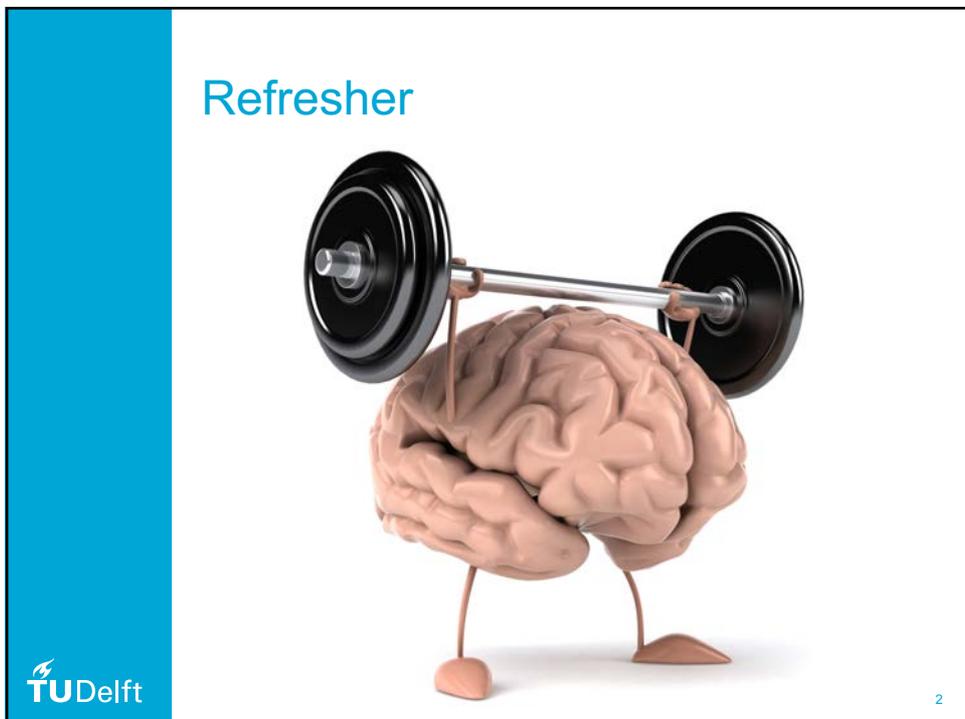




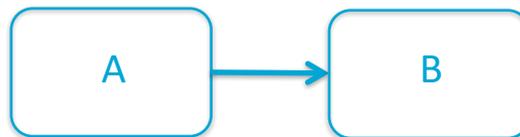
# WM0821TU – The psychology of safety

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Delft University of Technology, Delft, Netherlands



Refresher

## 'Modelogy' of safety science

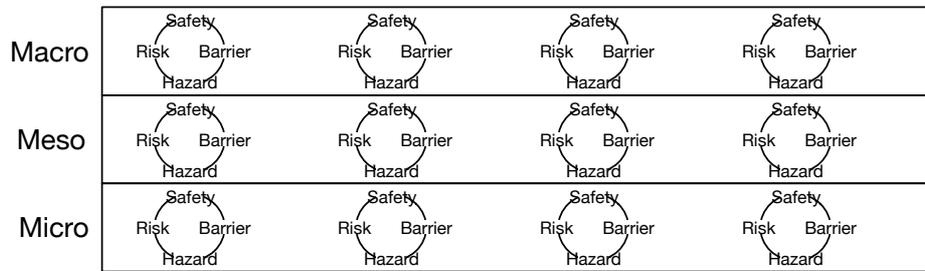


- Linear
- 'Newtonian' (consequence has cause)
- 'Cartesian' (mind and matter)
- (Heinrichian: 88-10-2, pyramid)
- Hindsight bias

## Levels at which to study and control safety and risk

- Micro level: technology, individuals
- Meso level: organisations
- Macro level: society

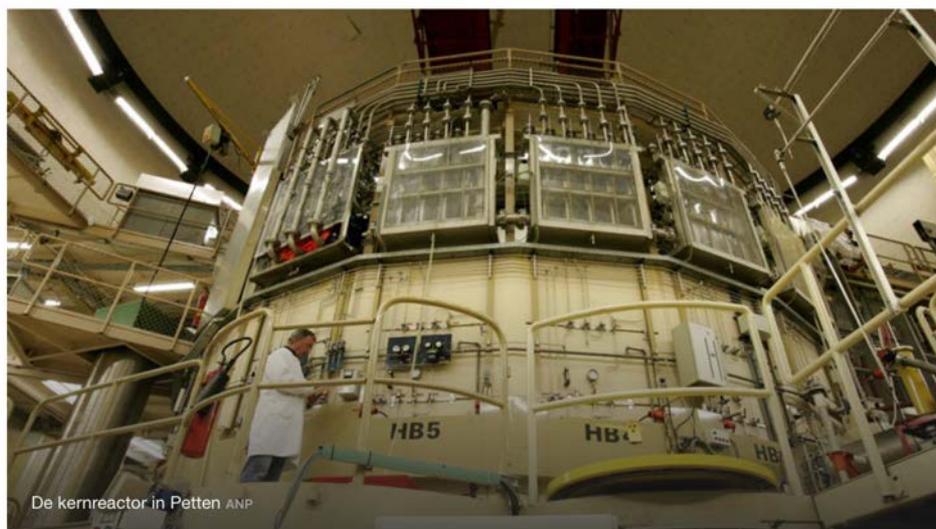
## Core concepts, stages and levels



Preoperation → Operation → Post-incident → Post-operation

## Partijen in Kamer: diepgaand onderzoek naar Petten

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## Dutch Radioisotope Producer has Implemented Strong Management System and Safety Culture, IAEA Review Finds

