Le poids des habitudes dans les addictions

Les lundis de la psychiatrie

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2$^{\text{ème}}$ année de thèse sous la supervision du Professeur Noël

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Plan

Decision-making

- Habit-like decisions
- Goal-directed decisions

Evaluation

- Outcome devaluation paradigm
- Two-step Markov task

Decisional balance and dimensional psychiatry

Habit and addiction

My thesis project and first results

Decision-making

Selection of an action among different alternatives to optimize the behavior.
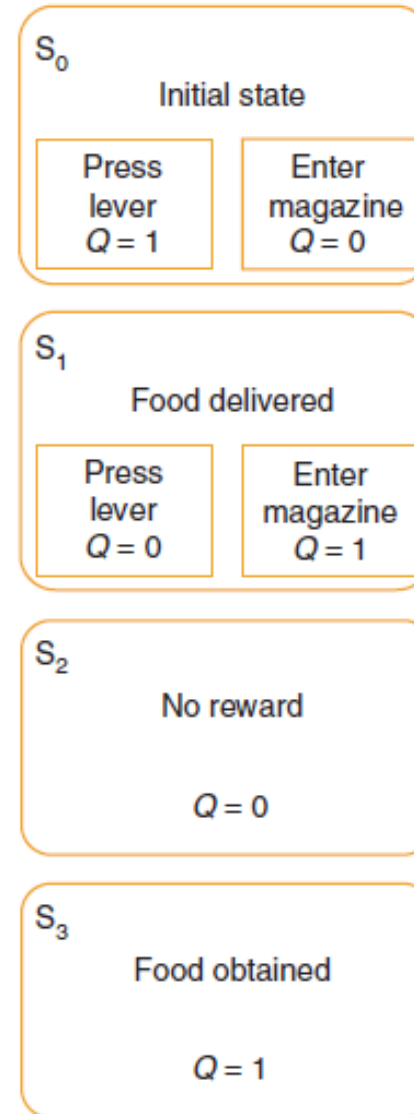
Predictions about action consequences.

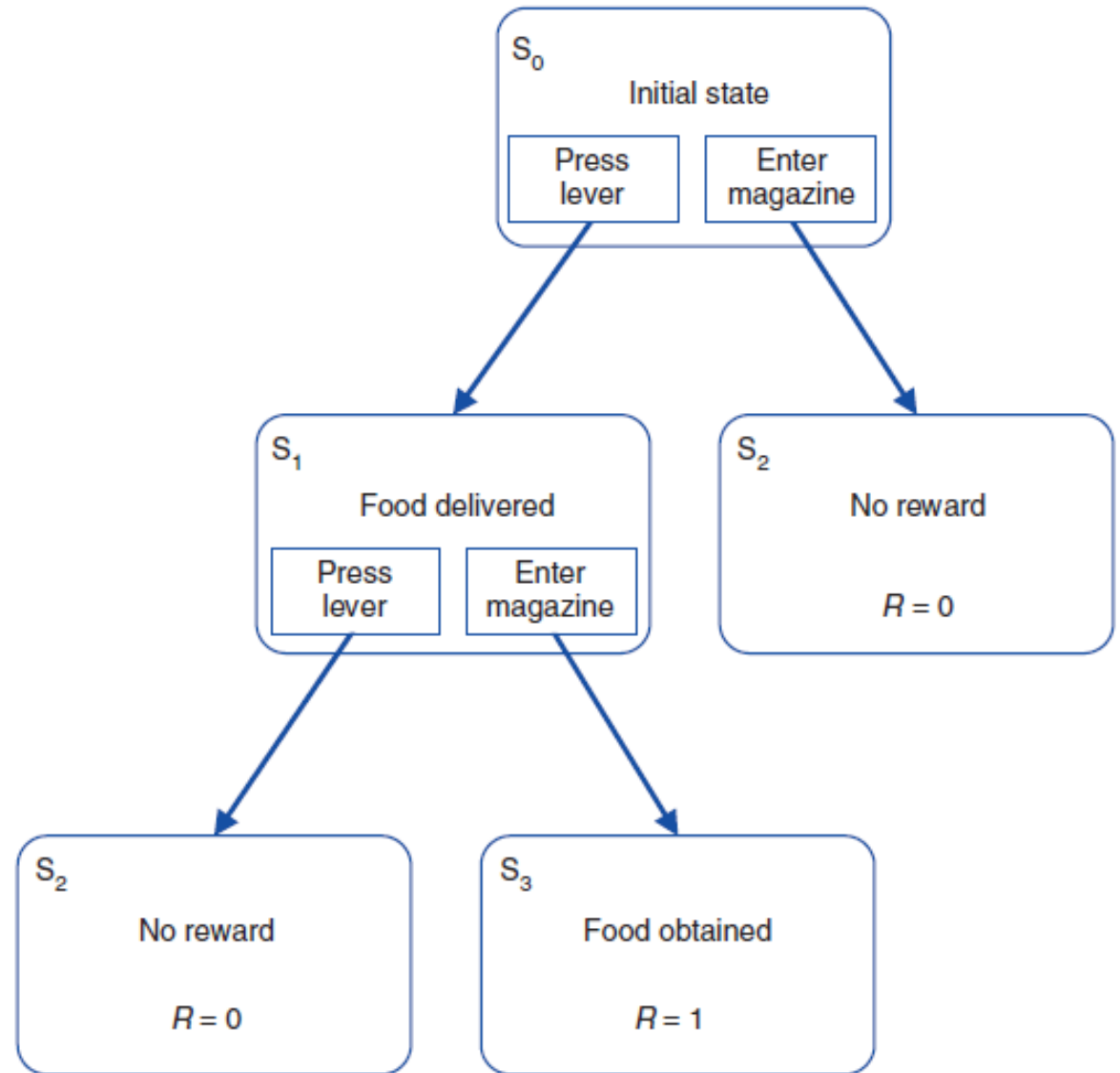Two parallel decision-making processes : habitual and goal-directed.

