Executive function as a function of sub-clinical psychopathy

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ABSTRACT

Some aspects of executive function are thought to be dysfunctional in psychopathic individuals. We administered a small battery of neuropsychological tests (spatial alternation task, object alternation task, and Porteus Maze) to two samples of college students and obtained a measure of psychopathy via a self-report questionnaire. Psychopathic traits were related to the tests of object alternation and Porteus Maze but not to the spatial alternation task. Our results support the hypothesis of orbitofrontal cortex (OFC) dysfunction with sparing of dorsolateral prefrontal cortex (DLPFC) in psychopathy and provide a downward extension of this theory to sub-clinical levels of psychopathy.

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1. Introduction

The concept of psychopathy refers to a constellation of personality traits and behaviours characterised by a lack of remorse, a lack of emotionality, impulsivity, and poor decision making. In turn, the concept is linked to antisocial behaviour, violence, and poor treatment prognosis (Hare & Neumann, 2008). The link between psychopathy and possible frontal lobe dysfunction arose from observations of similarities between individuals with acquired frontal lobe damage and those with psychopathy (Harlow, 1848).

Neuropsychological investigations of psychopathy have often, however, shown no sign of executive function impairment (e.g., Hare, 1984; Hart, Forth, & Hare, 1990). The reasons for this may be manifold but there appears to be an emerging theory that tasks that are associated with the function of the orbitofrontal cortex (OFC) are compromised in psychopaths, whereas those that are associated with dorsolateral prefrontal cortex (DLPFC) are unaffected. Lapierre, Braun, and Hodgins (1995) showed that tests associated with OFC function (Go/NoGo task; Porteus Maze Test) produced large differences between psychopathic and control offender groups, whilst those associated with DLPFC function (Wisconsin Card Sort Test) did not. Blair et al. (2006) examined the

spatial alternation (SA) task and the object alternation task (OA) in psychopaths. These two tasks appear very similar as both involve using the previous response to guide response selection on the next trial. Nevertheless, the OA appears to require intact OFC function, whilst the SA requires intact DLPFC function (Mishkin, Vest, Waxler, & Rosvold, 1969). In line with the OFC deficit hypothesis, psychopaths showed increased errors on the OA task but not the SA task (see also Mitchell, Colledge, Leonard, & Blair, 2002).

A common concern in the study of adult individuals with psychopathy is that their lifestyle, which often includes a range of risk and sensation seeking behaviours, may be responsible for differences in brain function and/or executive function. In particular, the excess use of drugs and alcohol can alter executive function, including many of the tasks mentioned above as providing evidence in support of the OFC deficit hypothesis (Bolla et al., 2003; Reay, Hamilton, Kennedy, & Scholey, 2006). Therefore, studies of sub-clinical levels of psychopathic traits within community samples may be able to provide "paralleling evidence" to studies of clinical psychopathy. However, to date, there have been few studies that have tested neuropsychological functioning of sub-clinical psychopathy. We have taken a small battery of tests that have been shown to be related to clinically defined psychopathy and tested to see if performance is related to self-reported psychopathy in a sample of college students. It is also expected that the effects of chronic drug or alcohol abuse may be less likely to be present than a clinical sample. In Experiment 1 we looked at the Object and the

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spatial alternation tasks, whilst in Experiment 2 we looked at the Porteus Maze task.

There is also increasing recognition that psychopathy at a global level is underpinned by a small number of factors, yet there is little data that has addressed which aspects of psychopathy may be related to which neuropsychological dysfunction. The Psychopathic Personality Inventory – Revised (PPI-R; Lilienfeld & Widows, 2005) produces a global psychopathy score and assesses the traits of Fearless Dominance (which involves social potency, immunity to stress, and fearlessness), Self-Centered Impulsivity (which involves impulsiveness, lack of planning, and blame externalisation), and Coldheartedness (which involves a lack of emotion). The questionnaire was developed to place greater emphasis on the personality traits related to psychopathy as compared to the often used clinical measure of psychopathy, the Psychopathy Checklist – Revised (PCL-R; Hare, 2003). The dimensions of Fearless Dominance and Self-Centered Impulsivity have been equated to the PCL-R factors 1 (Interpersonal/Affective) and 2 (Lifestyle/Antisocial) (see Rilling et al., 2007), however other authors have not found a close match between these two conceptualisations of psychopathy (Copestake, Gray, & Snowden, 2011; Hughes, Stout, & Dolan, 2013; Marcus, Fulton, & Edens, 2013).

