CSN | THE CENTER FOR THE STUDY OF NEUROECONOMICS AT GEORGE MASON UNIVERSITY

The Neuroeconomics of Trust

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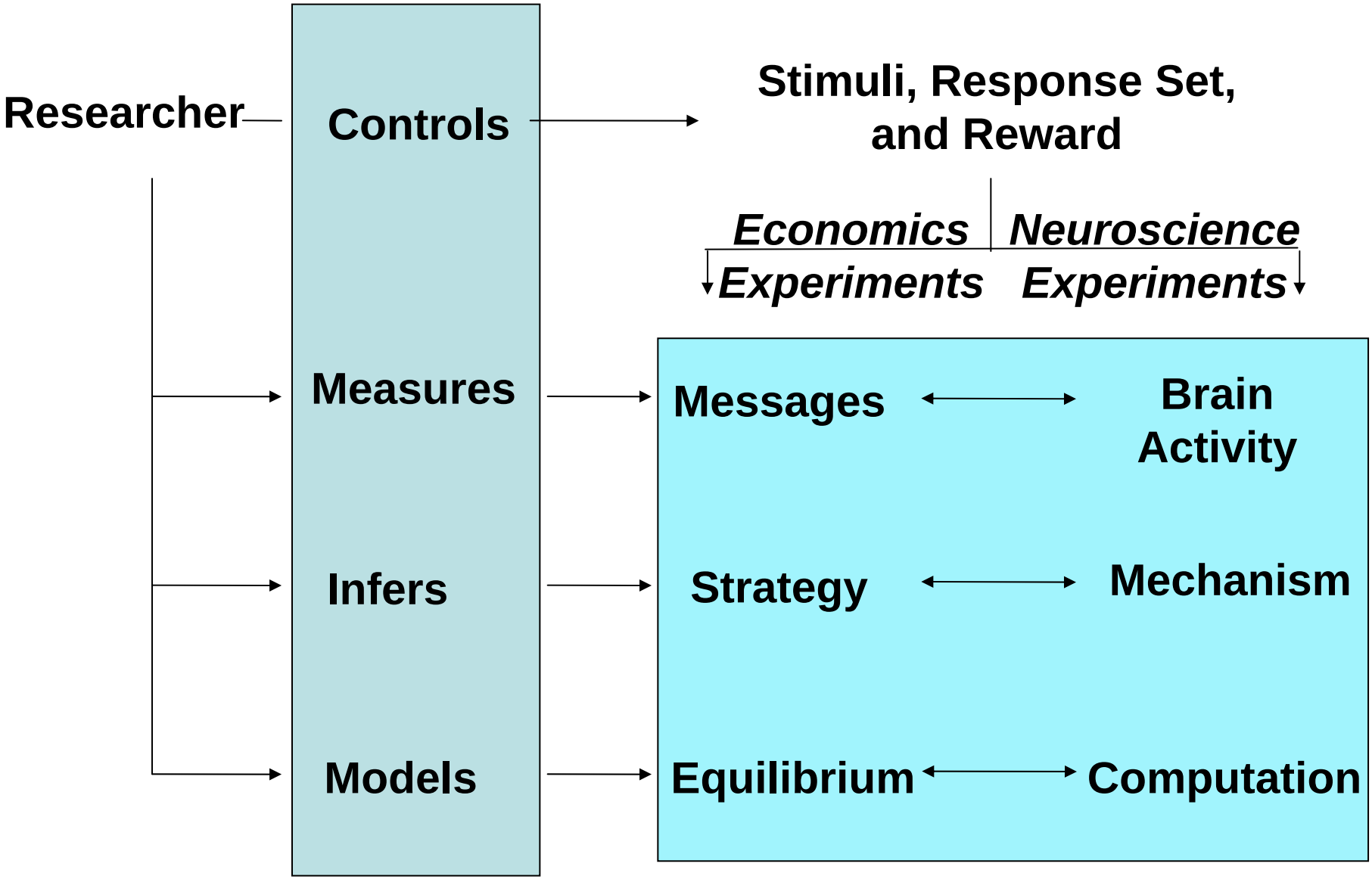
CSN | What is Neuroeconomics?

Neuroeconomics is an interdisciplinary research program with the goal of building a biological model of decision making in economic environments.

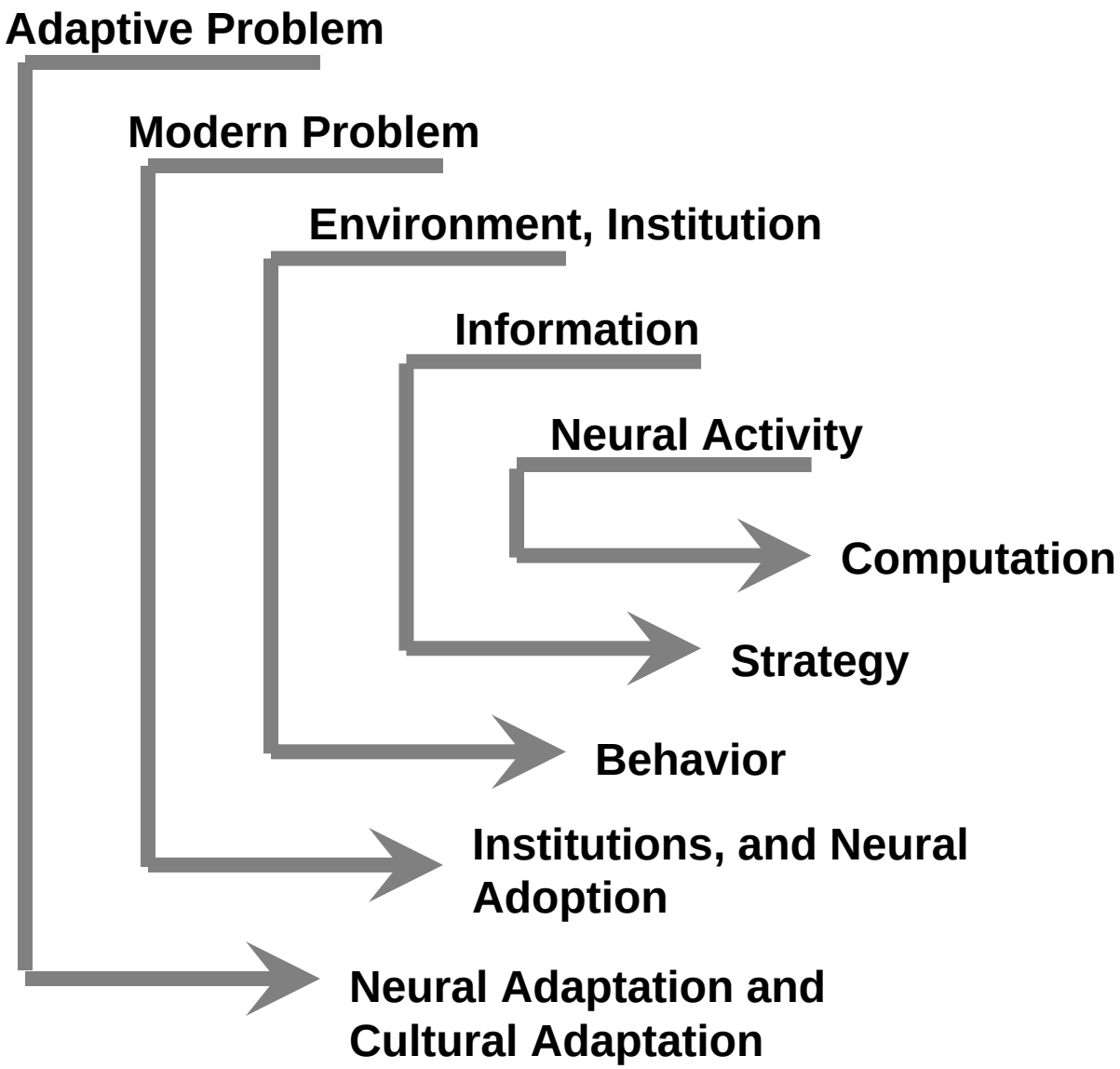
CSN | What is Neuroeconomics?



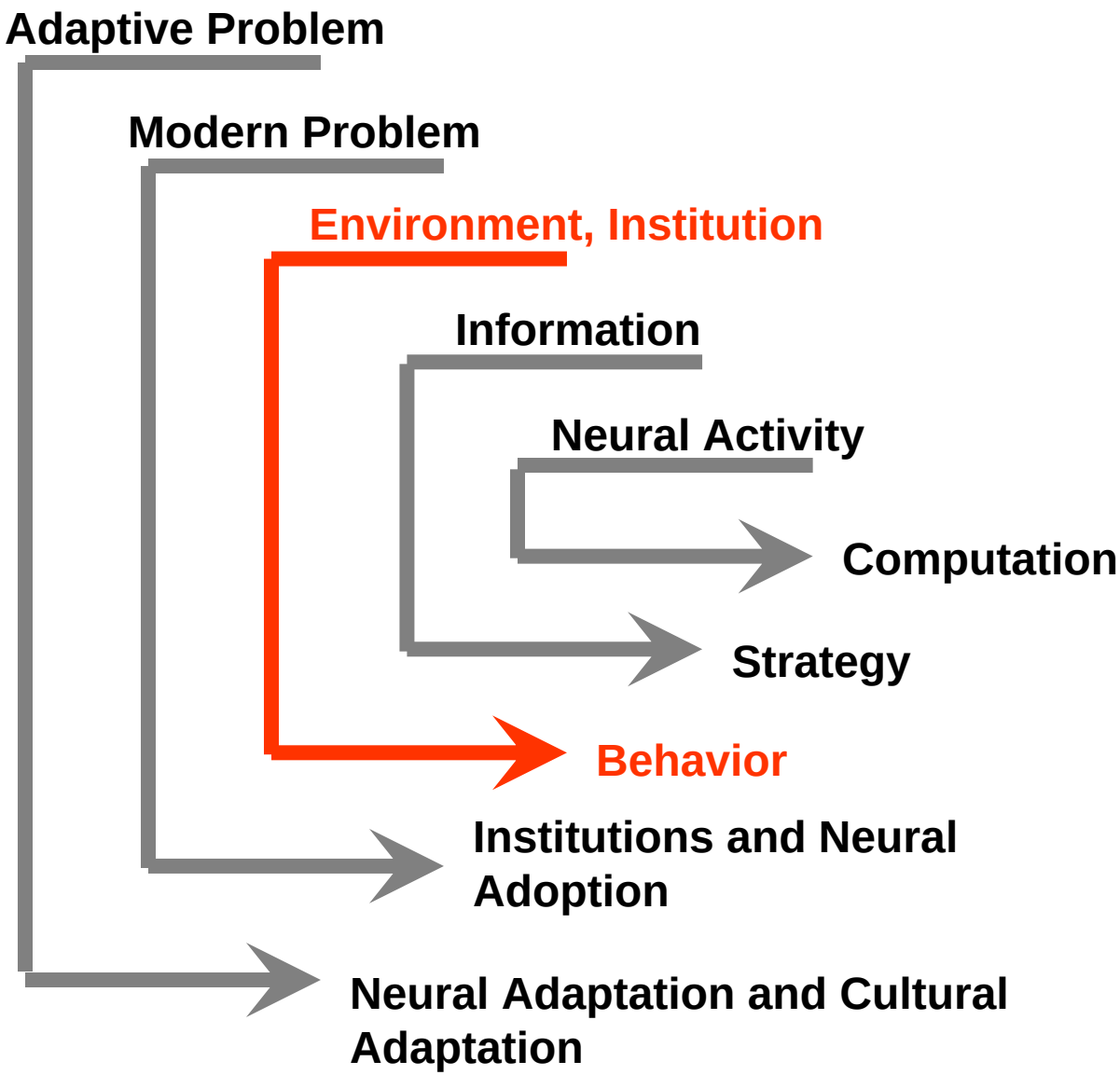
CSN | What does Neuroeconomics ask?

How do emergent mental computations in our evolved brains interact with the emergent computations of our constructed institutions to produce legal, political, and economic order?