Habitual system

- Association between state and action, stimulus and response

- No link between actions and consequences

- Retrospective system

- Inflexible but cost-efficient

- Mainly depends on striatal regions (memory)

- -> Model-free or system I

S_0 — Initial state
- Press lever $Q = 1$
- Enter magazine $Q = 0$

S_1 — Food delivered
- Press lever $Q = 0$
- Enter magazine $Q = 1$

S_2 — No reward
$Q = 0$

S_3 — Food obtained
$Q = 1$

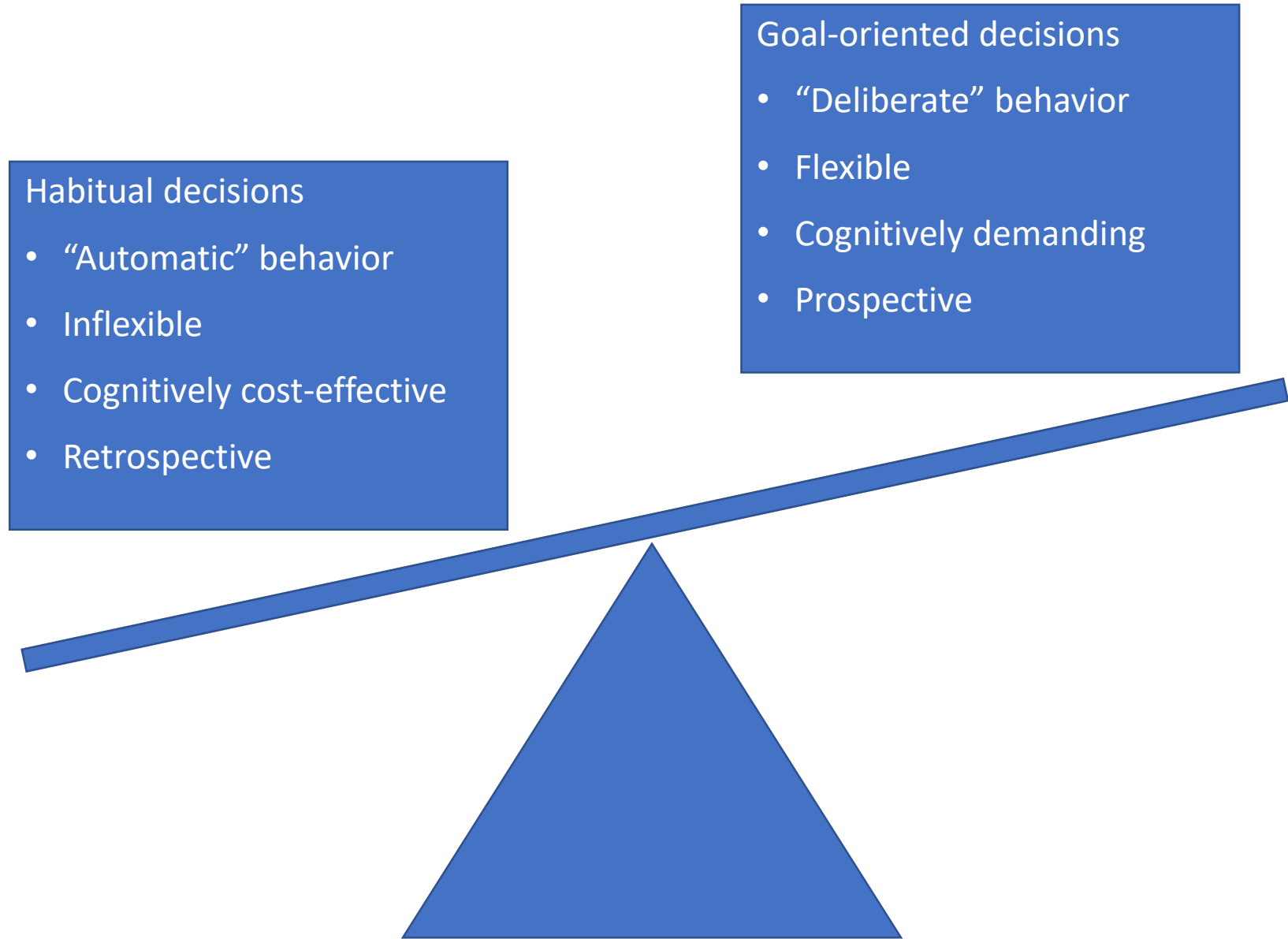Daw et al. (2005), Nature neurosciences

Goal-oriented system

- Mental map considering the initial state, the wished state and each choice consequences

