Technology and Innovation Management

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www.timgroup.ethz.ch

Exploration and Exploitation in individuals

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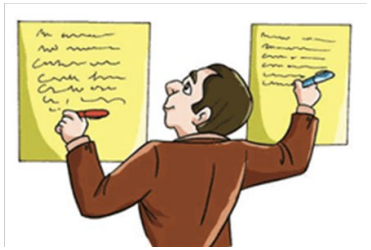
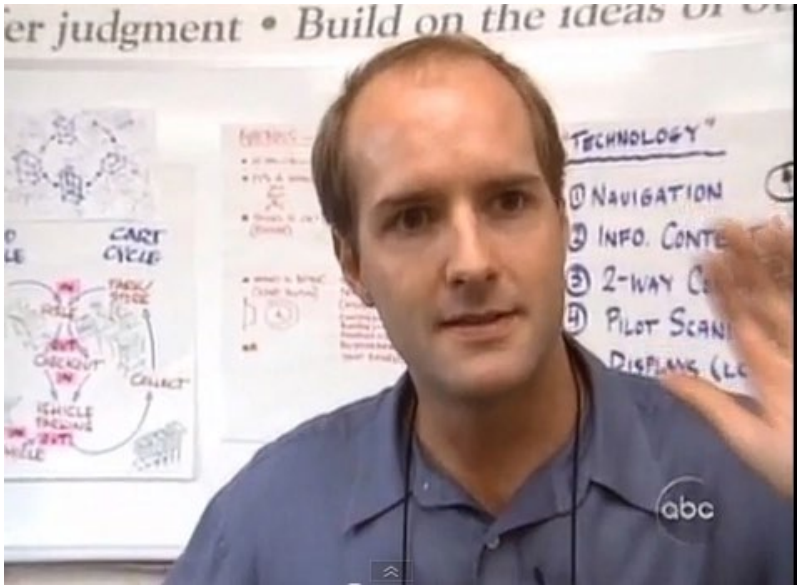
Last session

Courtesy of Xerox PARC

"The ability to simultaneously pursue both incremental and discontinuous innovation and change results from hosting multiple contradictory structures, processes, and cultures within the same firm" (Tushman & O'Reilly, 1996: 24)





Source: all images from the internet

Required Readings for today

- Laureiro-Martínez, D., Brusoni, S., Canessa, N., & Zollo, M. (2015). Understanding the exploration–exploitation dilemma: An fMRI study of attention control and decision-making performance. *Strategic Management Journal*.

Agenda

1. Ambidexterity at the individual level:
   your own examples

2. Ambidexterity at the individual level:
   the abilities required

3. Ambidexterity at the individual level:
   how to measure the required abilities

Learning objectives

Key concepts

- Understand what is exploration – exploitation at the individual level
- Know what is attention at the individual level, what are the two main types of attention, and understand why attention control is important

Methods

- Understand how exploration and exploitation can be measured in a very fine-grained way, and why it matters

Q&As

- Connect knowledge on attention to real life topics and examples (e.g. IDEO, your own decisions)
- (start to) Gain awareness about your own cognitive processes and the impact they have on decision-making

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Exploitation and Exploration

- Exploitation
  - Refinement, production, efficiency, implementation …
- Exploration
  - Variation, risk taking, experimentation, play, flexibility …
- Returns from exploration are uncertain, more remote in time, and organizationally distant from the locus of action and adaptation
  - E.g. the R&D lab!! Other examples?
- Returns from exploitation are reliably linked to the time and place in which they take place.
  - E.g. the manufacturing unit. Other examples?

Exploration and Exploitation in IDEO

Exploration	Exploitation
Intense Brainstorming (Deep Dive)	Well defined methodology
Intensive market research (anthropology)	Structured with distinct Phases
Build on unusual ideas / Demand unusual ideas	Active client management
Relatively flat, little hierarchy / Status comes from ideas / few titles	Clients are “trained” in conference room
Diverse teams (psychology, biology, engineering, design, MBA)	Simple rules (on the wall)
Failure is accepted	
Lead by example	
Low key / Informal	
Self-motivated / based on trust	

Examples of Exploration and Exploitation in your daily choices

Examples of Exploration and Exploitation in your daily choices

Is there a dilemma?
What is the dilemma?

What would be exploration?
Exploitation?
Ambidexterity?

What would lead to the highest "utility" or "payoff"?

Can you think of "abilities" that would help you maximize the utility in this situation?

At the Essence of Exploration and Exploitation

Let's make some decisions!

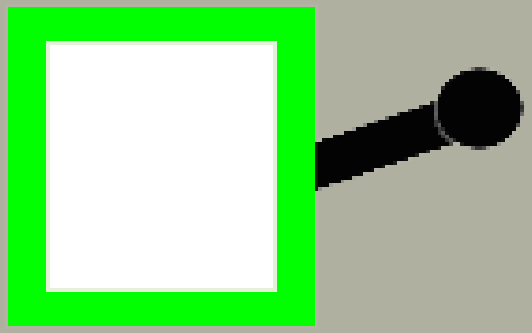
You can either play on your own and write down the scores you get

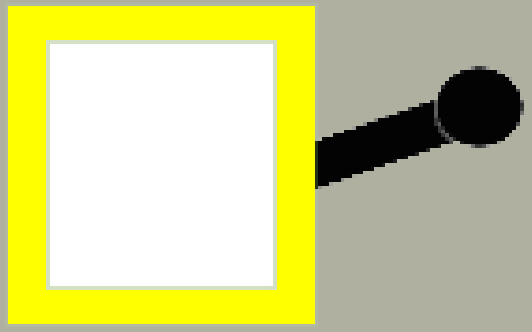
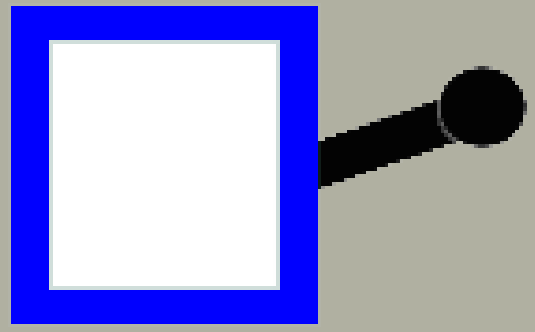
Or

