



Reasoning Skills within Software Testing

(expleo)

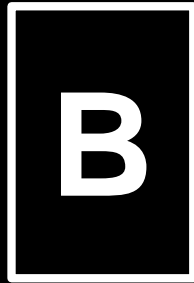
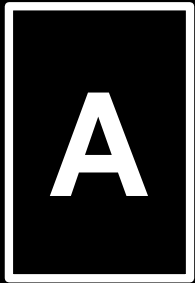
Think bold, act reliable

Rule discovery

(From Wason)

Card: Letter on one face, number on other

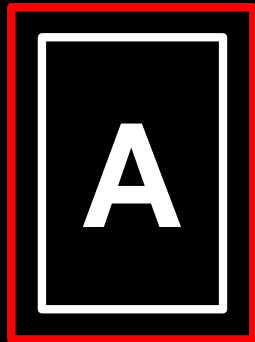
Rule: If the card has a vowel on one side then it always has an even number on the other



What card or cards should you turn over to determine the truth or falsity of the rule?

Rule discovery

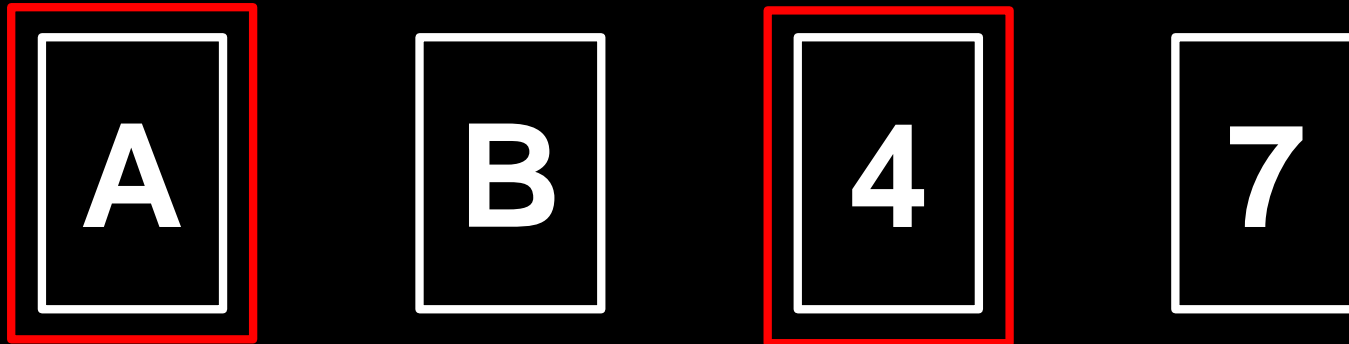
Rule: If the card has a vowel on one side then it always has an even number on the other side.



46% select A

Rule discovery

Rule: If the card has a vowel on one side then it always has an even number on the other side.

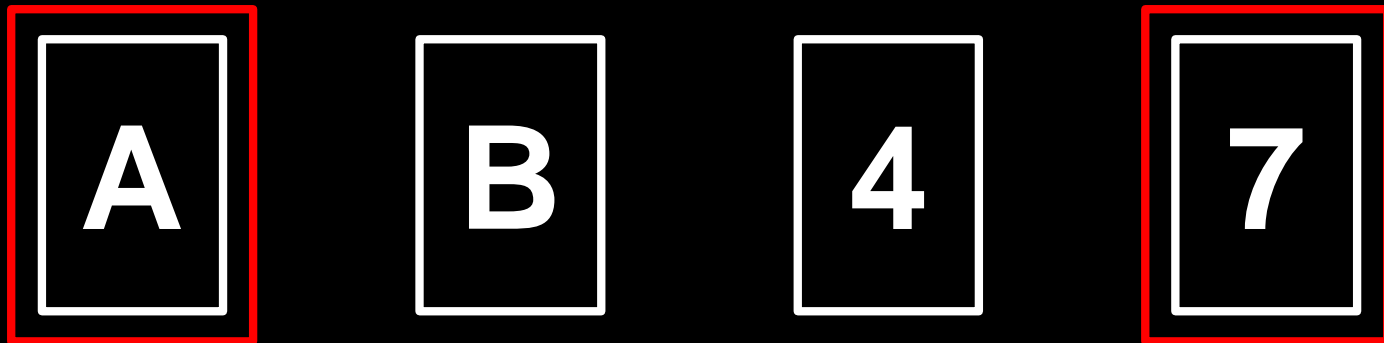


46% select A

32% select A & 4

Rule discovery

Rule: If the card has a vowel on one side then it always has an even number on the other side.



46% select A

32% select A & 4

Best answer is: A and 7

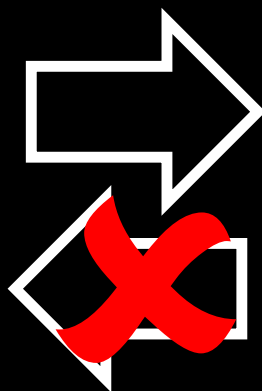
(4% select this)

Rule discovery

Rule: If the card has a **vowel** on one side then it always has an **even number** on the other side.

Front **A** **B** **4** **7**

Vowel



Number






Rule discovery

Rule: If the card has a **vowel** on one side then it always has an **even number** on the other side.

Front

A	B	4	7
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Reverse

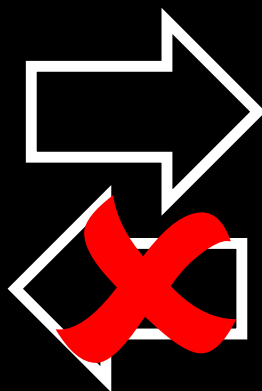
1 	1 	A 
2 	2 	B

Rule discovery

Rule: If the card has a **vowel** on one side then it always has an **even number** on the other side.











Vowel



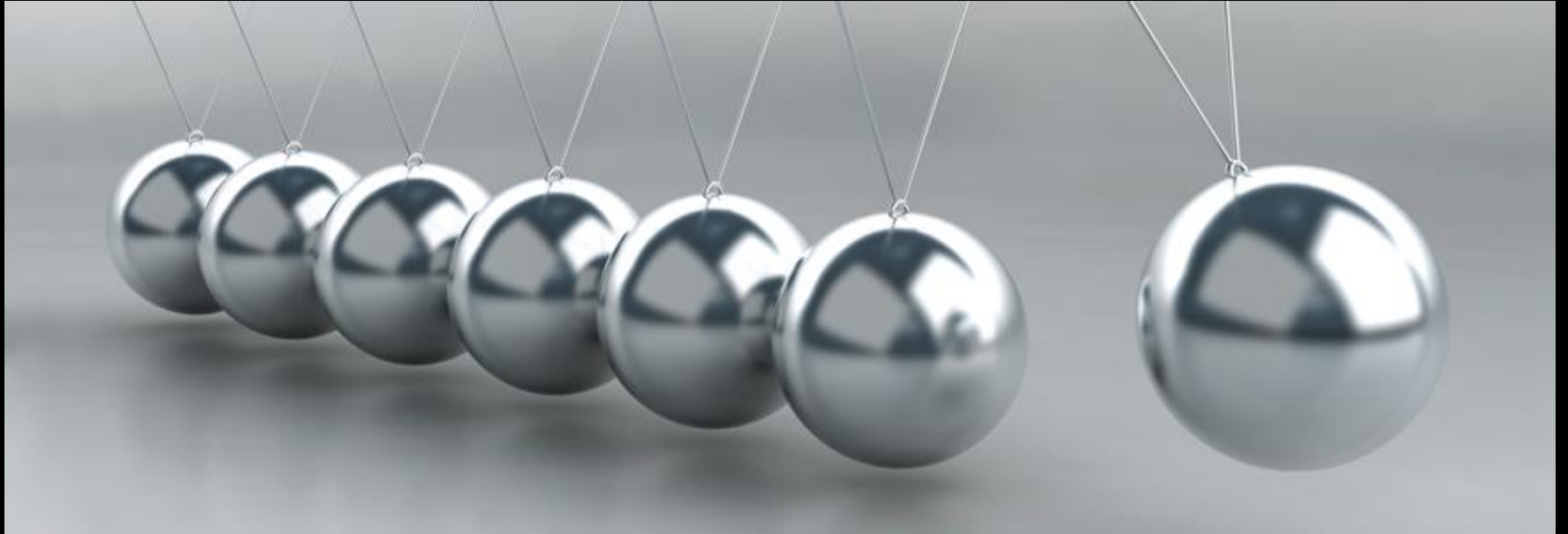
Number

Rule discovery

Rule: If the card has a **vowel** on one side then it always has an **even number** on the other side.