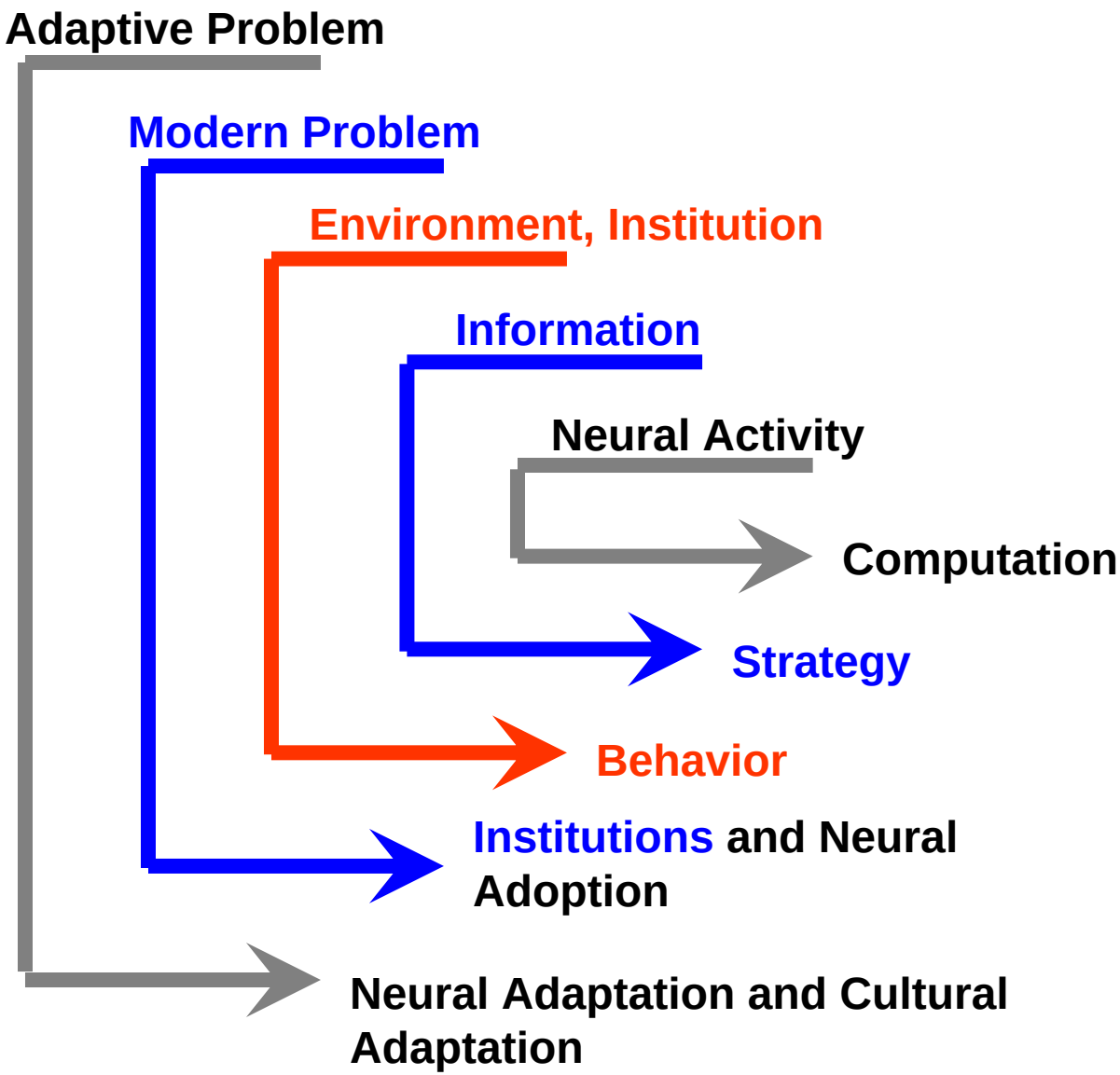
CSN | Research Levels



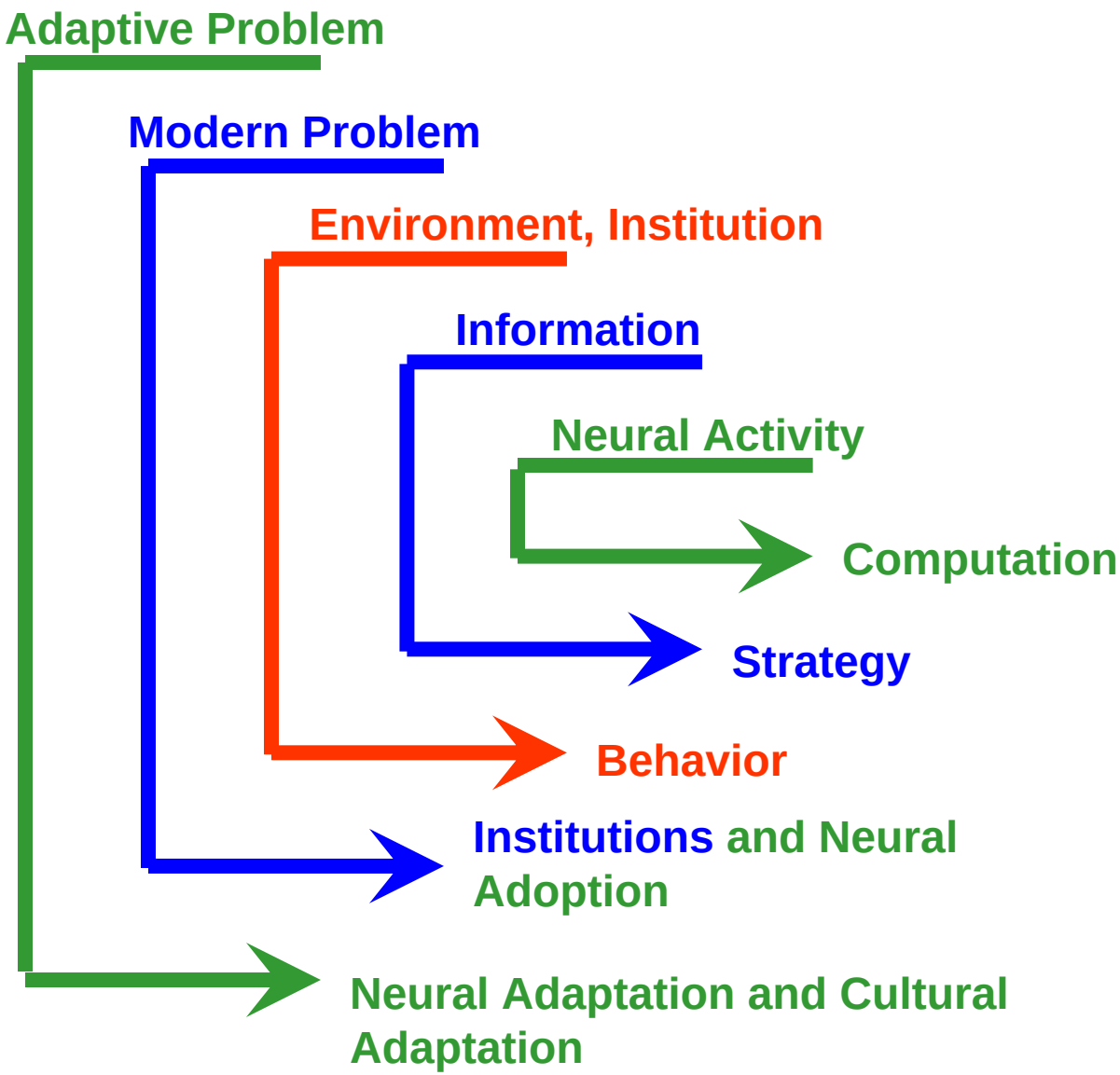
CSN | Experimental Economics



CSN | ESD and Behavioral

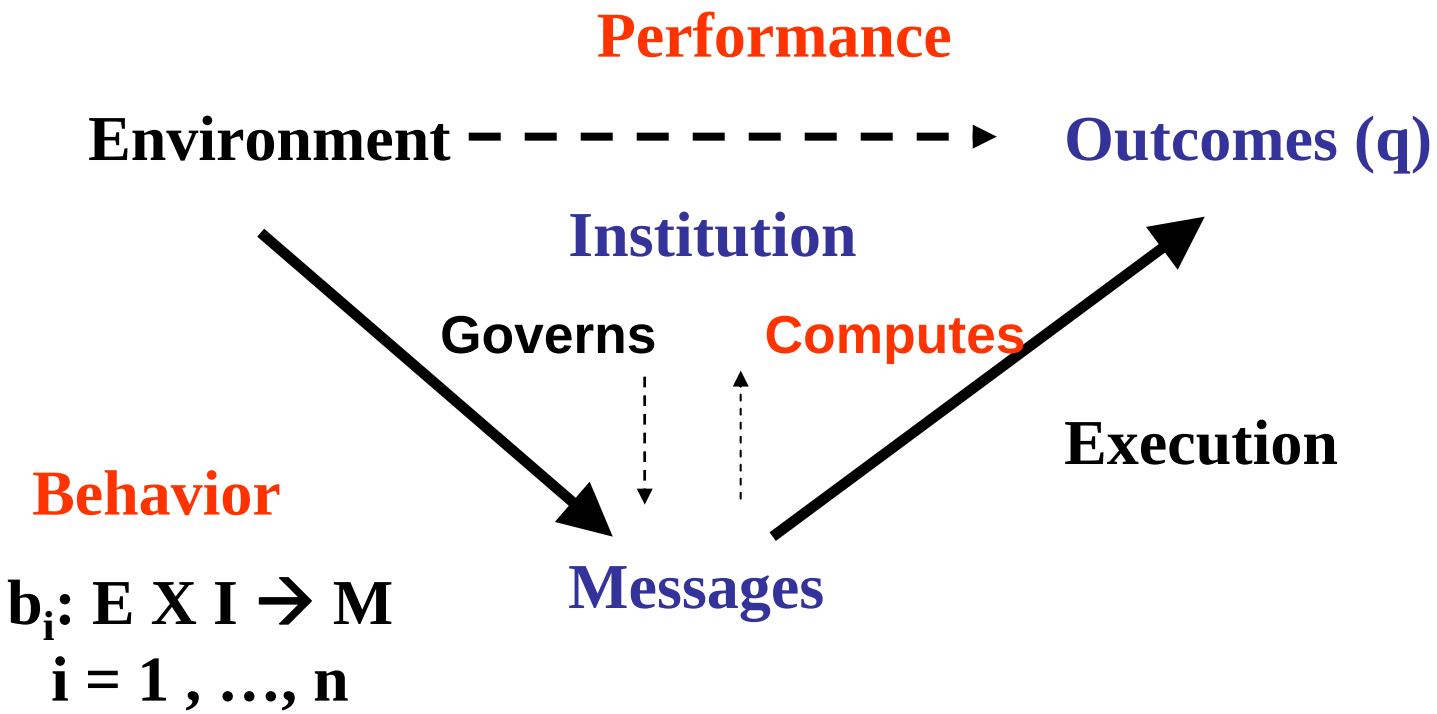


CSN | Evolutionary and Neuroeconomics



CSN | Experimental Economics & Microeconomic Systems

Experimenter would like to improve performance.



b_i: E X I → M

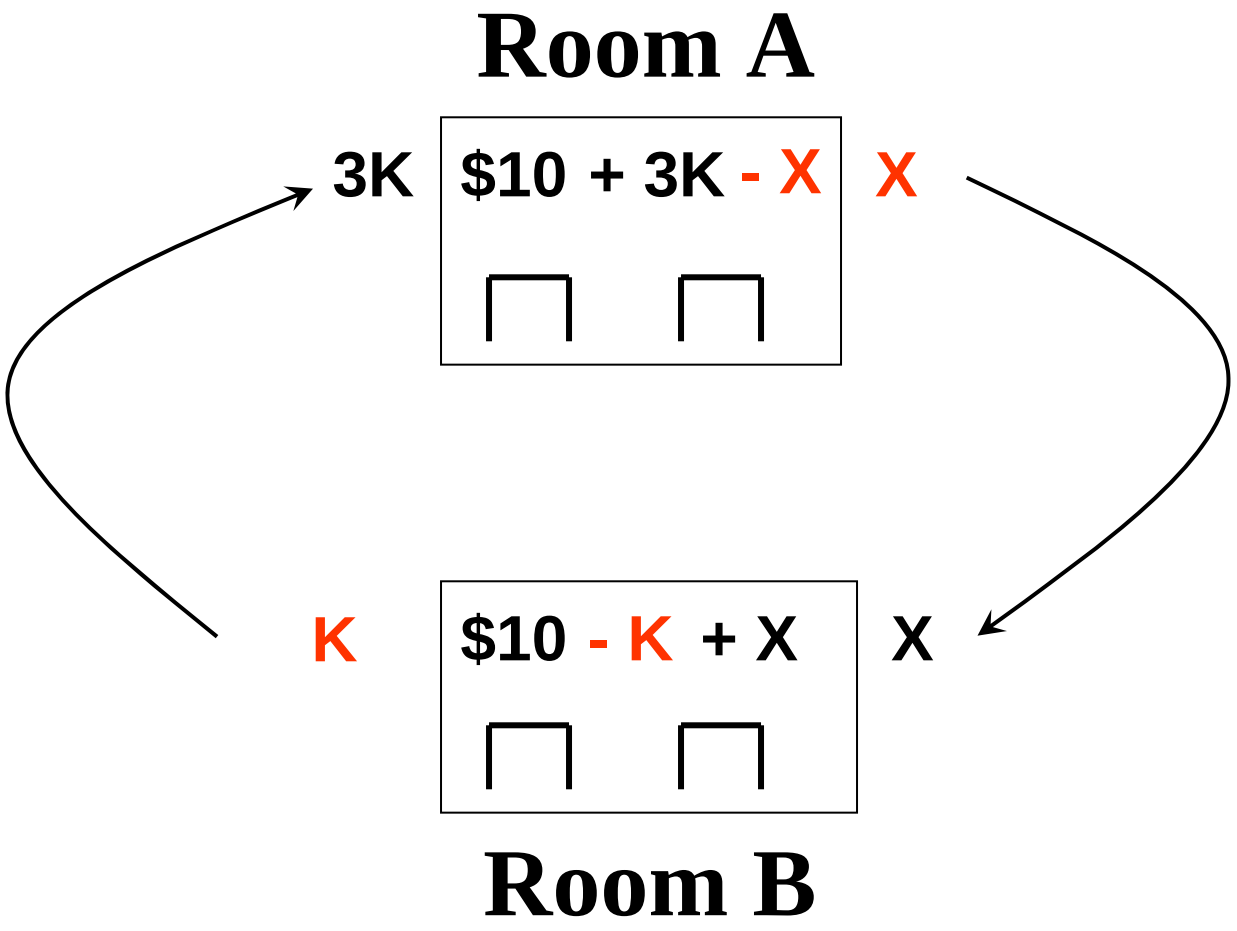
i = 1 , …, n

Experimenter would like to predict behavior.

CSN | The Investment Game

Berg, Joyce, John Dickhaut, Kevin McCabe (1995), “Trust, Reciprocity, and Social History,” Games and Economic Behavior, 10, pp. 122-142.

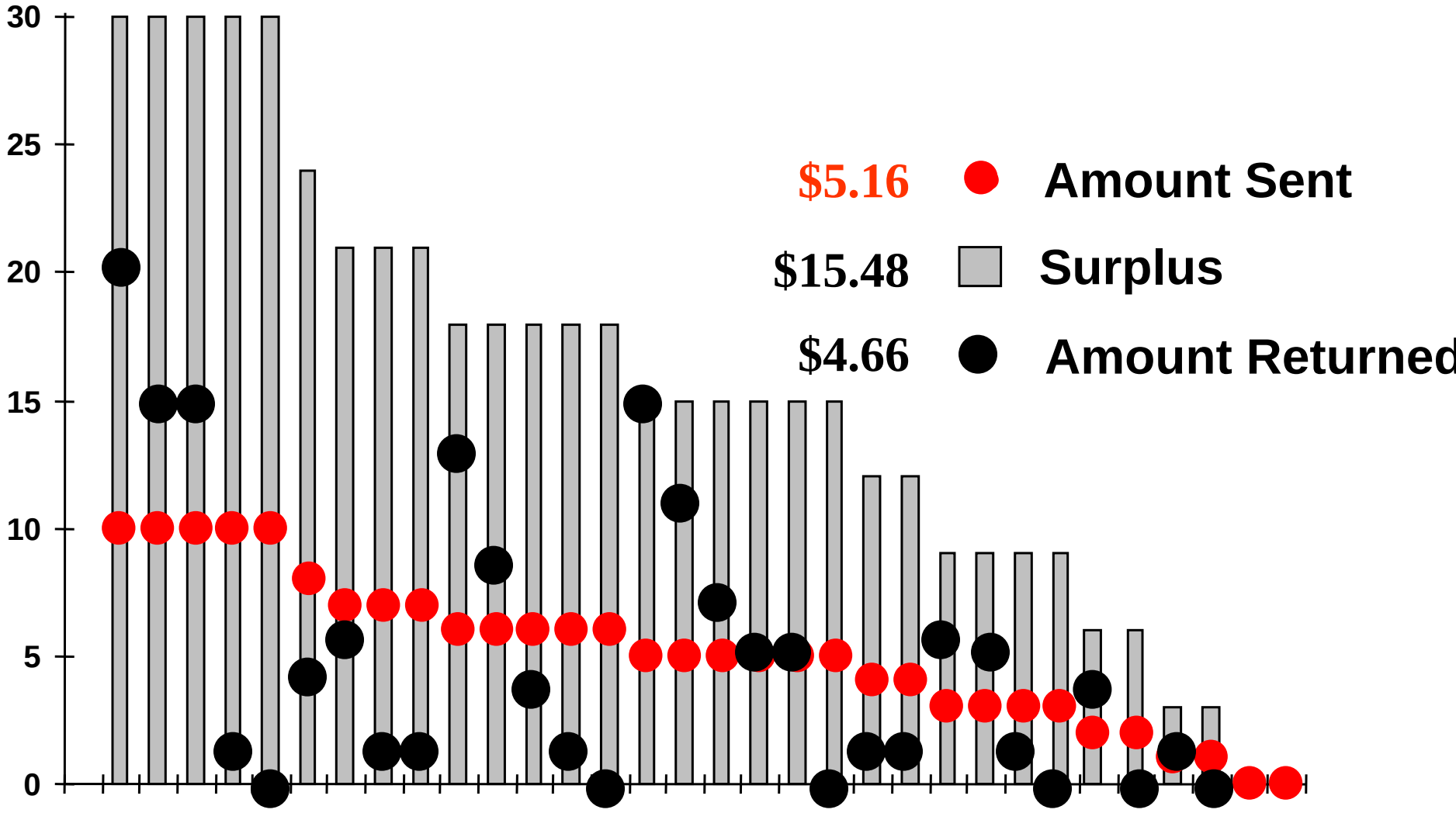
CSN | The Investment Game



CSN | Design

- **Play the Investment Game Once**
- **With A Random Anonymous Counterpart**
- **and a Random Role**
- **Both Start With $10 (show up fee)**
- **Amount Invested Triples**
- **Investor invests his or her show up fee**
- **Decisions made Double Blind**

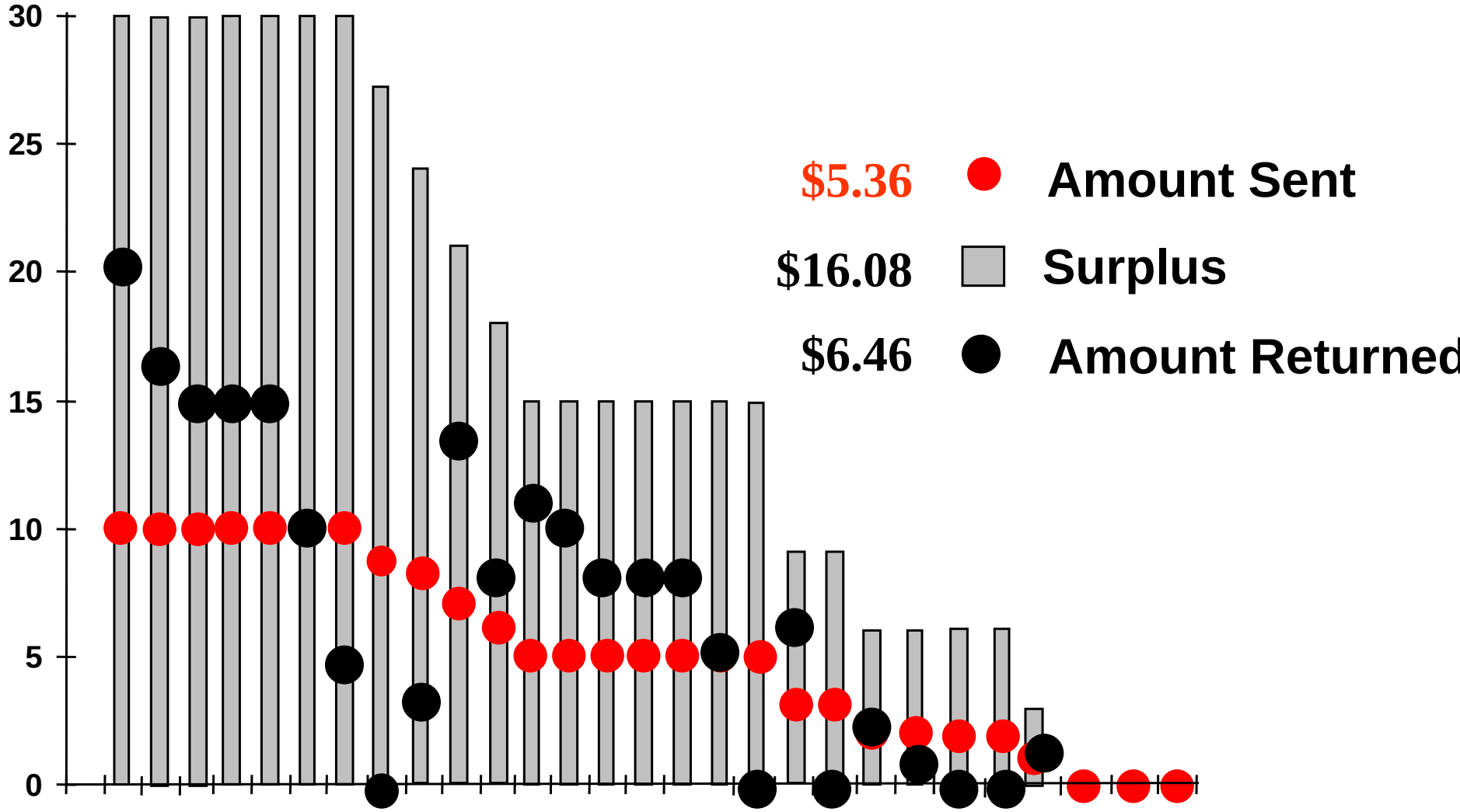
CSN | Results: N = 32



CSN | Social History Treatment

- **Inexperienced Players**
- **See What First Group Did (as avg. return by amount sent)**
- **Everything Else the Same**