You can join 2 volunteers on two laptops & come to the front of the classroom

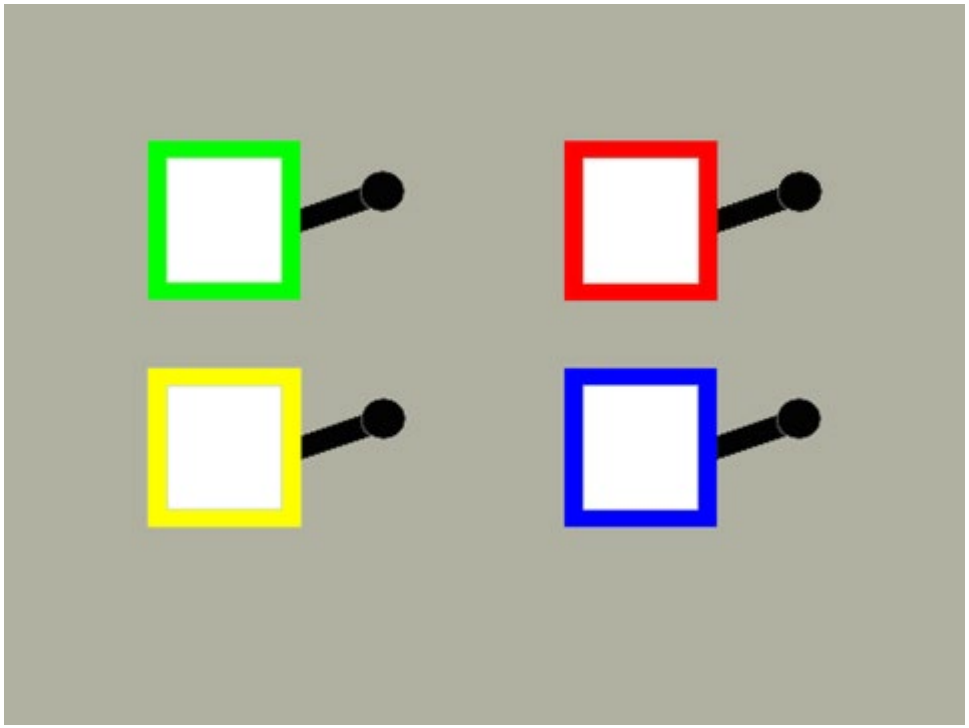
Or
You can be one of the two volunteers

When we are all ready go to:
http://laureirolab.timgroup.ethz.ch/frontend/5da98412a6bc311326aca1bd



At the Essence of Exploration and Exploitation



Is there a dilemma?
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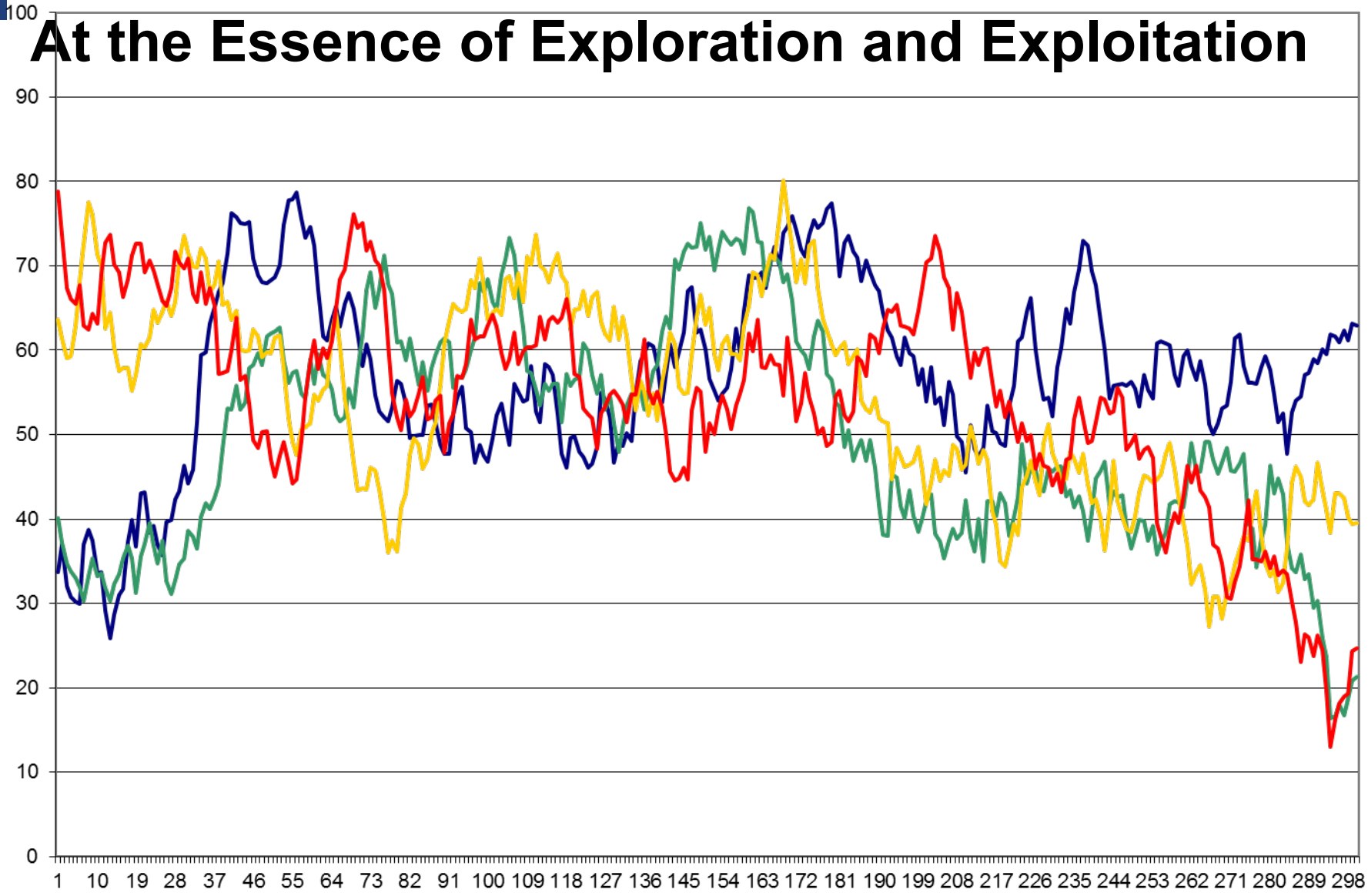
At the Essence of Exploration and Exploitation



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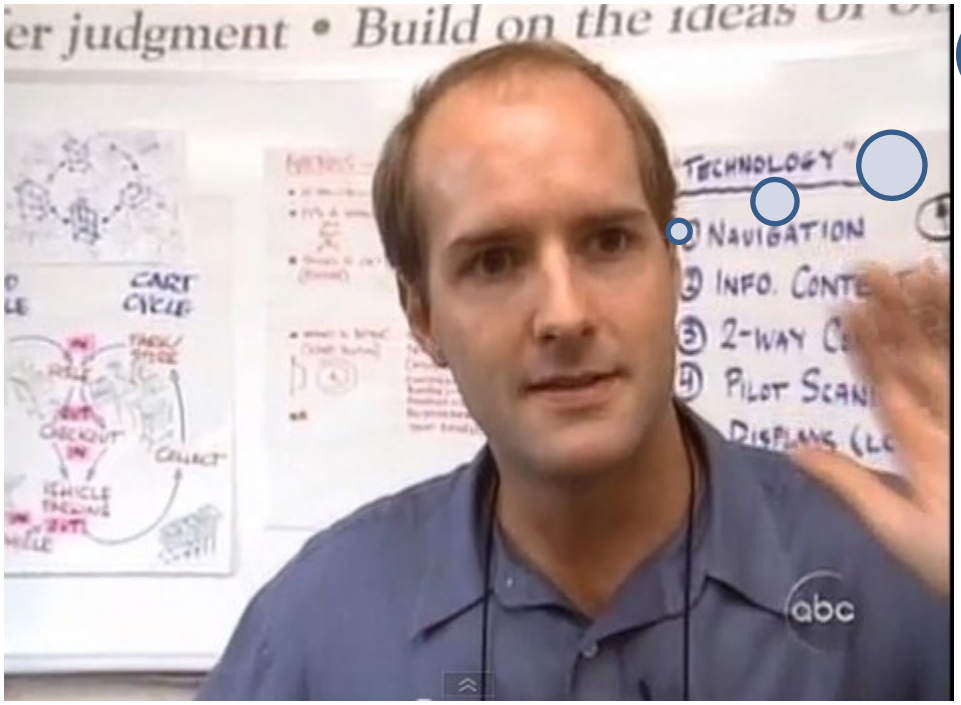
   your own examples

2. Ambidexterity at the individual level:
   the abilities required

3. Ambidexterity at the individual level:
   how to measure the required abilities

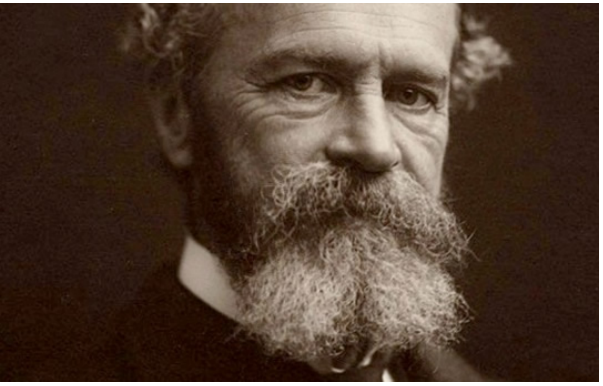


What should we pay **attention** to now?... And now? …and now what?...

