

**Evolution of decision making under risk:**  
**How comparative work on human and non-human primates can  
shed light on humans' decisions**

Workshop on Behavioral Insurance  
Thursday, April 15, 2021

**Francesca De Petrillo, PhD.**  
Research Fellow, Institute for Advanced Study in Toulouse



Francesca\_DePe



Toulouse  
School of  
Economics

# Variation in decision-making under risk

**Population variation:** differences in risk propensity across nations, and small-scale subsistence societies (Hsee & Weber 1999; Amir et al., 2019)

**Individual variation:** men tend to be more risk-prone than women and risk propensity change during aging (Charness & Gneezy 2012; Paulsen et al. 2012)

**Context variation:** specific currency of the reward at stake and the larger social context (Bault et al. 2008; Rosati & Hare 2016)

**Internal state variation:** emotional states affect individuals' risk preferences: disappointment and regret (Coricelli et al. 2007)

# Variation in decision-making under risk

## What is the origins of this variation?

### Cultural experiences

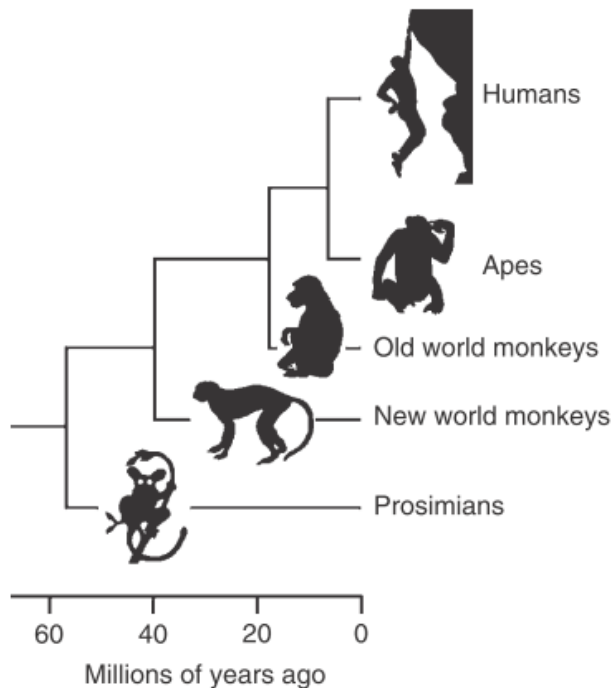
- Market experience  
(Amir et al. 2019)
- Cultural norms  
(Hsee & Weber 1999)
- Socialization practices  
(Croson & Gneezy 2009)

### Biological contributions

- Genetic differences  
(Cesarini et al. 2009)
- Hormonal status  
(Apicella et al. 2015)
- Maturation of the neural system recruited in the decision process  
(Galvan et al. 2007)

# Biological foundations of human decisions

Humans: **biological influences** (shared) + **cultural influences** (unique)



**Non-human primate can help us understand the biological foundation of human behaviour**

- similarities in their cognition and neurobiology
- Similarities in social behaviour, sex differentiation and development
- Lack human-specific form of culture and economic market

(De Petrillo & Rosati, 2021 Phil. Trans.)

# Biological foundations of human decisions

Non-human animals make decisions about value in their everyday lives

**Food choice**

**Mate choice**

**Ally choice**

TIME: rewards may be not immediately available

RISK: gains may be variable

## Evolutionary rationality

**When making decisions, Individuals maximize their fitness (number of offspring)**

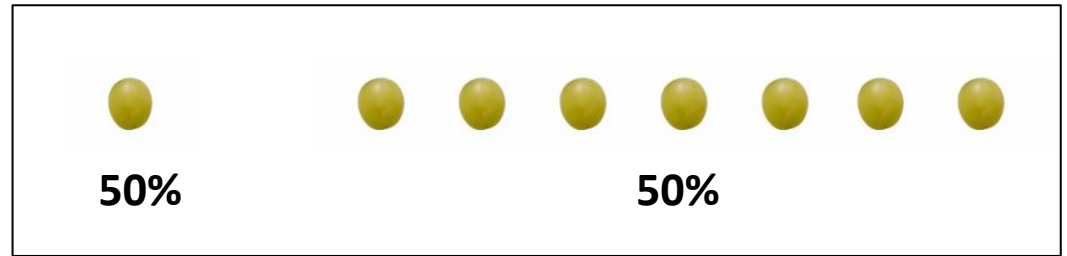
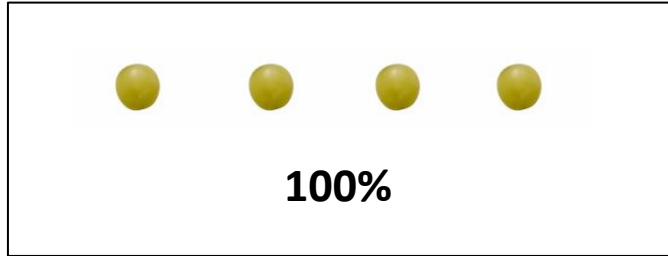