Front	A	B	4	7
<hr/>				
Reverse	1 	1 	A 	A 
	2 	2 	B 	B 

Was that difficult?



Thinking from a social Point of View

Rule discovery in a social context

Beer

Coke

25

17

Rule: You cannot drink alcohol until you are 18

Which people should you check?

Rule discovery in a social context

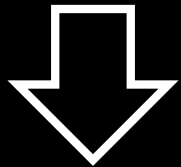
Rule: You cannot drink alcohol until you are 18

Beer

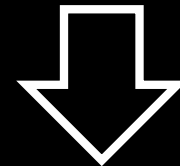
Coke

25

17



**How old
is this
person?**



**What
is this
Person
drinking?**

Rule discovery in a social context

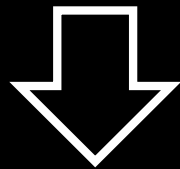
Rule: You cannot drink alcohol until you are 18

Beer

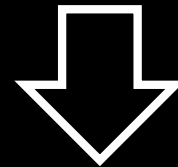
Coke

25

17



**How old
is this
person?**



**What
is this
Person
drinking?**

Why was this second test easier?

1. Concrete example

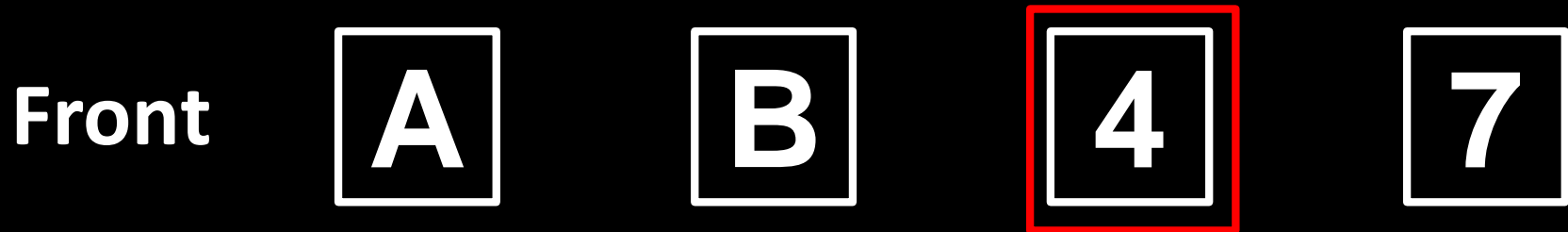
- Test case design – BDD and Spec by Example

2. Social contract

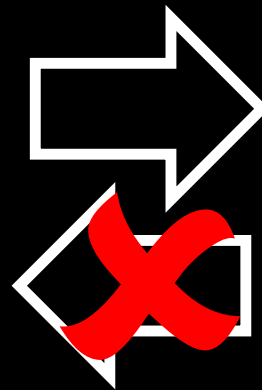
- People skilled at spotting social cheating
- Identify if a condition is unimportant

Rule discovery

Rule: If the card has a **vowel** on one side then it always has an **even number** on the other side.



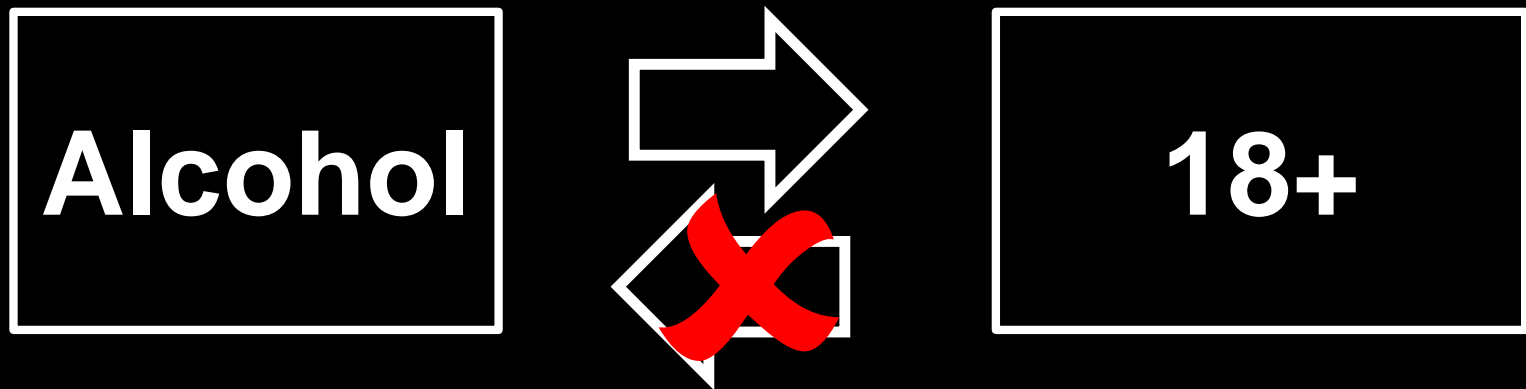
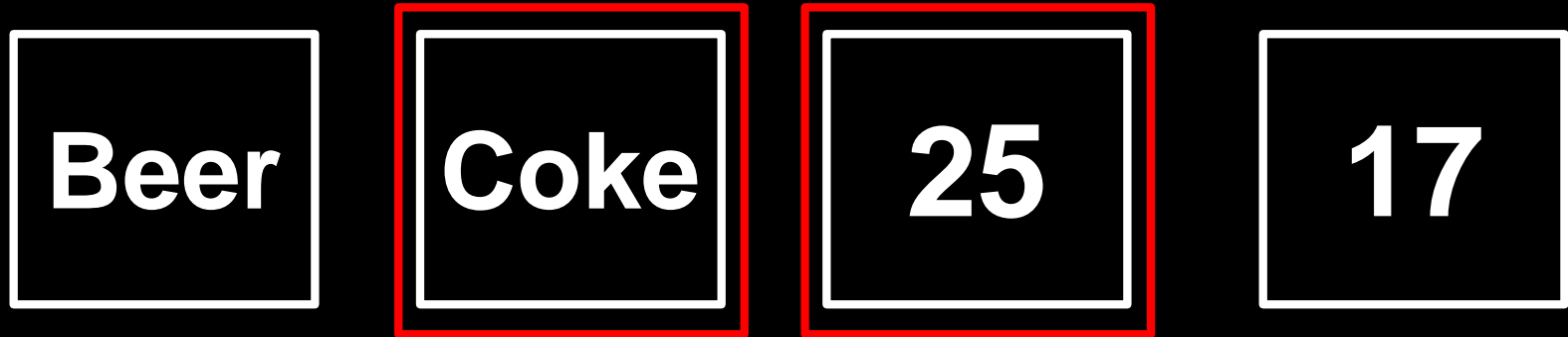
Vowel