Source: internet images

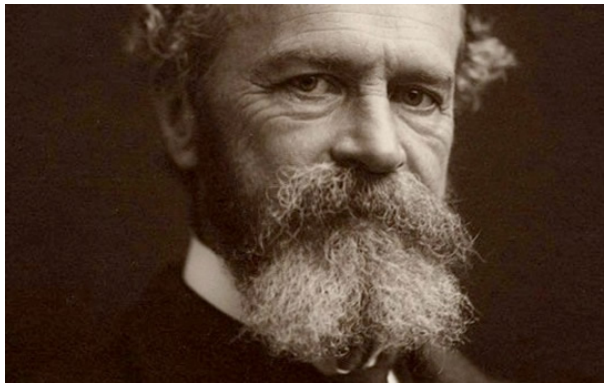

Attention !

What is attention?



Attention … “is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought, focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatter brained state which in French is called distraction, and Zerstreutheit in German.”
Source: William James, 1890 p.403-404

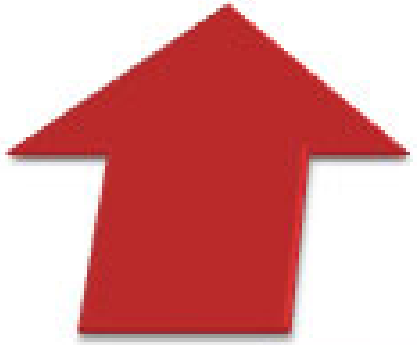
What are the main types of attention?



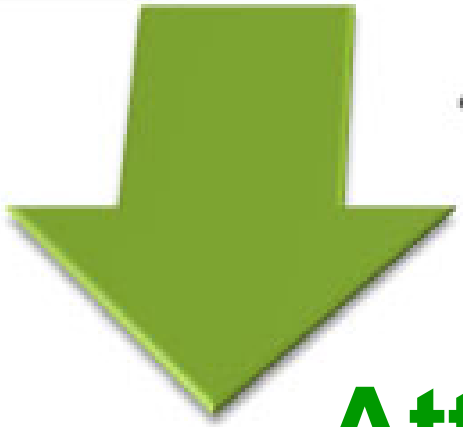
"One of the most extraordinary facts about our life is that, although we are besieged at every moment by impressions from our whole sensory surface, we notice so very small a part of them."
Source: William James, Writings, 1878-1879

Video link: https://youtu.be/qpPYdMs97eE

Two main types of attention



Bottom Up



Top Down

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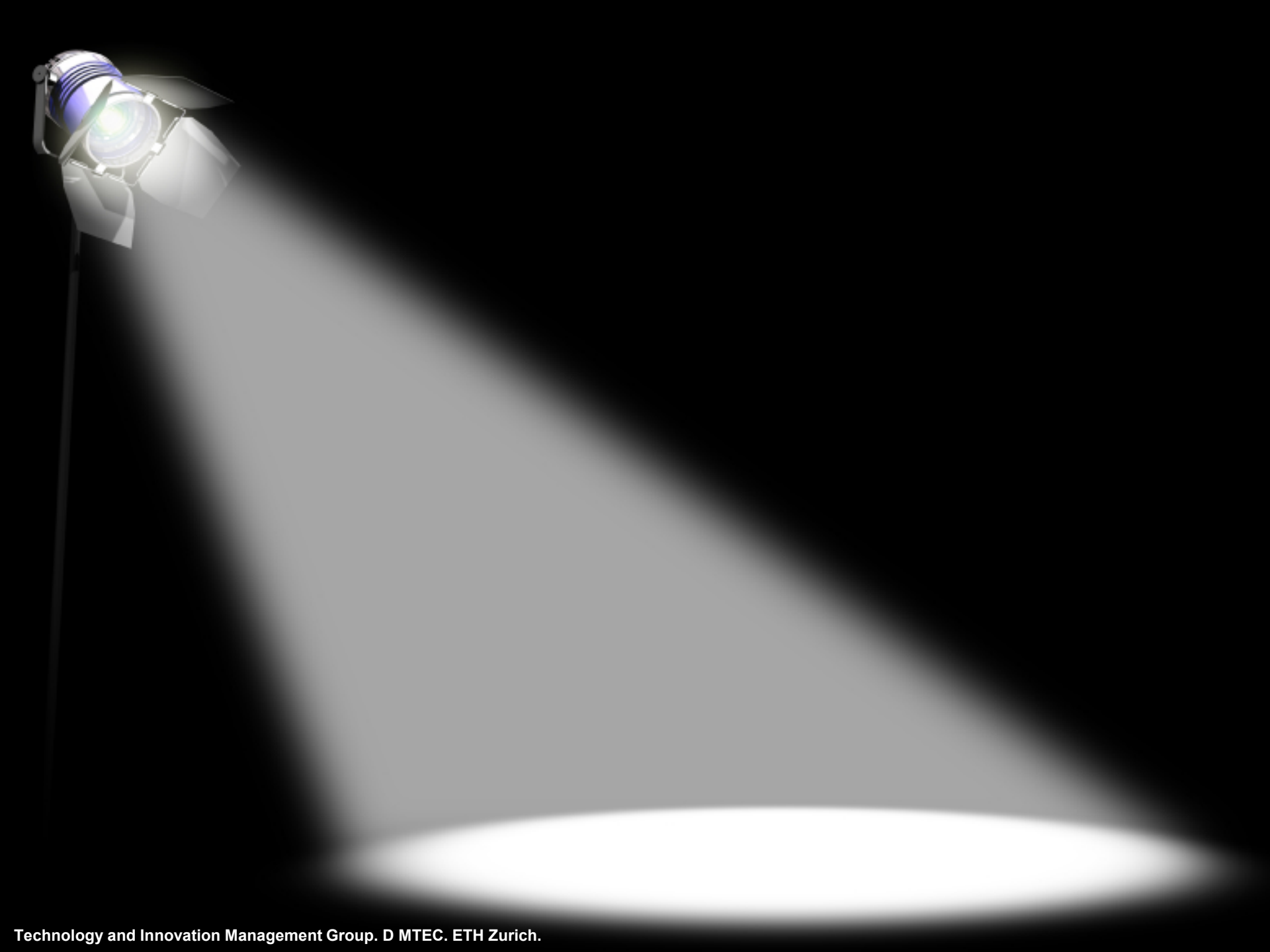
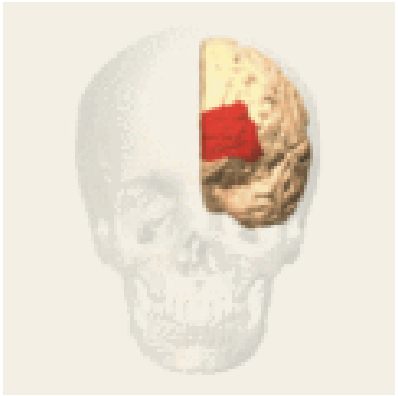
Attention control