Aabha Dixit, IAEA Office of Public Information and Communication

OCT 12 2016



Experts at the wrap-up meeting of the IAEA Integrated Nuclear Safety Assessment of Research Reactors mission in Petten, the Netherlands. (Photo: Nuclear Research Group of the Netherlands)

**Related Stories**

- Enhancing nuclear reactor safety in Africa: the IAEA conducts an Integrated Nuclear Safety Assessment of Research Reactors (INSARR) mission in South Africa with EC support [Read →](#)
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TU Delft 7

## Machinist rijdt door rood; spoorbomen blijven open

GISTEREN, 11:31 BINNENLAND

De machinist van de trein waarvoor gisteravond in het Groningse Uithuizermeeden de spoorbomen niet dicht gingen, heeft een rood sein genegeerd. Als gevolg daarvan ontstond een levensgevaarlijke situatie. Toen de machinist zijn fout opmerkte, remde hij, waarna de trein op de spoorwegovergang tot stilstand kwam.

Arriva zegt dat de spoorbomen op deze lijn reageren op het sein, en niet op **menselijke fout** gisteravond. De Arriva-passagierstrein was onderweg van Usquert naar Roodeschool. Er vielen geen gewonden.

Spoorbeheerder ProRail, Inspectie Leefomgeving en Transport kondigden samen met de politie een onderzoek aan naar de oorzaak van het incident. Aan het eind van de ochtend meldde Arriva op RTV Noord dat sprake was van een **menselijke fout**; de machinist had door een rood sein gereden. Hij is van de trein gehaald. Arriva wil er verder niets over zeggen.

TU Delft 8

## Overview

- Human information processing (Simone Sillem)
- Assumptions, psychology and behavior
- The human brain
- System 1 and System 2
- Risk: perception and decision making
- Learning
- (Safety) culture

## ASSUMPTIONS AND INTRODUCTION

## Assumptions

- 'Truth' does not exist
- The world doesn't speak for itself and therefore isn't composed of 'facts' that can be observed 'objectively' by people ('There are no facts, only interpretations' – Friedrich Nietzsche)
- The world and everything in it is the product of social construction, i.e. by people through their interactions with each other and their environment
- Especially in the social sciences, there are many viewpoints and interpretations possible

## Psychology?

- Clinical psychology > deviant behaviour
- Cognitive psychology (experimental psychology) > 'normal' (common) behaviour
  - Neuropsychology
  - Biopsychology, neuroscience
- Developmental psychology > behavioural development
- Educational psychology > learning behaviour
- Methods and statistics > epistemology
- Personality psychology > behavioural drivers
- Social psychology > social behaviour
  - Organizational psychology

## Types of research

- Experiments
- Correlational research
- Surveys
- Naturalistic observations
- Case studies

## Behavioural influences

1. Internal factors
  - a. Human nature (common)
  - b. Personality (unique)
2. External factors
  - a. Environment
    1. Physical environment
    2. Social environment
  - b. Culture