Food or calories are treated as proxy for fitness  
(MacArthur & Pianka, 1966; Charnov, 1976; Stephen & Krebs, 1986).

# Measuring risk preferences in non-human animals

Series of choices between two different quantities of consumable reward:

«**Safe**» option (constant food amount) vs. «**Risky**» option (variable food amount)



# Non-human animals risk preferences



**Non-human animals are usually risk averse for gains**

**Risk-sensitivity theory:** the individual's energy budget affects risk preference

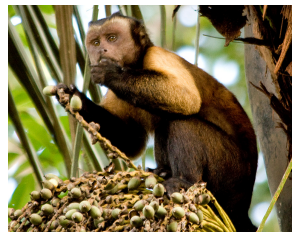
negative energy budget → risk proneness, positive energy budget → risk aversion

(Kacelnik & Bateson 1996; Kacelnik & El Mouden 2013; Platt & Huettel 2008)

# The evolution of risk preferences

**Ecological rationality hypothesis:** differences in natural history explain differences in decisions

(Gigerenzer et al. 1999; Stevens 2010; De Petrillo et al. 2015; Rosati 2017)



Capuchin  
monkeys



Chimpanzees  
**Risk prone**



Bonobos  
**Risk averse**



Humans

2 mya

6-8 mya

40 mya



# Brown tufted capuchin monkeys

Wild capuchins exploit a wide variety of risky food sources and engage in potentially hazardous activities

(Perry and Rose 1994; Visalberghi and Fragaszy 2013)

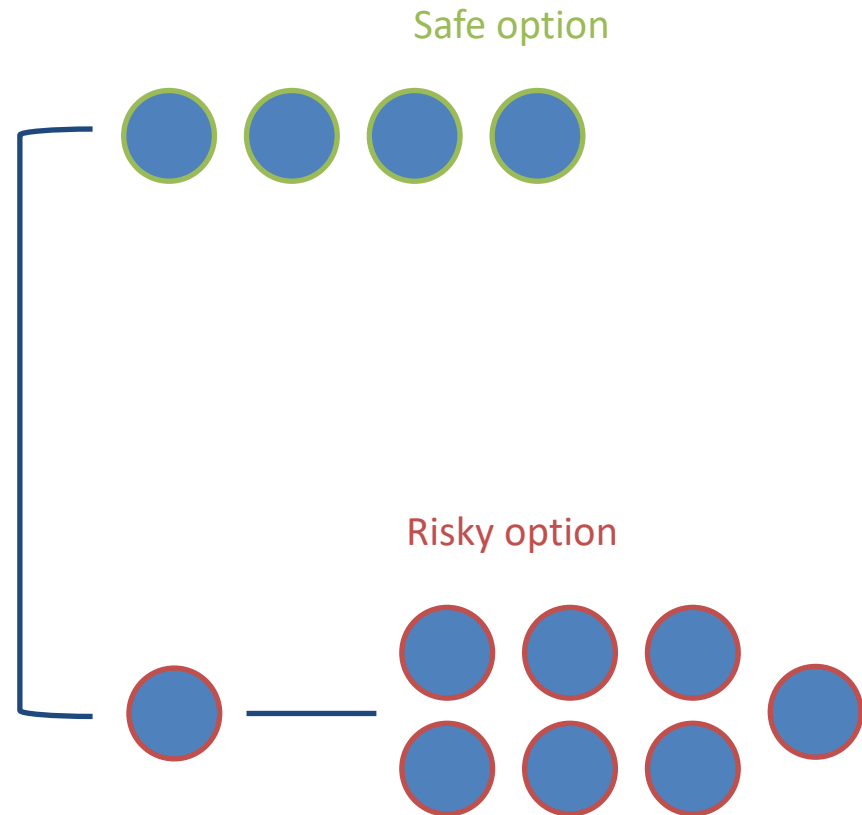


# The quantity risky choice task

**Quantity risky choice task:** same procedure used in chimpanzees and bonobos



N = 10 (5 males, 5 females)