- Prospective system

- Flexible but cognitively costly

- Mainly depends on the ventromedial prefrontal cortex (executive functioning)
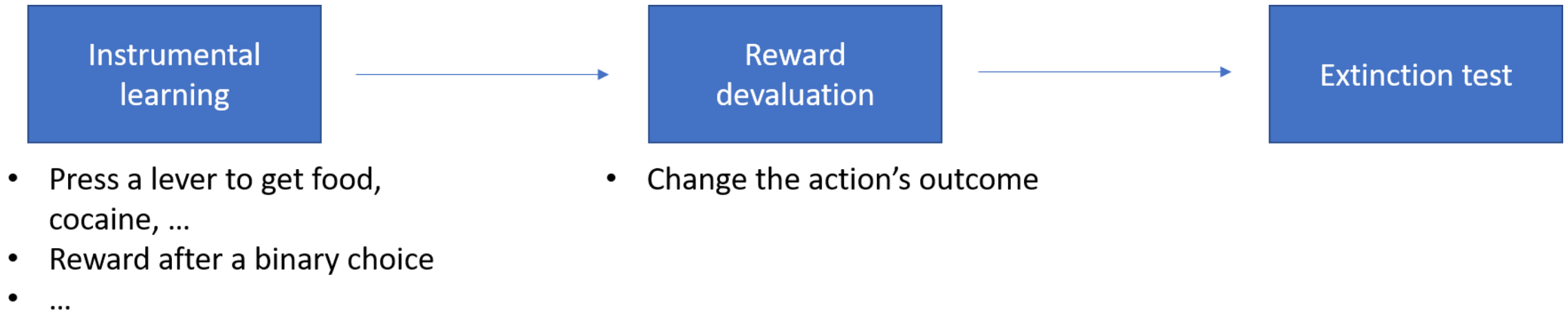
- -> Model-based or system II

Daw et al. (2005), Nature neurosciences

Two decision-making processes working in parallel

Dickinson, A. (1985)
Kahneman, D. (2011)
Daw, N. et al. (2005; 2011)
Dolan & Dayan (2013)

Habitual decisions

- "Automatic" behavior
- Inflexible
- Cognitively cost-effective
- Retrospective

Goal-oriented decisions

- "Deliberate" behavior
- Flexible
- Cognitively demanding
- Prospective

Outcome devaluation paradigm

| Instrumental learning | → | Reward devaluation | → | Extinction test |

- Press a lever to get food, cocaine, …
- Reward after a binary choice
- …

- Change the action's outcome

Adams & Dickinson (1981), Quarterly Journal of Experimental Psychology
Zapata et al. (2010), The Journal of Neurosciences
Hogarth (2012), JEP

