Game theory and brain imaging: A successful match? An attempt to identify neural correlates of Machiavellian strategies

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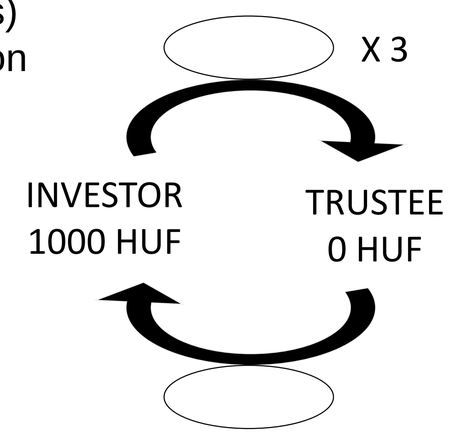
BACKGROUND

In spite of having shortcomings in various areas of social cognition, especially in mindreading (Paal and Bereczkei, 2007), Machiavellian individuals are typically very successful in several other tasks, including solving social dilemmas. High Mach individuals tend to advocate self-interest and are likely to manipulate and exploit others in order to get closer to their goals (Fehr, 1992; Jones and Paulhus, 2009). They are often described as rational, cold, impersonal and practical; they can stay emotionally detached from a situation (Christie and Geis, 1970). We assume, that a profound examination of neural structures associated with decision making processes is required to learn more about Machiavellians' abilities that enable them to successfully exploit and manipulate others. We report here a newly designed event-related fMRI experimental paradigm we used to scan high- and low-Mach individuals as they were playing a series of single turn trust games.

METHODS

Subjects:

- 27 healthy, right-handed subjects (14 females)
  - 15 low-Machs, 12 high-Machs (measured on Christie and Geis' [1970] Mach-IV scale)
- mean age: 23 yrs; SD: 2,4



Trust game:

- A total of 48 turns
  - 12 turns as INVESTOR (first player)
  - 24 turns as TRUSTEE (second player)
  - 12 turns CONTROL condition

Task:

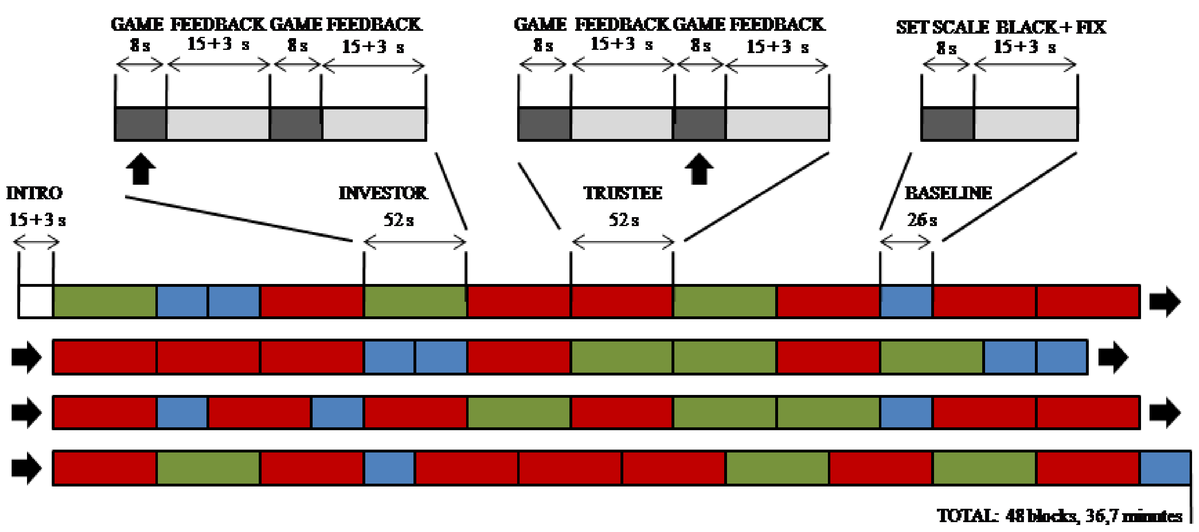
- as INVESTOR or TRUSTEE: using an adjustable 9-point Likert-scale presented on-screen, subjects were asked to indicate the amount of money to transfer to their peer
- in the CONTROL condition, participants were shown a specific amount (written as text, e. g. „three-hundred") and the cursor on the scale was required to be set to the appropriate unit

Structure of a game turn:

- initial capital of INVESTOR: 1000 HUF ➲ INVESTOR's offer (arbitrary amount) ➲ the offer gets tripled ➲ TRUSTEE's initial capital: 0 HUF ➲ TRUSTEE receives the tripled offer ➲ TRUSTEE's offer (arbitrary amount)
- participants were led to believe, they were playing real peers – in fact, the peer's decisions were provided by a premade computer script

Data acquisition

- 3T Siemens MAGNETOM TrioTim fMRI scanner (Diagnostics Center of Pecs, Hungary)
- TR/TE = 2000/36ms, flip angle = 76°, ST = 4 mm; slice no. = 23.
- whole brain analysis (SPM5 software package), threshold p < .001, unc.



