

Title	Investigating the multivariate relationship between impulsivity and psychopathy using canonical correlation analysis
Authors	Fox, Siobhán;Hammond, Sean
Publication date	2017-02-14
Original Citation	Fox, S. and Hammond, S. (2017) 'Investigating the multivariate relationship between impulsivity and psychopathy using canonical correlation analysis', <i>Personality and Individual Differences</i> , 111, pp. 187-192. doi:10.1016/j.paid.2017.02.025
Type of publication	Article (peer-reviewed)
Link to publisher's version	10.1016/j.paid.2017.02.025
Rights	© 2017, Elsevier Ltd. All rights reserved. This manuscript version is made available under the CC-BY-NC-ND 4.0 license. - <a href="https://creativecommons.org/licenses/by-nc-nd/4.0/">https://creativecommons.org/licenses/by-nc-nd/4.0/</a>
Download date	2025-05-16 19:59:17
Item downloaded from	<a href="https://hdl.handle.net/10468/5455">https://hdl.handle.net/10468/5455</a>



**UCC**

**University College Cork, Ireland**  
Coláiste na hOllscoile Corcaigh

1 **Abstract**

2 **Background:** Impulsivity is generally considered a core feature of psychopathy,  
3 however one problem with understanding the association between these constructs is  
4 that both are multifaceted. Existing research often treats one or both of these  
5 constructs as unidimensional with important information regarding the complex nature  
6 of the relationship being lost. To clarify this issue the present study employs a  
7 canonical correlation analysis (CCA) which allows for the comparison of two  
8 multifaceted measurement scales simultaneously.

9 **Methods:** Respondents (n=970) completed the Barratt Impulsiveness Scale (BIS-11)  
10 and the Psychopathic Personality Inventory (PPI). CCA was performed to explore the  
11 strength and nature of the association between impulse control and psychopathy.

12 **Results:** There was a large correlation ( $r = .57$ ) between BIS-11 and PPI total scores.  
13 Further exploration using CCA showed that 70.2% of the variance was shared between  
14 the subscales, and three significant canonical functions emerged. These were found to  
15 be interpretable and suggest that impulsivity relates to the broader psychopathy  
16 domain in a complex fashion, and that non-planning impulsivity may be the primary  
17 trait which distinguishes between psychopathy subtypes.

18 **Discussion:** The findings support a complex multi-dimensional relationship between  
19 impulsivity and psychopathy. The simple impulsivity-psychopathy correlation has  
20 much less explanatory power than has a multivariate approach.

21 **Keywords:**

22 Impulsivity; Psychopathy; Individual Differences; Self-Control; Sensation Seeking;  
23 Self-Report Measurement; Canonical Correlation Analysis.

## 24 **1. Introduction**

25 Impulsivity or ‘impulse control’ is central to the study of personality. Impulse control is  
26 considered a core trait within most of the dominant theories of personality, and there are also  
27 numerous theories of impulsivity specifically. One of the key areas of personality theory  
28 where impulse control is discussed is within forensic or offending populations. There are  
29 substantial differences in definitions of impulsivity but one generally accepted definition is “a  
30 predisposition toward rapid, unplanned reactions to internal or external stimuli without regard  
31 to the negative consequences of these reactions to the impulsive individuals or to others”  
32 (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). This definition suggests the  
33 potentially pathological nature of the construct. This implies the likelihood of negative  
34 outcomes which may befall people with impulsive traits or those displaying impulsive  
35 behaviours.

36 Psychopathy has been a construct of interest since Cleckley’s (1941) seminal work ‘the Mask  
37 of Sanity’ which he published in 1941 (Hare & McPherson, 1984). Since then, psychopathy  
38 has become one of the most widely researched personality constructs, especially in forensic  
39 populations. The distinctive features of psychopaths are egocentricity, deceitfulness, shallow  
40 emotions, lack of empathy, stimulation seeking, *impulsivity*, and a tendency to ignore or  
41 violate social conventions and rules (Hare, 2003). Alternative definitions of psychopathy  
42 have been put forth in the literature, but notably the role of impulsivity is consistently  
43 identified as a key facet of the construct. Hare (2003) regards impulsivity as “one of the  
44 hallmarks of psychopathy”. Hart and Dempster (1997) stated that impulsivity is a cardinal  
45 feature of psychopathy and Blaszczynski, Steel and McConaghy (1997, p.85) furthered this  
46 notion in their claim that “impulsivity and psychopathy are one and the same thing”.  
47 Psychopathy has even been conceptualised as purely an externalising/disinhibitory disorder  
48 (e.g. Patrick et al., 2005).