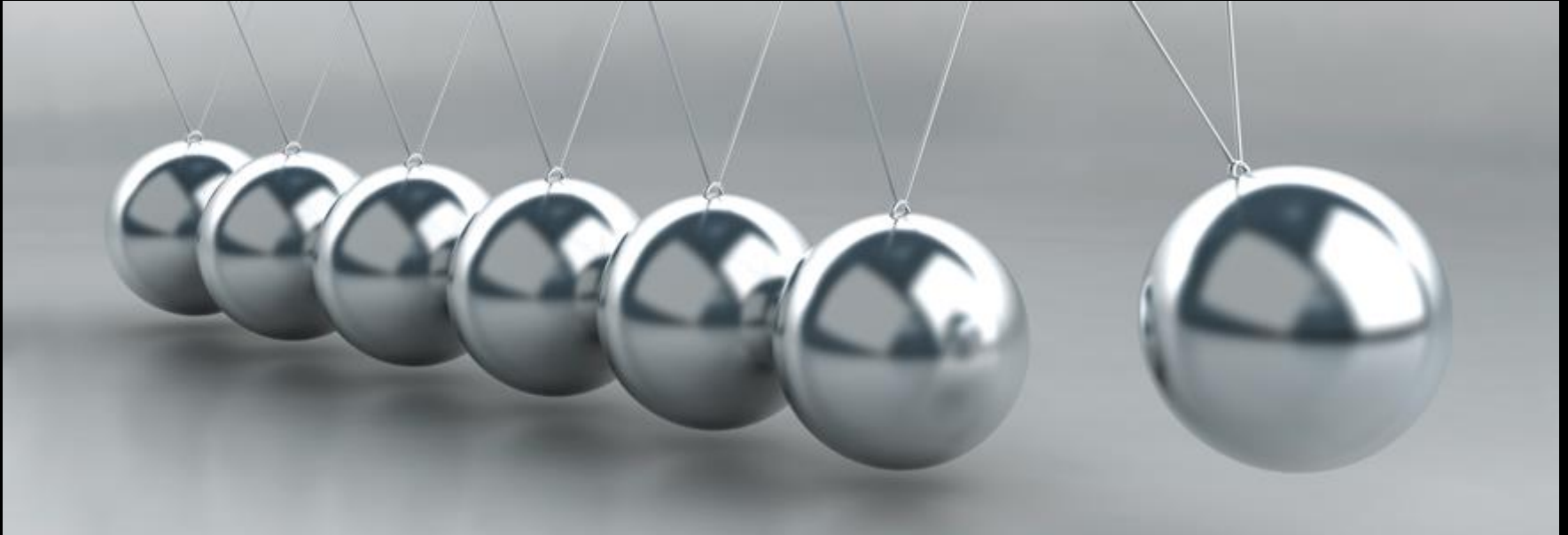


Number

Rule discovery in a social context

Rule: To **drink alcohol** you must be **18+**

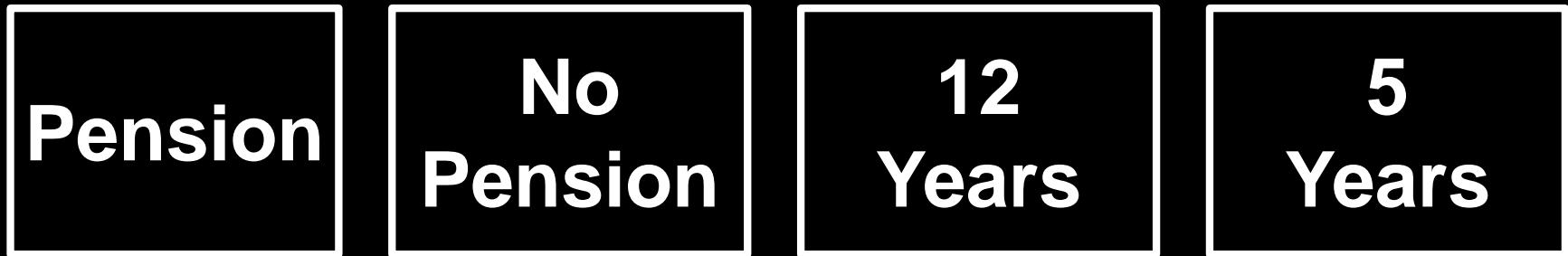




Reframing to a different actor PoV

(Gigerenzer)

Rule discovery in a social context



Employees entitled to a pension after 6 years' service

You are a pension trustee – **safeguard the fund**

Which people should you check?

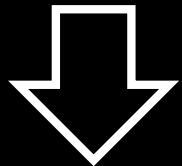
Rule discovery in a social context

Pension

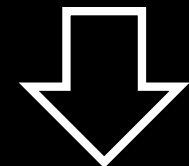
**No
Pension**

**12
Years**

**5
Years**

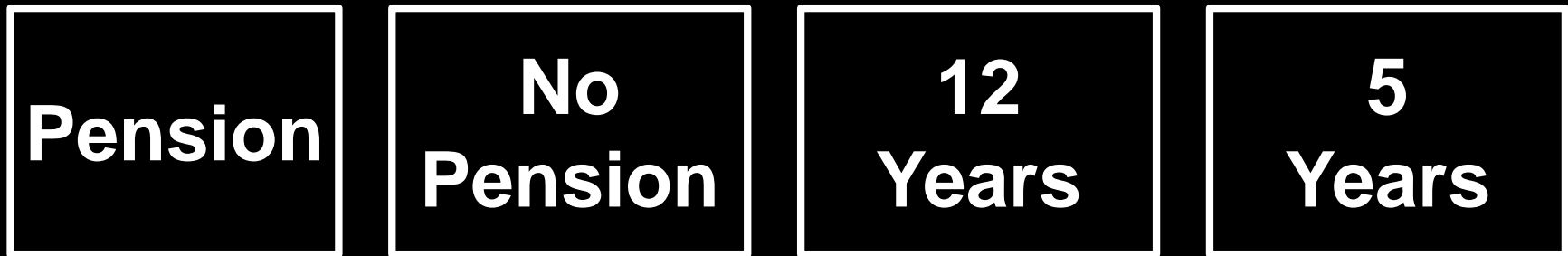


**How long
has this
person
worked?**



**Is this
person
getting a
pension?**

Rule discovery in a social context



Employees entitled to a pension after 6 years' service

You are a union rep – **safeguard your members**

Which people should you check?

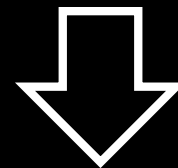
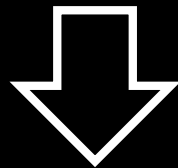
Rule discovery in a social context

Pension

**No
Pension**

**12
Years**

**5
Years**



**How long
has this
person
worked?**

**Is this
person
getting their
pension?**

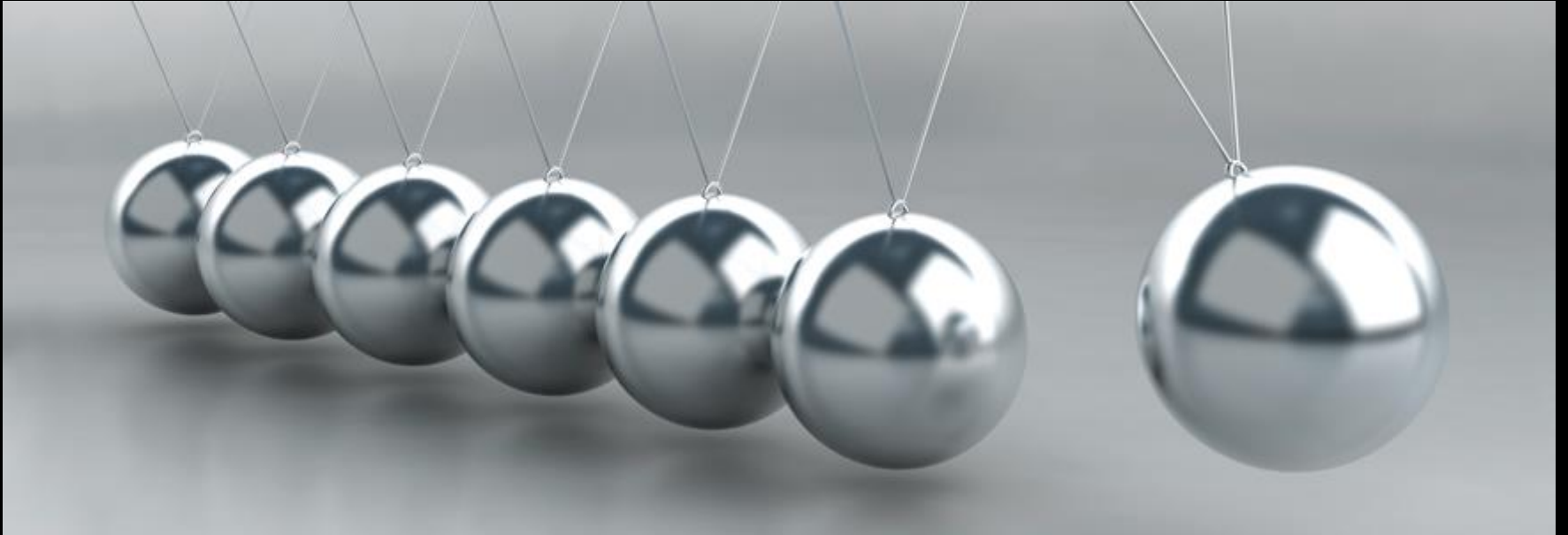


Lessons:

1. Reasoning is DIFFERENT than it looks

2. Social context

- Becomes easier
- Identify different problems/tests

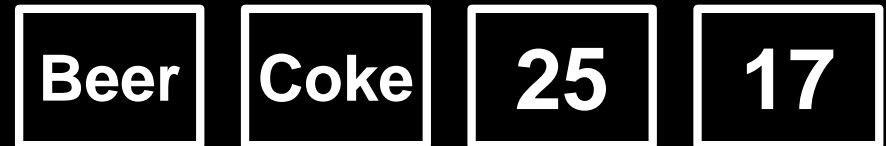


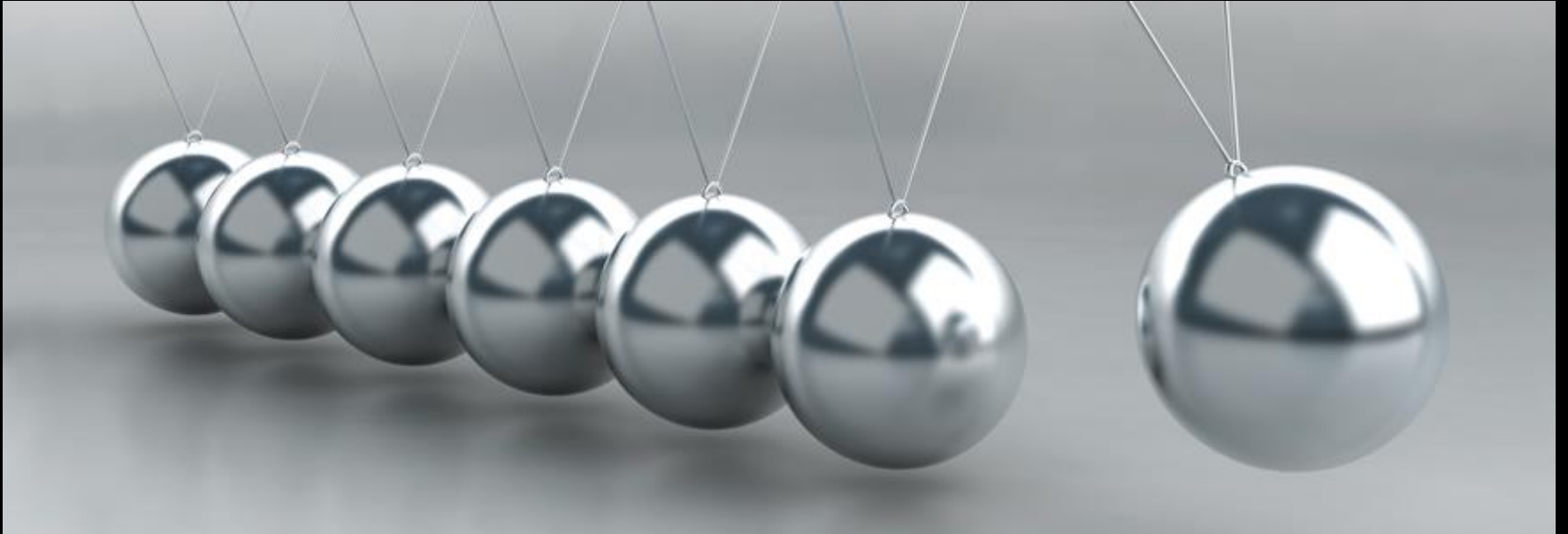
Types of Reasoning

- **Indicative reasoning**
- – true & false



- **Deontic reasoning**
 - permissions
 - obligations
 - prohibitions

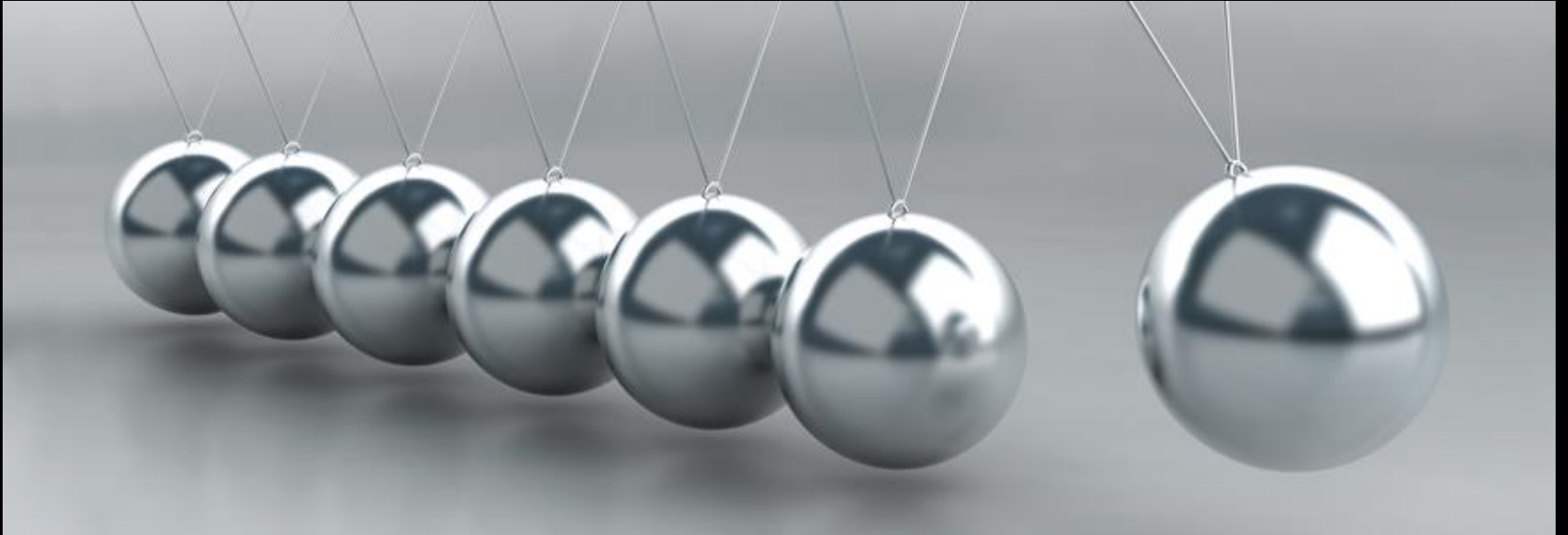




3 Theories relevant to non-logical reasoning

3 Theories

- 1. Dominance Theory**
- 2. Theory of Mind**
- 3. Error Management Theory**



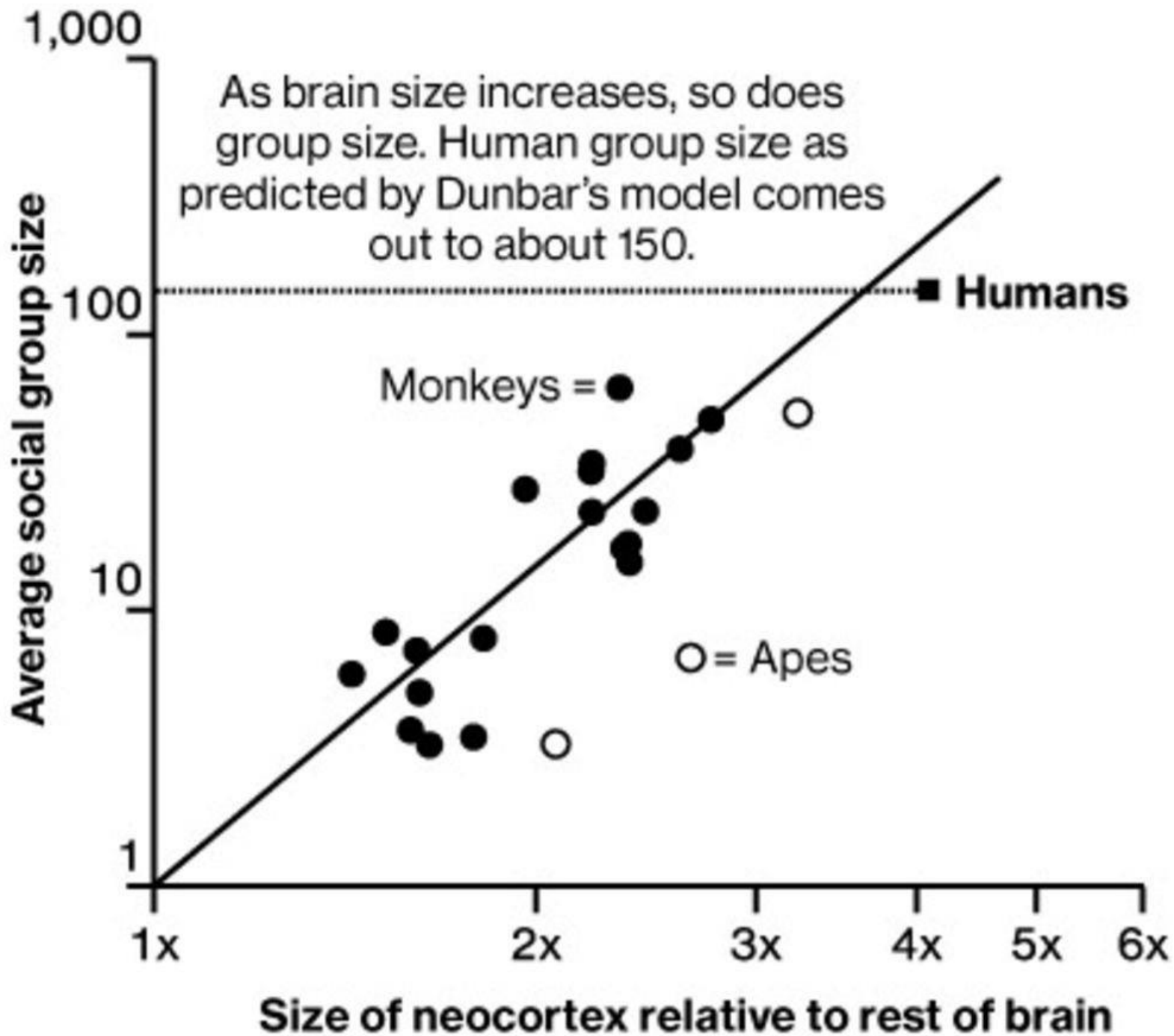
Dominance Theory

Why do we reason?

- **Intelligent organisms have an advantage**
- **Pressure to compete & cooperate driving intelligence**

Dominance theory

- **Dominance hierarchy**
- **We live in a group**
- **SOCIAL group**
- **Social HIERARCHY**



Dominance theory

- **Dominance hierarchy**
- **We live in a social group**
- **Social HIERARCHY**
- **How do you survive & prosper?**

How do you survive & prosper?

Dominant position