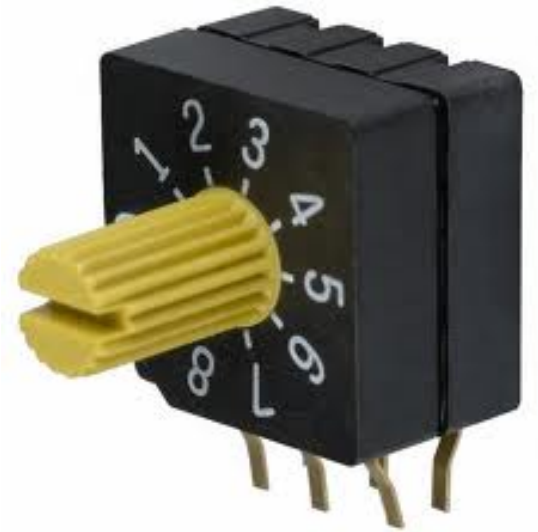
Attention Control

- Also called «Cognitive control capabilities» or “Executive functions”

- Attention control is responsible for:
  - initiating appropriate actions
  - inhibiting inappropriate and impulsive behaviors
  - selecting sensory information and storing relevant information
  - thinking abstractly and drawing analogies
  - planning future actions



Sources: www.istockphoto.com, www.dfp-design.de



Sources: www.istockphoto.com

An example of: Attention control

Top Down

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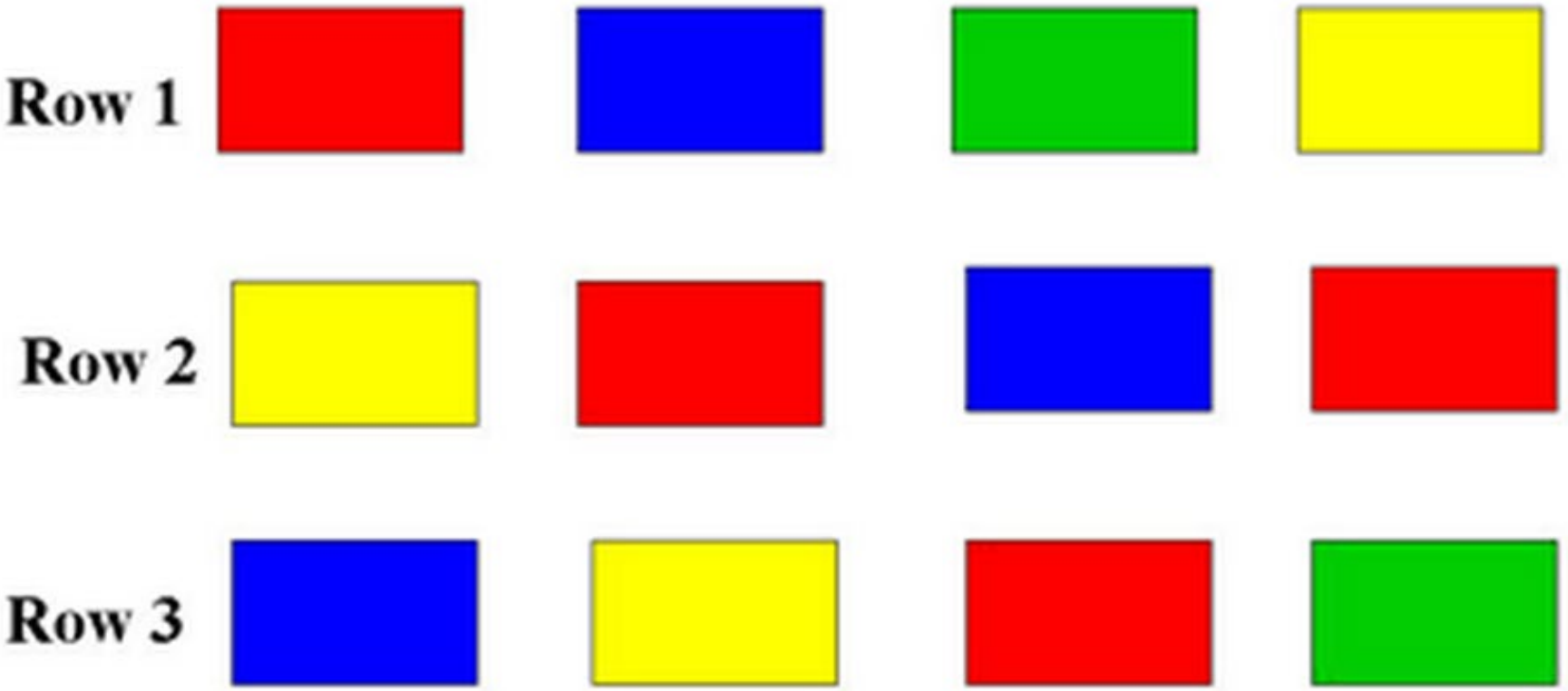
Attention control

An example of: Attention control

State the colors as fast as you can



Source: From John Gosbee, MD, MS, VA National Center for Patient Safety

Now state the colors as fast as you can

Row 1	Red	Blue	Green	Yellow
Row 2	Yellow	Green	Blue	Red
Row 3	Green	Red	Yellow	Blue

Source: From John Gosbee, MD, MS, VA National Center for Patient Safety

Now state the colors as fast as you can

Row 1	Red	Blue	Green	Yellow
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Again, state the colors as fast as you can

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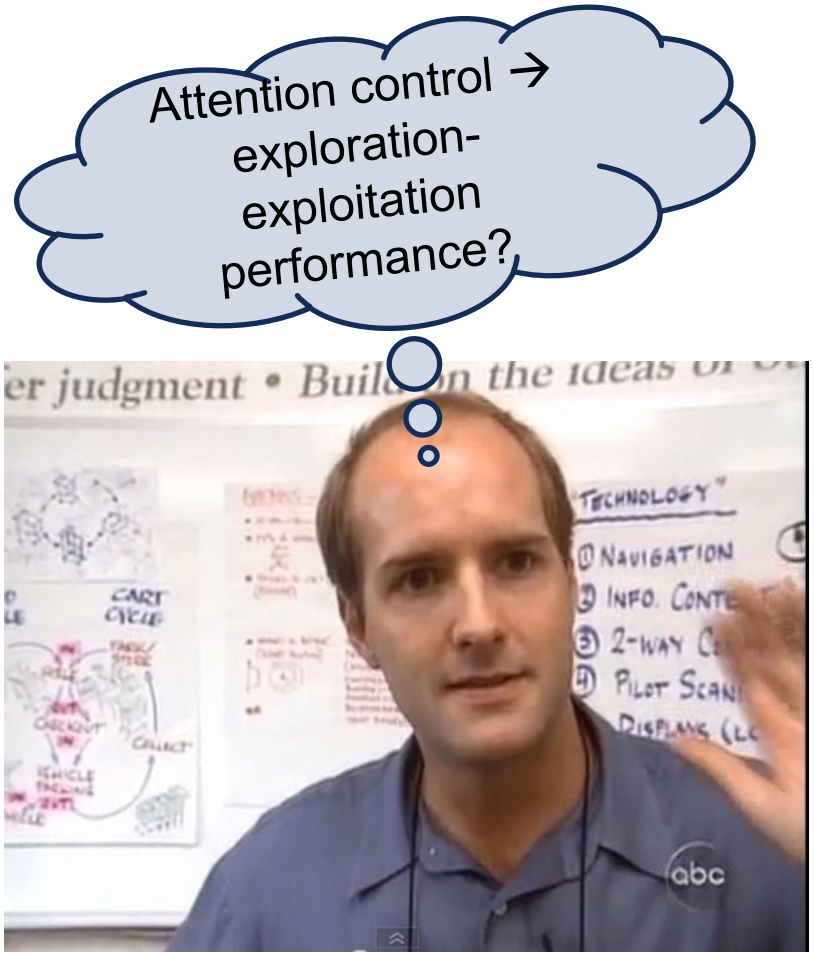
Objective of the study