2. Methods

2.1. Participants

The participants for Experiments 1 and 2 were 90 and 60 undergraduate students (51% and 80% female) respectively. Participants were either given course credit or were paid for their participation. Ethical approval was obtained from Cardiff School of Psychology Ethical Committee.

2.2. Measures

2.1.1. Psychopathic Personality Inventory – Revised

The PPI-R (Lilienfeld & Widows, 2005) is a 154 item self-report measure of psychopathy. Each question is answered on a four-point scale of 1 (False), 2 (Mostly False), 3 (Mostly True), and 4 (True). Participants were presented with written instructions about the PPI-R and how it should be completed. The PPI-R produces a global psychopathy score and scores for the Fearless Dominance, Self-Centered Impulsivity and Coldheartedness scales.

2.1.2. Spatial and object alternation tasks

The tasks were presented on a test apparatus made to the same specifications as Freedman, Black, Ebert, and Binns (1998). This was a frame of 55 cm wide and 65 cm high, anchored to a stimulus board with 2 reinforcement wells 24 cm apart onto which target stimuli were placed. In the OA task the two three-dimensional objects differed in shape and colour; in the SA task the two objects were identical. On the first trial, both spaces/objects were baited with a prize (a paper disc with 'prize' written on it) and the person was therefore correct. On each subsequent trial following a correct response the prize was either located on the other side (for the spatial alternation task) or the other object (for the object alternation task). Following an incorrect response the trial was repeated until the correct response was chosen. This procedure continued until 12 consecutive correct responses were made or 80 trials have been completed. The number of errors was taken as the measure of performance. Other details followed the procedures of Blair et al. (2006).

2.1.3. Porteus Maze

The Vineland revision of the Porteus Maze test (Porteus, 1965) was used to assess impulsive errors in executive functioning. The test consists of ten labyrinths, each one increasing in difficulty. Participants gained a Qualitative score (Q-score), that is intended to reveal any haphazard, impulsive or over-confident habits of action. The higher the Q-score, the more impulsive errors were made (wall crossing, cutting corners, pencil lifts, sinuous course, wrong direction).

2.2. Procedure

The participants first completed the PPI-R and then the two alternation tasks in Experiment 1 or the Porteus Maze task in Experiment 2. The order of the tasks in Experiment 1 was counterbalanced across participants (later analysis showed no effect of this order).

2.3. Data analysis

Data were tested for normality of distribution. The error rates for the SA and OA tasks were not normal due to a large number of people making no errors and there was no transformation that could approximate the normal distribution. Hence, non-parametric statistics were applied whenever these data were involved in the analysis. All other distributions did not deviate from the assumptions of normality and parametric statistics were used for these. Correlations were compared using the methods described by Steiger (1980).

3. Results

3.1. Descriptive statistics

The overall scores on the PPI-R and the neuropsychological tests are shown in Table 1.

3.2. Psychopathy and spatial and object alternation

Results are shown in Table 2. Overall, no significant correlations were found between the global psychopathy score and either the SA or OA task. However, there was a significant correlation between the subfactor of Fearless Dominance and errors in the OA task, but not in the SA task. This difference between these correlations was marginally significant ($p = .05$). The correlation between Fearless Dominance and OA errors was larger than for the Self-Centered Impulsivity and Coldheartedness subscales ($p = .08$; $p = .09$; respectively).

Table 1
Descriptive statistics for the two Experiments. Sample size was $N = 90$ for Experiment 1 and $N = 60$ for Experiment 2.

	Experiment 1		Experiment 2	
	Mean [Median]	SD [IQR]	Mean	SD
PPI-Total	284.0	37.9	281.8	37.2
Fearless Dominance	111.7	20.4	113.3	21.1
Self-centered impulsivity	140.7	21.6	140.7	22.1
Coldheartedness	31.4	5.4	27.9	5.7
SA errors	10.9 [9.0]	8.6 [3–20]	–	–
OA errors	5.0 [3.0]	6.9 [0–7]	–	–
Q-score	–	–	24.6	12.9

Note: IQR = inter quartile range.

Table 2
Inferential statistics (correlations for the two Experiments).

