Cognitive flexibility in Pathological Gambling and Alcohol Dependence: An fMRI study

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Introduction

- A lack of cognitive flexibility is evident in alcohol dependence (AD):
  - Perseveration and stereotypical behaviour emerge as compulsive drinking behaviour.
  - Neurocognitive studies indicate cognitive inflexibility in AD, which is sometimes attributed to the neurotoxic effects of ethanol .
- Cognitive inflexibility has also been found in pathological gambling (PG), an addictive behaviour without toxic effects of drugs on the brain with broad neurobiological resemblance to substance use disorders (van Holst et al., 2010).
- Yet, brain functioning underlying diminished cognitive flexibility in pathological gambling and alcohol dependence has not been studied as of yet.

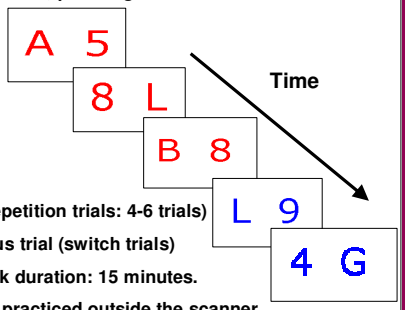
Aims:

- Compare the neural correlates of cognitive flexibility in pathological gambling and alcohol dependence to healthy controls
- to better understand perseverative behaviour in addictions
- compare substance dependence to addictive behaviour without neurotoxic effects of substances

Methods

Cognitive flexibility paradigm: Switch-task (Sohn et al., 2000)

- presentation of two stimuli: a letter and a digit.
- if color of letter is red: press left for vowel, press right for consonant
- If color is blue: press left for even, press right for odd



- Trial types:
  - same as previous trial (repetition trials: 4-6 trials)
  - switch from color previous trial (switch trials)
- Event related paradigm. Task duration: 15 minutes.
- The task was explained and practiced outside the scanner.

Participants:

20 pathological gamblers (PG), 21 alcohol dependent (AD) persons, 19 healthy controls.

PG and AD groups recruited from a local outpatient treatment clinic.

Exclusion: severe psychopathology, psychoactive drugs, TBI

	Problem gamblers (n=20)	Alcohol dependents (n=21)	Healthy controls (n=19)	ANOVA (two-tailed)
Age, mean (SD)	36.15 (12.11)	42.90 (8.67)	37.47 (11.33)	$H(2)=4.15$ p=0.125
Age of onset addiction, mean	27,25 (11,43)	30,38 (8,13)	-	$F(1,39)=1.03$ $p=0.32$
South Oaks Gambling Screen	11.16 (3.18)	0.14 (0.39)	0.05 (0.22)	$\chi^2(2)=49.36$ $p<0.001$
Alcohol Use Disorder Identification test	5.15 (2.94)	28.75 (4.55)	4.89 (4.50)	$\chi^2(2)=38.89$ $p<0.001$
Number of trials during training	139,4 (68,1)	167,0 (61,4)	134,4 (68,1)	$F(2,50)=1.46$ $p=0.24$
RT during fMRI trials	1142.9 (200.1)	1187 (288.9)	1040 (213.0)	$F(2,57)= 1.96$ $p=.15$

Analysis

- ANOVA (two-tailed) followed by group comparisons for behavioral data
- fMRI data:
  - Contrast images for switch versus repetition trials were entered into a second-level (random effects) analysis.
  - Main effects across groups for each contrast were analyzed with one-way ANOVA implemented in SPM5 corrected for multiple comparisons according to the Family Wise Error (FWE) method.
  - Group interactions are reported at $P<0.001$, masked with the appropriate main effect at $p<0.05$.

Results

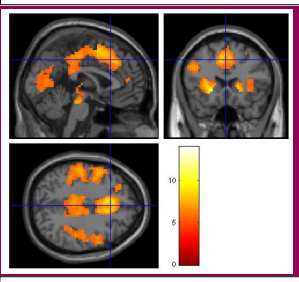
Behavioral:

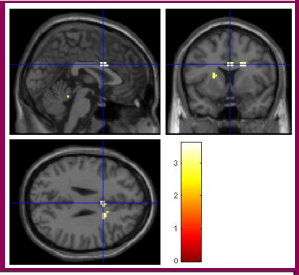
- The Alcohol Dependent group tended to have slower reaction times than the healthy controls (HC), $p=.07$

fMRI:

Main effects of switching behavior (switch vs. stay) in all three groups:

- Bilateral: putamen, medial, middle, and superior frontal gyrus, parahippocampal gyrus
- Right: anterior cingulate cortex (ACC) (see figure below left).





- Group interaction alcohol dependents vs healthy controls and pathological gamblers vs healthy controls (switch vs. stay):

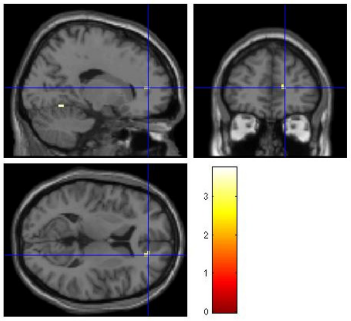


Figure above right:

AD < HC :
right anterior cingulate
Bilateral parahippocampal gyrus
right middle frontal gyrus

Figure left:

PG < AD:
right anterior cingulate
left parahippocampal gyrus
right middle temporal gyrus

Conclusions

fMRI:

- Pathological gamblers and alcohol dependent persons activate error monitoring areas less than healthy controls during switch trials
- Less control over behavior during effortful cognitive proccesing
- AD show less activity in executive areas (middle frontal gyrus). This may be related to toxic effect of alcohol on the brain, and behavioral performance

Behavioral:

- Alcohol dependent persons tend to react slower and need more trials to reach a similar level as HC

First study to investigate cognitive flexibility and it's neuronal substrates in pathological gambling and alcohol dependence:

Less activation during switching may result in more difficulty exerting flexibly over addiction related behavior: e.g. disengaging from addictive behavior.

References

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