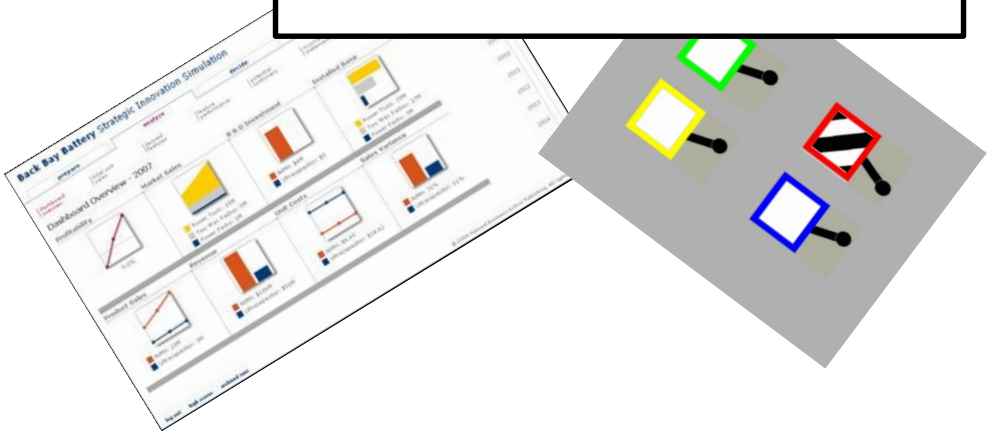
- Exploitation - exploration trade off (March 1991)
  - Punctuated equilibrium vs. ambidexterity vs. continuum
  - Organizational level
- Gap: individual-level (Smith and Tushman 2005, Gupta et al. 2006, Mom et al. 2007)
- Motivation: link neuropsychological research to understand <u>what explains individuals' differential abilities in managing the exploitation-exploration trade off</u>

Study design

- 53 expert decision makers:
  - matched sample of 28 specialists and 25 generalists
- Simulation (Christensen and Shih)
- Four-armed gambling task (Daw et al. 2006)