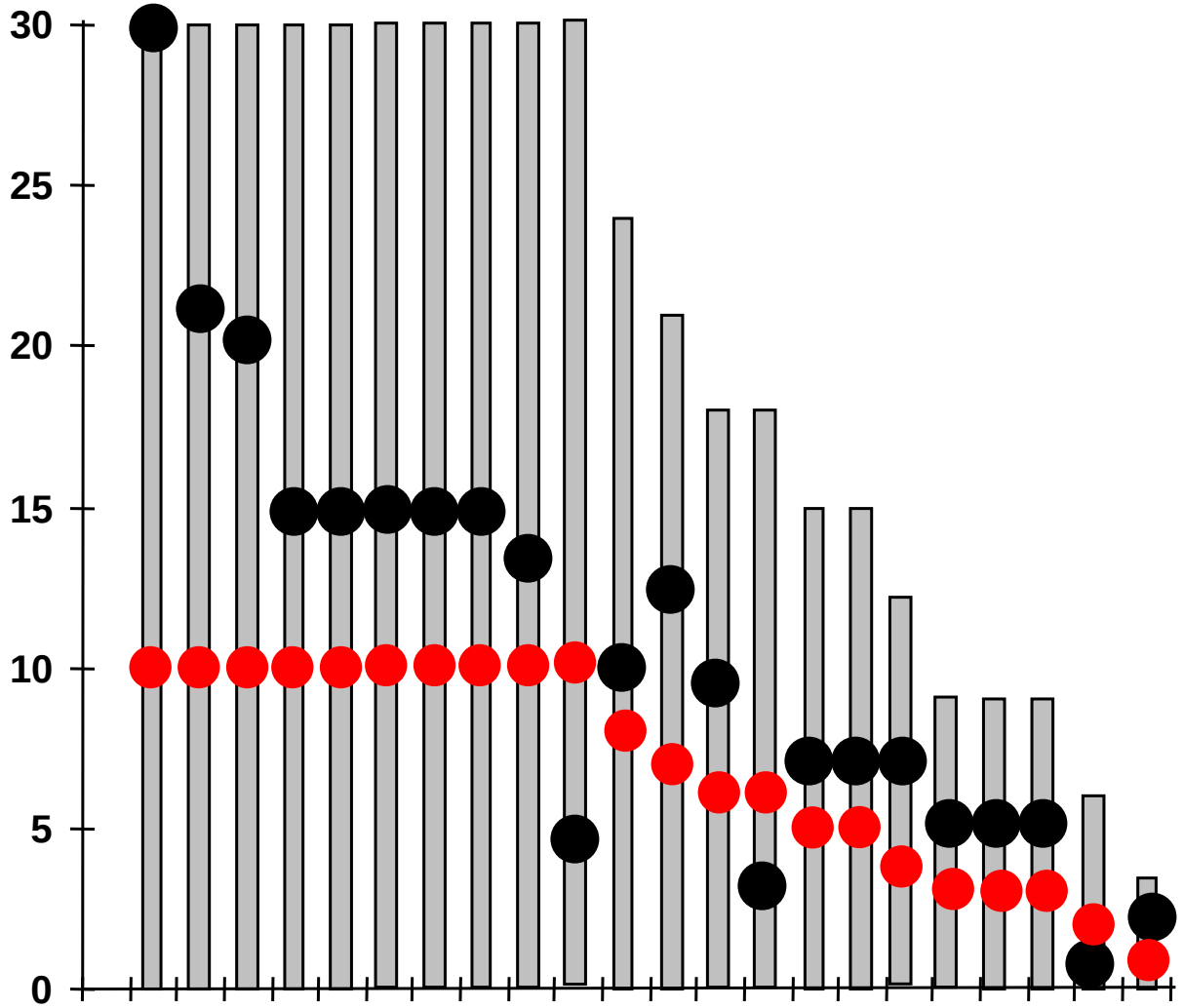
CSN | Social History Results: N = 28



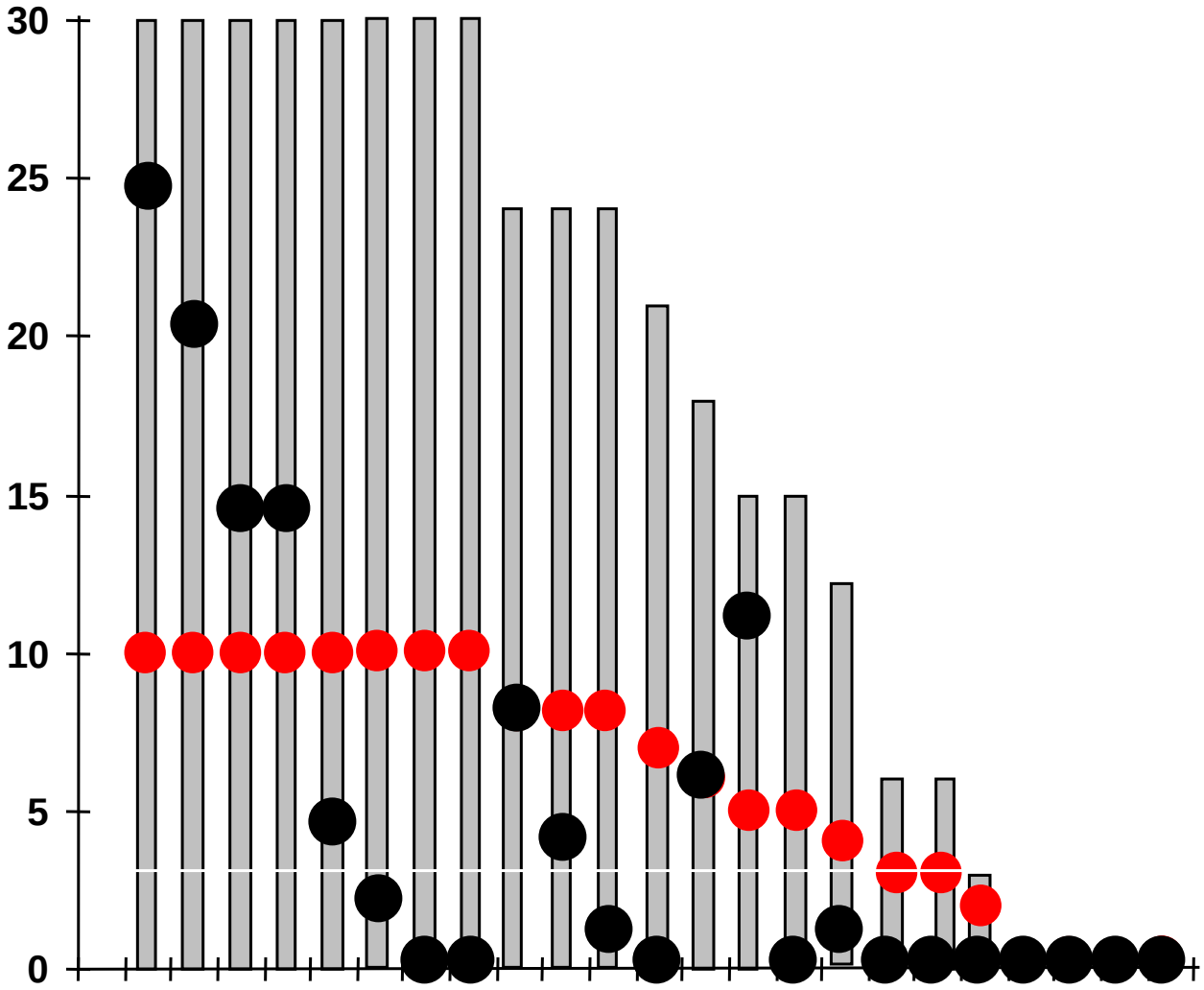
CSN | Two Period Investment Game

- Play the Investment Game Twice
- With the Same Partner
- In the Same Role
- Double Blind
- Nothing Carries Over

CSN | Results: N = 23, First Period



CSN | Results: N = 23, Second Period

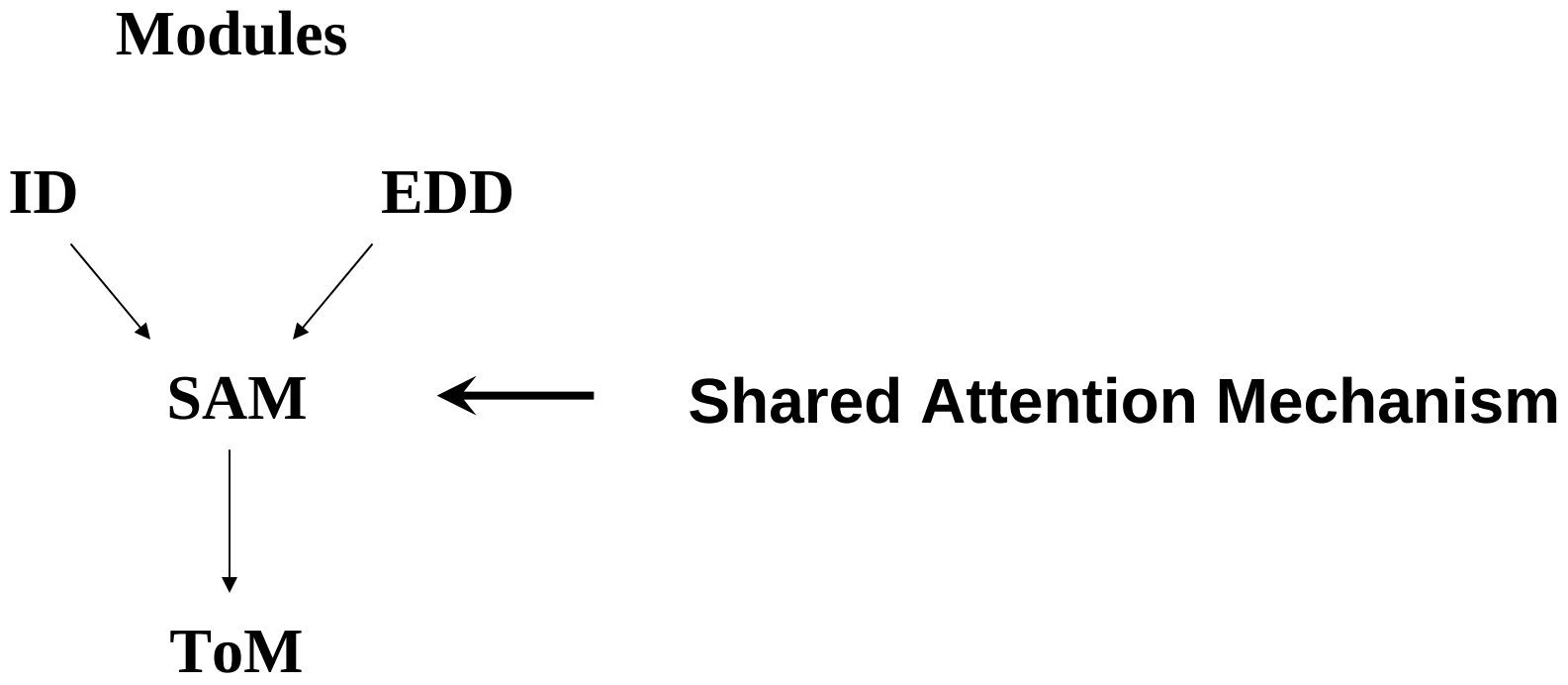


CSN | Theory of Mind Helps Explain Trust

Hypothesis: Cooperation with another person requires theory of mind to invoke a reciprocal goal and prefrontal control to maintain the reciprocal goal over a myopic self interested goal.

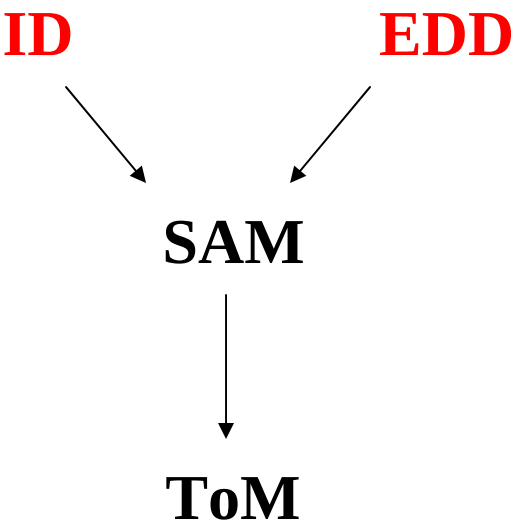
CSN

Theory of Mind Mechanism
Simon Baron-Cohen



CSN | Mental Representations

Modules



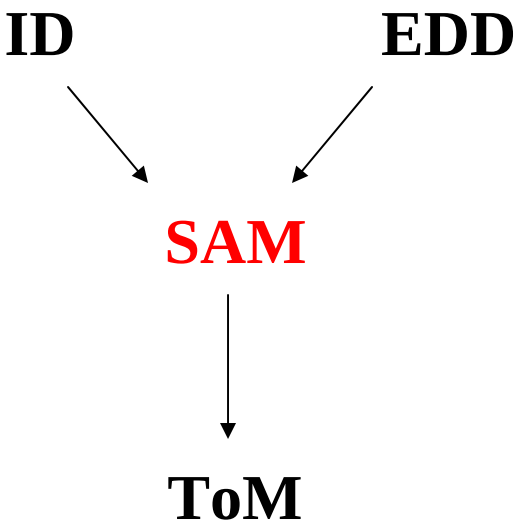
Mental Representations

Dyadic

Agent – Attitude – Proposition

CSN | Mental Representations

Modules



Mental Representations

Dyadic

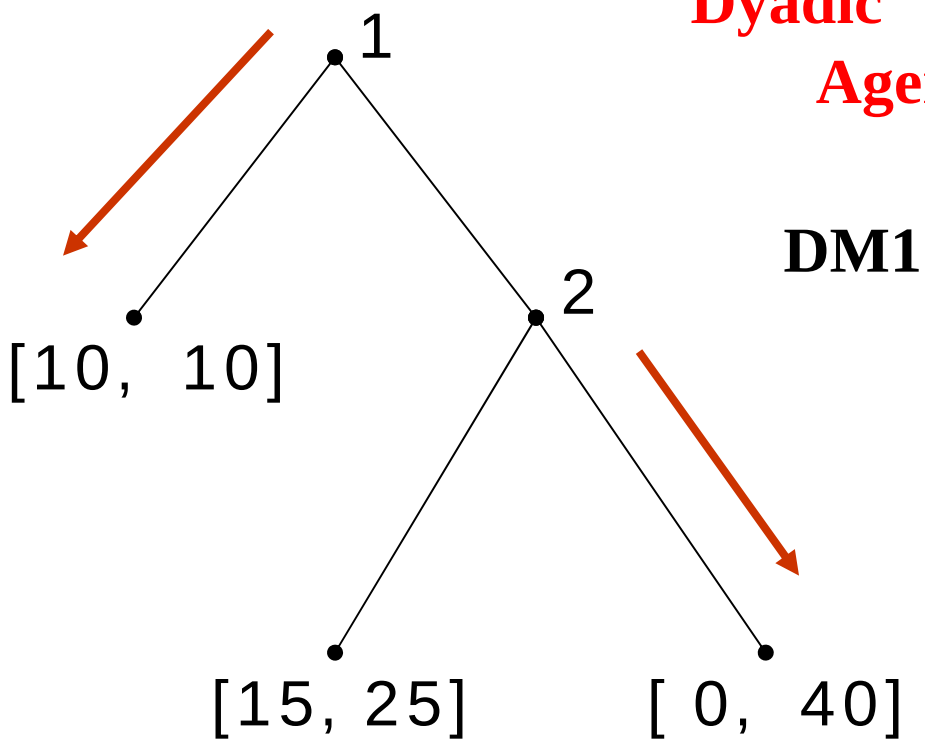
Agent – Attitude – Proposition

Triadic

Agent – Attitude – (Self – Attitude –Proposition)