	Spatial alternation errors	Object alternation errors	Q-score
PPI-Total	.07	.13	.27[*]
Fearless Dominance	−.01	.22[*]	.24[*]
Self-centered impulsivity	.15	.06	.23[*]
Coldheartedness	.08	.06	.01

[*] $p < .05$.

3.3. Psychopathy and Porteus Maze

Global psychopathy score was significantly correlated with Q-score indicating that those higher on the construct of psychopathy made more of these types of errors. Significant correlations between Q-score were also noted for the subfactors of Fearless Dominance and Self-Centered Impulsivity, but not for the subfactor of Coldheartedness. The differences in correlations were marginally significant (Fearless Dominance and Coldheartedness, $p = .09$; Self-Centered Impulsivity and Coldheartedness, $p = .06$).

4. Discussion

4.1. OFC theory of psychopathy

Our major aim was to test the notion that performance on tasks that are thought to be reliant upon the functioning of the OFC may be poorer in those high on traits of psychopathy. To this end we chose two tasks (Porteus Maze and OA) that are thought to be dependent on the intact OFC function, and one that was thought to be related to DLPFC function. The pattern of results is supportive of the notion of an OFC dysfunction in psychopathy, and extends this association to non-clinical levels of psychopathy.

Our secondary aim was to look at different subfactors of psychopathy and their relation to putative OFC dysfunction. Several models/measures of psychopathy now exist and most agree that the global concept of psychopathy is underpinned by several subfactors.

For the OA task, the increase in errors appears to be confined to the Fearless Dominance scale. The concept of Fearless Dominance has been suggested to be most related to the interpersonal-affective dimension of psychopathy (Benning, Patrick, Salekin, et al., 2005) and has been shown to be related to other markers of poor processing of affective stimuli such as a lack of modulation of startle response by negative pictures (Benning, Patrick, & Iacono, 2005; Justus & Finn, 2007). Possible reasons for poor OA performance have been suggested to be (1) an inability to withhold a prepotent response (the last rewarded object), (2) an inability to encode and hold the memory of the last object rewarded, or (3) an inability to inhibit interference from previous trials (Zald, Curtis, Folley, & Pardo, 2002). It is unclear which of these, or possible other, explanations may account for the current findings, and none show an obvious relationship to the personality traits covered by the concept of Fearless Dominance.

The Q-score on the Porteus Maze was related to both the factors of Fearless Dominance and Self-Centered Impulsivity. Self-Centered Impulsivity is thought to relate more to the antisocial aspects of psychopathy, and includes such traits as impulsiveness, nonconformity, and a lack of planning. Thus, the Q-score, which reflects such behaviours as rule breaking and impulsive errors, would seem to be a task that has good face validity to measure this factor. It is noted that Q-score is also raised in other antisocial populations (Riddle & Roberts, 1977). Again, it is less clear why the dimensions of Fearless Dominance might be also related to such behaviours.

4.2. Limitations

The use of an undergraduate sample means that there is a restricted range of psychopathy (and, possibly, neuropsychological) scores in comparison to offender populations, and this may lower our ability to detect associations with the measures taken. Hence, the positive findings are all the more encouraging given this limitation. Second, the samples we used consisted of both males and females. There is increasing evidence that the expression of psychopathy and its associations to both personality variables and performance on a variety of tasks is modulated by gender (Justus & Finn, 2007; O'Leary, Taylor, & Eckel, 2010). It would be of interest to be able to compare the relationships between psychopathy and executive functions for each gender, but this would require larger samples than those collected in the present work. Third, we used what is probably currently the most population self-report measure, the PPI-R. However, there have been recent concerns as to the replicability of the factor structure of this instrument (Neumann, Malterer, & Newman, 2008) and other issues that question its construct validity (Neumann, Uzieblo, Crombez, & Hare, 2013). It may be beneficial for future studies to use other, and perhaps complimentary, conceptions of psychopathy. Finally, we have tested only three tasks of putative executive function. There are many other conceptualizations and tests of executive function (Lezak, 1995) and, hence, our results represent only a small insight into these relationships.

4.3. Conclusions

Our data show that two tasks thought to be dependent on OFC function are related to poor performance on those scoring high on aspects of self-reported psychopathy and provide support for the OFC dysfunction theory of psychopathy, and provide a downward extension of this theory to a sub-clinical sample.

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