Two-step Markov task

- Continuous evaluation
- Discrimination between too much habit and not enough goal-oriented behavior
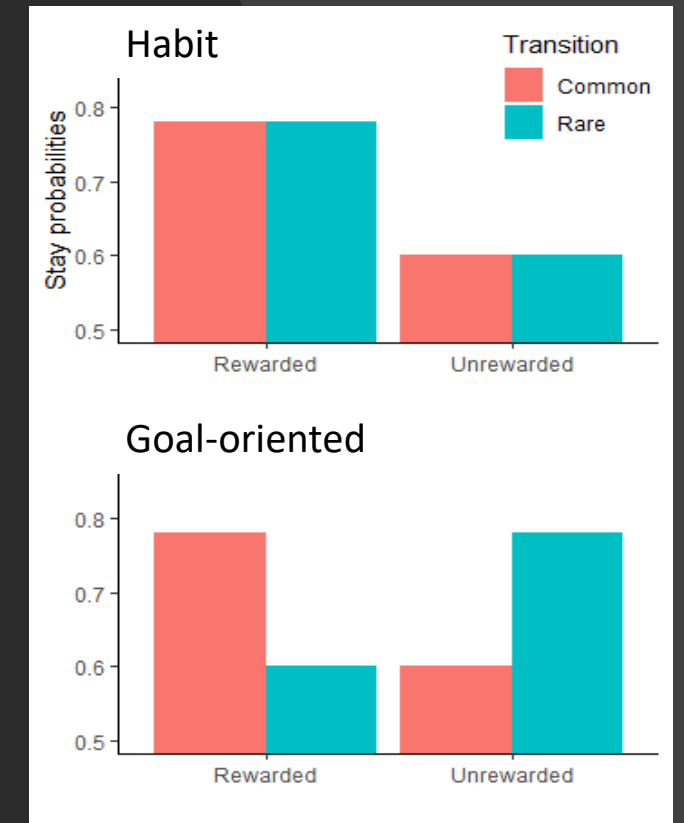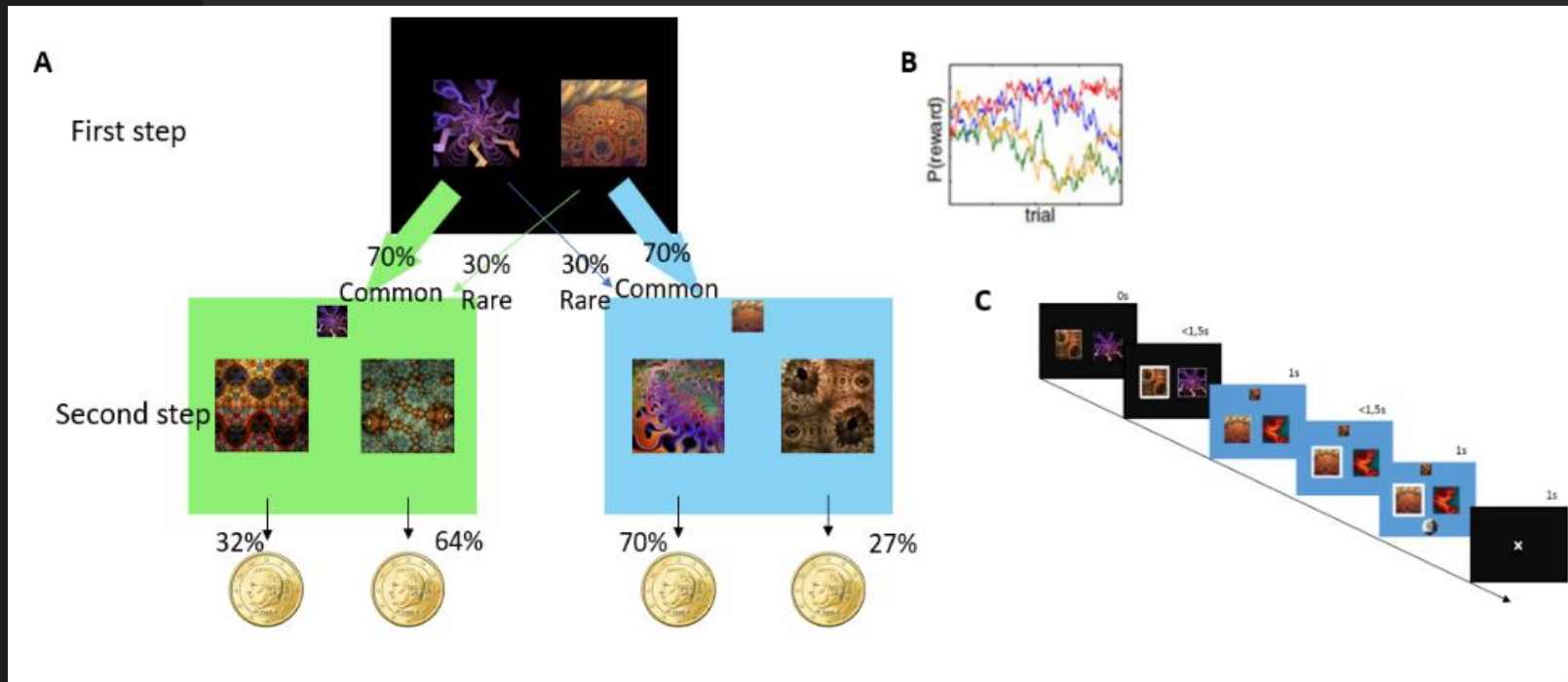
Daw et al. (2011), Neuron
Otto et al. (2013), PNAS

Decisional balance and dimensional psychiatry

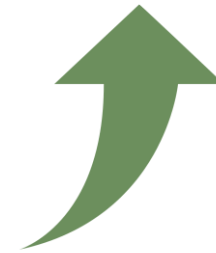**Decreased goal-oriented decisions**

Stress

Individuals with high impulsivity

Patients suffering from OCD, eating disorders

Compulsive behavior and intrusive thoughts

Patients suffering from addiction?

Enhanced goal-oriented decisions

Individuals with high cognitive capabilities

Habit and addiction

Addiction : recurrent behavior, hardly controllable and resisting to their negative consequences.

Decision making : Selection of an action among different alternatives to optimize the behavior.

Counterintuitive ascertainment : the behavior persists despite the loss of his rewarding nature.

Probable imbalance between past-oriented habit and goal-oriented behavior.