# The quantity risky choice task

1. **Neutral:** 50% chance to receive 7 food items

(average payout = **4 food items**)



2. **Advantageous:** 67% chance to receive 7 food items

(average payout = **5.2 food items**)



3. **Disadvantageous:** 33% chance to receive 7 food items

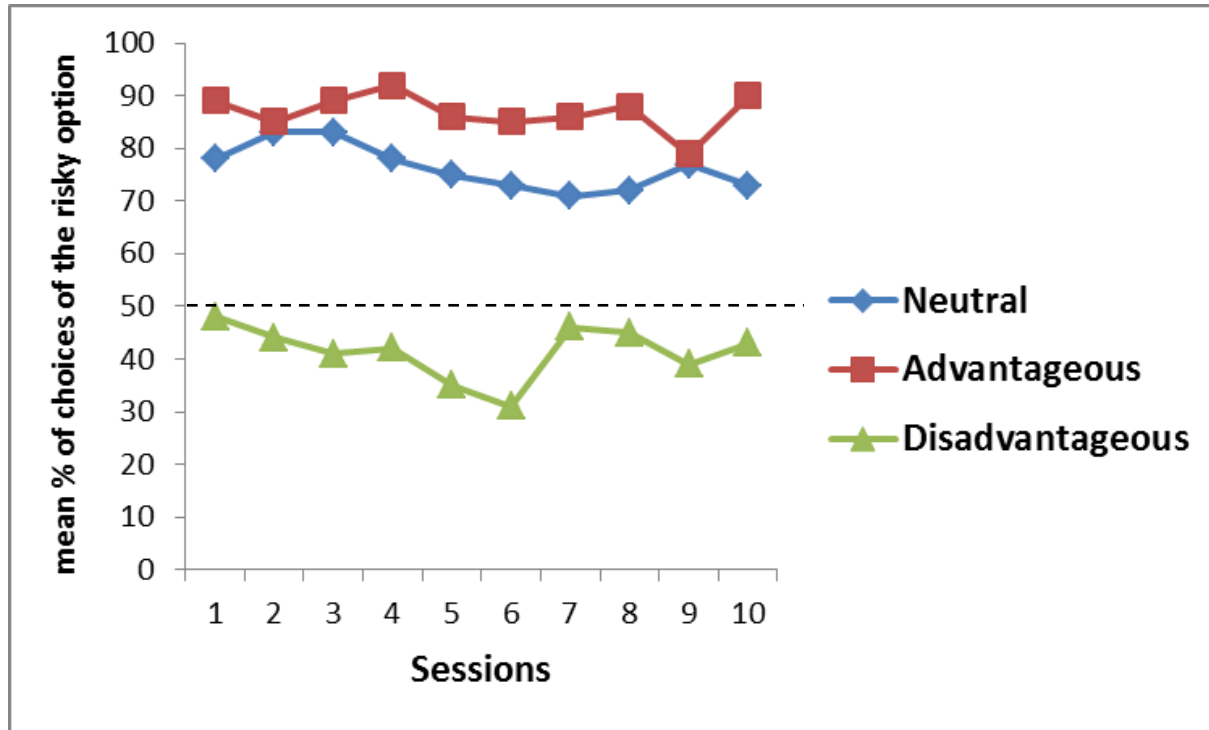
(average payout = **2.8 food items**)



(De Petrillo et al., 2015)