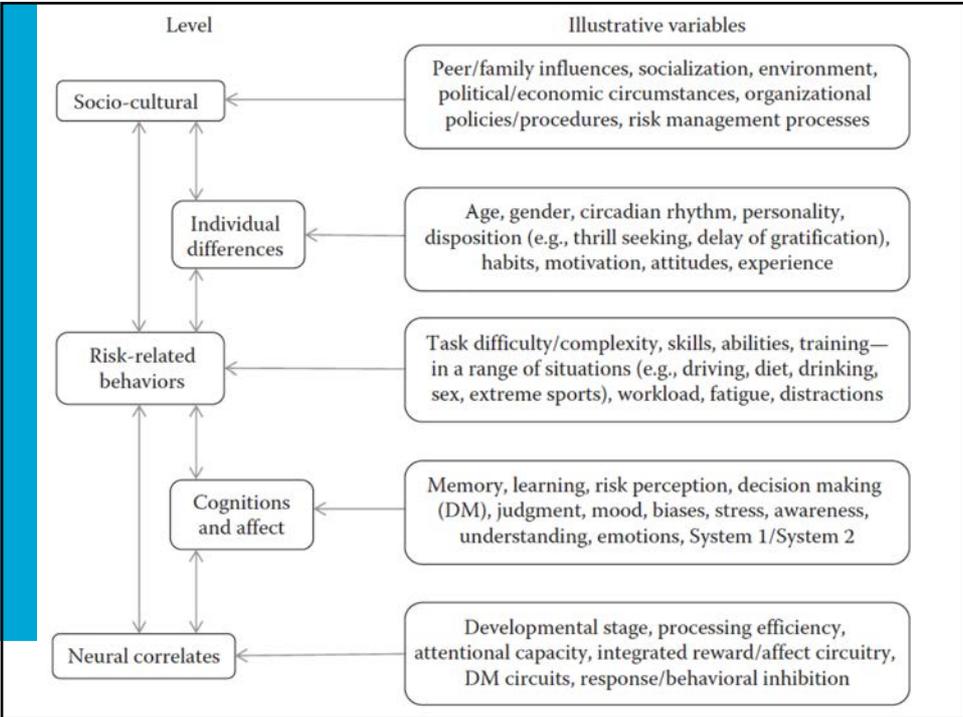
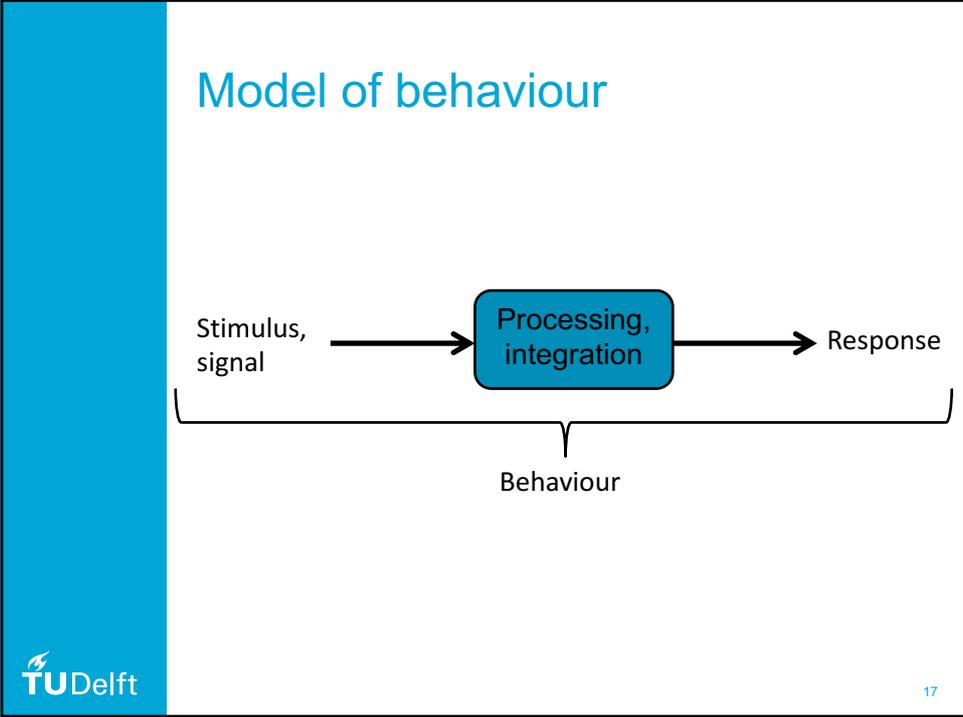
## But, what is behaviour?

- Van Dale: 'The way somebody behaves'
- Hofstede: 'Words and deeds'
- Nelissen: It is impossible to define behaviour properly

## And safe behaviour?

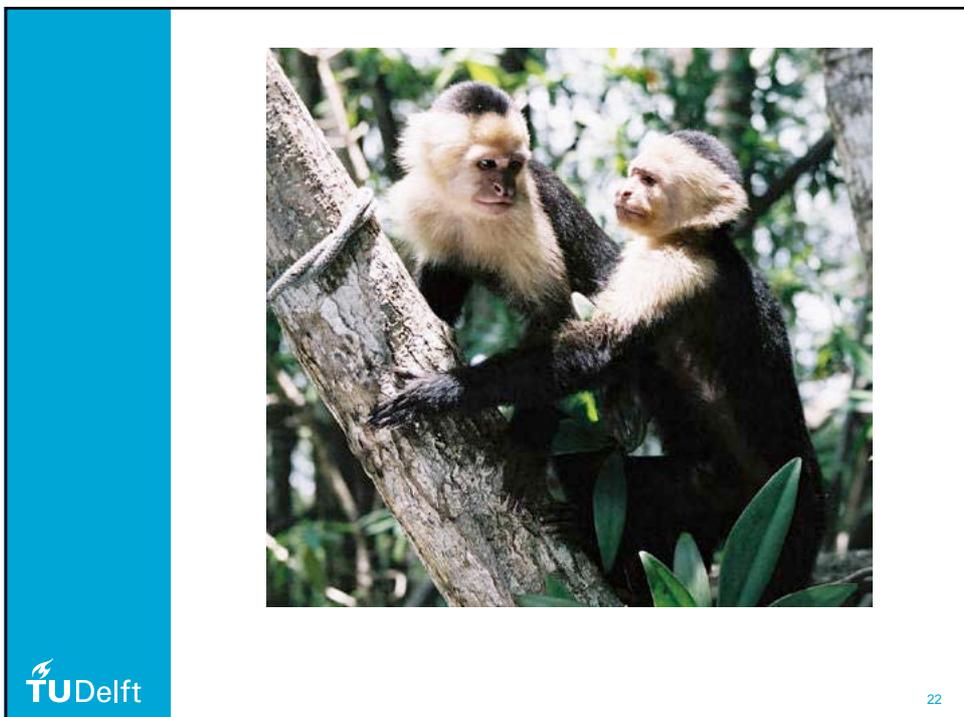
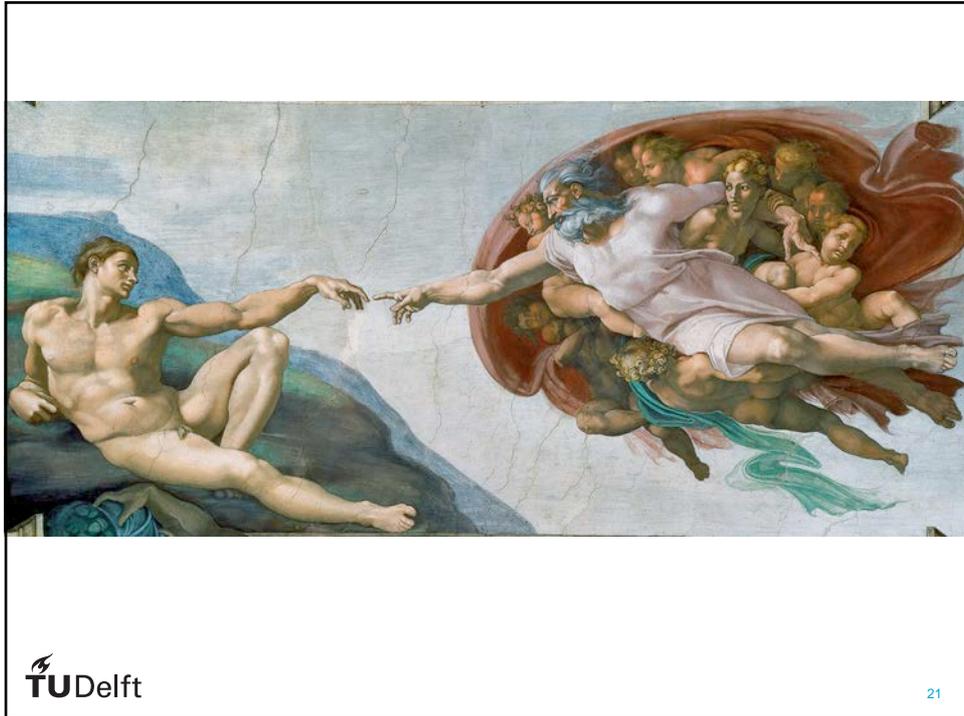
Generic safety performance scale (Burke et al. 2002):