Habit and addiction

| In favor of a decisional imbalance	
Outcome devaluation paradigm	
Sjoerds et al. (2013)	Alcohol-dependent patients
Ersche et al. (2016)	Cocaine-dependent patients
Markov Task	
Gillan et al. (2016)	Alcohol-dependent subjects
Sebold et al. (2014)	Alcohol-dependent patients
Voon et al. (2015)	Methamphetamine users
Voon et al. (2015)	Binge eaters
Doñamayor et al. (2018)	Binge drinkers
In disfavor of a decisional imbalance	
Outcome devaluation paradigm	
Hogarth et al. (2011, 2012a, 2012b)	Tobacco users
Hogarth (2018)	Drug addicts
Markov Task	
Voon et al. (2015), Sebold et al. (2017)	Alcohol-dependent patients
Nebe et al. (2017)	Binge drinkers
Deserno et al. (2015)	Young social drinkers
Reither et al. (2016)	Children of alcoholic father

Reduced model-based decision-making in gambling disorder (accepted manuscript, scientific reports)

Florent Wyckmans, Ross Otto, Miriam Sebold, Nathaniel Daw, Antoine Bechara, Mélanie Saeremans, Charles Kornreich, Armand Chatard, Nemat Jaafari, Xavier Noël

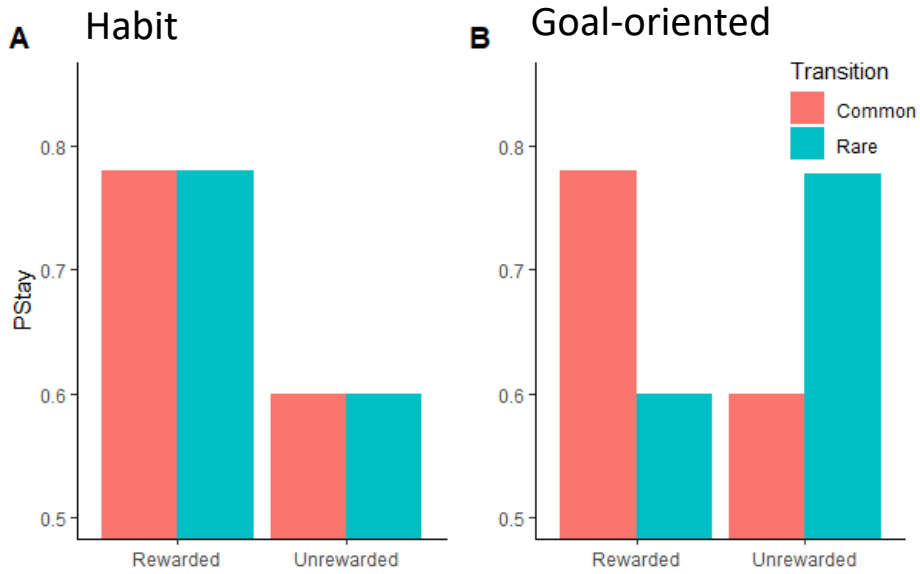→ Study of the addiction without the substance's confounding effect !