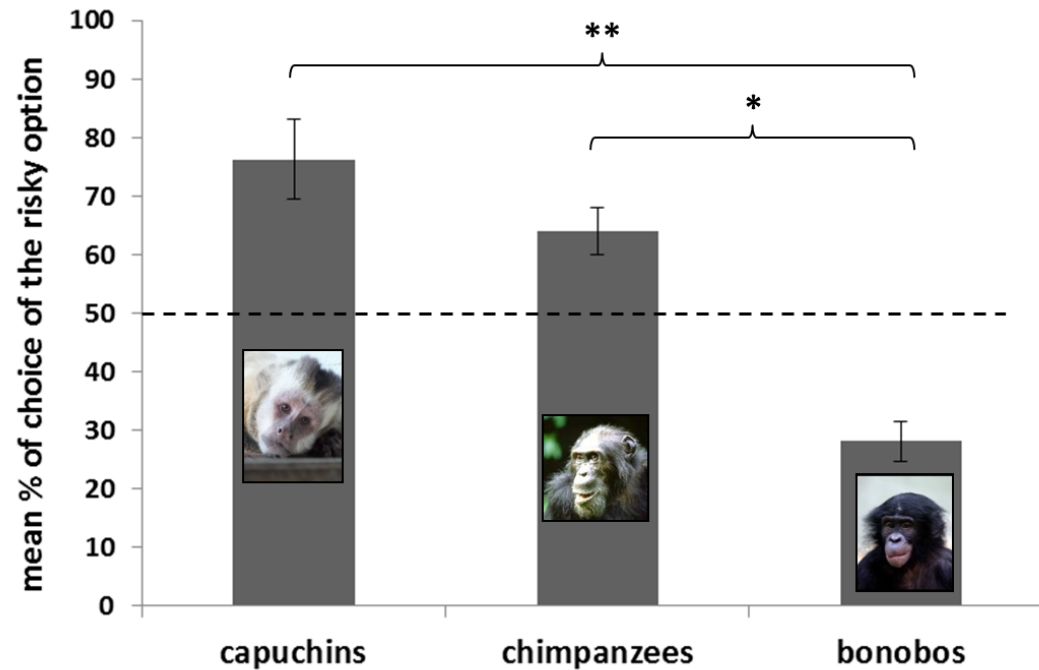
# Capuchin choice - Example

# Capuchins' risk preferences



Flexible choices: Neutral ~ Advantageous > Disadvantageous

# Comparison across species



Risk proneness: capuchins ~ chimpanzees > bonobos

- No sex differences
- No age differences

**Species that rely on more variable resources have evolved higher tolerance for risk**

# Emotions and decision-making

## Emotions affect human risky choices

- People make choices that minimize the chance to feel regret
- Shift from risk seeking to risk aversion after gambling and losing

(Heilman et al. 2010; Coricelli et al., 2005, 2007; Coricelli & Rustichini 2010)