1. Using personal protective equipment;
2. Engaging in work practices to reduce risk;
3. Communicating health and safety information;
4. Exercising employee rights and responsibilities.



## INTERNAL FACTORS (DISPOSITION)







## Internal factors: nature vs. nurture

1. Human nature (innate behaviour, genes): general
2. Personality (learned behaviour, adaptation): unique

## Innate behaviour

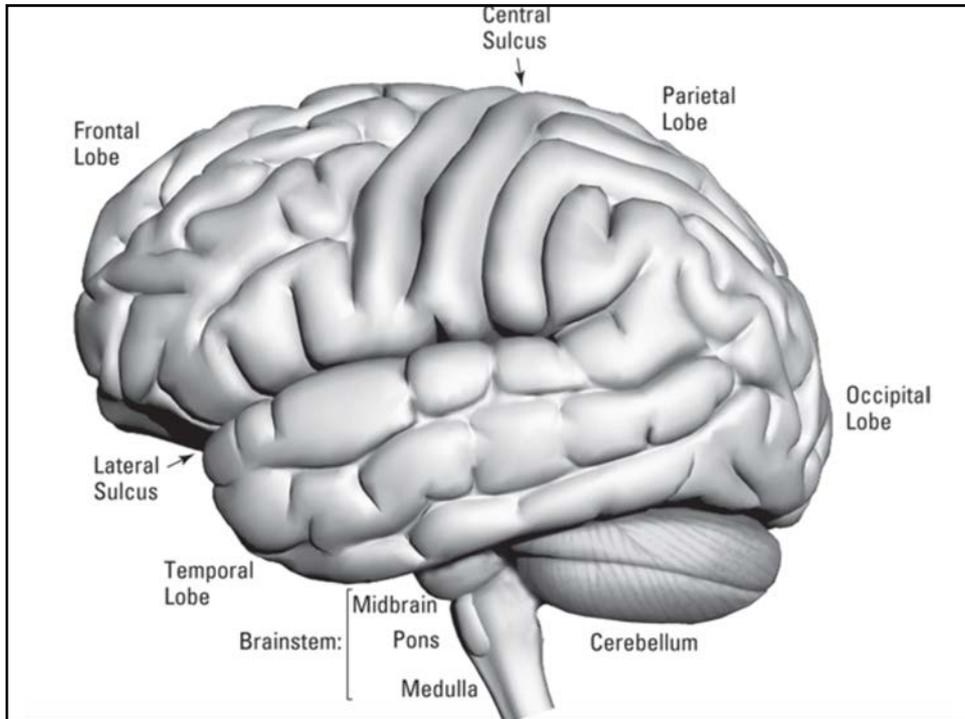
- Survival
- Cohabitation (living together)
- Reproduction

## Innate behaviour (cont.)

- Intuition
- Pain
- Fear
- Herd-drive
- Rescue drive
- Efficiency

## The human brain

“My brain: it’s my second favorite organ”  
- Woody Allen, Sleeper (1973)

