 294–305.
- Banerjee, Abhijit V. (1992). 'A simple model of herd behaviour'. In: *Quarterly Journal of Economics* 107.3, pp. 797–817.
- Bernard, C., Mateusz Maj, and Steven Vanduffel (2010). *Improving the Design of Financial Products in a Multidimensional Black-Scholes Market*. Tech. rep. Working Paper Universiteit Brussel.

Bibliography ii

- Buehler, R., D. Griffin, and M. Moss (1994). 'Exploring the planning fallacy: why people underestimate their task completion times'. In: *Journal of Personality and Social Psychology* 67, pp. 36–381.
- Camerer, Colin and Dan Lovallo (1999). 'Overconfidence and excess entry: An experimental approach'. In: *The American Economic Review* 89.1, pp. 306–318.
- Daniel, Kent D., David Hirshleifer, and Avanidhar Subrahmanyam (June 2001). 'Overconfidence, Arbitrage, and Equilibrium Asset Pricing'. In: *The Journal of Finance* 56.3, pp. 921–965.
- Eustace, Deogratias and Heng Wei (2010). 'The role of driver age and gender in motor vehicle fatal crashes'. In: *Journal of Transportation Safety & Security* 2.1, pp. 28–44.

Bibliography iii

- Fama, Eugene F. (Jan. 1965). 'The Behavior of Stock Market Prices'. In: *Journal of Business* 38.1, pp. 34–105.
- — (1970). 'Efficient capital markets: A review of theory and empirical work'. In: *Journal of finance* 25.2, pp. 383–417. ISSN: 0022-1082.
- Fershtman, Chaim and Uri Gneezy (2001). 'Discrimination in a segmented society: An experimental approach'. In: *The Quarterly Journal of Economics* 116.1, pp. 351–377.
- Fischhoff, B., P. Slovic, and S. Lichtenstein (1977). 'Knowing with certainty: the appropriateness of extreme confidence'. In: *Journal of Experimental Psychology: Human Perception and Performance* 3, pp. 552–564.

- Friedman, Milton (1953). 'The case for flexible exchange rates'. In: *Essays in Positive Economics*. University of Chicago Press, pp. 157–203.
- Froot, K. and E. Dabora (1999). 'How stock prices affected the location of trade'. In: *Journal of Financial Economics* 53, pp. 189–216.
- Gilovich, Thomas, R. Vallone, and Amos Tversky (1985). 'The hot hand in basketball: on the misperception of random sequences'. In: *Cognitive Psychology* 17, pp. 295–314.
- Hailemariam, Abebe et al. (n.d.). 'Gender Gaps in the Severity of Road Traffic Accidents'. In: ().

- Harris, L. and E. Gurel (1986). 'Price and volume effects associated with changes in the S&P500: new evidence of the existence of price pressure'. In: *Journal of Finance* 41, pp. 851–860.
- Kahneman, Daniel and Amos Tversky (1974). 'Judgement under uncertainty: heuristics and biases'. In: *Science* 187, pp. 1124–1131.
- — (1979). 'Prospect Theory: An Analysis of Decision under Risk'. In: *Econometrica* 47.2, pp. 263–291.
- Keynes, John F. Maynard (1936). *The General Theory of Employment, Interest, and Money*. London: Palgrave Macmillan. ISBN: 9780230004764.

- Kouabenan, Dongo Rémi et al. (2001). 'Hierarchical position, gender, accident severity, and causal attribution'. In: *Journal of Applied Social Psychology* 31.3, pp. 553–575.
- Lamont, O. and Richard H. Thaler (2003). 'Can the Markets add and Subtract? Mispricing in tech stock carve-outs'. In: *Journal of Political Economy* 111, pp. 227–268.
- Lord, C., L. Ross, and M. Lepper (1979). 'Biased assimilation and attitude polarization: the effects of prior theories on subsequent considered evidence'. In: *Journal Personality and Social Psychology* 37, pp. 2089–2109.
- Mackay, Charles (1841). *Memoirs of extraordinary Popular Delusions and the Madness of Crowds*. First. New Burlington Street, London, UK: Richard Bentley.

- Nosfinger, John R. and Richard W. Sias (1999). 'Herding and feedback trading by institutional and individual investors'. In: *The Journal of Finance* 54.6, pp. 2263–2295.
- Obeng, Kofi (2011). 'Gender differences in injury severity risks in crashes at signalized intersections'. In: *Accident Analysis & Prevention* 43.4, pp. 1521–1531.
- Oklahoma. Institute of Group Relations, University of and Muzafer Sherif (1961). 'Intergroup conflict and cooperation: The Robbers Cave experiment'. In: 10, pp. 155–184.
- Rabin, M. (2002). 'Inference by believers in the law of small numbers'. In: *Quarterly Journal of Economics* 117, pp. 775–816.

- Rudman, Laurie A and Stephanie A Goodwin (2004). 'Gender differences in automatic in-group bias: Why do women like women more than men like men?' In: *Journal of personality and social psychology* 87.4, p. 494.
- Savage, Leonard J. (1954). *The Foundations of Statistics*. New York: Wiley.
- Shefrin, Hersh and Meir Statman (June 2000). 'Behavioral Portfolio Theory'. In: *Journal of Financial and Quantitative Analysis* 35.2, pp. 127–151.
- Shleifer, A. (1986). 'Do demand curves for stocks slope down'. In: *Journal of Finance* 41, pp. 579–590.
- Smith, Adam (1759). *The Theory of Moral Sentiments*. New York: Cosimo.
- Sumner, William Graham (2007). *Folkways: A study of mores, manners, customs and morals*. Cosimo, Inc.

- Szumska, Emilia, Damian Frej, Paweł Grabski, et al. (2020). 'Analysis of the Causes of Vehicle Accidents in Poland in 2009-2019'. In: *LOGI–Scientific Journal on Transport and Logistics* 11.2, pp. 76–87.
- Tversky, Amos and Daniel Kahneman (1973). 'Availability: A heuristic for judging frequency and probability'. In: *Cognitive Psychology* 5.2, pp. 207–232.
- — (1981). 'The framing of decisions and the psychology of choice'. In: *Science* 211.4481, pp. 453–458.
- Weinstein, N. (1980). 'Unrealistic optimism about future life events'. In: *Journal of Personality and Social Psychology* 39, pp. 806–820.

Nomenclature

$\wedge$	the logical "and" operator
$P(A)$	the probability that event A occurs in a given time frame
BF	Behavioural Finance
DLC	Dual Listed Company
EMH	Efficient Market Hypothesis
EUT	Expected Utility Theory
LSE	London Stock Exchange
LTCM	Long Term Capital Management (hedge fund)
MtM	Marked to Market

Nomenclature ii

NYSE	New York Stock Exchange
RDP	Royal Dutch Petroleum
SEUT	Subjective Expected Utility Theory
STT	Shell Transport and Trading