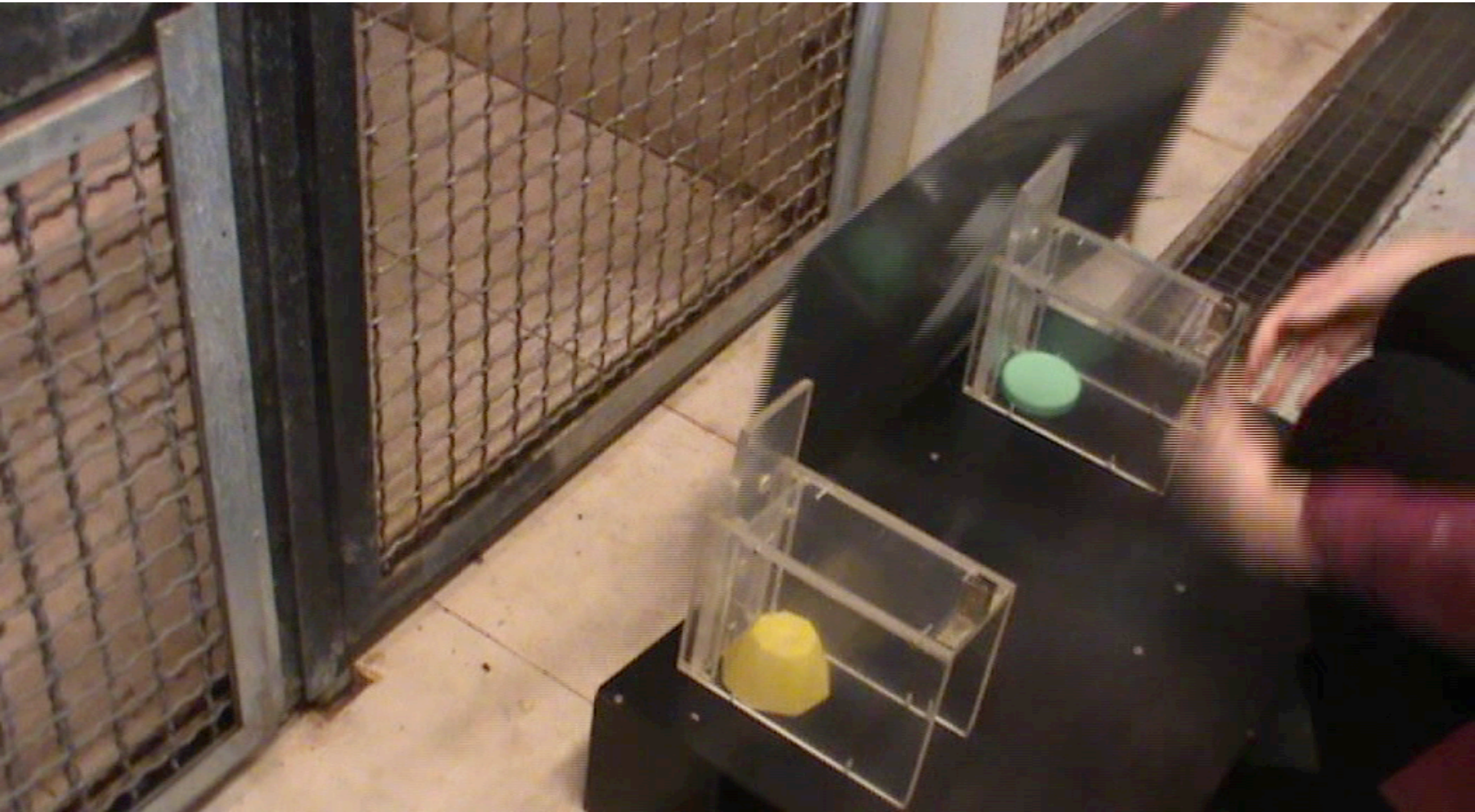
## Measuring monkey emotions

- Scratching and stress indicators
- Choice switching



(De Petrillo et al. 2017 *Animal Behaviour*)

## Switching behaviour - example

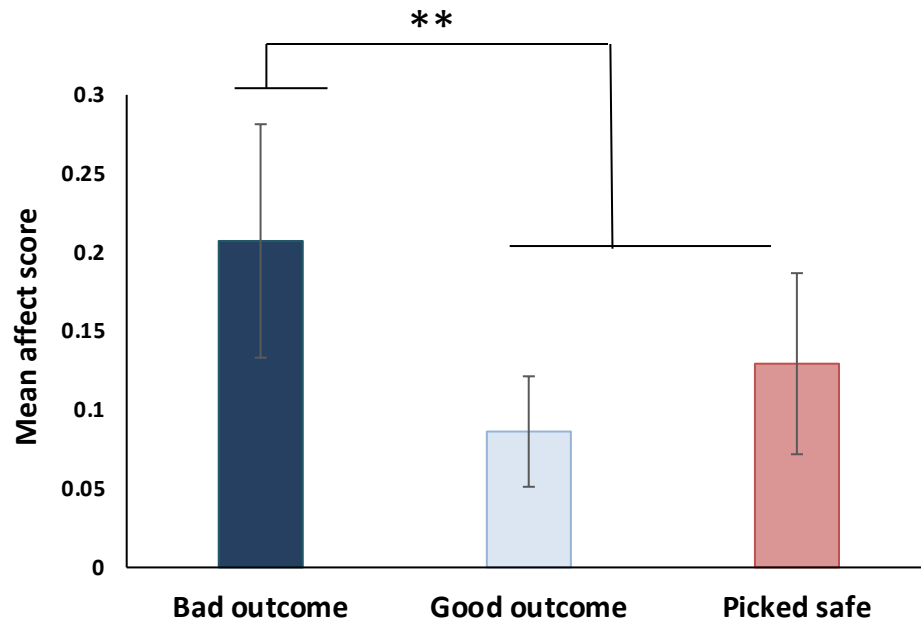


(De Petrillo et al. 2017 *Animal Behaviour*)