Method
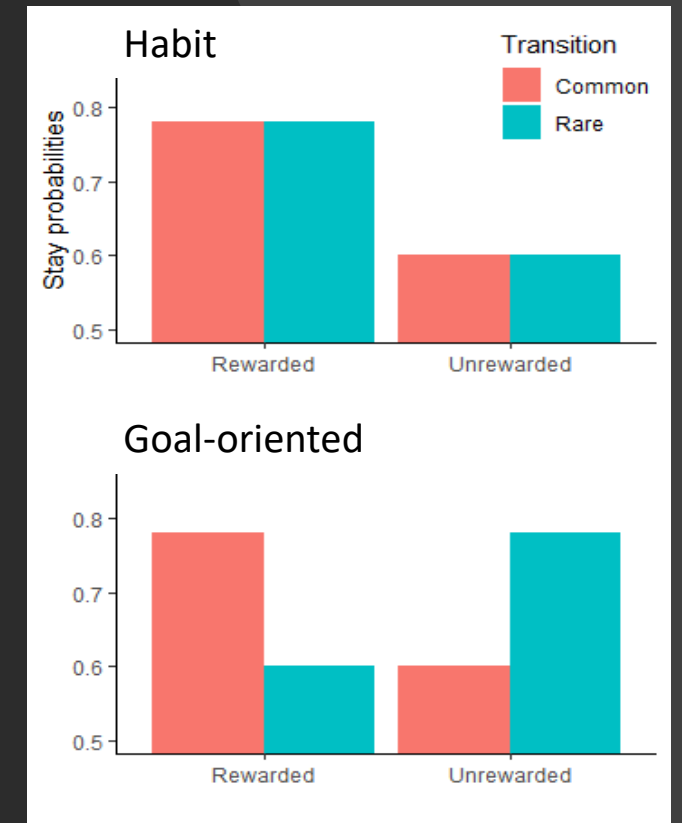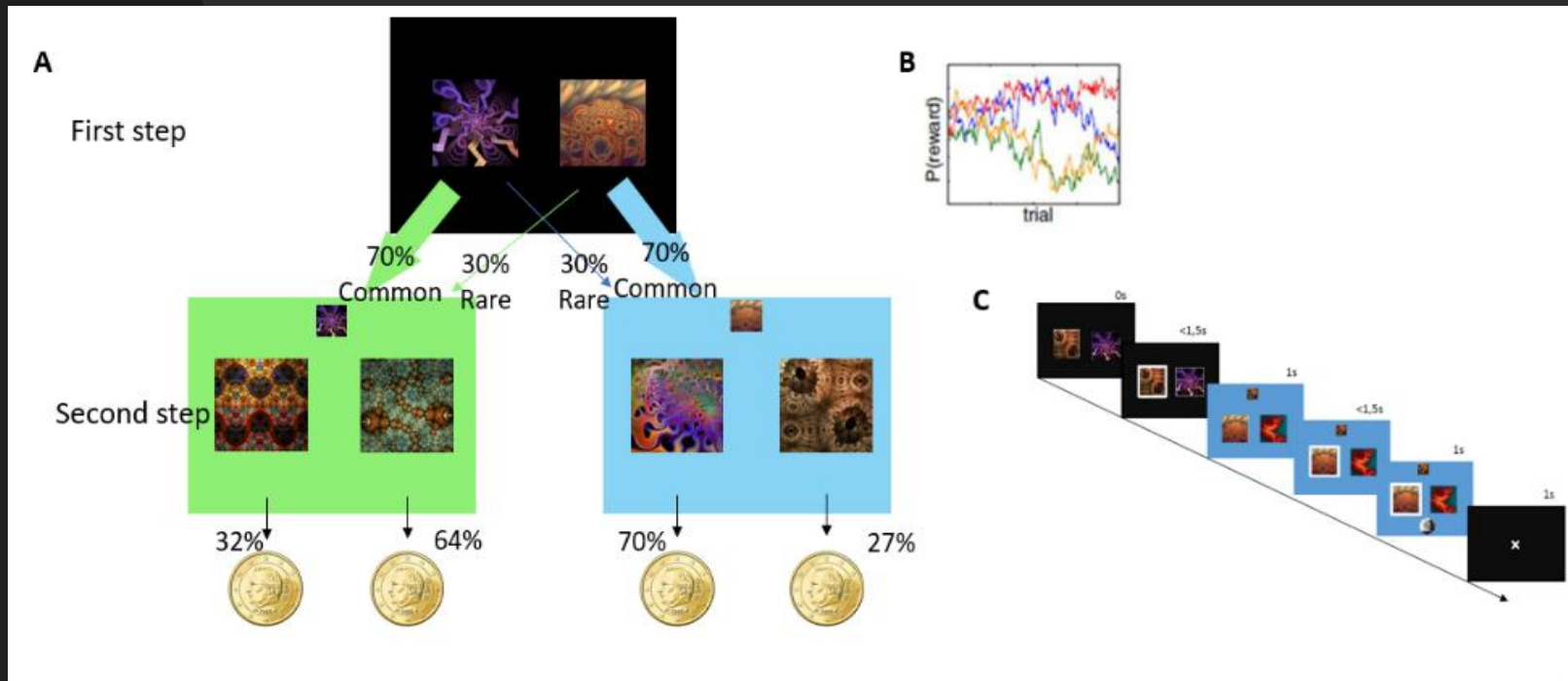