Sources: www.istockphoto.com, www.dfp-design.de

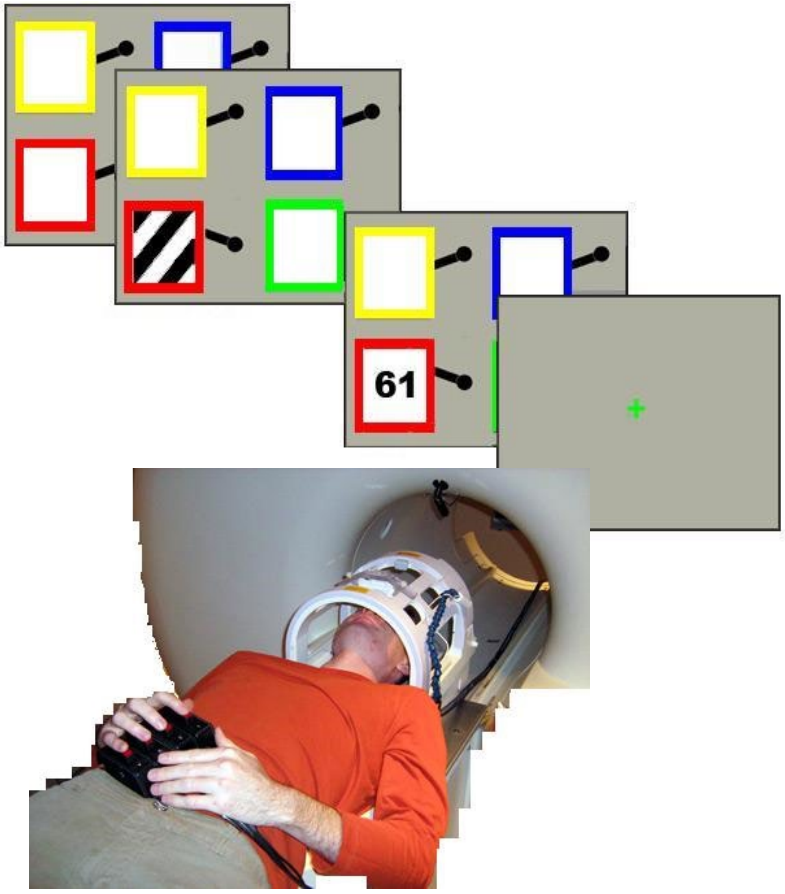
Exploration-exploitation Performance



Sources: internet images

Four-armed gambling task

Source: owned by D.Laureiro



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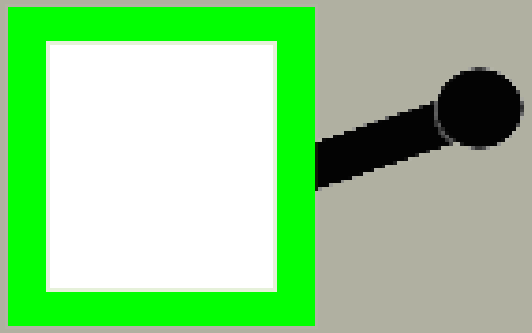
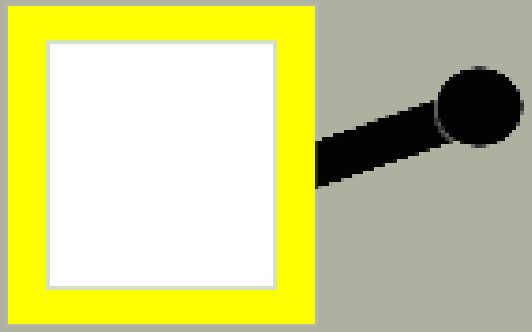
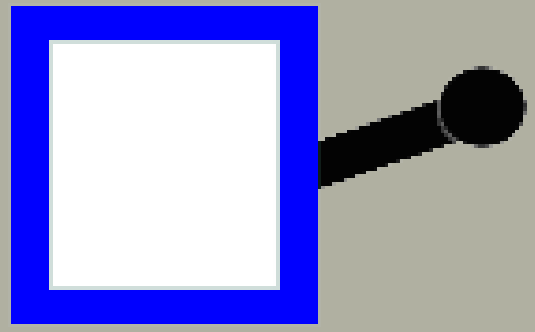
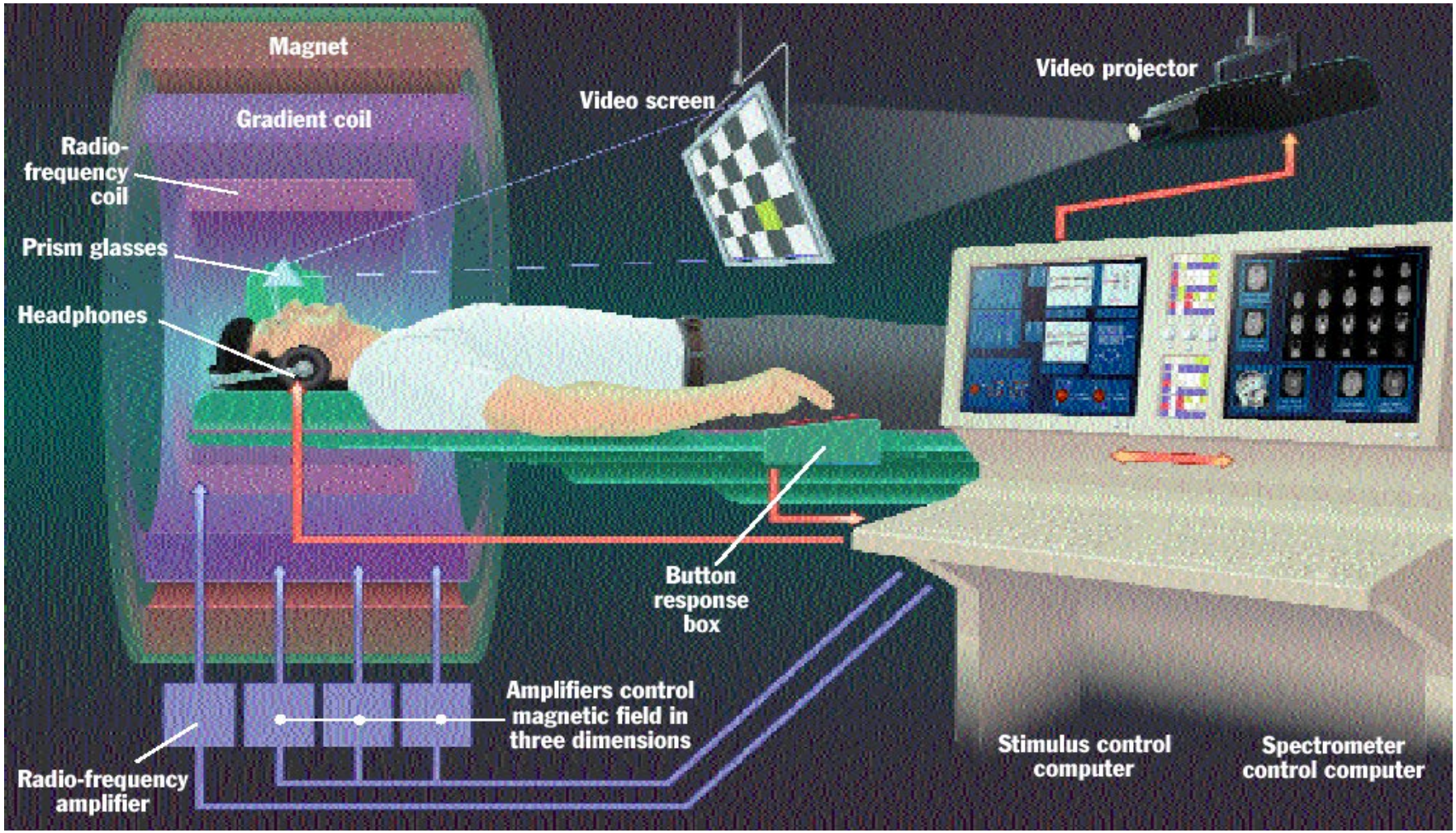


Source: owned by DLaureiro

Setting fMRI study



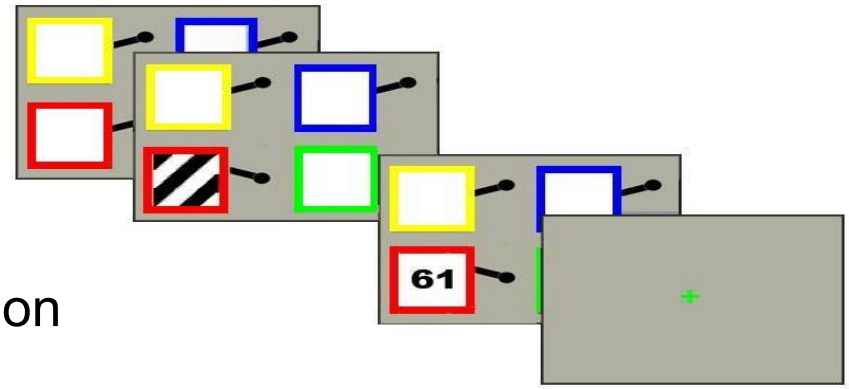
Source: internet images

Measures

1. Neural antecedents: all brain analyses; event-related *f*MRI analyses; BOLD signal

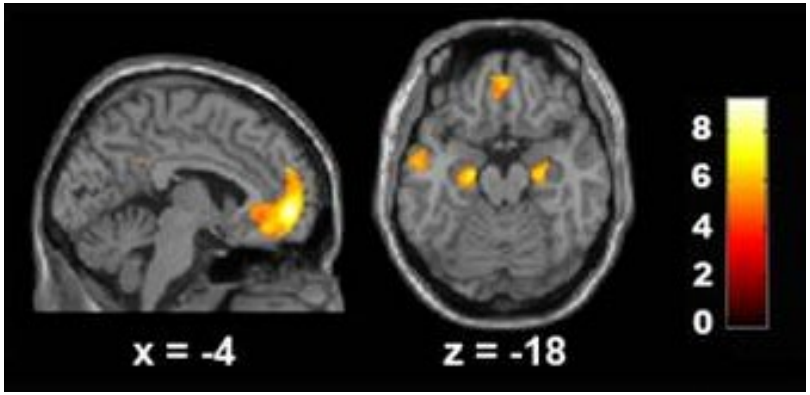
2. Behavior: exploitation vs exploration

3. Decision-making performance: total payoff over 300 trials



Source: Laureiro-Martinez et al. 2015

Exploitation



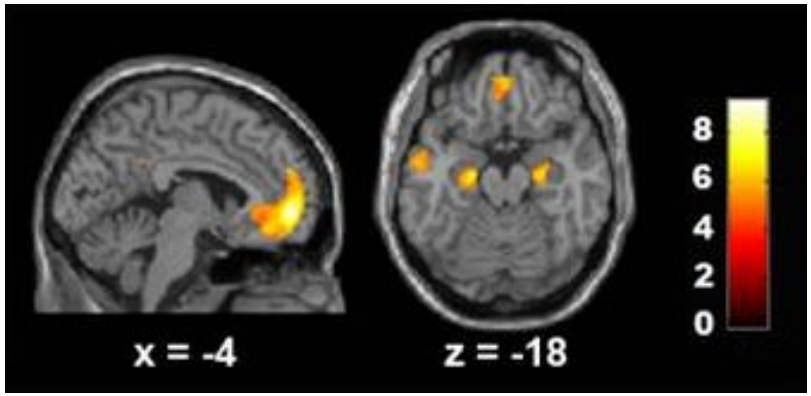
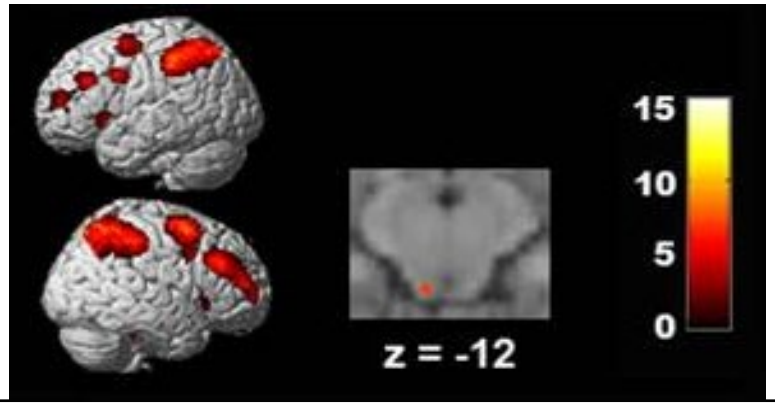
Learning, reward perception, memory, persistence