- **Rule enforcement**
- **Punishment**
- **Vigilance**

NOT dominant

- **Guile**
- **Deception**
- **Skiving**
- **Alliance building**
- **Appeasement, Bartering**
- **Kinship, Friendship...**

How do you survive & prosper?

Dominant position

- **Rule enforcement**
- **Punishment**
- **Vigilance**

NOT dominant

- **Guile**
- **Deception**
- **Skiving**
- **Alliance building**
- **Appeasement, Bartering**
- **Kinship, Friendship...**

- **Importance of dominance theory**
- **Origin & Importance of deontic reasoning skills**

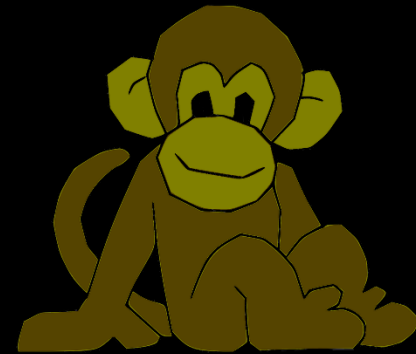


Theory of Mind

Theory of mind

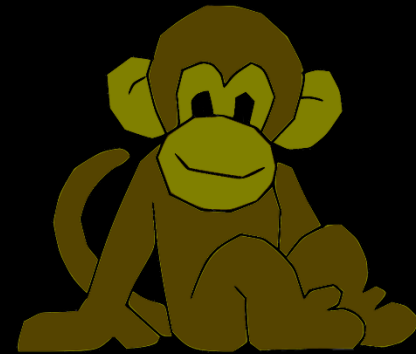


Rock



Belle

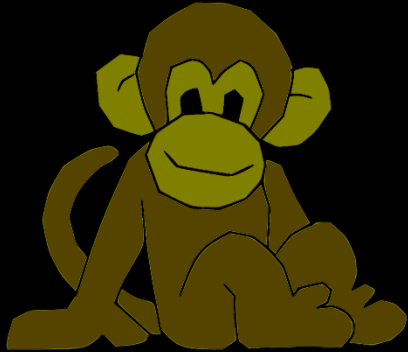
Theory of mind



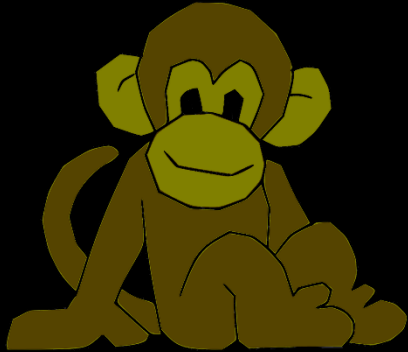
Theory of mind



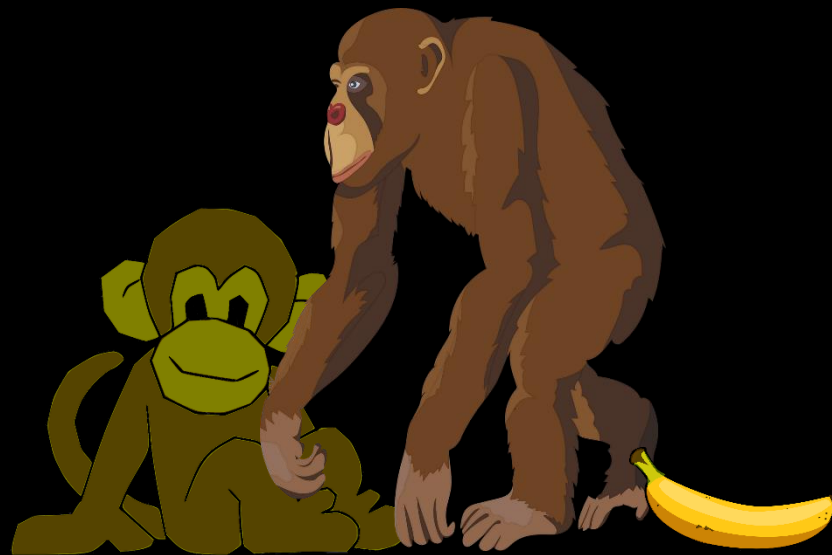
Theory of mind



Theory of mind



Theory of mind



Theory of mind



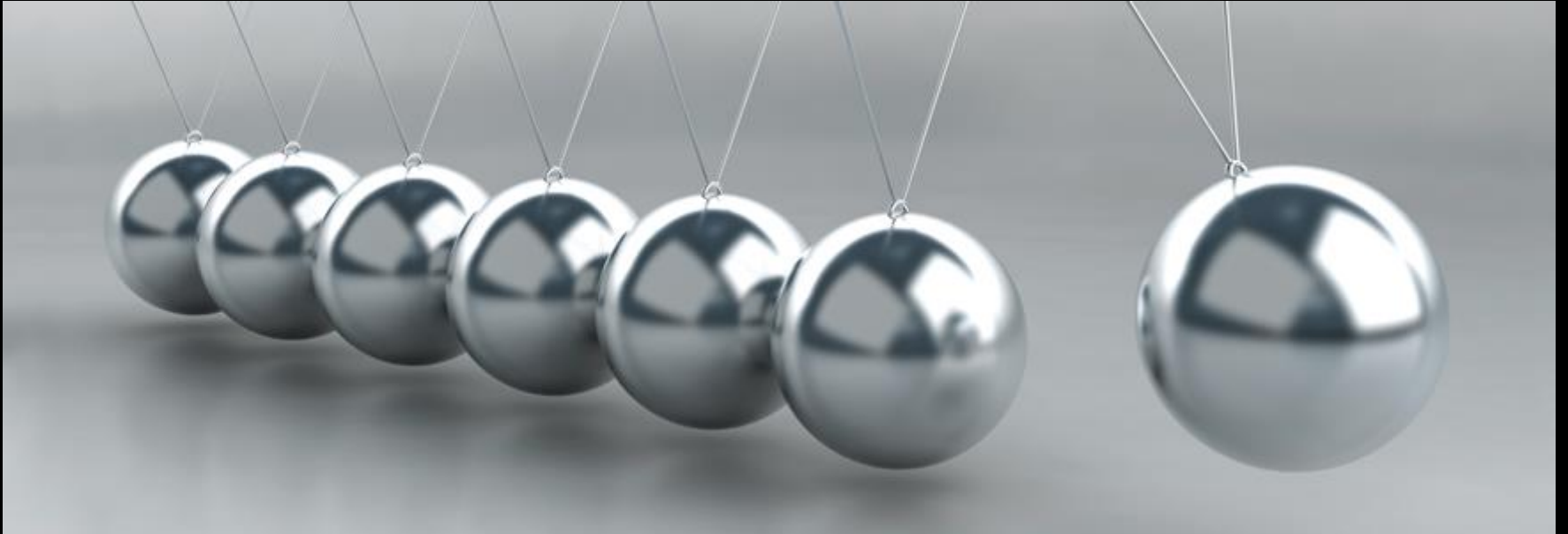
Theory of mind

What is happening within Belle's mind?