### 50 *1.1 Relationship between impulse control and psychopathy*

51 Despite the widely accepted association between impulsivity and psychopathy, a clear  
52 understanding of this relationship is hindered by the inconsistent definitions and the  
53 multifaceted nature of each construct. There is a debate in the literature over how many  
54 dimensions should constitute 'impulse control', however there is consensus that this is a  
55 multi-dimensional - not unidimensional - trait. The number of dimensions ranges from two  
56 (e.g. Dickman, 1991) to five (e.g. Lynam et al.). The most widely cited model of impulse  
57 control is Barratt's three factor model, measured by the self-report questionnaire the Barratt  
58 Impulsiveness Scale (BIS; Patton et al., 1995). The three subscales comprising the BIS are:  
59 Attentional, Motor, and Non-Planning Impulsiveness. Evenden (1999, p.358), following an  
60 extensive literature review, concluded that "even though almost all authors are in agreement  
61 that impulsivity is multifactorial, there is little agreement to what these factors are even  
62 within a single field of research such as human personality traits". Thus, impulse control is  
63 now regarded as a multi-dimensional construct which must include measurement of its sub-  
64 dimensions for accurate assessment (Patton, Stanford, & Barratt, 1995).

65 Similarly, most self-report measures of psychopathy use a two-factor structure (e.g. the  
66 Psychopathy Checklist-Revised comprises Factor 1: "selfish, callous and remorseless use of  
67 others", and Factor 2: "chronically unstable, antisocial and socially deviant lifestyle" [Hare,  
68 1991]), however there is debate regarding the convergence of these factors. Another problem  
69 is that studies utilising the construct of psychopathy have generally worked with a unitary  
70 measure of the overall score, a now substantial body of literature suggests a multi-faceted  
71 conceptualisation is more appropriate (see Skeem, Poythress, Edens, Lilienfeld, & Cale,  
72 2003, for a review). Increasing evidence suggests that psychopathic personality, or

73 psychopathy (Lewis, 1974), is not a monolithic construct but is instead a constellation of  
74 several partially independent traits (Skeem, Polaschek, Patrick, & Lilienfeld, 2011, as cited in  
75 Berg 2015). This erroneous reliance on a unitary definition of psychopathy may help to  
76 explain some conflicting research findings, for example in the inconsistent relationships  
77 reported between impulsivity and psychopathy (e.g. Karpman, 1948; Woodworth & Porter,  
78 2002). One explanation would be that the multiple dimensions of psychopathy bear differing  
79 relationships with impulsivity and related constructs. There is a small body of research  
80 comparing the two constructs but this issue of multi-dimensionality has not typically been  
81 taken into account.

82 The psychopathic personality inventory (PPI, Lilienfeld & Andrews, 1996) and its revision  
83 (PPI-R, Lilienfeld & Widows, 2005) represent a measure of psychopathy which considers its  
84 multifaceted nature. Recent studies have demonstrated that seven of the eight PPI content  
85 scales operate as indicators of two higher order, and largely orthogonal, factors, labelled  
86 Fearless Dominance (FD; Benning, Patrick, Blonigen, Hicks, & Iacono, 2005) and Self-  
87 Centered Impulsivity (SCI; Lilienfeld & Widows, 2005). A second benefit of the PPI and  
88 PPI-R over similar scales is that they exclude items which explicitly measure anti-sociality,  
89 meaning that they offer a 'purer' measure of psychopathy.

90 Several studies have confirmed that (a lack of) impulse control is a key feature in  
91 psychopathy (e.g., Blackburn & Coid, 1998; Gray & Hutchison, 1964; Vitacco & Rogers,  
92 2001). Impulsivity entails rapid, spontaneous, ill-planned, excessive and potentially  
93 maladaptive behaviour (Enticott & Ogloff, 2011) and has been related to various offences  
94 (Patton, Stanford, & Barratt, 1995) and aggression (Halperin & Newcorn, 1998) as cited in de  
95 de Tribolet-Hardy, Vohs, Mokros, & Habermeyer (2014).