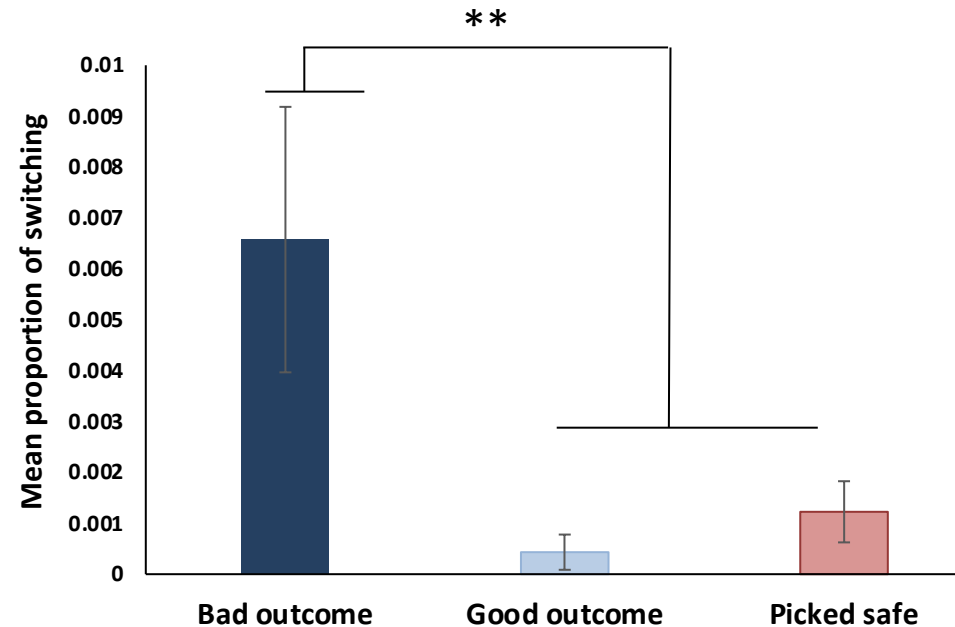


# Emotional responses to the choice outcome

## Negative emotions



## Switching attempts



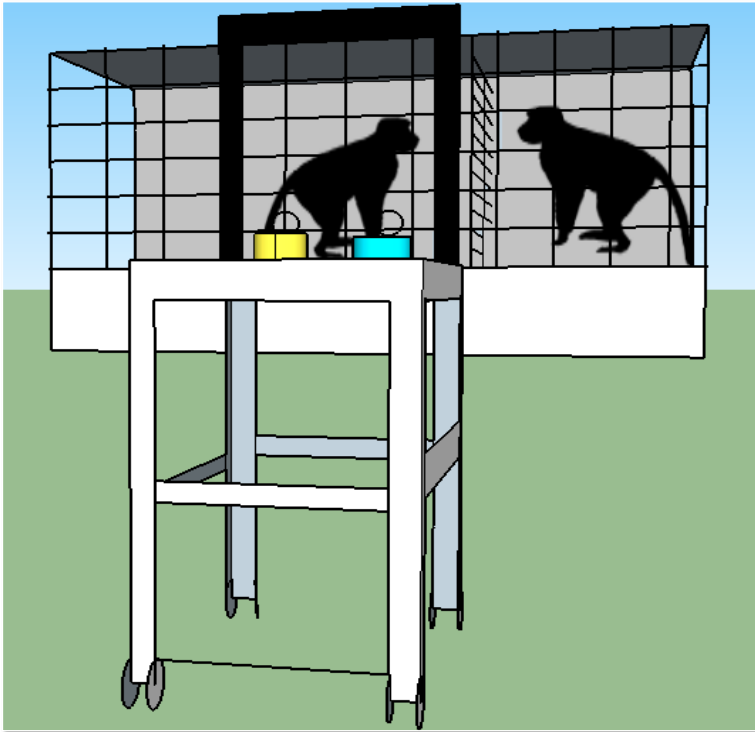
- More negative emotions and switching after gambling and receiving a bad outcome
- No effect of these emotions on capuchins' subsequent choices

(De Petrillo et al. 2017 *Animal Behaviour*)

# Social context and decision-making

People make more risky choices in the presence of others (Hill & Buss 2010; Bault et al. 2008)