CSN

Dyadic M-Representations Support Non-Cooperation



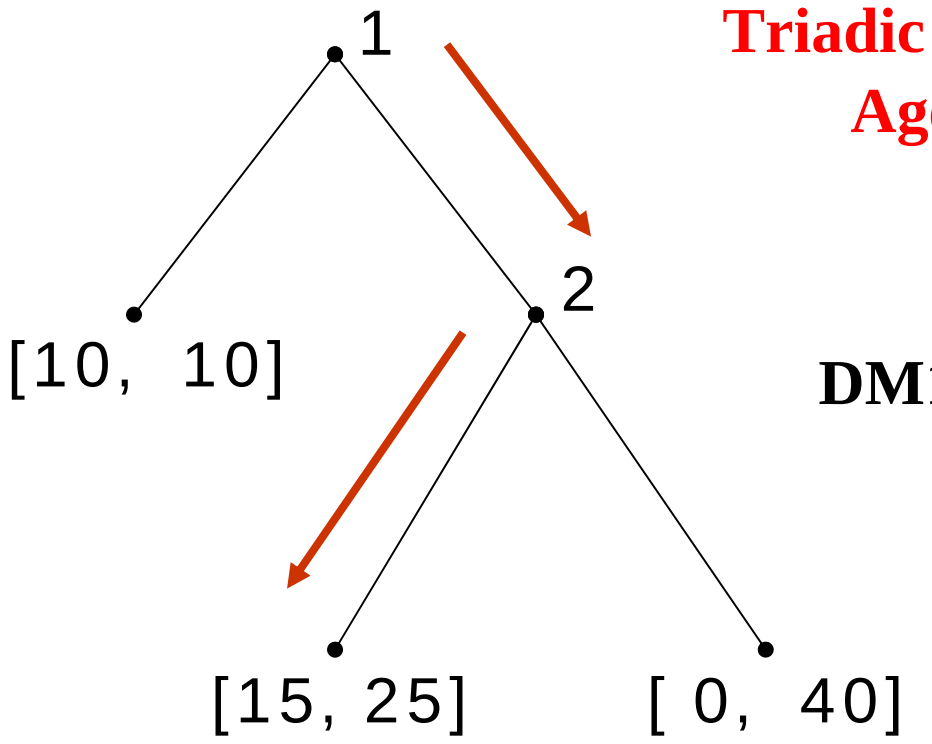
Dyadic

Agent – Attitude – Proposition

DM1: DM2 prefers more money to less.

CSN

Triadic M-Representations Support Cooperation

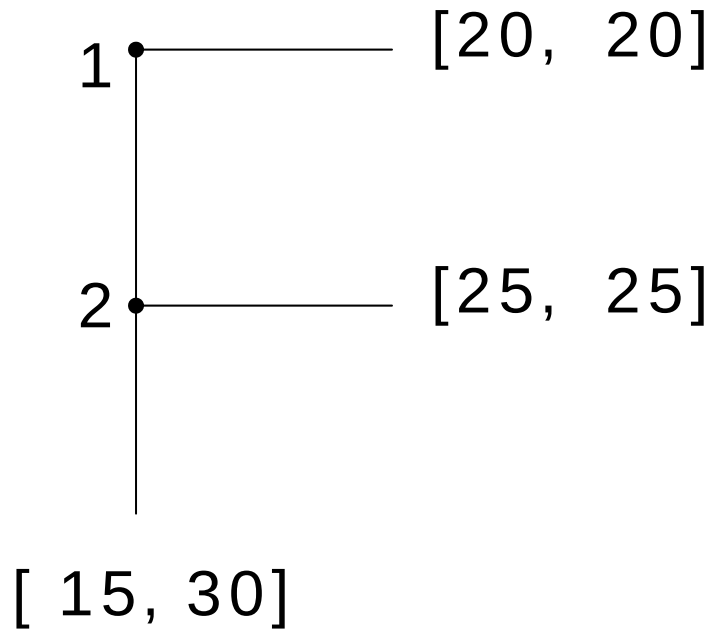


Triadic

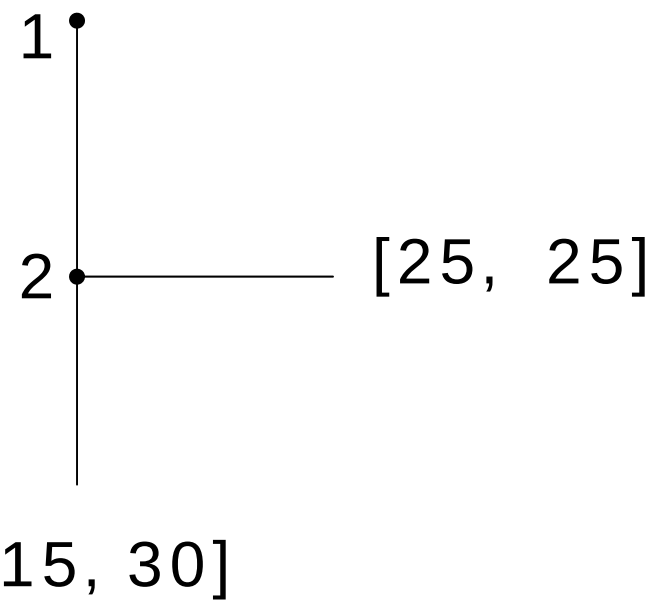
Agent – Attitude – (Self – Attitude –Proposition)

DM1: DM2 sees that DM1 is trying to achieve mutual gains.

CSN | Studying Theory of Mind in Trust Games



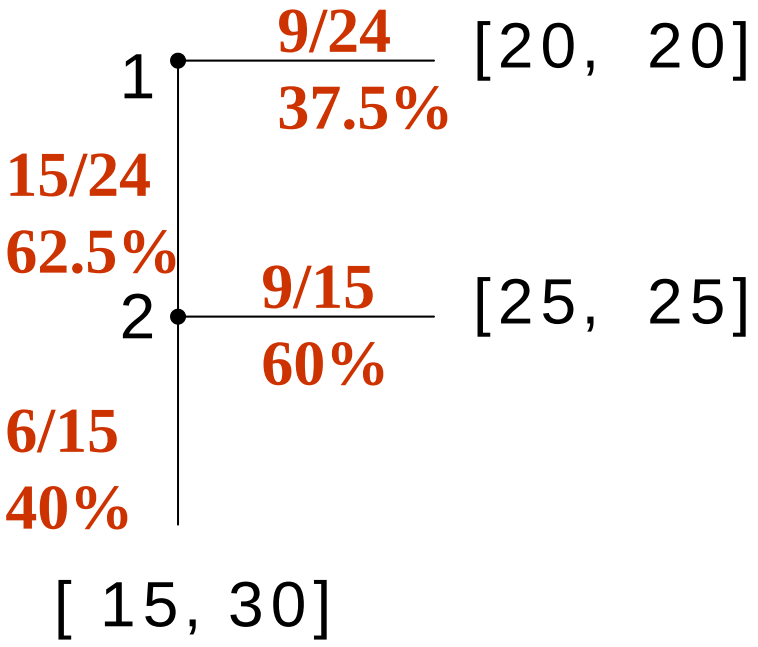
Voluntary Trust Game



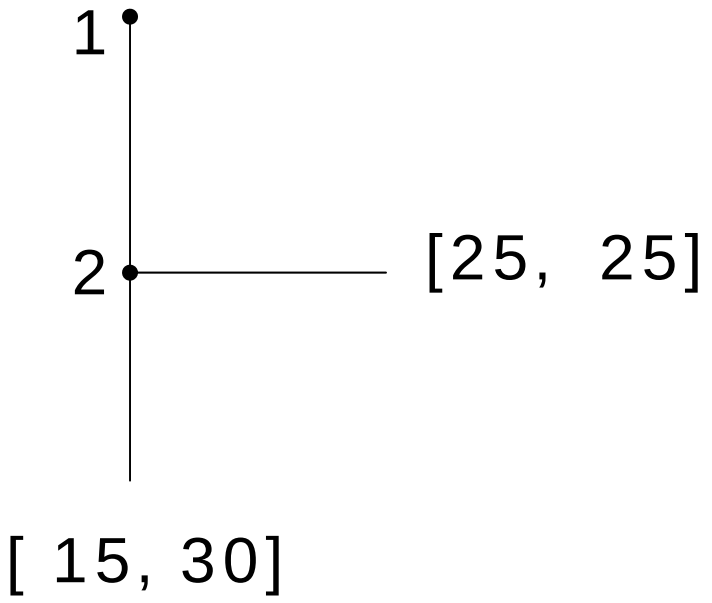
Involuntary Trust Game

Kevin McCabe, Mary Rigdon and Vernon Smith (2003), "Positive Reciprocity and Intentions in Trust Games," Journal of Economic Behavior and Organizations, 52, pp. 267-275.

CSN | Data



Voluntary Trust Game



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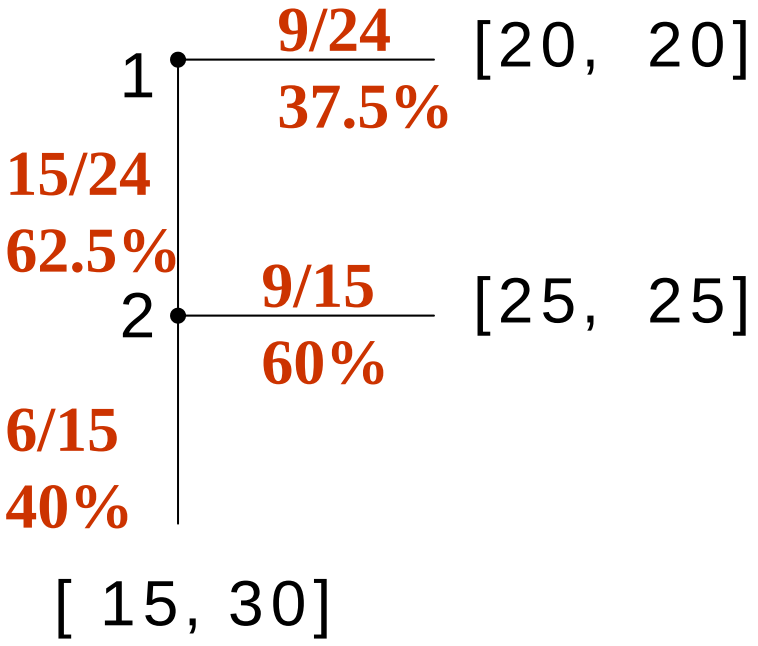
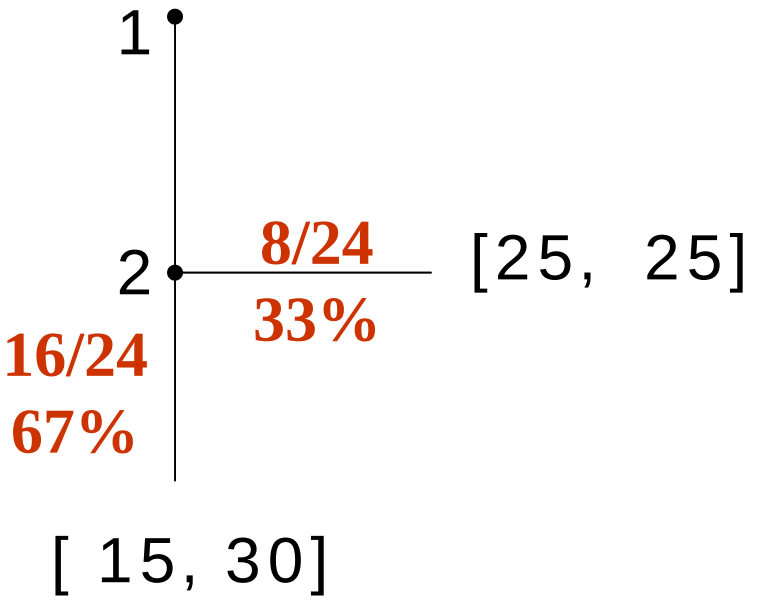


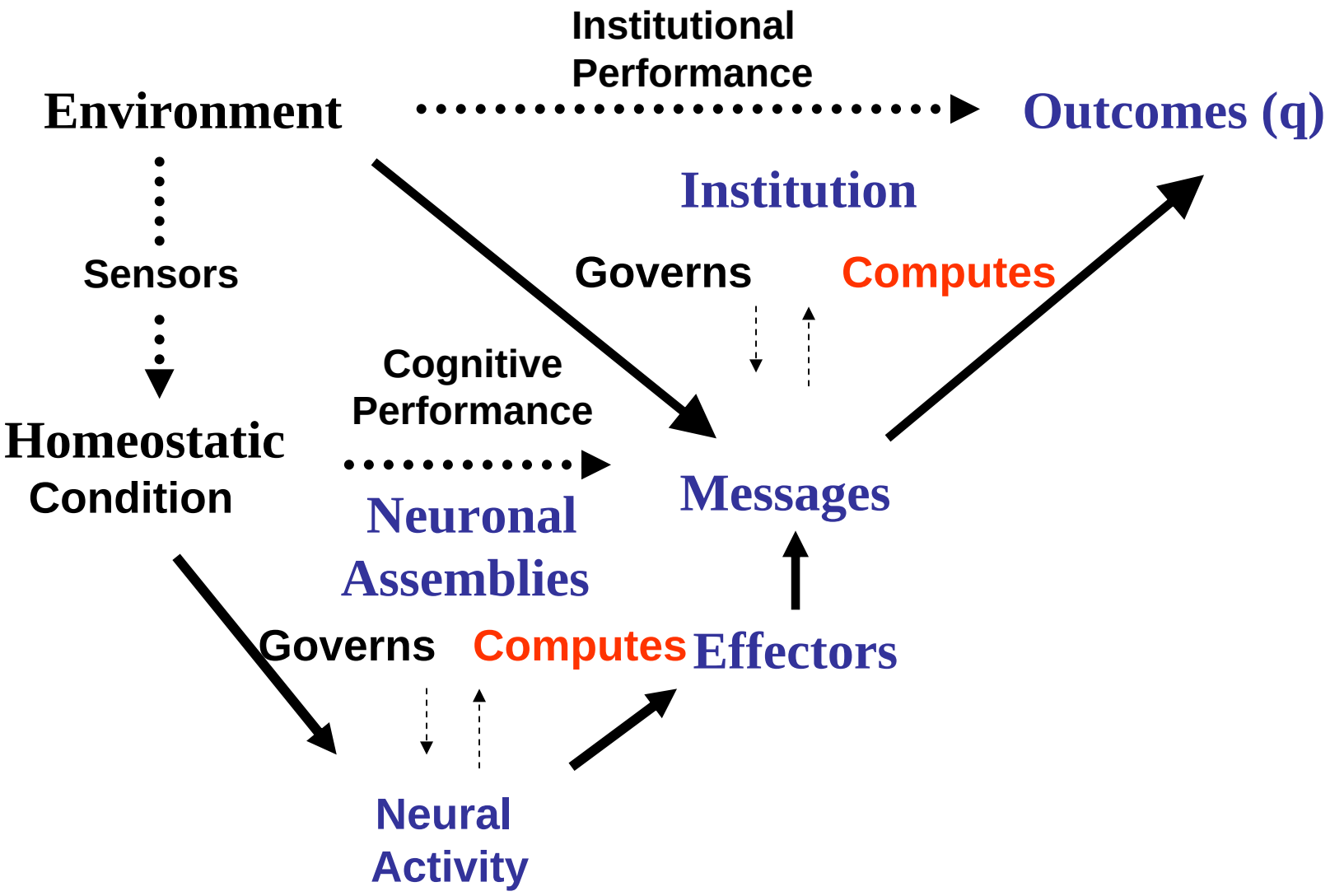
Voluntary Trust Game



Involuntary Trust Game

Kevin McCabe, Mary Rigdon and Vernon Smith (2003), "Positive Reciprocity and Intentions in Trust Games," Journal of Economic Behavior and Organizations, 52, pp. 267-275.