...Within Rock's mind?

Evolution of mind

- **Arms race**
- **Ever increasing mental capacity**
- **to represent & manipulate**
- **internal representations**
- **in minds of others.**
- **Ability to reason is a by-product of this**



Error Management Theory

Error Management Theory

We do not minimise errors

We minimise **LOSSES** from errors

When does it pay to make a mistake?

- **Two types of error:**
- **Type 1: False positive**
 - **React when no threat/opportunity present**
- **Type 2: False negative**
 - **Fail to react to a threat that is present**

When does it pay to make a mistake?

When does it pay us to make a mistake?

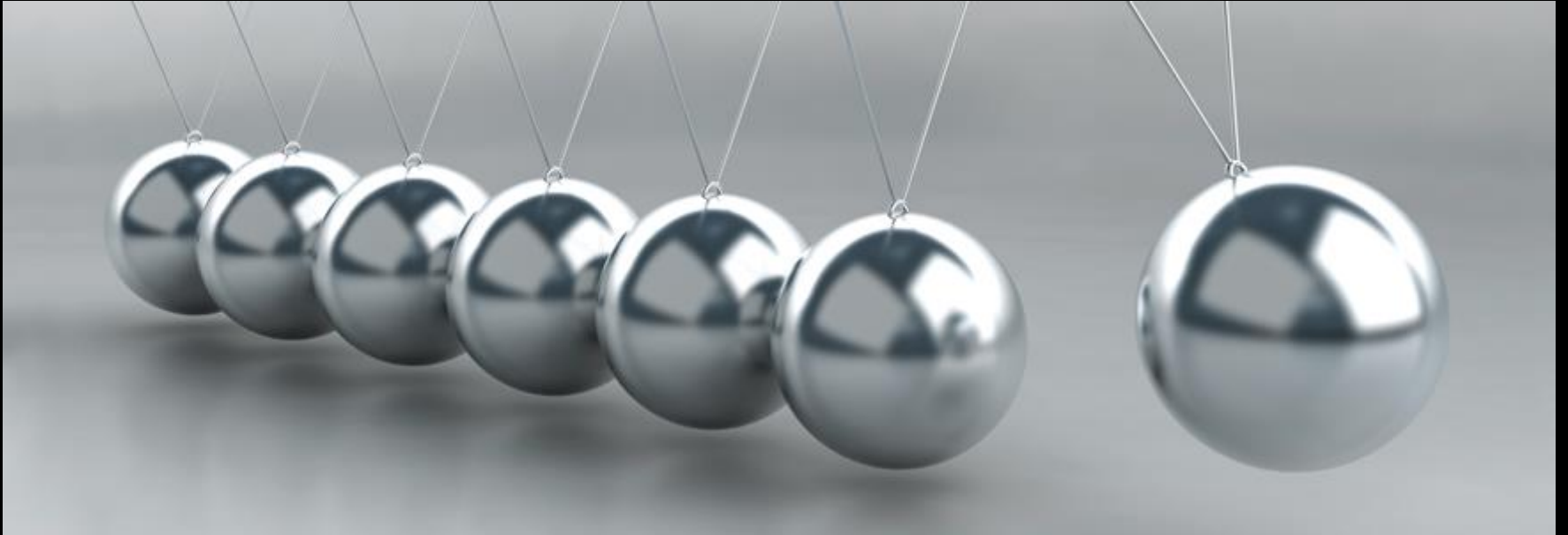
Under conditions of:

- 1. Uncertainty**
- 2. Asymmetric costs**

When does it pay to make a mistake?

Asymmetric costs





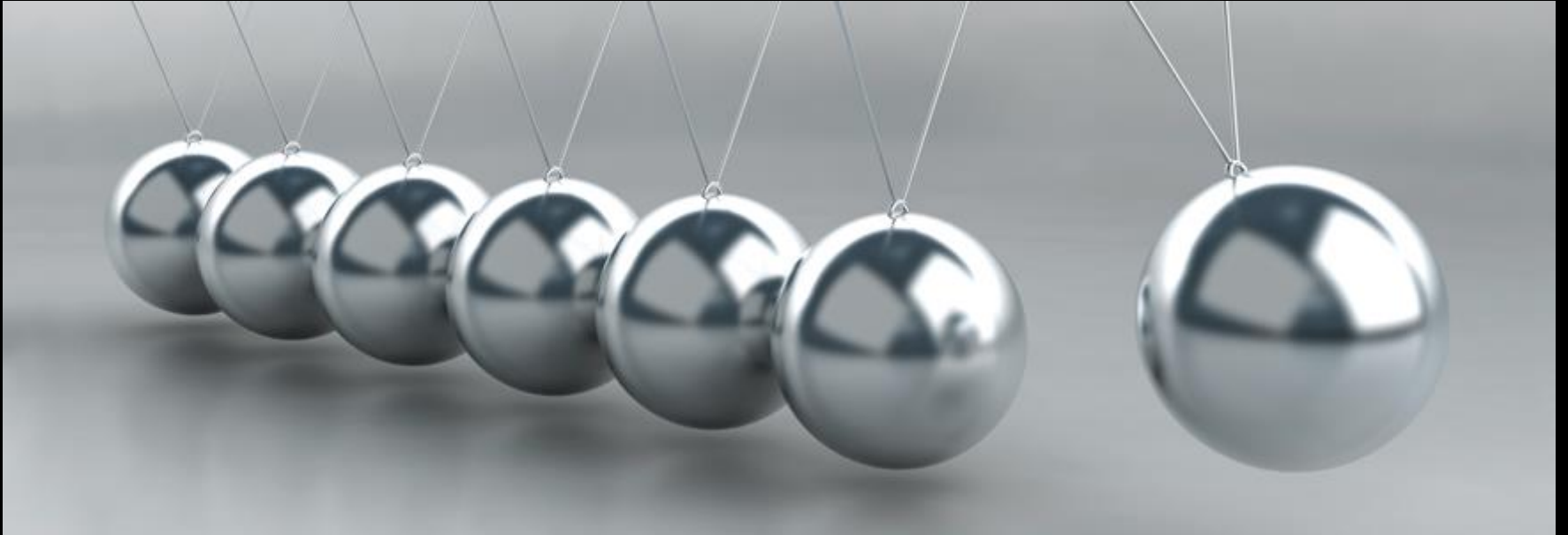
Cognitive biases and Error Management Theory

- **Confirmation bias**
- **Congruence bias**
- **Experimenter's or expectation bias**
- **Illusory Correlation**
- **Observer-expectancy effect**
- **Survivorship bias**

- **Automation bias**
- **Clustering Illusion**

- A bias may be **economically** irrational
- But we maximize survival, it is **adaptively** rational
- Behaviour is not tuned to expected **payoffs**, but expected **fitness**

- **Our reasoning is flawed**
- **Because Error Management uses biases**
- **Towards low-cost errors**
- **Outside of our awareness**



Example of a bias

A

B

4

7

Beer

Coke

25

17

Wason 2-4-6 Test

2 4 6

The above three numbers conform to a simple rule

Find the rule:

- Give me 3 numbers
- I reply 'Conforms' or 'Does not conform'

Steps to solution:

- **Develop hypothesis**
- **Tests:**
- **Aim to break hypothesis**
- **Actual: Tests to confirm hypothesis**

- **Testers: No better than average population**

Confirmation bias

search for

interpret

favour

recall

information that affirms our prior beliefs

**Sensory
Input
10 million
Bits/second**

■
**Conscious processing
~ 8 – 40 Bits/second**

The next second we do the same again

Cognitive ladder

Software Coding:

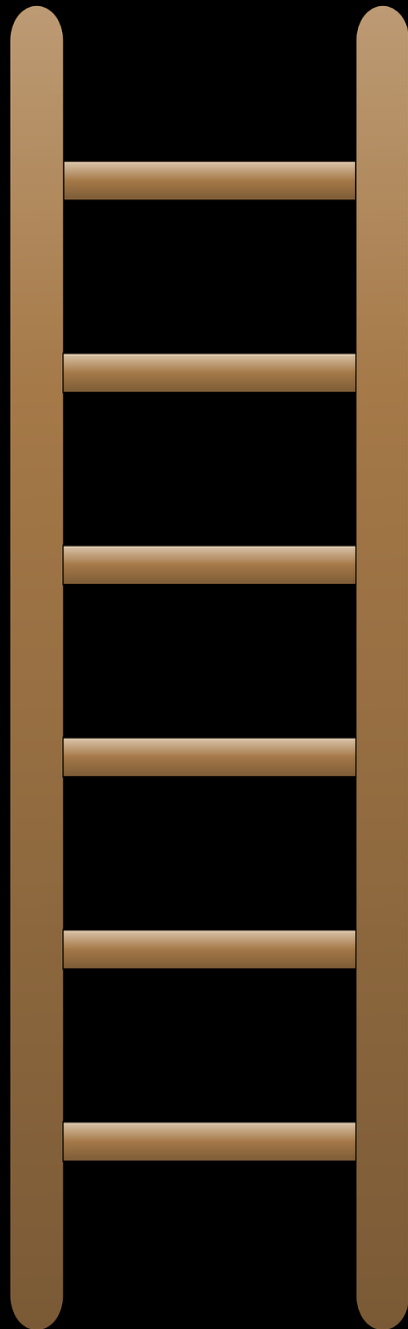
...