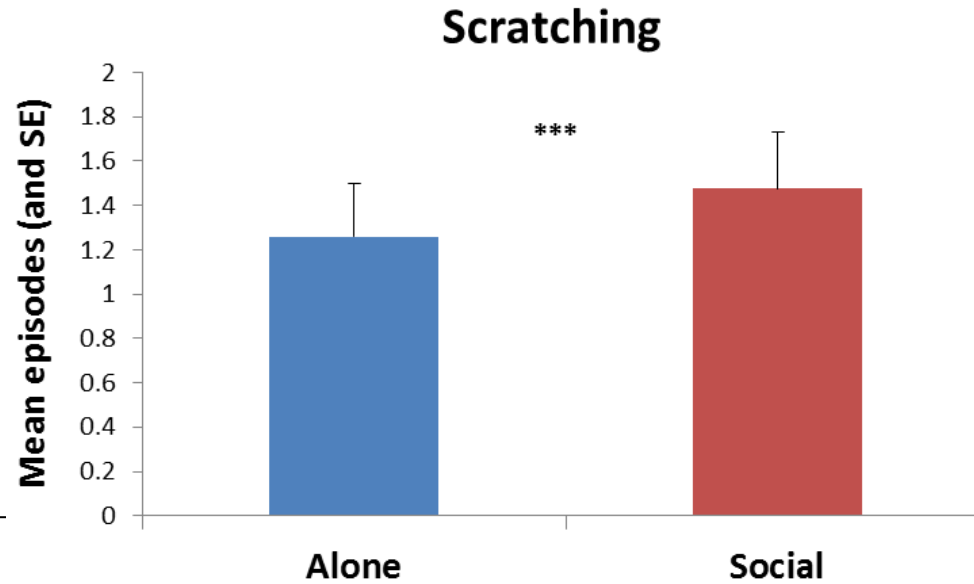
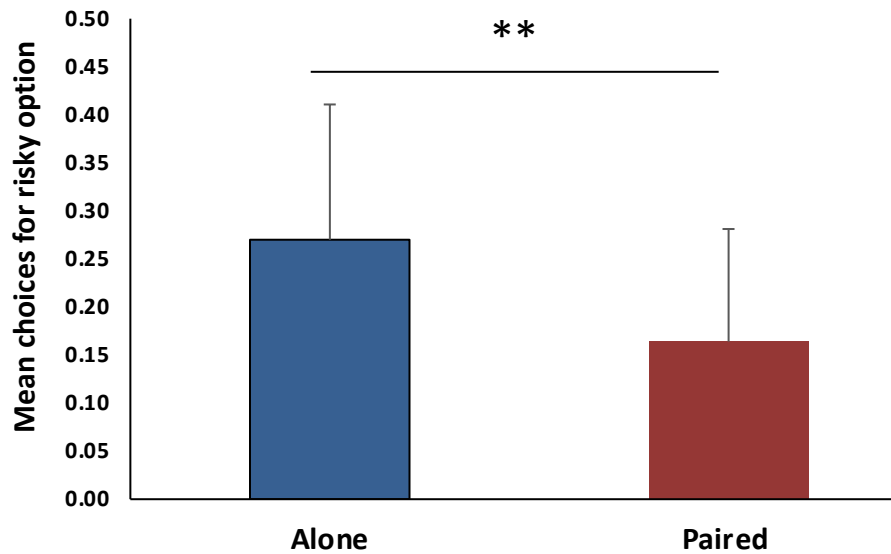
## Monkey choices with or without conspecific observer



- ***Alone*** (N = 10)
- ***Paired*** with dominant *bystander*  
(low ranking individuals N = 6)
- ***Paired*** with subordinate *bystander*  
(high ranking individuals N = 4)

(Zoratto, De Petrillo et al. 2018 *Behavioral Brain Research*)

# Social context and decision-making



**Capuchins are more risk-prone when alone**  
*(And more stressed with a partner)*

(Zoratto, De Petrillo et al. 2018 *Behavioral Brain Research*)

# The importance of a comparative approach

**Like humans, (some) non – human primates:**

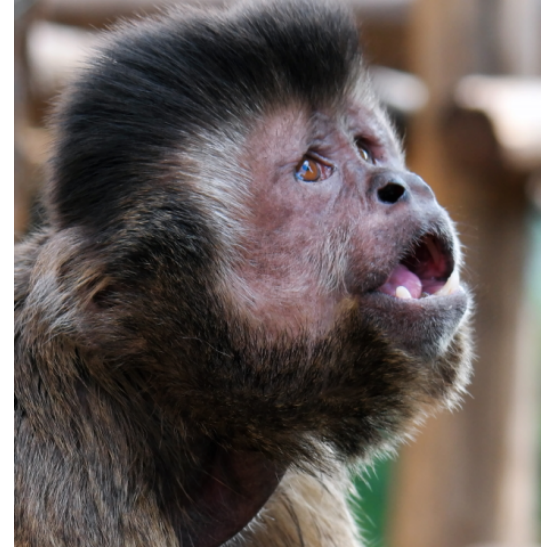
Are sensitive to variation in their payoff