96 Some previous research has examined the relationship between the PPI and self-reported  
97 impulsivity. Ray, Poythress, Weir and Rickelm (2009) investigated the relationship between  
98 the FD and SCI subscales of the PPI-R and the UPPS impulsive behaviour scale (UPPS;  
99 Whiteside & Lyman, 2001) in a forensic sample. Results showed that all of the UPPS  
100 subscales were significantly associated with PPI-R total score. When this relationship was  
101 investigated for the subscales of the PPI-R, only the SCI was significantly associated with all  
102 of the UPPS scales; FD was strongly associated only with sensation seeking, weakly  
103 associated with (lack of) premeditation, unrelated to urgency, and negatively associated with  
104 (lack of) perseverance. The authors acknowledged some limitations of their study including  
105 its small sample size, and recommended that future research use alternative measures of  
106 impulsivity. The UPPS measures very specific subtypes of impulsivity such as sensation  
107 seeking which have been shown through meta-analysis to bear non-significant correlation  
108 with measures of 'general impulsivity', such as the Barratt Impulsiveness Scale (BIS-11;  
109 Patton, Stanford & Barratt, 1995; Cross, Copping & Campbell, 2011).

110 In a study among psychiatric inpatients, Edens and McDermott (2010) investigated the  
111 relationships between PPI-R total score, the SCI subscale, the FD subscale and impulsivity,  
112 as measured by the BIS-11, as well as a number of other criterion measures. They found that  
113 PPI-R and BIS-11 total scores were moderately correlated ( $r=.32, p<.001$ ). A different  
114 pattern of correlations was evident however when the total BIS-11 score was compared with  
115 the two subscales. SCI was strongly and positively associated with impulsivity ( $r=.32,$   
116  $p<.001$ ). FD was negatively, though not significantly, associated with impulsiveness ( $r=-.10,$   
117  $p>.05$ ). Having found extensive cross-loading of the fearlessness content scale, the authors  
118 computed an alternative version of the FD scale (which they labelled FD<sub>2</sub>) substituting for the  
119 full fearlessness content scale a subscale which loaded uniquely on FD. The negative  
120 correlation between FD<sub>2</sub> and impulsivity was significant, albeit small ( $r=-.23, p<.01$ ).

121 Furthermore a test of these dependant correlations indicated these opposing associations were  
122 significantly different from each other ( $t(194) = 6.86, p < .001$ ). The magnitude of this  
123 difference was even more pronounced when examining  $FD_2$ . Such findings are consistent  
124 with previous research and with theoretical conceptualisations of primary and secondary  
125 psychopathy.

126 One limitation of Eden and McDermott's study is that they only reported the total score for  
127 impulsivity. Investigation of the correlations between all of the subscales of both measures  
128 would likely have provided a clearer picture of the nature of the associations of psychopathy  
129 and impulsiveness constructs. Indeed, in a recent review Poythress and Hall (2010, p.120)  
130 concluded that "the blunt assertion that 'psychopaths are impulsive' is no longer defensible,  
131 and that future models of psychopathy need to consider more complex associations among  
132 the various manifestations of these two constructs".

133 The present study addresses this gap, expanding on previous research by exploring the  
134 relationship between psychopathy and impulsivity while taking into account the multi-faceted  
135 nature of each construct in a large non-offending sample. The primary hypothesis of this  
136 study is that the set of impulsivity variables and the set of psychopathy variables are related  
137 to each other.

138

## 139 **2. Method**

### 140 *2.1 Participants*

141 Participants were drawn from a University (student) population. In total, 1149 responses were  
142 returned, however due to missing data (where 1 or more questions were left unanswered) the  
143 final  $n = 970$ . Of the sample, 69.4% ( $n = 673$ ) respondents were female. Ages of participants

144 ranged from 17 to 66 years ( $M = 22.2$ ,  $SD = 6.42$ ). The majority of respondents were Irish  
145 (88.6%). Two other nationalities comprised >1% of the total sample, these were British (2%)  
146 and American (1.9%).