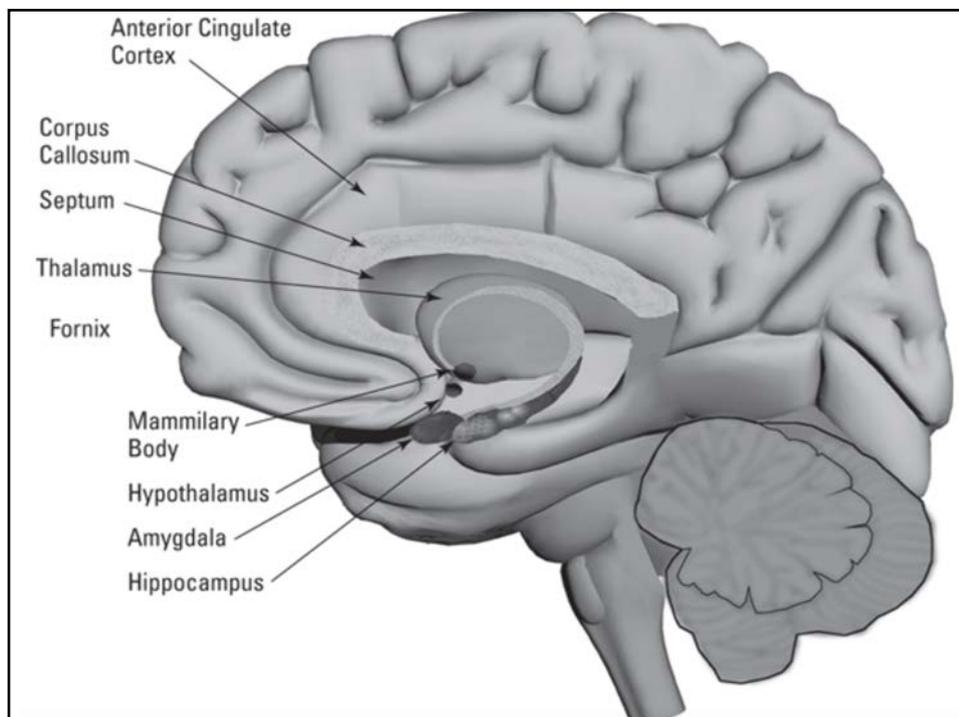


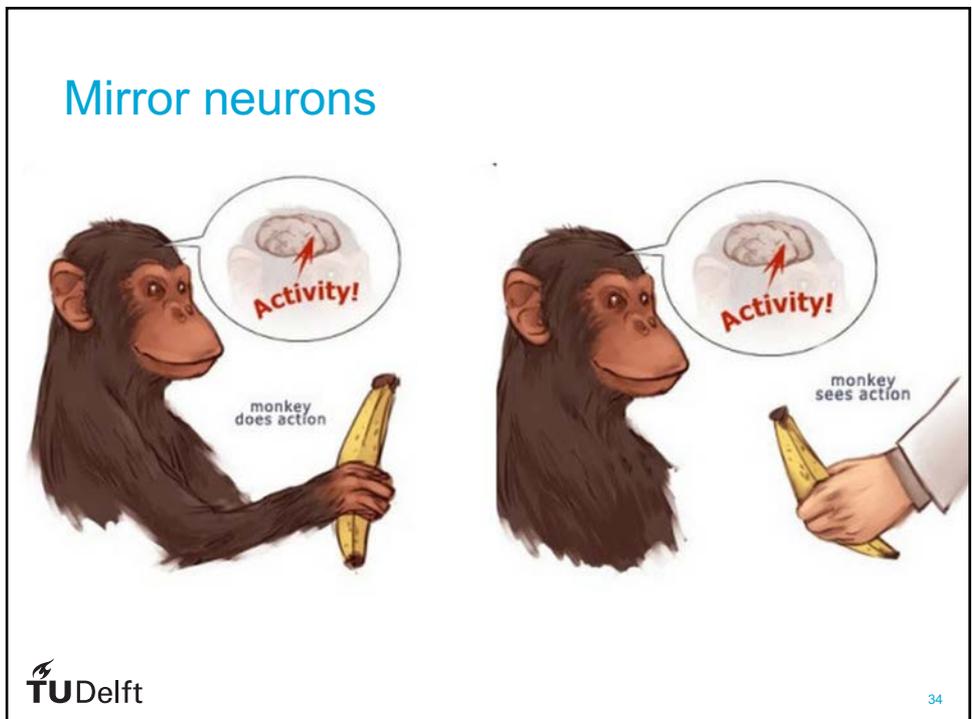
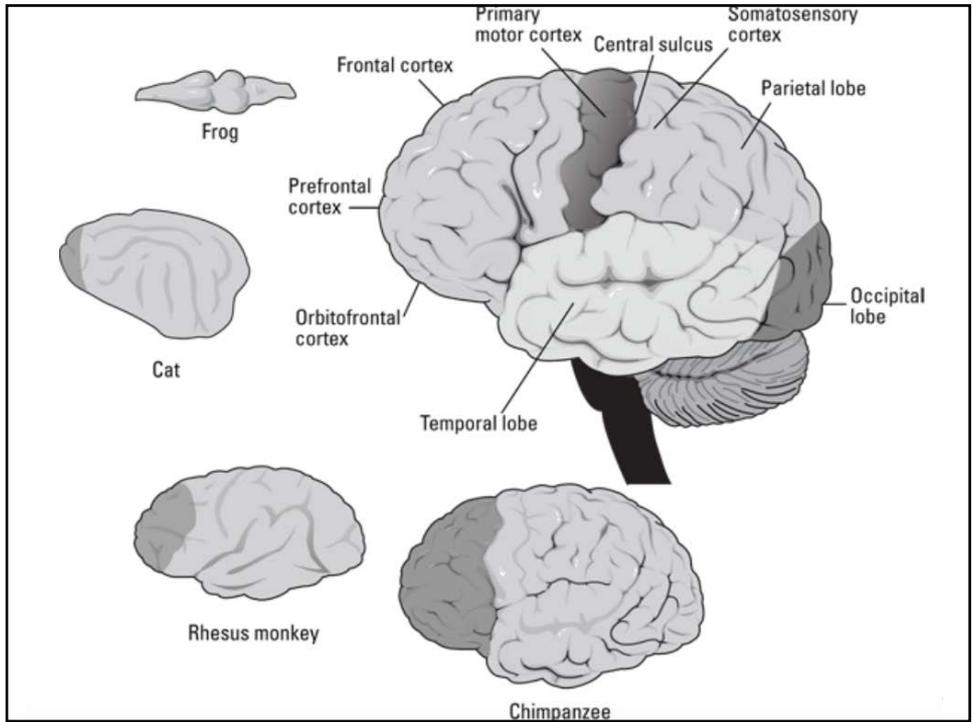
Why is the human brain so big?