RESULTS

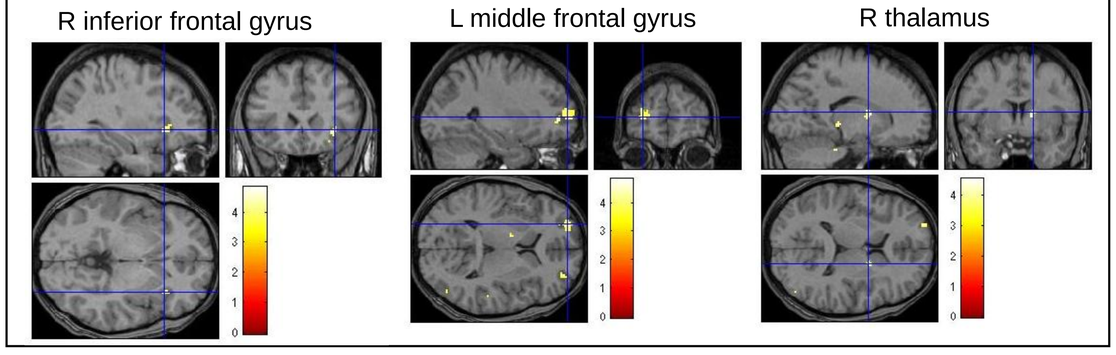
Three contrasts were defined:

GAME > CONTROL
INVESTOR > CONTROL
TRUSTEE > CONTROL
} high- vs. low-Machs

Across all three contrasts, the high-Mach group of participants consistently showed a higher degree of brain activation.

Region	Brodmann Area	Active voxels	T-value	Voxel coordinates (MNI)		
				x	*y*	*z*
Game > Baseline						
R inferior frontal gyrus	BA11/47	22	4,57	32	22	-2
R middle frontal gyrus	BA6/8	9	4,29	28	50	6
R superior frontal gyrus	BA6/8	20	4,83	28	14	56
L middle frontal gyrus	BA10	58	4,28	-26	56	6
L superior frontal gyrus	BA10	34	3,57	-18	50	4
R precuneus		3	4,02	14	-36	50
L globus pallidus		4	4,31	-14	-6	4
Investor > Baseline						
R middle frontal gyrus	BA6/8	24	4,53	28	12	54
R superior frontal gyrus	BA6/8	31	4,53	28	12	54
L middle frontal gyrus	BA10	18	3,87	-26	62	12
L superior frontal gyrus	BA10	4	3,71	-28	55	5
R fusiform gyrus	BA20	10	4,55	50	-58	-16
R middle temporal gyrus	BA39	9	3,66	40	-76	-2
L middle temporal gyrus	BA37	4	3,99	-64	-54	-4
R anterior cingulate cortex	BA24	4	3,73	10	-16	44
R thalamus		12	4,35	14	0	6
R putamen		8	4,35	14	0	6
L globus pallidus		4	4,09	-12	-4	0
R globus pallidus		6	3,99	14	0	6
Trustee> Baseline						
R inferior frontal gyrus	BA47	22	4,31	30	22	-6
L middle frontal gyrus	BA10	9	4,17	-30	60	12
L superior frontal gyrus	BA10	4	3,63	-26	58	4
R parahippocampal gyrus	BA36	3	4,12	32	-22	-28

R inferior frontal gyrus | L middle frontal gyrus | R thalamus



CONCLUSIONS

We found that high-Mach people, compared to low-Machs, gain a higher profit by the end of the game and show a higher activation in specific brain regions during decision-making processes in a social dilemma task. We found increased neural activation in areas that are involved in inference making and reward-related decision making. High Mach's success in exploiting others may result from their skill in inferring possible actions from others' behavior (that may yield a relatively large final payoff), and anticipating reward and threat to their self-interest.

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