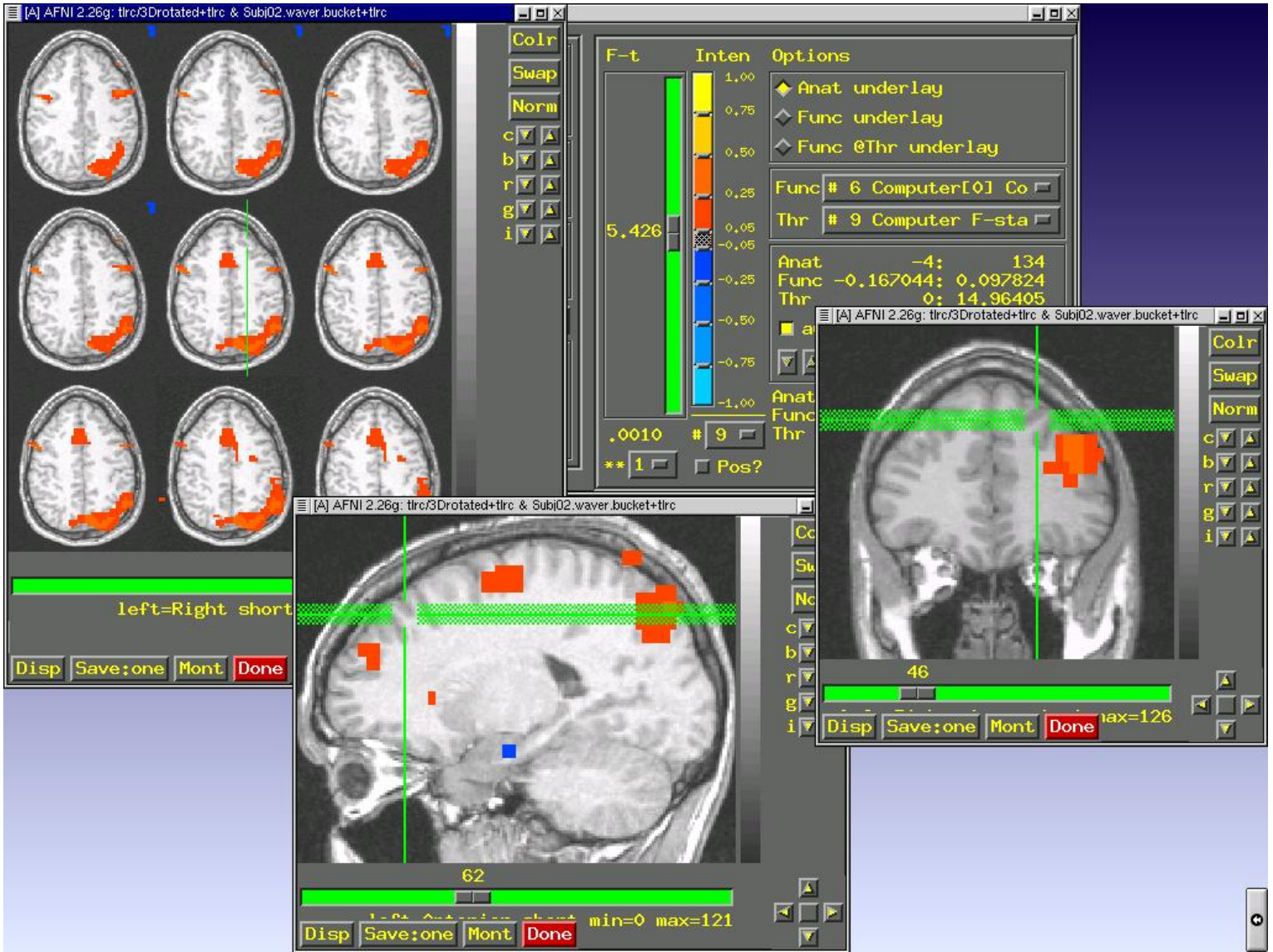
CSN | Neuroeconomics Systems



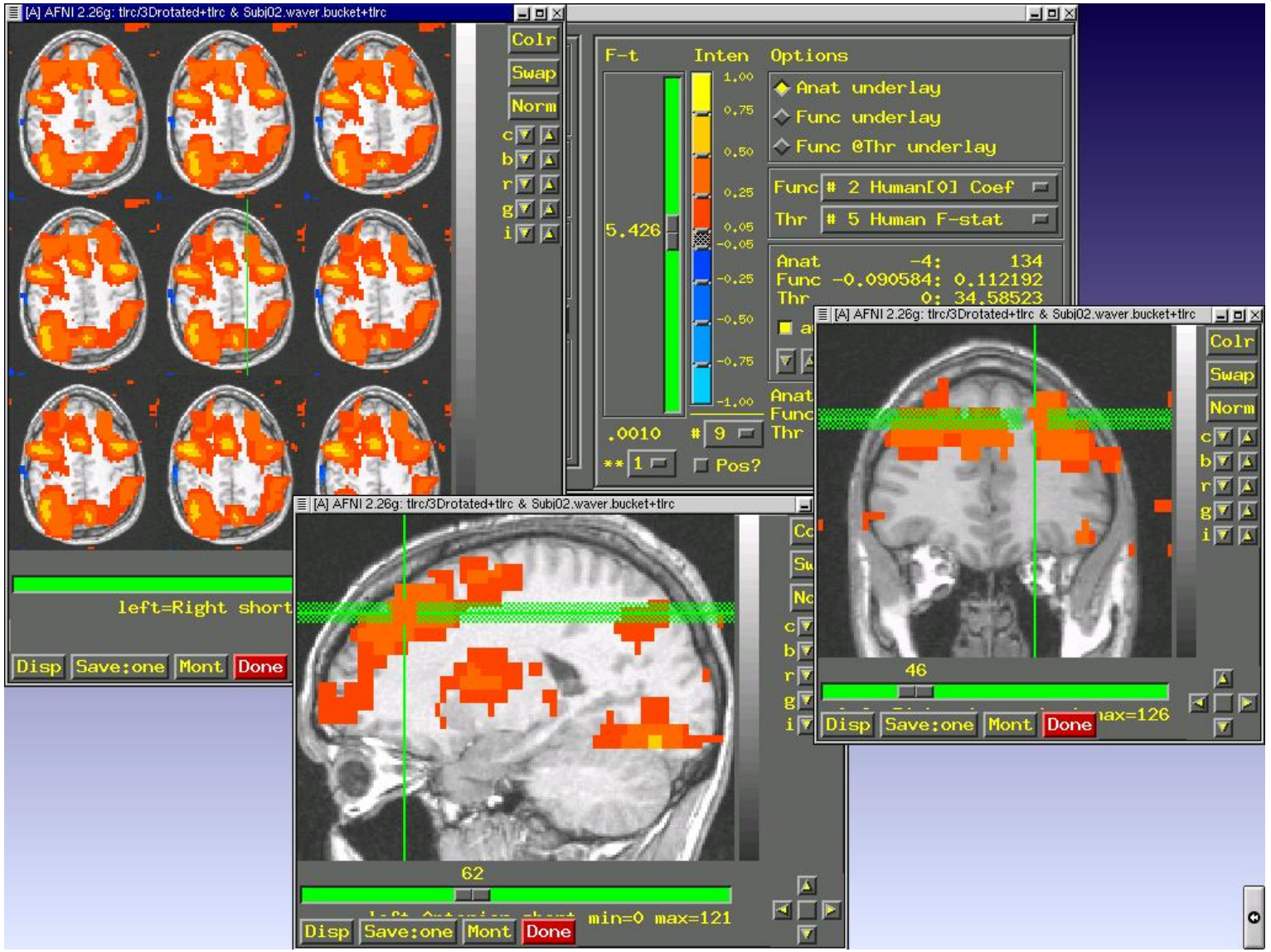
CSN | Imaging Two Person Exchange

Kevin McCabe, Daniel Houser, Lee Ryan, Vernon Smith, and Theodore Trouard, “A Functional Imaging Study of Cooperation in Two-Person Reciprocal Exchange,” Proceedings of the National Academy of Sciences, (98)2001, pp. 11832-11835.

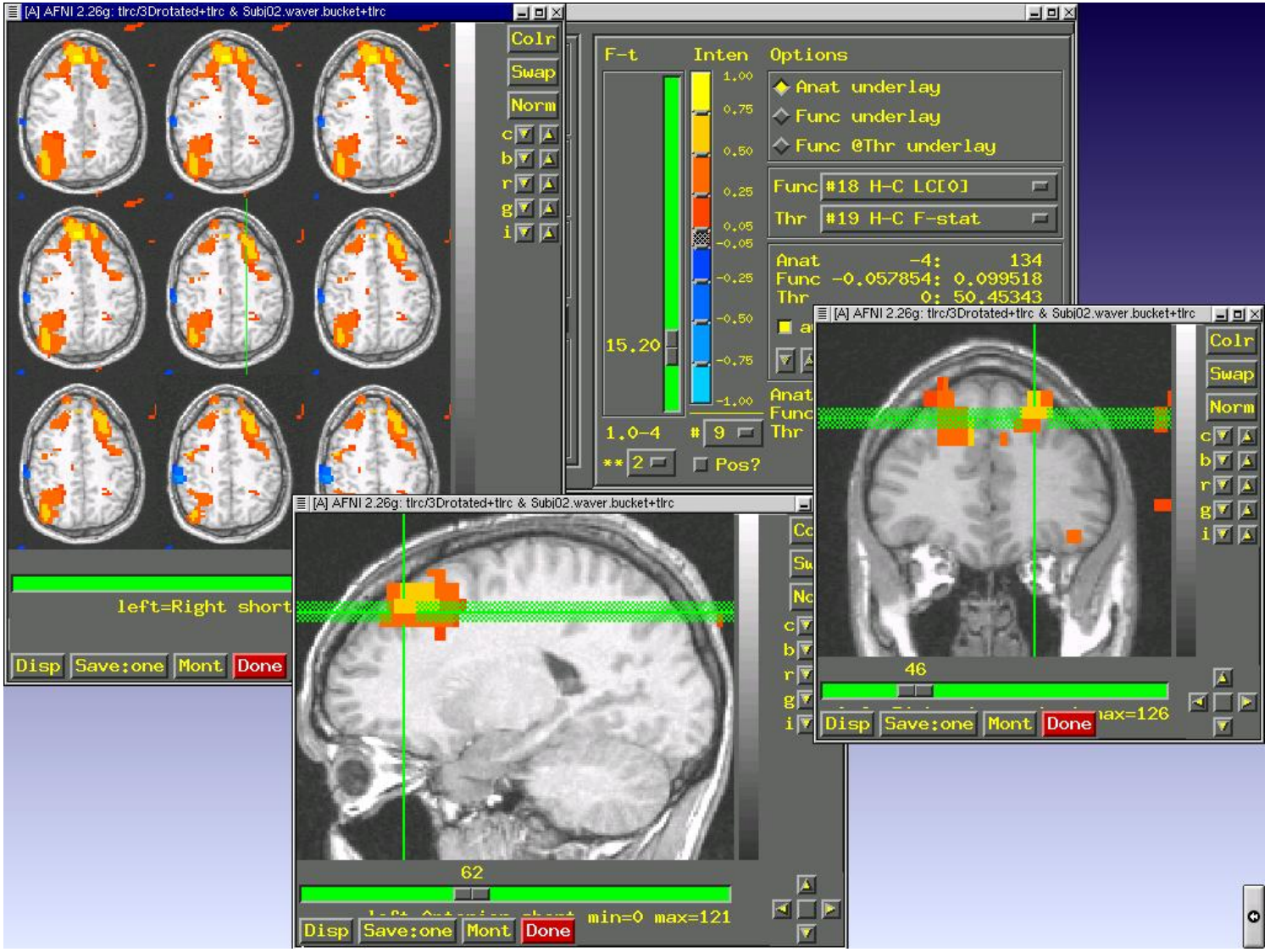
CSN | Playing the Computer



CSN | Cooperating with a Human



CSN | Human > Computer



CSN | Oxytocin and Trust

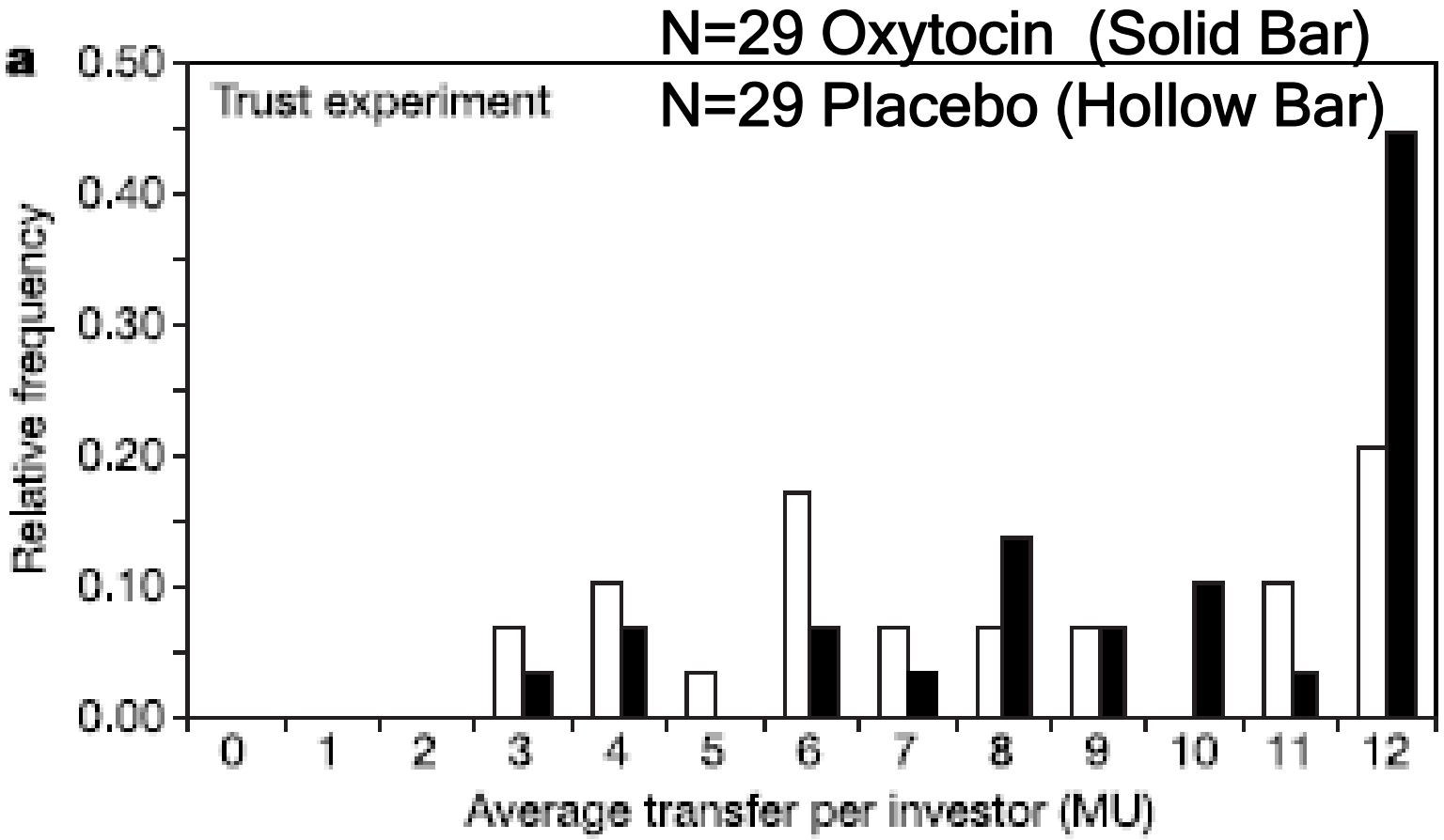
Michael Kosfeld, Markus Heinrichs, Paul J. Zak, Urs Fischbacher, and Ernst Fehr, “Oxytocin increases trust in humans,” Nature (435), 2005, pp. 673-676.

Uses the Investment Game.