Hi-level language

Assembly Lang

Machine Code

Binary

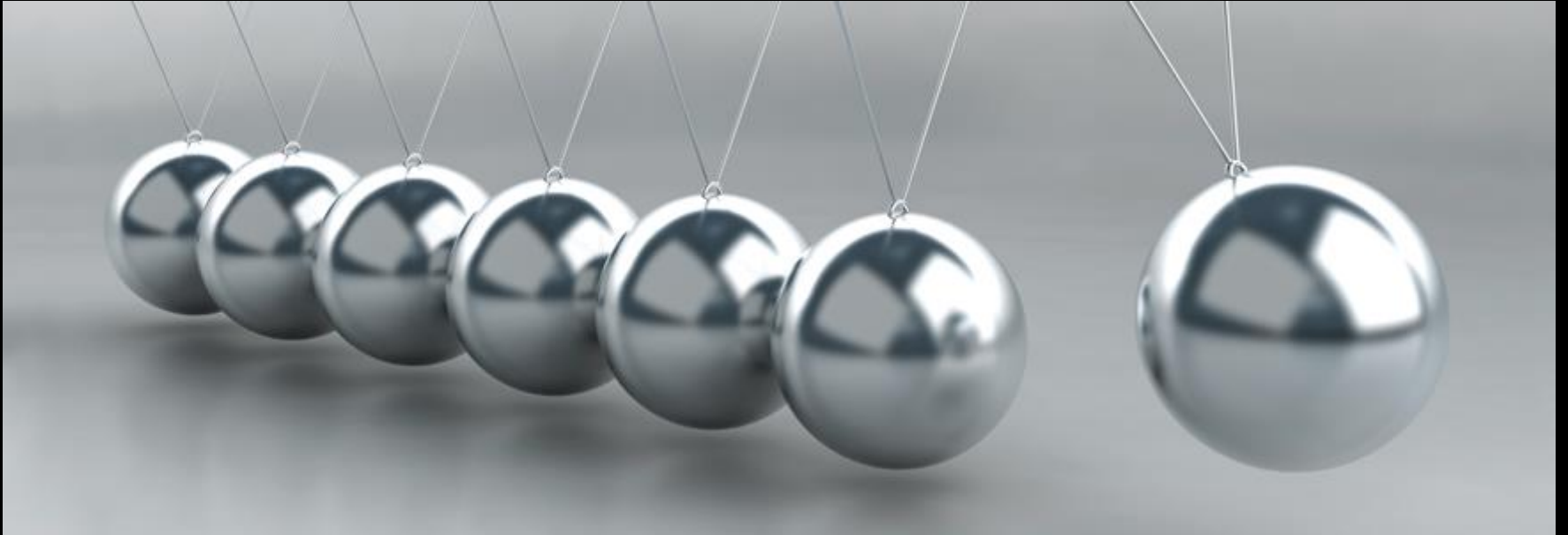


Decision/Action

Error Management

Heuristics

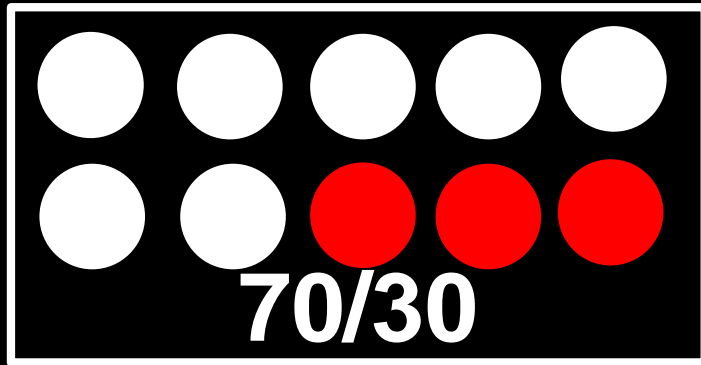
1st principles



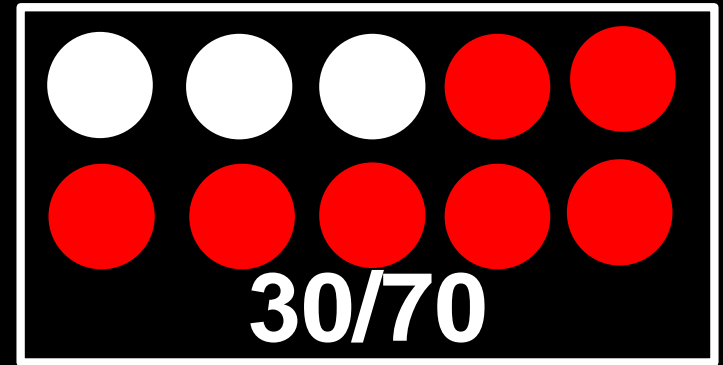
Other aspects of reasoning

Drawing balls from an urn

A



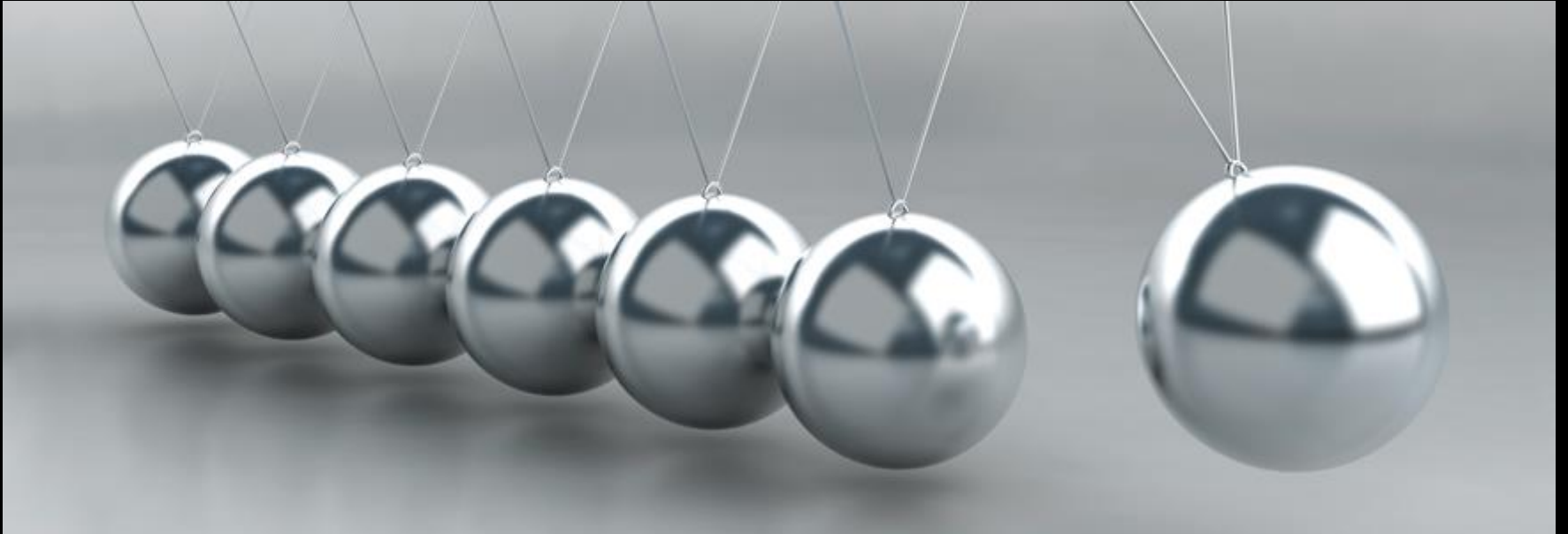
B



Draw sample of balls from urn

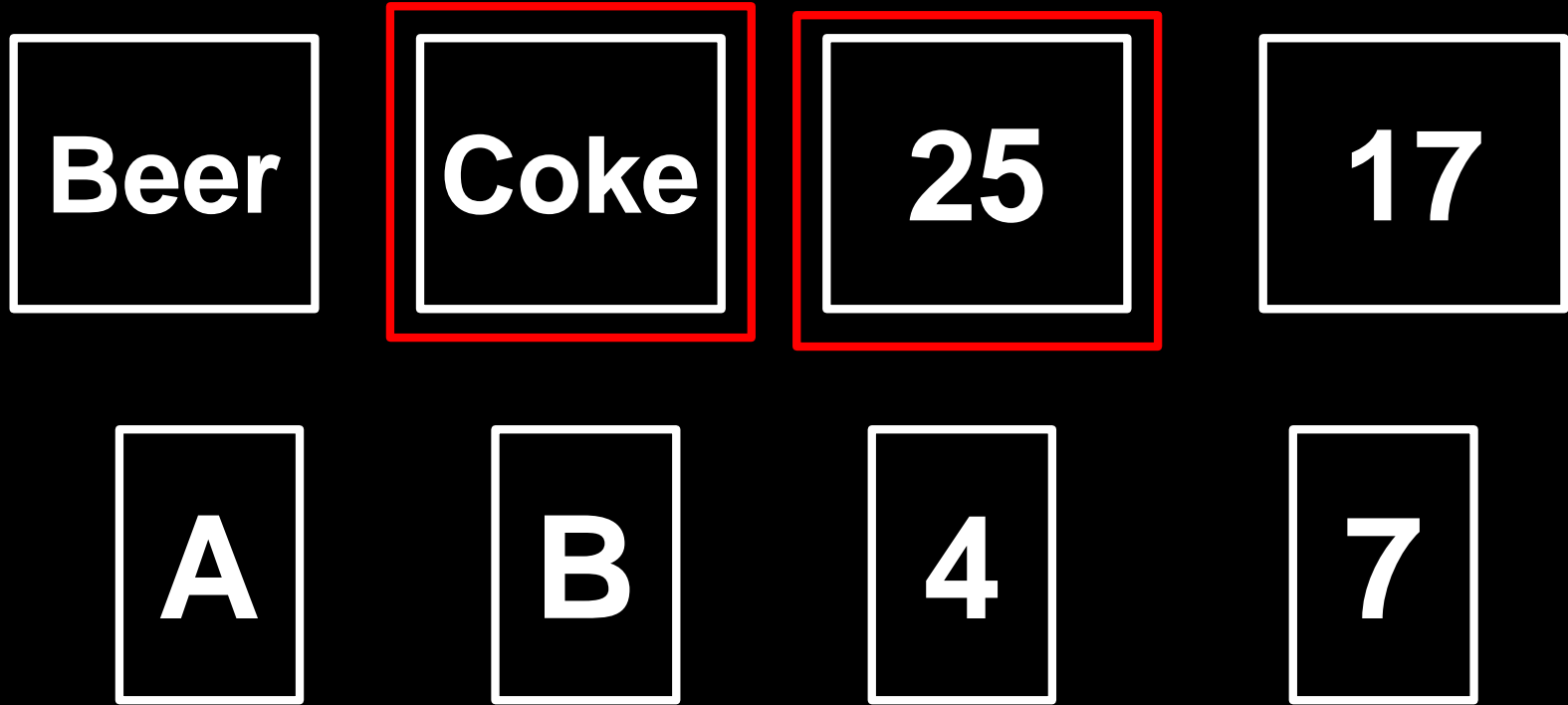
From urn A or B?

Testers influenced by non-diagnostic information

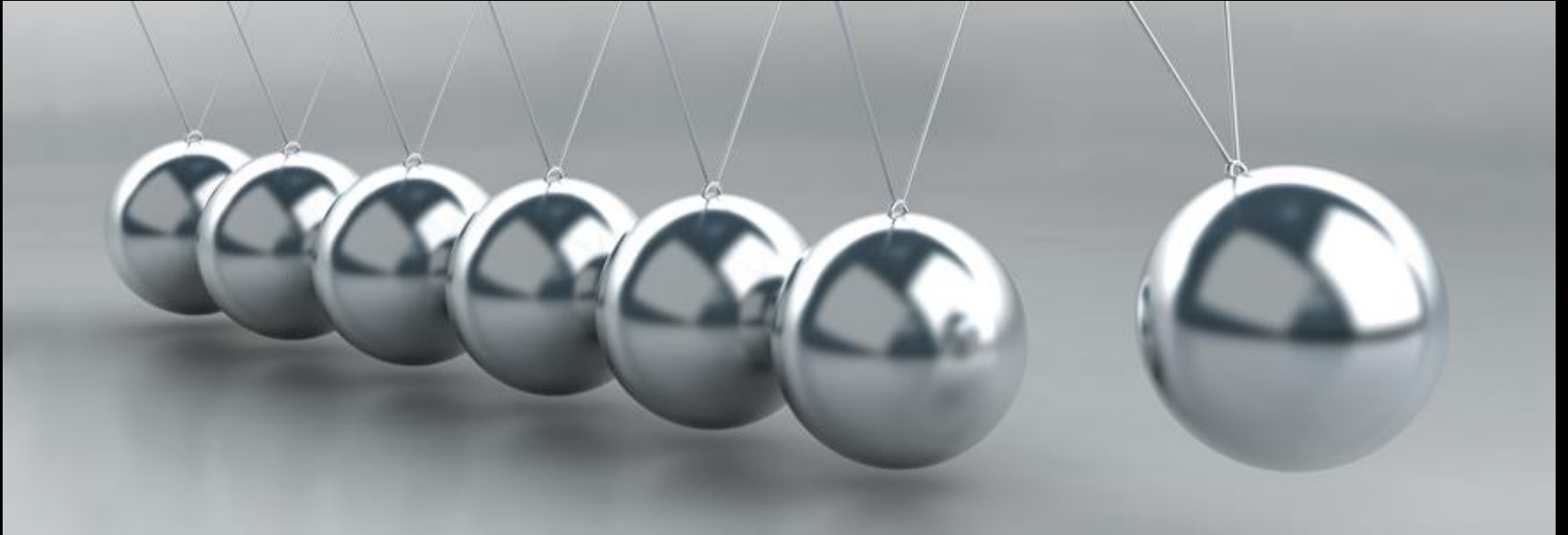


**Downsides to priming for social reasoning or
Anthropocentric thinking**

Downsides to priming for social reasoning



- May exclude valid tests
- May ask wrong questions



Conclusion

Conclusion

Reasoning is important

To improve how we reason:

- **Understand sources of reasoning**
- **Indicative & deontic reasoning**
 - Social reasoning
 - Dominance theory
 - Theory of mind
 - Error management theory
- **Assign more value to reasoning**