Dopaminergic regions

Ventro medial pre frontal cortex

Hippocampus (subiculum)

Source: Laureiro-Martinez et al. 2015

Exploitation	Exploration
	
Learning, reward perception, memory, persistence Dopaminergic regions Ventro medial pre frontal cortex Hippocampus (subiculum)	**Attention control regions, planning, idea generation** Bilateral fronto-parietal regions Fronto polar cortex Anterior cingulate cortex Locus coeruleus Thalamus Anterior insula

Source: Laureiro-Martinez et al. 2015

Finding on Generalists vs. Specialists

Generalists' decision-making performance is better

- Higher cumulative payoff ($p = 0.084$)

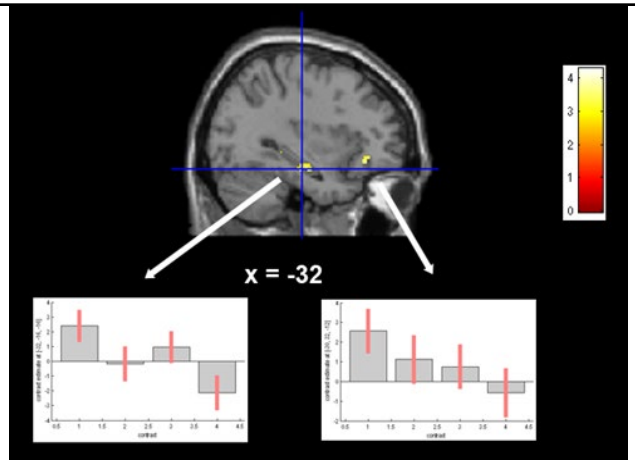
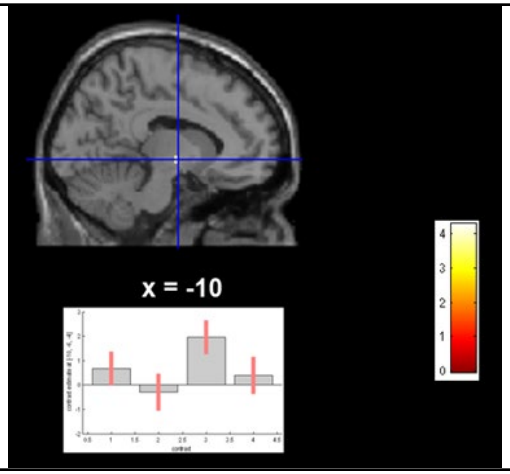
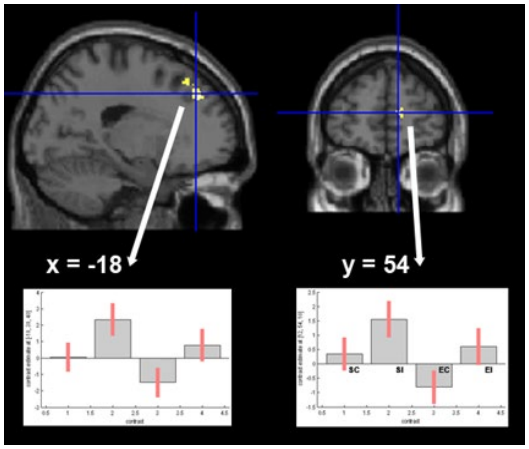
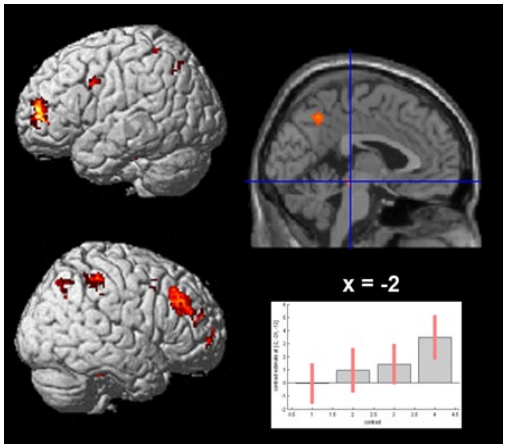
No significant differences in

- Number of exploitative vs explorative choices
- Number of switches

Generalists and specialists **explore** and **exploit** at different moments

What is the antecedent of such difference?

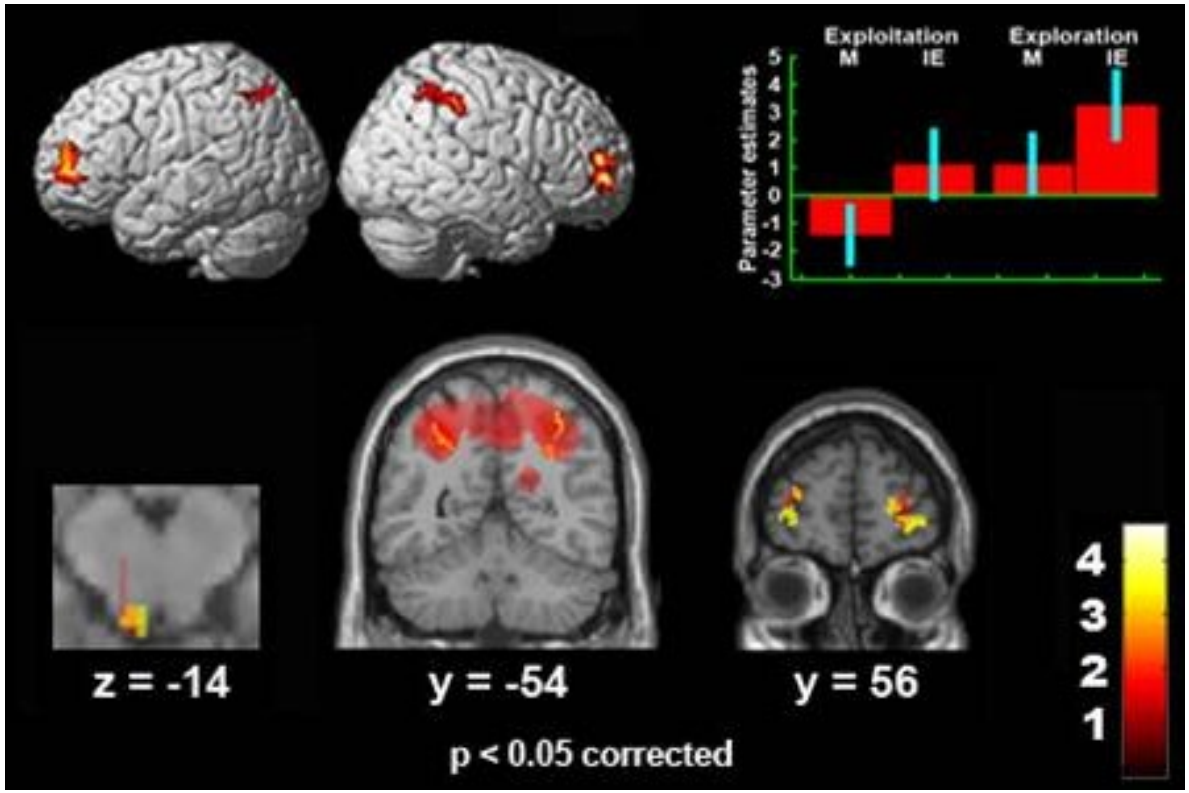
Finding on Generalists vs. Specialists

	Exploitation	Exploration
Specialists		
Generalists		

Source: Laureiro-Martinez et al. 2015 Frontiers in Human Neuroscience

Generalists' brain exploring

- Generalists show stronger activations in regions related to attention control, planning, idea generation, behavioral switching.