## Some brain facts

- 100 billion neurons, each with up to 10.000 connections
- 200+ specialized areas (> phrenology)
- Semantic versus episodic memory
- Neocortex: 50 X 50 cm, 2-4 mm thick, 6 layers of cells
- Left brain (analytical, verbal) – right brain (intuitive, non-verbal)
- The brain is a highly interconnected, parallel processing, integrated structure





## Innate behaviour: risk detection

- Risk sensitivity
  - Innate: fear, pain avoidance
  - Learned: what to avoid
- Risk understanding
  - Scenarios

## Take away messages

- The brain is an incredibly complex organ which is, basically, always 'on'
- It is well-equipped for behaviour and adaptation
- Memories are coloured with emotion (pleasant – unpleasant)
- Memories are personal 'constructions' (episodic memory) and consist of 'experiences' not 'facts'
- Motor programs (automatisms) are 'brain patterns' acquired through practice, which are not easily always (un)learned
- The brain contains (highly) specialized areas that are not apparent from the outside

## Back to risk: decision theory

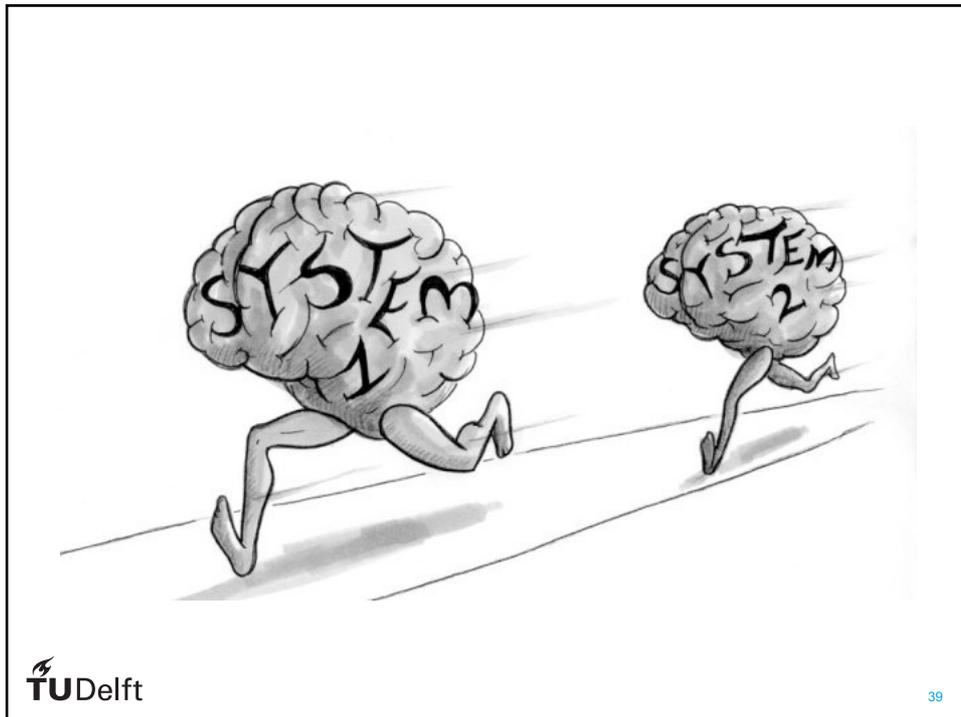
- Logical or normative analysis
- Descriptive study
- Prescriptive interventions

Fischhoff & Kadvany, 2011

## Or, put in another way

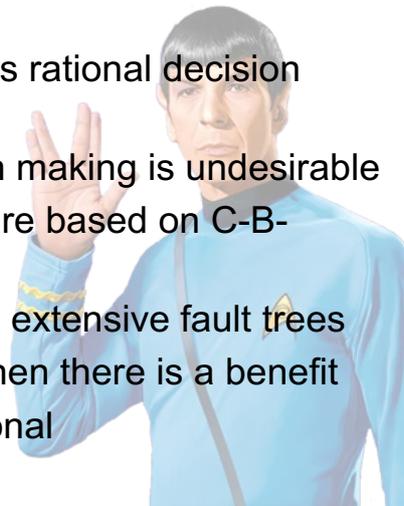
- Risk as analysis
- Risk as feelings
- Risk as politics

Slovic et al., 2004



## Rationality in (risky) decisions

- Ideal image: man as rational decision maker
- Emotion in decision making is undesirable
- Measures (if any) are based on C-B-analysis
- Much effort put into extensive fault trees
- Prevention: only when there is a benefit
- Strictly logical, rational



**Street Calculus**

**Risk factors**

- black
- male
- aggressive body language
- baseball cap on backwards
- short hair
- baggy jacket
- wrong neighborhood

**RF = 3**

**Mitigating Factors**

- female
- over 40
- loafers
- tie and coat
- whistling
- Sondheim
- Fed Ex envelope
- polo shirt

**MF = 4**

4 > 3  
**Risk: Acceptable.**

GOOD evening.