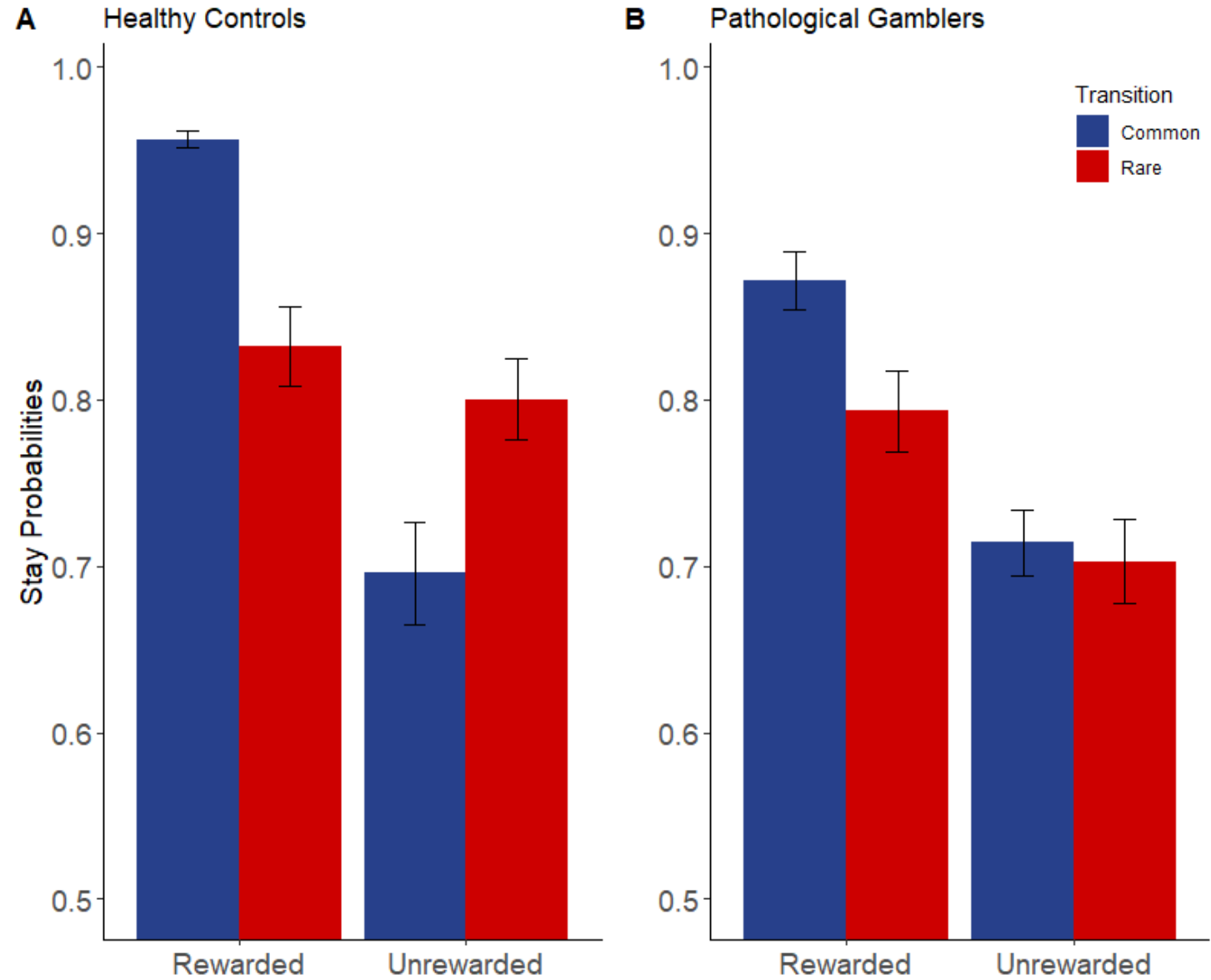45 active pathological gamblers
33 control subjects