**Different decision strategies depending on the species**

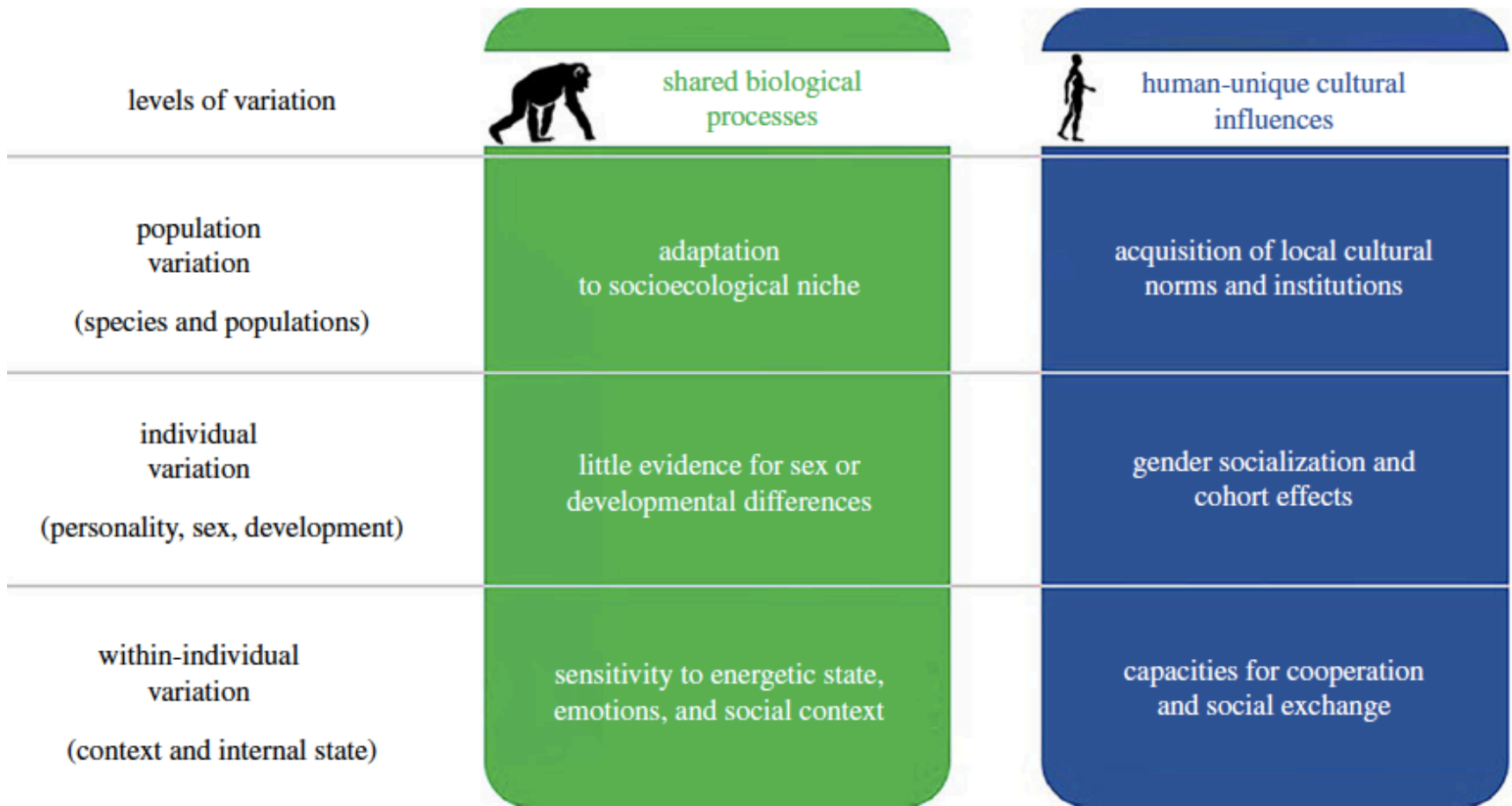
Exhibit emotional responses to outcomes

Change decision making strategies depending on the social context

**This suggests that some psychological processes driving human decision making strategies might be shared with other primates.**



# The importance of a comparative approach



Adapted from (De Petrillo & Rosati, 2021 *Phil. Trans.*)

**Culturally based traits are more malleable and amenable to interventions → new clues for promoting optimal economic behaviour in humans**

# Thank You!

**Francesca De Petrillo, PhD.**  
francesca.de-petrillo@iast.fr

 **Francesca\_DePe**