Good evening.

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THINKING,  
FAST AND SLOW

DANIEL  
KAHNEMAN

WINNER OF THE NOBEL PRIZE IN ECONOMICS

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## Systematic irrationality

- Daniel Kahneman, Nobel Prize 2002
- People are rational in their irrationality
- There are distinct mechanisms that steer our risk perception and decision making

## The 'experiential' system (system 1)

- Holistic
- Affective (pleasure – pain), associative
- Behaviour mediated by past experiences
- Reality encoded in images, metaphors and narratives
- Rapid processing: immediate action
- Self-evident: experiencing is believing

## The analytic system (system 2)

- Analytic (take things apart and study them separately)
- Logical: reason (what is sensible)
- Behaviour mediated by conscious appraisal
- Reality encoded in abstract symbols, words and numbers
- Slower processing: delayed action
- Justification through logic and evidence

## System 1 and system 2 (cont.)

System 1 reacts immediately, automatically, is therefore hard (impossible?) to control.

This reaction is influenced by:

- Imagineability (images, stories)
- The outcome (loss aversion)
- Ways of formulating (a.o. anchoring)

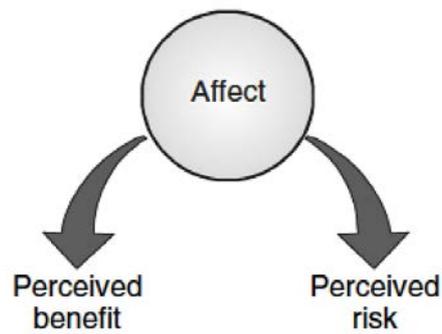
System 2 has to be set 'on' (i.e. consciously)

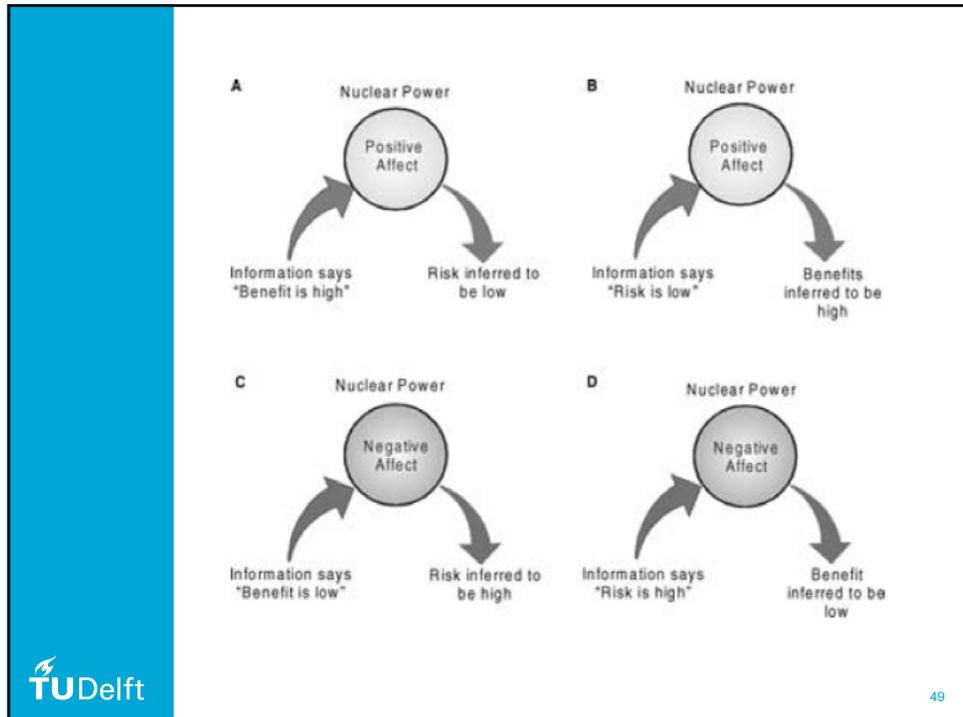


## The psychology behind irrational decisions



## The affect heuristic





## Examples

- Toxicologists' rating of exposure
- Jelly beans: 7 in 100 vs. 1 in 10
- Clinicians: 10 of every 100 patients vs. 10%

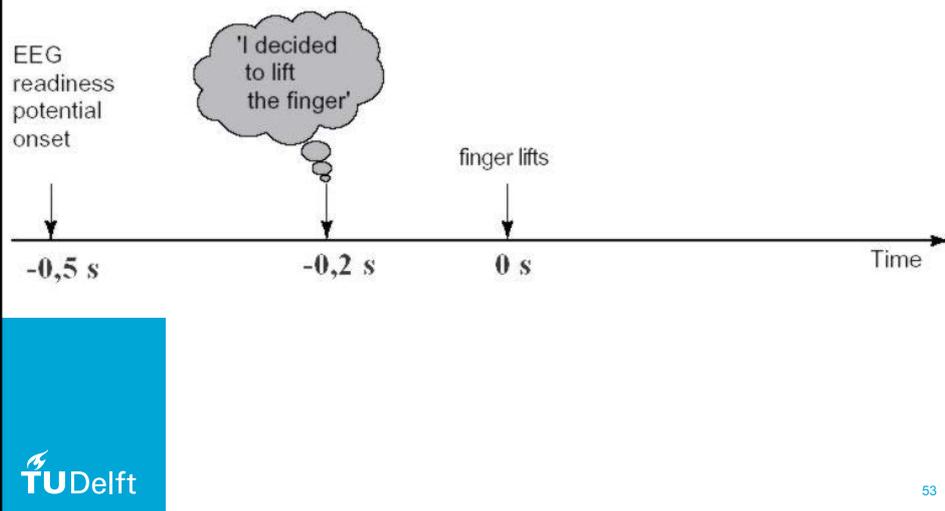
## Learned behaviour

‘Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select – doctor, lawyer, artist, merchant-chief and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.’ – John B. Watson (1925)