CSN | Subgenual (Septal) Area

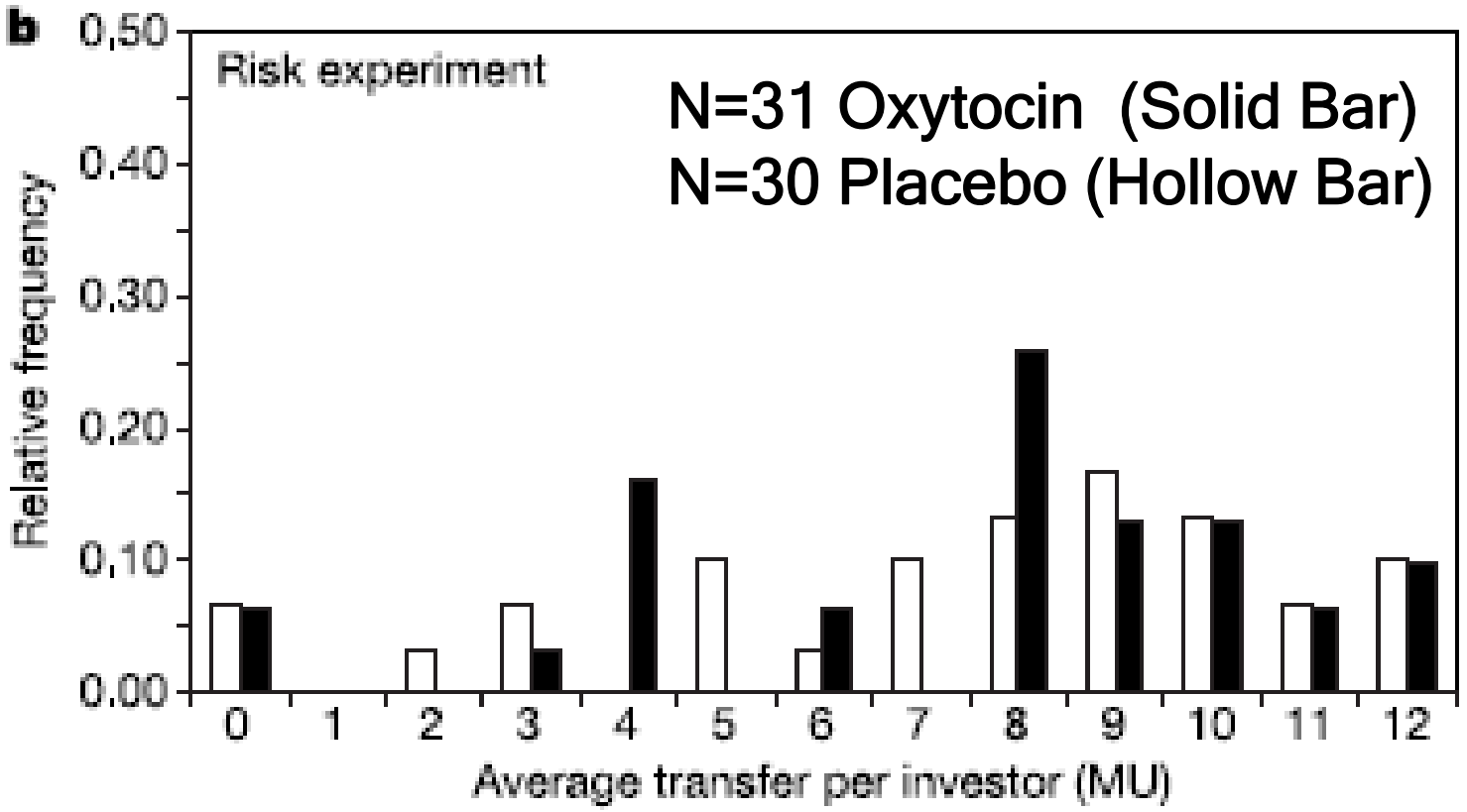
- Primitive, four layered archicortex (Freedman et al., 2005)
- Key role in controlling septohypothalamic function in social attachment and the release of the neuromodulators oxytocin and vasopressin (Young & Wang, 2004)
- Subgenual cortex and adjacent septual structures are activated when humans looked at their babies and romantic partners (Aron et al., 2005; Bartels & Zeki, 2004)

CSN | Increases Extreme Trust



Oxytocin increases trust, but not trustworthiness. Increases seeking behavior, but reduces the correlation between trust and trustworthiness.

CSN | Does not increase risk taking



Oxytocin does not increase risk seeking behavior in general.

CSN | Two Systems for Trust

Frank Krueger, Kevin McCabe, Jorge Moll, Nikolaus Kriegeskorte, Roland Zahn, Maren Strenziok, Armin Heinecke, Jordan Grafman, "Neural correlates of trust," Proceedings of the National Academy of Sciences, Early Edition December 4, 2007.

Subjects

44 volunteers (22 males, 22 females; age: 28.3 ± 7.1 years; education:
17.3 ± 2.1 years)

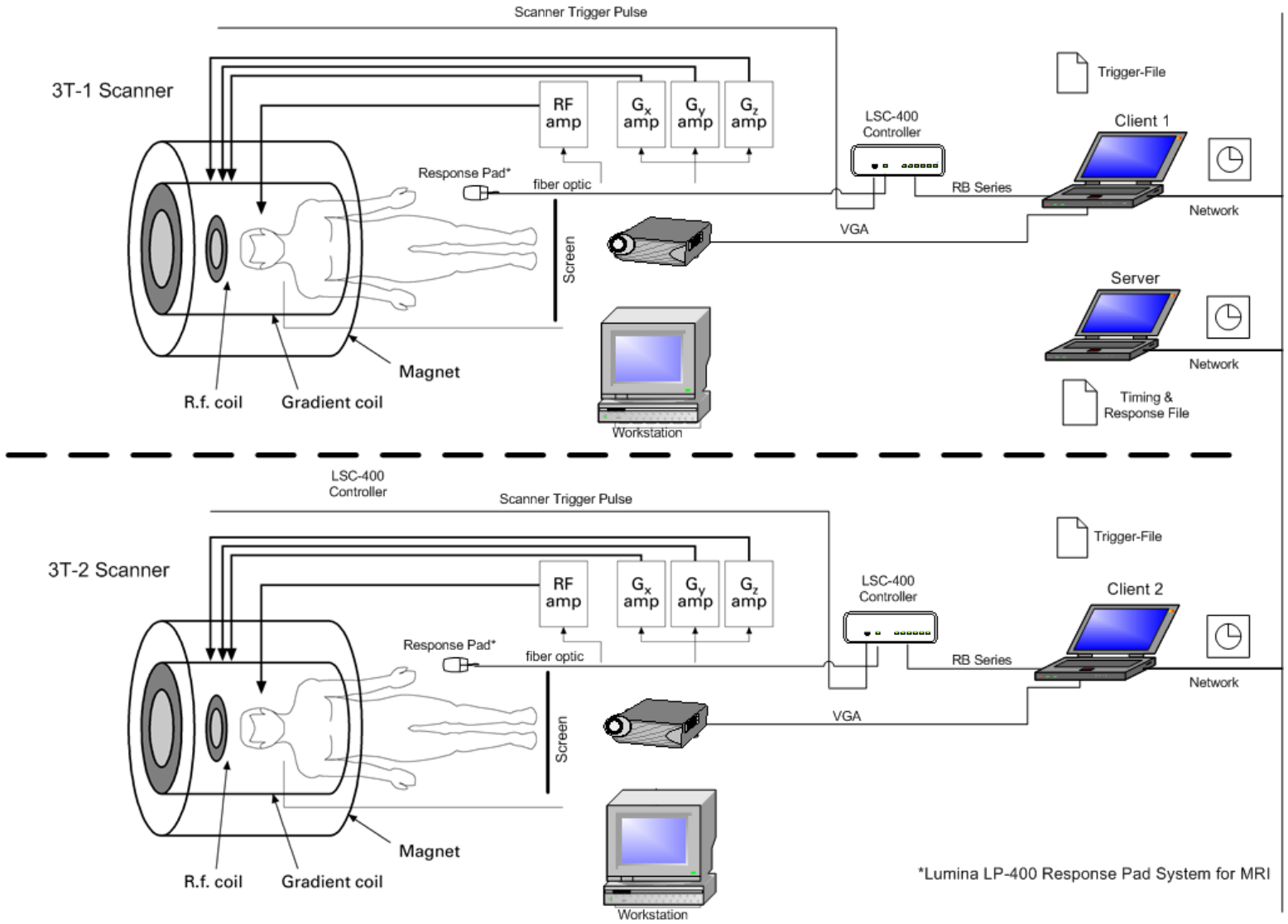
CSN | Summary of Results

Individuals use two trust strategies with different benefits and costs:

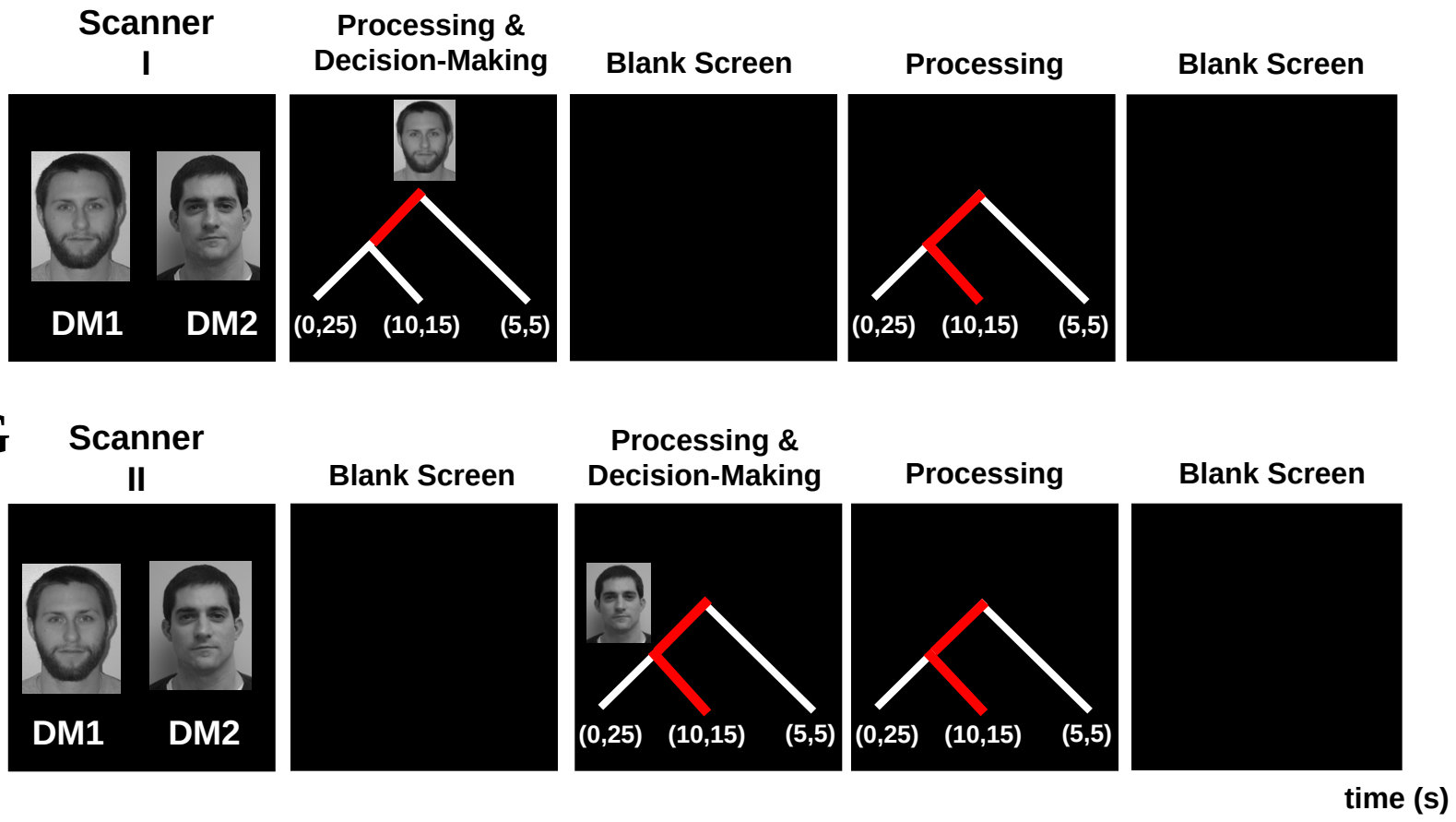
Conditional Trust Strategy

Unconditional Trust Strategy

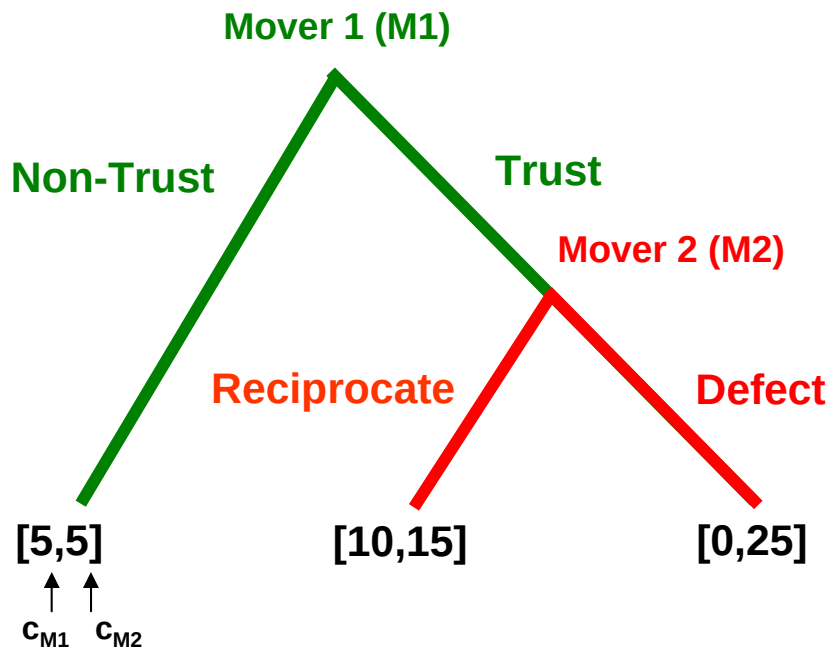
CSN | Simultaneous scanning



CSN | Procedure

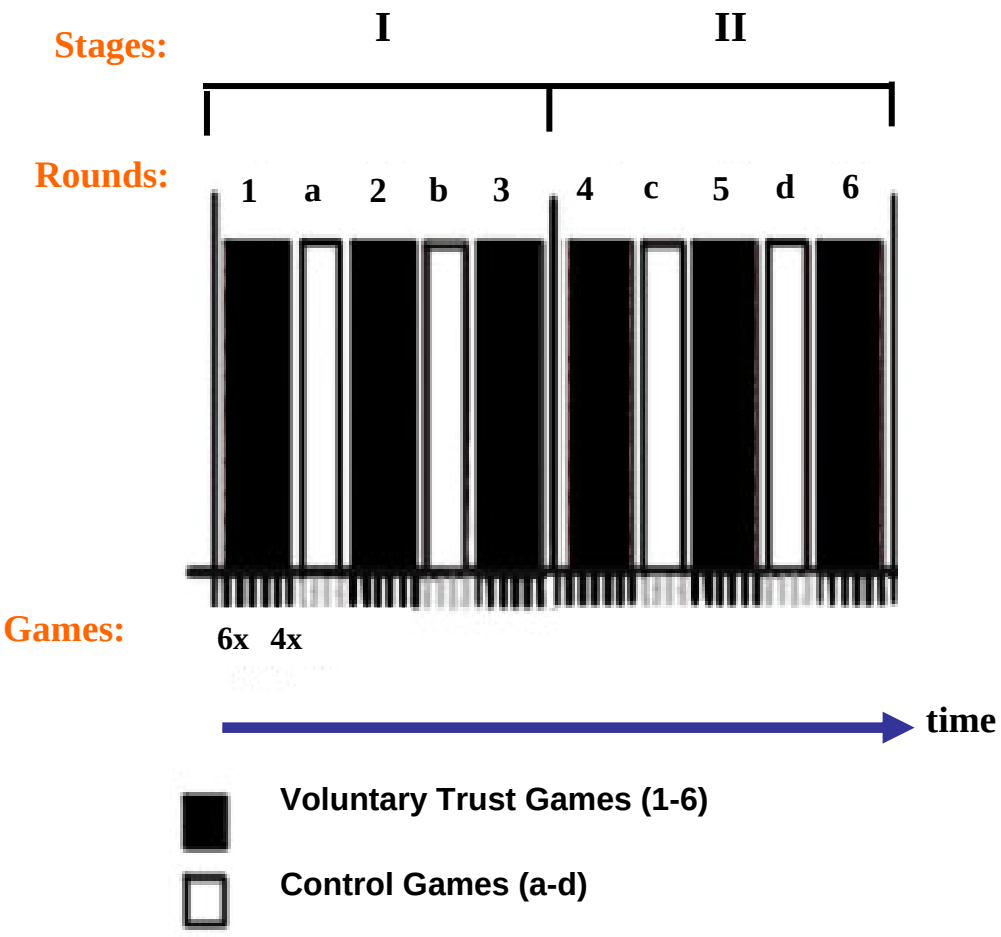


CSN | Voluntary Trust Game

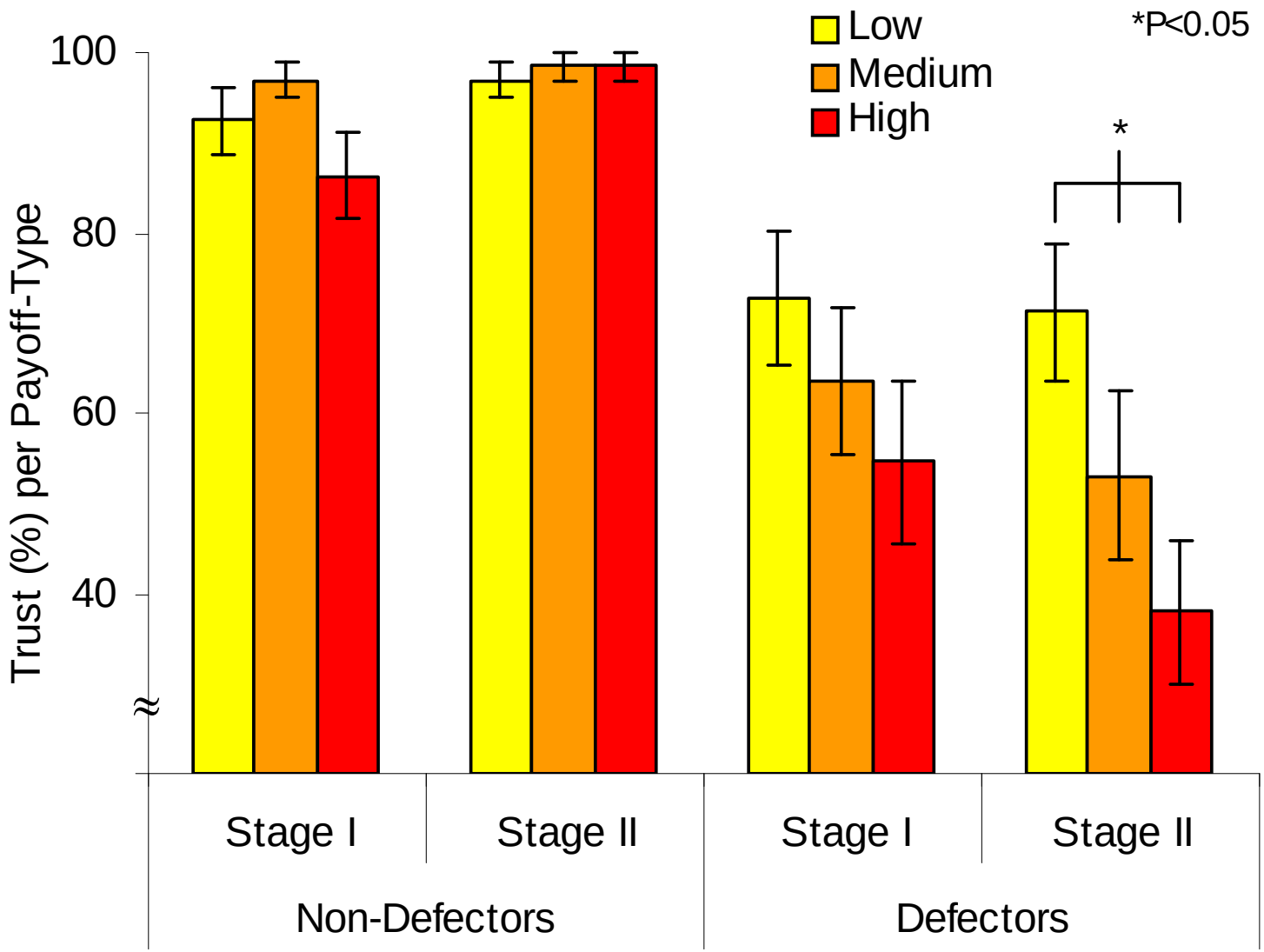


Payoffs		c_{M1}	c_{M2}
low	p_1	[5,5]	[10,15]	[0,25]
	p_2	[10,10]	[15,25]	[0,40]
medium	p_3	[15,15]	[25,40]	[0,65]
	p_4	[20,20]	[30,50]	[0,80]
high	p_5	[25,25]	[40,65]	[0,105]
	p_6	[30,30]	[45,75]	[0,120]

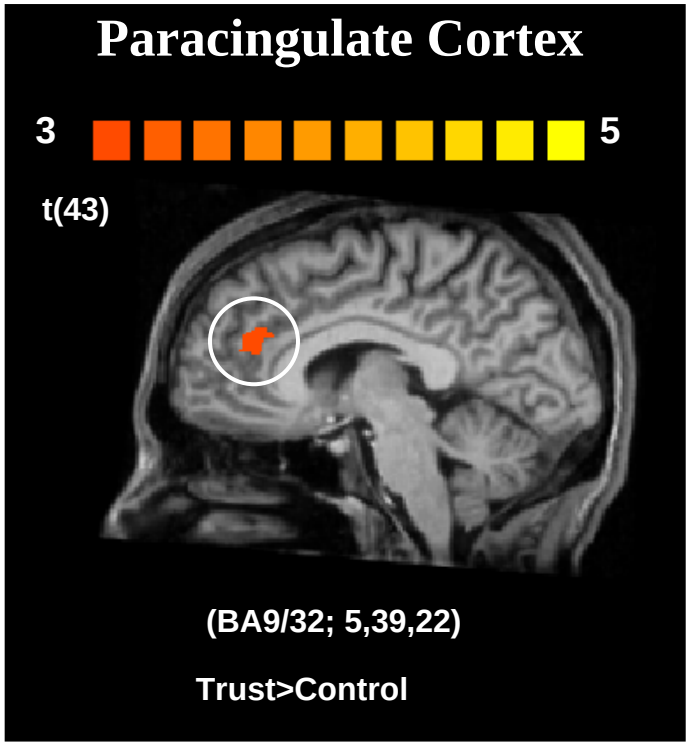
CSN | Blocked Design

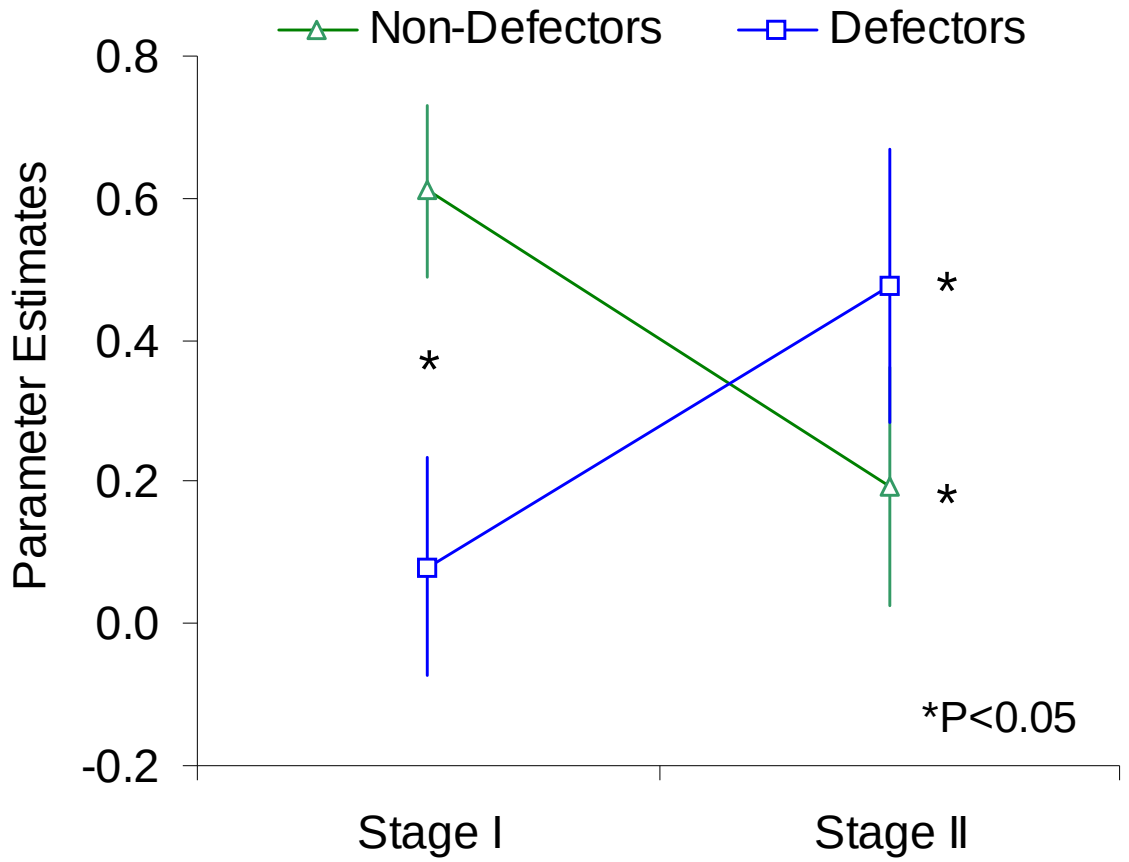


CSN | Trusting Behavior



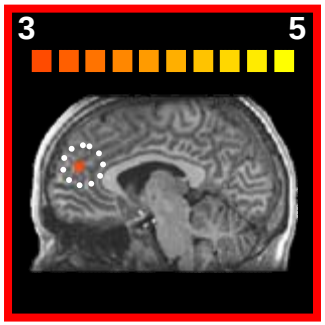
CSN | Theory of Mind



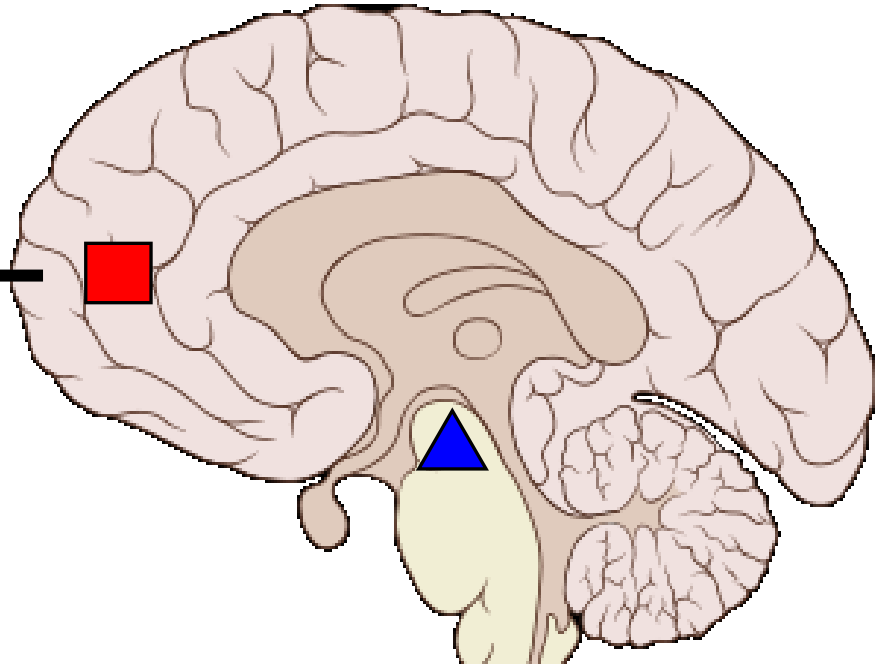


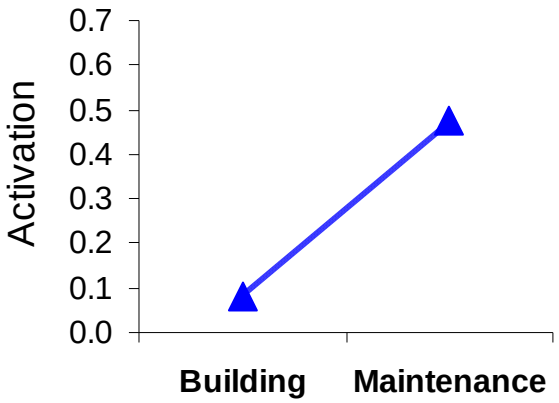
CSN | Results: Conditional Trust Strategies

dmPFC



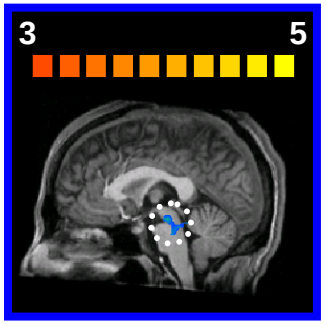
Goal Knowledge





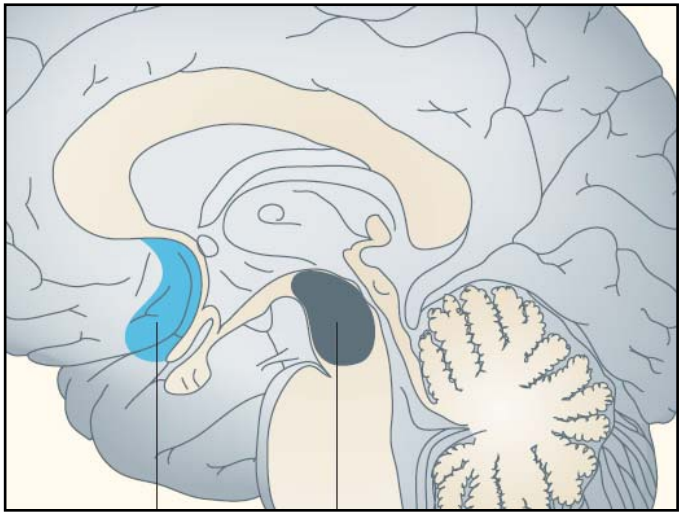
Conditional Trust

Ventral Tegmental Area

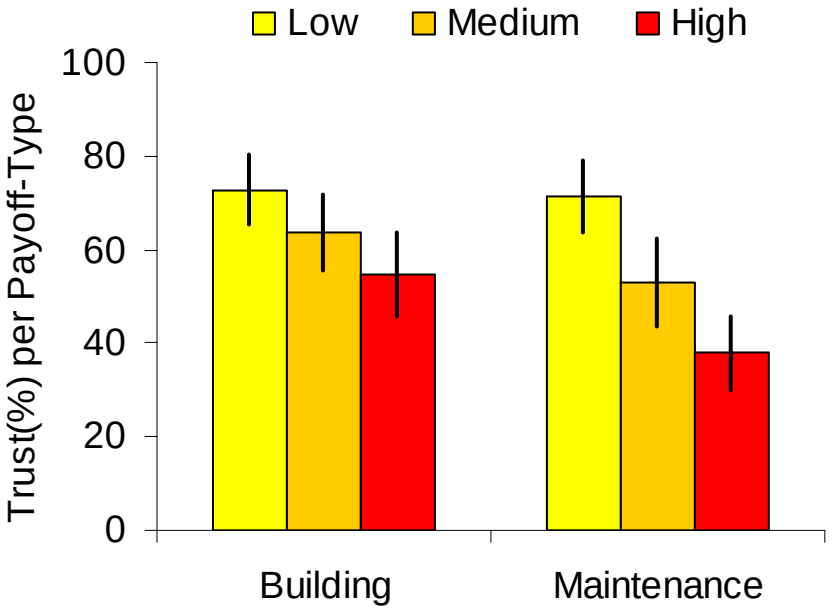


Krueger et al., *Proc Natl Acad Sci*, 2007.

