

Default-mode network dysfunction in psychopathic prisoners

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Project

INTRODUCTION

Psychopathy is a complex disorder characterized by blunted affect, interpersonal problems, impulsivity, and highly antisocial behavior. Critically, psychopaths are a dangerous population who are far more likely to commit violent crimes and recidivate after being released from prison (Hart & Hare, 1996).

In this study, we analyzed functional MRI data of psychopaths and nonpsychopaths within a prison population. Our two primary goals were to 1) determine what brain regions can best distinguish psychopathic prisoners from non-psychopathic prisoners and 2) investigate why certain brain regions succeed in separating the two groups with high levels of accuracy.

Background and Rationale

· ERP studies show that psychopaths exhibit differences in regional brain activity when completing the Go/NoGo response inhibition task (Kiehl et al., 2000).

· Psychopaths also show behavioral deficiencies on more complex inhibition tasks. such as those involving rewards (Hiatt & Newman, 2006).

· Studies have found that psychopaths' primary areas of dysfunction are in the anterior and posterior cingulate cortices, orbital frontal cortex, parahippocampal gyrus, amygdala, insula, and anterior superior temporal gyrus-all of which are within the "paralimbic system" (Kiehl, 2006).

· Because many of these "paralimbic regions" are also in the default-mode network (DMN) and DMN dysfunction has been implicated in several psychiatric disorders (Broyd et al., 2008), we were particularly interested in the ability of DMN regions to separate psychopaths from non-psychopaths.

METHODS

Participants and Group Selection

· 97 prisoners scanned in a mobile 1.5T scanner.

· After an extensive interview process and case file examination, each prisoner was given a Psychopathy Checklist-Revised (PCL-R) score, which is considered the "gold standard" for diagnosing psychopathy and has a range of 0-40.

· 22 prisoners were labeled "psychopaths" after receiving a PCL-R score of 28 or higher-a commonly used cut-off score for psychopathy. To match the psychopathic group, we created a non-psychopathic group of 22 prisoners with scores centered on the median of the sample, which is 20. The mean PCL-R scores for the psychopathic and non-psychopathic groups are 31.34 and 20.08, respectively.

Design

· Each prisoner underwent fMRI scanning while completing an event-related. visual Go/NoGo task. A total of 440 TRs were recorded (220 TRs per run).

• Contrasts for analyses include: Task > Baseline; Go > Baseline; NoGo > Baseline; Go > NoGo: NoGo > Go.

· fMRI data was analyzed in SPM5 and was estimated using a standard HRF with RWLS to de-weight volumes with excessive motion.

· Due to high variability and low volume of incorrect trials (misses and false alarms), correct and incorrect trials were collapsed in our analysis,

BEHAVIORAL RESULTS

	NON-PSYCHOPATHS	PSYCHOPATHS	p-VALUE
MEAN GO-RT	455 ms	442 ms	0.43
MEAN NO-GO % CORRECT	76.16	74.18	0.62
MEAN GO % CORRECT	97.86	98.74	0.31
D PRIME	3.22	3.04	0.44

Using t-tests to examine behavior, we found no significant differences between psychopaths and non-psychopaths.

SUPPORT VECTOR MACHINE ANALYSIS

To achieve the goal of maximally distinguishing psychopaths from non-psychopaths, we used a linear support vector machine (SVM) pattern classifier. This multivariate approach detects differences in patterns of activity and can often be a more sensitive method in distinguishing data.



SUPPORT VECTOR MACHINE RESULTS







Right Superior Parietal (84.09)

Right Middle Frontal (77.27)



NoGo > Baseline



Left Posterior Cingulate (77.27) Right Superior Parietal (75)

*All regions survive a Bonferroni-corrected threshold at n < 0.05 Note: No regions in Go>NoGo or NoGo>Go survived multiple comparisons correction

ANATOMICAL ROI ANALYSIS

To address the goal of investigating why certain brain regions succeed in separating psychopaths from non-psychopaths with high levels of accuracy, we conducted regions-of-interest (ROI) analyses on the AAL regions that achieved percent correct scores surviving a Bonferroni correction at p < 0.05. These analyses provided an independent method to examine if differences in overall activity could help explain the high predictive power of certain anatomical regions.





DISCUSSION AND CONCLUSIONS

We provide compelling and converging evidence that psychopaths fail to deactivate a focal region of their default-mode network (posterior cingulate cortex) when engaged in a Go/NoGo task. While this effect appears to be more severe in conditions of increasing difficulty (NoGo trials), it is modestly seen in Go trials, reaches its highest significance in the Task>Baseline contrast, and is not significant in the NoGo>Go contrast (not displayed). These data indicate this is a general task-related dysfunction in psychopathy that leads to high prediction accuracy when trying to distinguish psychopaths from average prisoners. Consistent with research showing DMN dysfunction in other psychiatric disorders, proper task-related deactivation of this network appears to be instrumental in maintaining proper functioning.

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