Research questions

- Does the participants repeat his first step choice ?

- What are the determinants of the first step choice? Previous reward (habit) or the interaction between the previous reward and the previous transition (goal-oriented) ?

- Are goal-oriented processes weakened among pathological gamblers ?

- Does it depend on the outcome valence ?

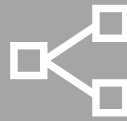- Does response times follows decision-making processes ?

Behavioral results

A Healthy Controls

B Pathological Gamblers

Transition
Common
Rare

Stay Probabilities

Rewarded Unrewarded

Behavioral results

Each participant show habitual and goal-directed decisions

Habitual behavior does not seem affected by pathological gambling
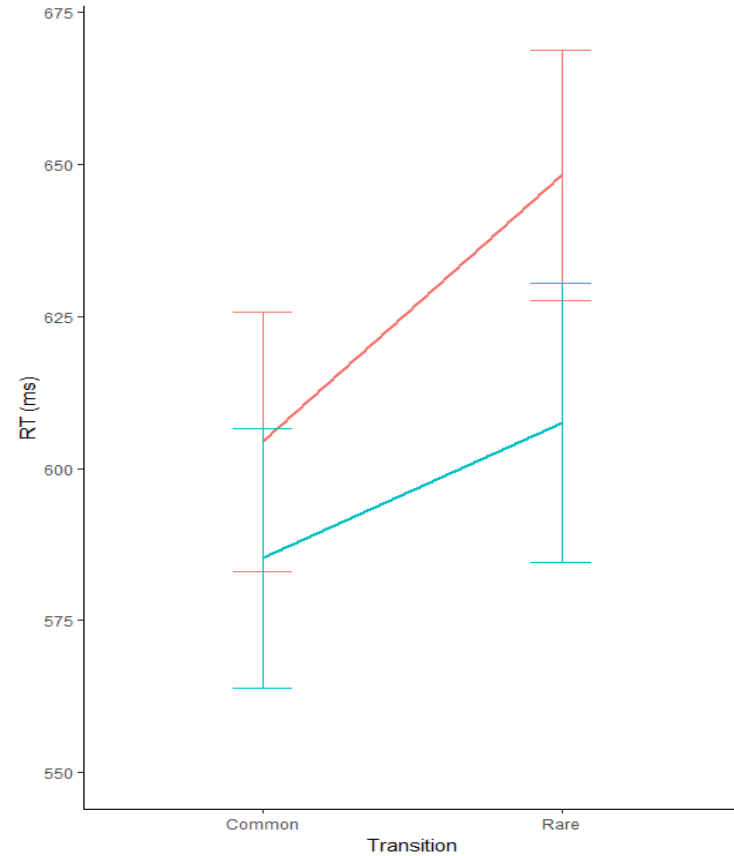
Behavior is significantly less goal-directed among pathological gamblers
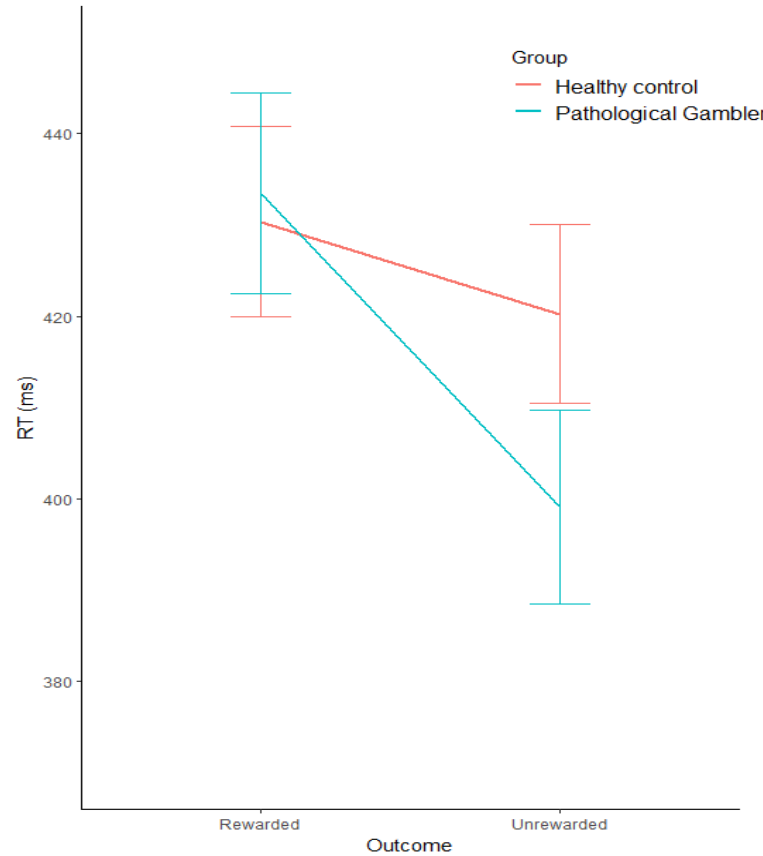
This diminution appears only after unrewarded trials

Response time analysis

A Second step response time by transition and group

B First step response time by previous outcome and group

C

Group
- Healthy control
- Pathological Gambler

R = 0.4, p = .007

In short

- Habitual behavior is not affected by gambling disorder

- Goal-directed behavior is diminished among gamblers, but only after a fail attempt

- Shorter reaction time after a loss

Are negative emotions responsible for this diminished goal-oriented system ?

Future researches and openings

PHYSIOLOGICAL STRESS AND COGNITIVE CAPACITIES IMPACT ON DECISIONAL BALANCE

STUDY OF ALCOHOL-DEPENDENT PARTICIPANTS

IMPACT OF THE INDUCED CRAVING ON DECISIONAL BALANCE

Thank you very much!

- Mixt logistic regression
- DV : Probability to maintain the first stage choice.
- IV :
  - Group : Pathological gamblers vs healthy controls
  - Outcome : Rewarded previous trial vs non rewarded
  - Transition : Common vs Rare transition at the previous trial

Behavioral results

Coefficient	Estimate (SE)	z-value	p-value	Signification
Intercept	1,67 (0,1)	16,26	< .001***	
Group	-0,16 (0,1)	-1,54	.12	
Outcome	**0,55 (0,06)**	**9,05**	**<.001***	Habit's signature
Transition	**0,2 (0,05)**	**3,86**	**<.001***	
Group*Outcome	-0,02 (0,06)	-0,42	.67	Interaction group*habit
Group*Transition	0,04 (0,05)	0,7	.48	
Outcome*Transition	**0,32 (0,06)**	**5,14**	**<.001***	Goal-directed' signature
Group*Outcome*Transition	**-0,12 (0,06)**	**-2**	**<.05***	Interaction group*Goal-directed

Behavioral results

Unrewarded trial (Outcome = -1)			
	Estimate (std. Error)	Z value	p value
Intercept	1.12 (0.09)	11.93	<.001***
Group	-0.13 (0.09)	-1.41	0.16
Transition	**-0.12 (0.05)**	**-2.16**	**<.05***
Group * Transition	**0.16 (0.05)**	**2.95**	**<.01****
Rewarded trial (Reward = 1)			
	Estimate (std. Error)	Z value	p value
Intercept	2.22 (0.14)	16.07	<.001***
Group	-0.18 (0.14)	-1.34	0.18
Transition	**0.51 (0.1)**	**5.32**	**<.001***
Group * Transition	-0.09 (0.1)	-0.92	0.36

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