Bilateral
FrontoPolar Cortex

Bilateral parietal cortex
Intraparietal sulcus

Locus coeruleus (LC)

Source: Laureiro-Martinez et al. 2015 Frontiers in Human Neuroscience

How can attention be measured outside the scanner?

Behavioral replication studies

Attention Control Regions

- Sustained attention
- Working memory
- Planning and generativity
- Reflective capacity

→ Decision-making performance

89+43+39 MSc students in Management

+…multiple other samples

Functional components of Attention control

Sustained attention

Working memory

Planning and generativity

Reflective capacity

Source: internet images

Behavioral replication studies

Attention Control Regions

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89+43+39 MSc students in Management

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Attention control is related to performance

Attention control regions

Bilateral FrontoPolar Cortex

Bilate
Intra

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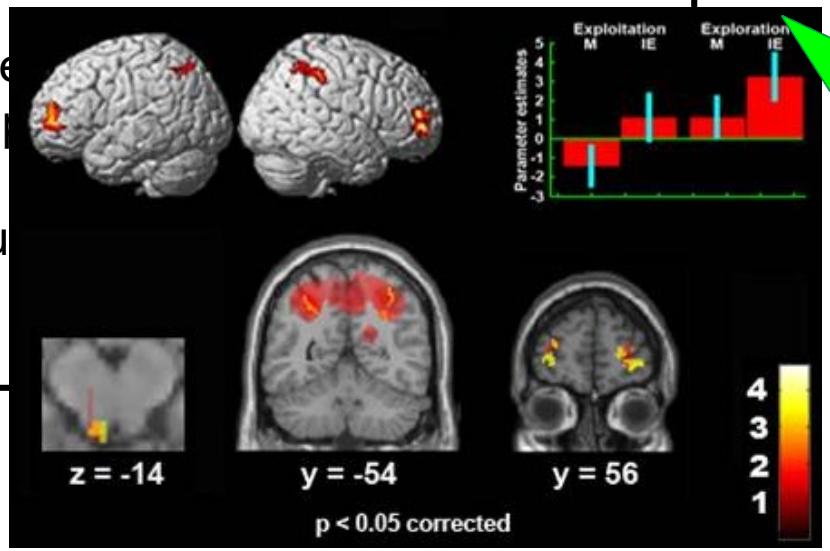
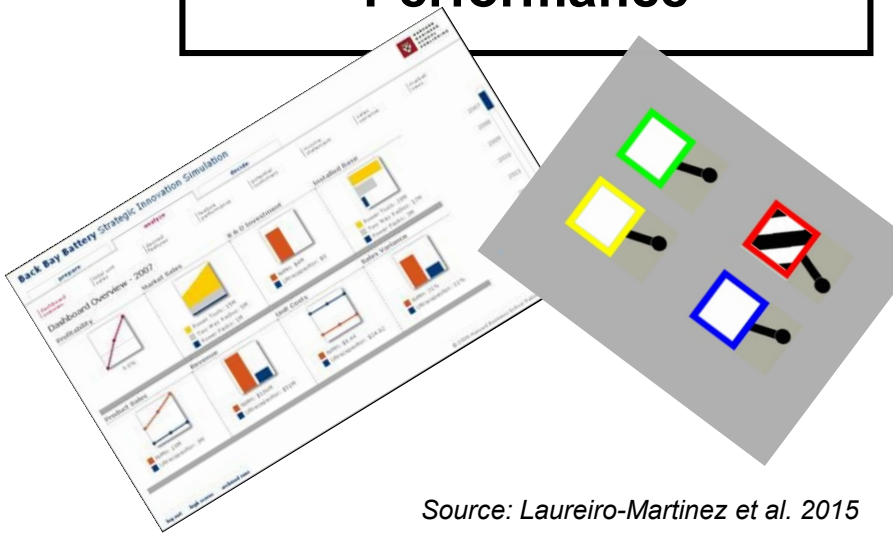


Exploration-exploitation Performance



Source: Laureiro-Martinez et al. 2015

Did we make it?

Key concepts

- Understand what is exploration – exploitation at the individual level
- Know what is attention at the individual level, what are the two main types of attention, and understand why attention control is important

Methods

- Understand how exploration and exploitation can be measured in a very fine-grained way, and why it matters

Q&As

- Connect knowledge on attention to real life topics and examples (e.g. IDEO, your own decisions)
- (start to) Gain awareness about your own cognitive processes and the impact they have on decision-making

Thesis opportunity

Exploring and Exploiting while thinking-aloud

There is a fundamental tension at the core of strategic decisions: exploring new options with uncertain possibilities and exploiting known opportunities with expected rewards. This tension appears at many levels: from individuals choosing a restaurant for lunch to companies acquiring a startup or investing in their own research and development.

The exploration-exploitation dilemma, as this tension is called, has been thoroughly studied a validated. Most of the studies use simulations, and quantitative data to investigate how explorative and exploitative choices influence a company's learning process. Unfortunately, we know little of what considerations people make before choosing either option.

In this thesis, we aim at studying the thinking processes behind exploration/exploitation decisions. You will use a technique called think-aloud. This technique, used daily for research at companies like Google or Facebook, allows following the thoughts of people as they make choices. From this thesis, you learn the motivation and approaches people use while learning and adapting to an environment and will contribute to expanding our understanding of the reasoning behind the fundamental tension of exploration and exploitation.

In our lab, we have studied exploration-exploitation decisions in depth and have developed experiments and tasks to understand how individuals perform these decisions. This thesis will build upon our previous methods and will focus on understanding the thinking processes behind decisions. This is not an easy task; it is one that will require a highly motivated, creative, and ambitious person interested in understanding the cognitive processes at the core of innovation and strategy. If you have such interests, we look forward to hearing from you!

During your thesis work, you will be welcomed into the TIM group and will work with Doctoral student Jose P. Arrieta and with Dr. Daniella Laureiro.

References

A classic on the tension: March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, *2*(1), 71-87.

Work from our group: Laureiro-Martínez, D., Brusoni, S., Canessa, N., & Zollo, M. (2015). Understanding the exploration-exploitation dilemma: An fMRI study of attention control and decision-making performance. *Strategic Management Journal*, *36*(3), 319-338.

Laureiro-Martínez, D., & Brusoni, S. (2018). Cognitive flexibility and adaptive decision-making: Evidence from a laboratory study of expert decision makers. *Strategic Management Journal*, *39*(4), 1031-1058.

On the methods: Ericsson, K. A., & Simon, H. A. (1998). How to study thinking in everyday life: Contrasting think-aloud protocols with descriptions and explanations of thinking. *Mind, Culture, and Activity*, *5*(3), 178-186.

Applications

Please contact Jose Arrieta (jarrieta@ethz.ch) with your CV, a brief email stating your motivation, your time availability, and/or any further inquiries.