## Learned behaviour: personality

- Personality traits (i.e. risk orientation, risk perception, LoC)
  - Automatisms (perception, SRK, coordination)
  - Conscious behaviour and consciousness
  - Static views (i.e. traits, drive, The Big Five)
  - Dynamic views (all motivation theories)
  - Reasoned action (Fishbein & Ajzen)
- Beware of the ‘rotten apple’!

## Libet's 1980's experiments

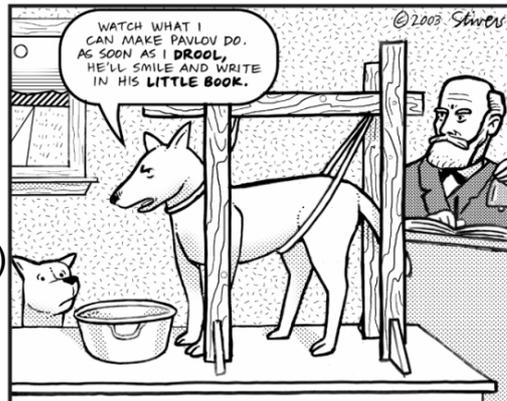


## The difference between classical and operant conditioning



## Learning

1. Habituation
2. Conditioning
  - a. Classical conditioning
  - b. Operant conditioning
  - c. Trial and error
  - d. Drilling, training
3. Imitation (mimicking)
4. Learning through understanding



## Imitation

‘Each of us is in fact what he is almost exclusively by virtue of his imitativeness.’ – William James

## Group conformity

- The elevator
- Solomon Asch



## Imitation (Dijksterhuis 2007): social glue

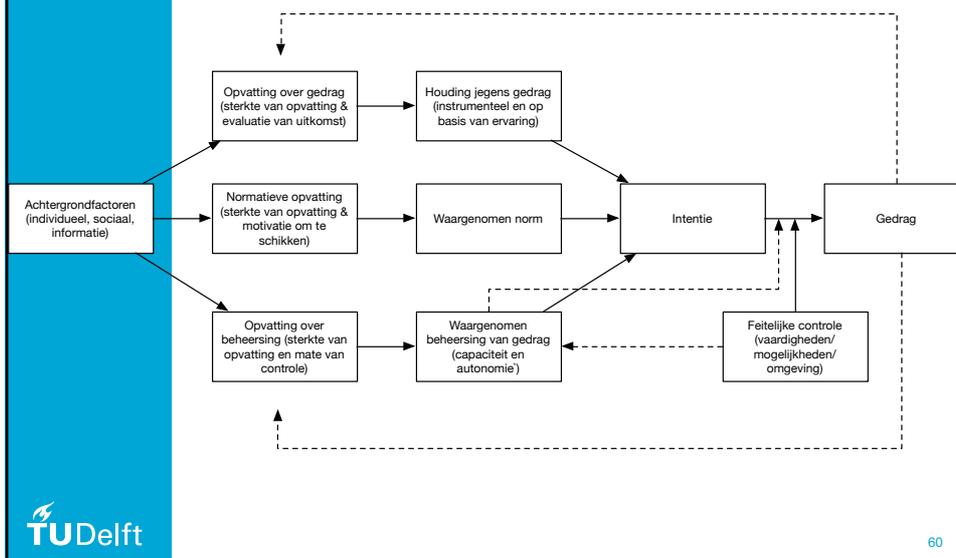
- Facial expressions
- Body posture
- Gestures
- Speech related things
- Tendency to imitate is very strong with humans
- Example: waitresses



## Conscious vs. subconscious

“Consciousness is a much smaller part of our mental life than we are conscious of, because we cannot be conscious of what we are not conscious of. How simple is that to say; how difficult to appreciate! It is like asking a flashlight in a dark room to search around for something that does not have any light shining upon it. The flashlight, since there is light in whatever direction it turns, would have to conclude that there is light everywhere. And so consciousness can seem to pervade all mentality when actually it is not” – Julian Jaynes, 1976

## Reasoned behaviour (Fishbein & Ajzen 2010)

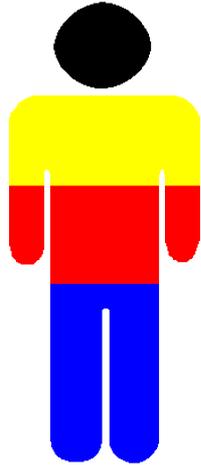


## EXTERNAL FACTORS (SITUATION)

### External factors

- Environment
  - Physical environment
  - Social environment
    - Leader
    - Group
- Culture

## Mental 'software'



Personality – unique

Culture – shared with a group

Nature – shared with everybody