CSN | Conditional Trust: Ventral Tegmental Area (VTA)



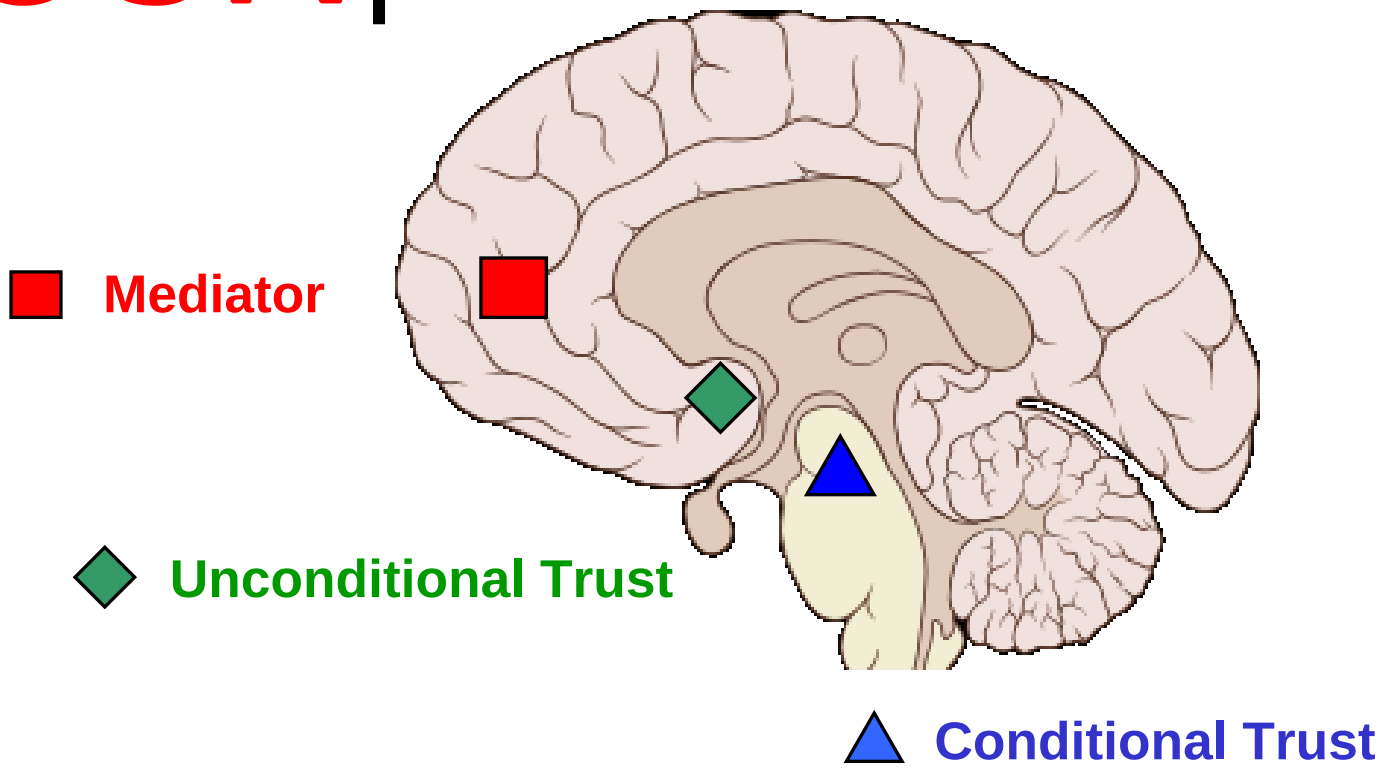
SA VTA



- **VTA is linked to the dopaminergic reward system providing a general reinforcement mechanism to encode expected and realized reward (Schultz and Dickinson, 2000).**

VTA => Evaluation of expected reward

CSN | Conclusions: Trust Strategies



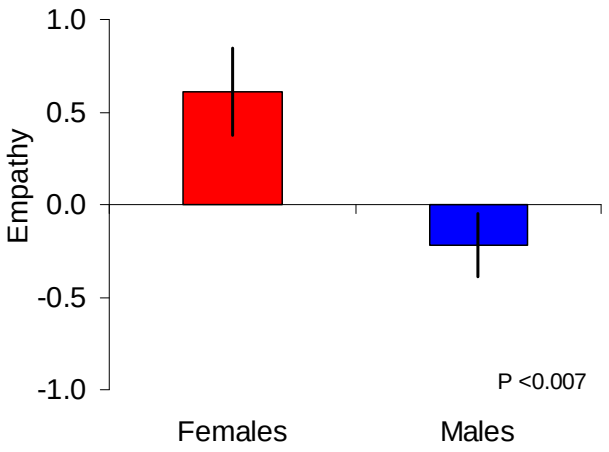
- mPFC mediates trust strategies during different phases in social relationships
- mPFC interacts with more primitive neural systems in maintaining unconditional (SA) and conditional trust (VTA) in a social relationship

Gender Differences

❑ Groups

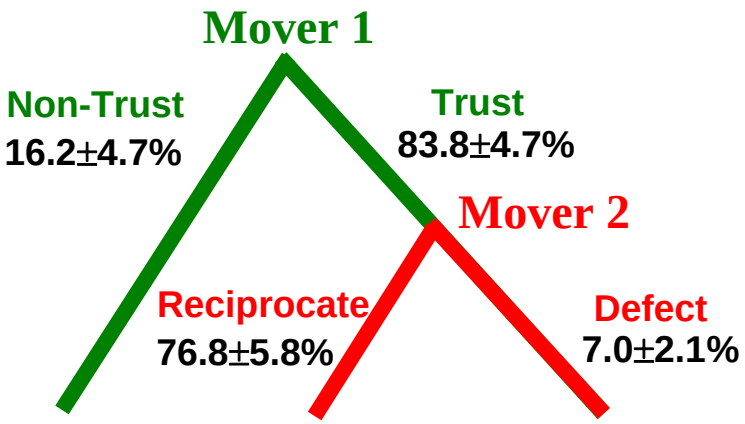
Balanced Emotional Empathy Test (BEES)

- **Emotional Empathy = feeling what the other person feels**
- **9-point agreement-disagreement scale (n=30)**



Example: I cannot feel much sorrow for those who are responsible for their own misery.

❑ Sub-Groups



Non-Defector Pairs
=
Unconditional Trust Group

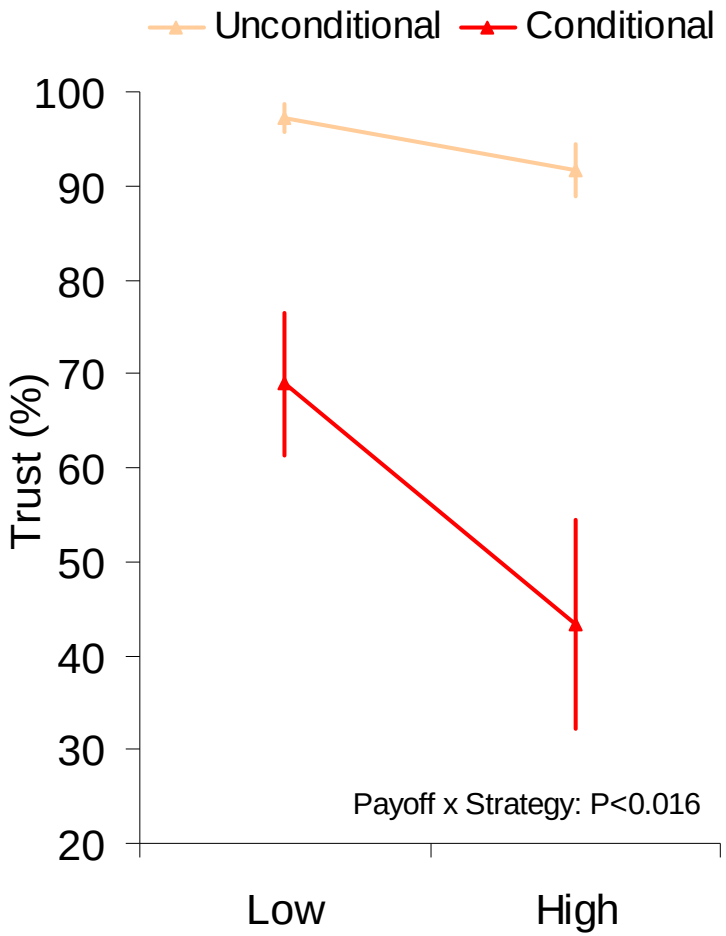
females males

Defector Pairs
=
Conditional Trust Group

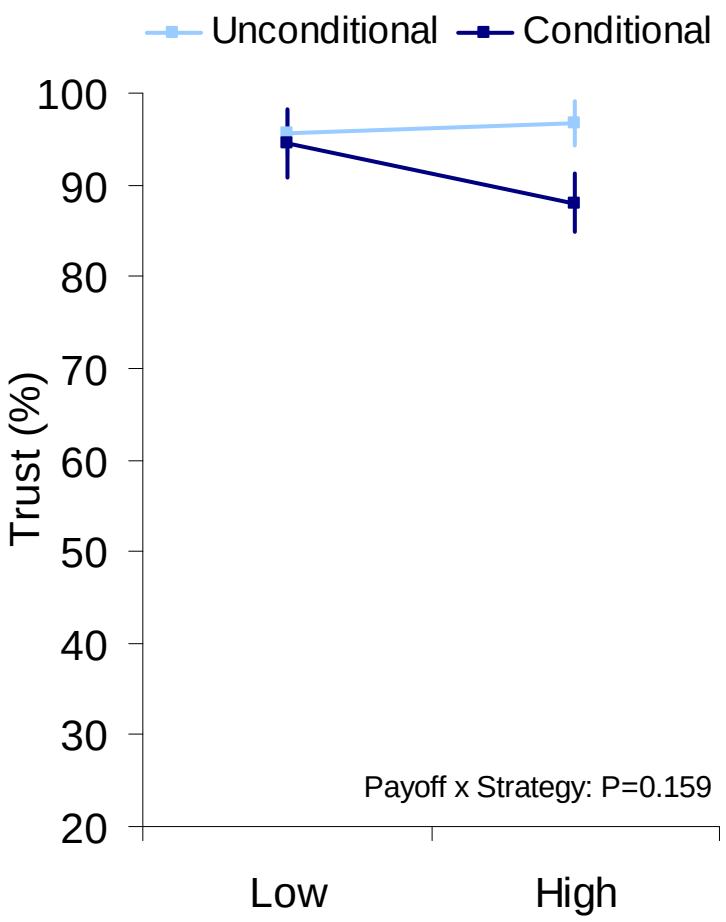
females males

CSN | Trust Decisions

Females

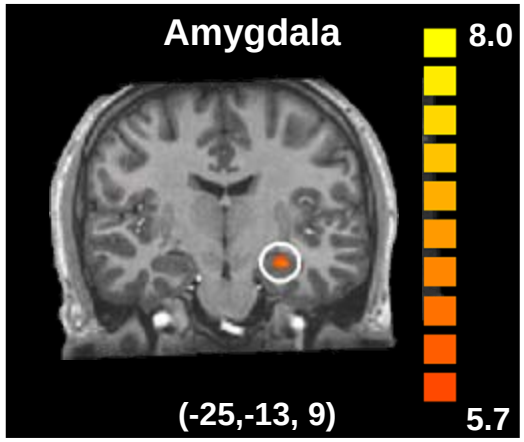


Males

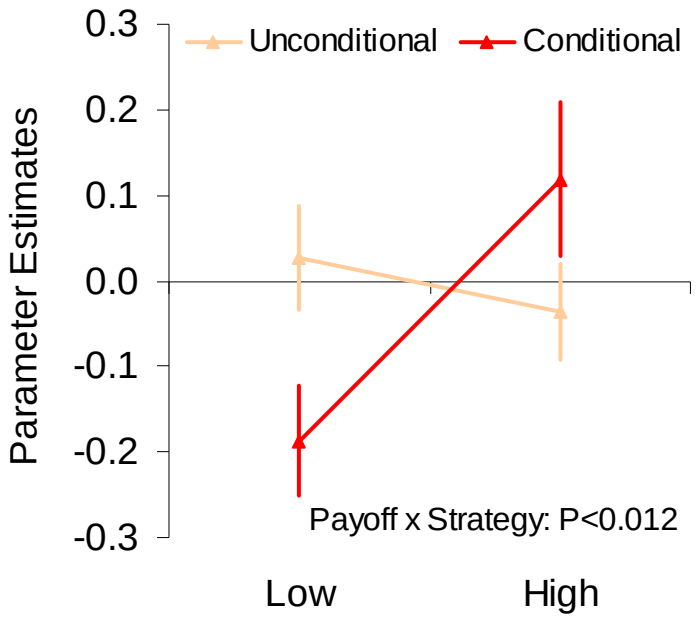


Gender x Payoff x Strategy

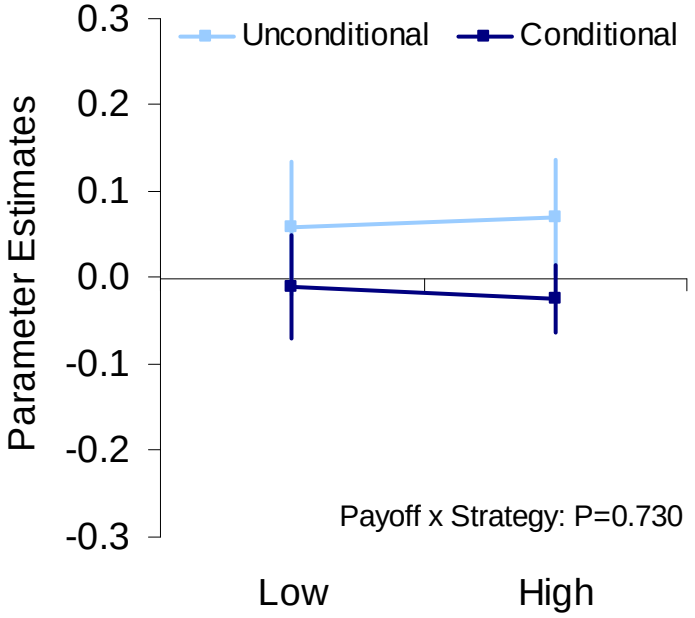
CSN | Brain Activation



Females



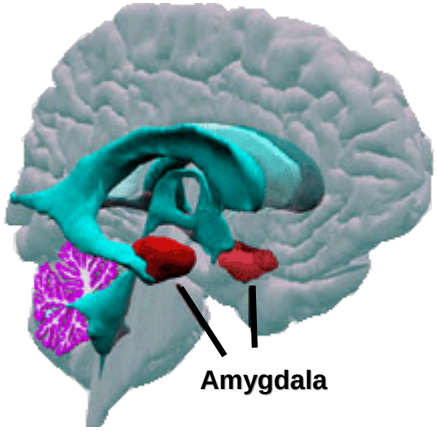
Males



Gender x Payoff x Strategy

CSN | Conclusions: Gender Differences

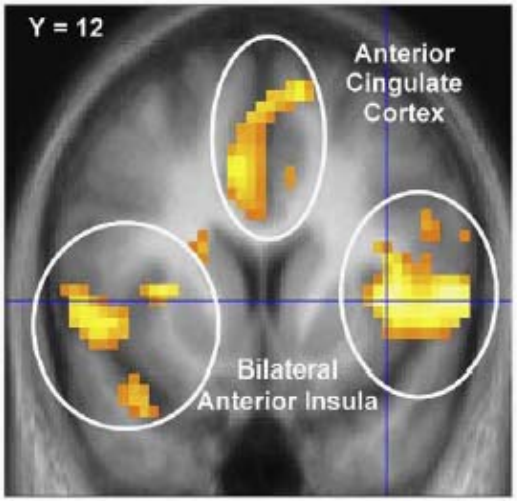
Females score higher on empathy, indicating that they are better able to understand the emotional states of others.



After defection, females trusted less with increasing stakes and this is mirrored with increasing activation of the amygdala – a brain region that modulates fear.

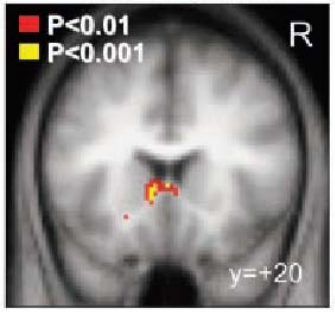
Gender differences during social interaction are driven by the increased sensitivity of females to changes in social context, leading to trust adaptation which is associated with a brain region known for fear processing.

CSN | Three Systems for Exchange

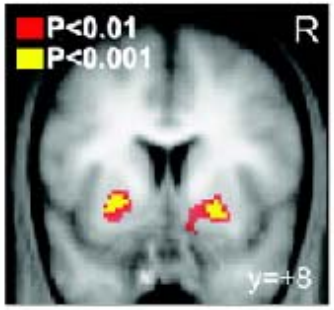


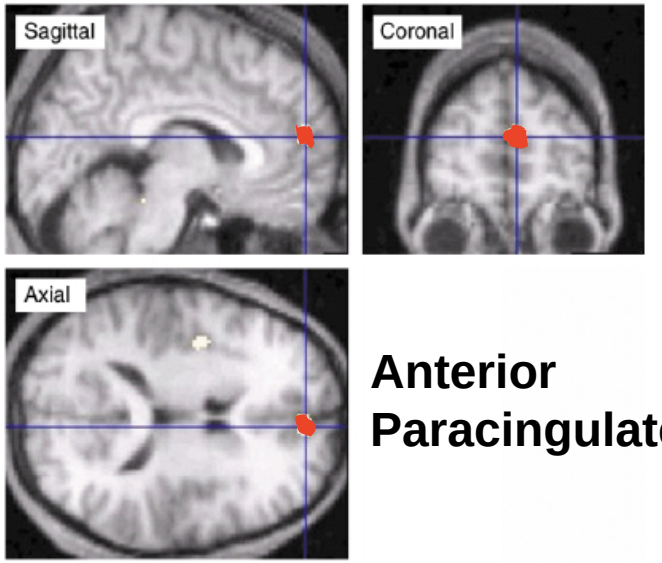
Pain Empathy Network

Dorsal Striatum



Ventral Striatum





Anterior Paracingulate

Theory of Mind

Goal Directed Learning

CSN | Thank You and Questions