147

## 148 2.2 Measures

149 2.2.1 *Barratt Impulsiveness Scale, version 11 (BIS-11, Patton et al., 1995)*. The BIS-11 is a  
150 widely used and well-validated self-report measure of impulsivity. It consists of 30 items  
151 which form three distinct scales, namely: Attentional, Motor, and Non-planning  
152 Impulsiveness. Items were scored on a four-point Likert scale, with four indicating the most  
153 impulsive response. The higher the summed score from all responses, the higher the level of  
154 impulsivity. Eleven items were worded to indicate ‘nonimpulsiveness’ to avoid response sets  
155 such as acquiescence.

156 Internal consistency of the BIS-11 has generally been reported as good, often with  
157 Cronbach’s alpha values greater than .8 (e.g. Spinella, 2007; Stanford et al., 2009; but see  
158 also von Diemen et al., 2007). Test-retest reliability is also consistently reported to be  
159 satisfactory (e.g. Fossati, Di Ceglie, Acquarini, & Barratt, 2001; Stanford et al., 2009).

160 2.2.2 *Psychopathic Personality Inventory (PPI, Lilienfeld & Andrews, 1996)*. The PPI is a  
161 self-report measure of psychopathy which is suitable for use among general population  
162 samples, i.e. it is devoid of any items that measure anti-sociality. The PPI consists of 187  
163 items which have been shown through factor analysis to form eight subscales, namely Social  
164 Potency, Fearlessness, Coldheartedness, Impulsive noncompliance, Blame Externalisation,  
165 Carefree Nonplanfulness, Stress Immunity, and Machiavellian Egocentricity. Items are



166 scored on a four-point Likert scale with higher total scores indicative of higher level of  
167 psychopathic traits present.

168 Lilienfeld and Andrews (1996) have reported high internal consistency for the PPI total score,  
169 ranging from .89 to .93. Internal consistency for the eight PPI subscales ranged from .70 to  
170 .90.

171

### 172 *2.3 Procedure*

173 The BIS and the PPI were compiled into one computer based survey using ‘Survey Monkey’,  
174 a web-based survey tool. The survey was distributed electronically to a University population  
175 via email. This study was conducted in accordance with the Psychological Society of Ireland  
176 Code of Ethics and was granted ethical approval from the Social Research Ethics Committee,  
177 X University. In the invitation email, the full aims of the study were outlined, and the  
178 voluntary nature of participation was highlighted. No remuneration or other form of incentive  
179 was offered for participation. Participants were made aware that they could stop completing  
180 the survey at any time and that their answers provided to then would be deleted. They were  
181 provided with contact details for the researchers should they have any queries.

182

### 183 *2.4 Data analysis*

184 Simple relationships between the scales were investigated using bivariate correlations. A  
185 canonical correlation analysis was performed to explore the strength and nature of the  
186 association between impulsivity and psychopathy. Preliminary analyses were conducted  
187 using SPSS version 18, the canonical correlation analysis was conducted with a Windows  
188 computer program written by the second author and can be made available on request.

189 The present study employed canonical correlation analysis techniques for numerous reasons.  
190 Canonical correlation provides a statistical analysis for research where each subject is  
191 measured on two sets of variables and the researcher wants to know if and how the two sets  
192 relate to each other (Tabachnick & Fidell, 1996). Much of the previous research interested in  
193 the relationship between impulsivity and psychopathy has used multiple regression. In  
194 multiple regression a set of predictor variables is related to a single criterion variable, in other  
195 words a total score for psychopathy is related to all of the sub-scales of an impulsivity  
196 measure, or vice-versa. Canonical correlation is similar in theory to multiple regression,  
197 however in Canonical correlation there are several variables on both sides of the equation.  
198 Sets of variables are combined to produce, for each side, a predicted value that has the  
199 highest correlation with the predicted value on the other side. The combination of variables  
200 on each side can be thought of as a dimension that relates the variables on one side to the  
201 variables on the other (Tabachnick & Fidell, 1996). As psychopathy and impulsivity are  
202 multivariate in nature, an analytic approach that allows for multiple independent variables is  
203 preferred. Use of canonical correlation for this study enabled a more in-depth analysis of the  
204 relationship between impulsivity and psychopathy than would have been possible with  
205 univariate statistical procedures such as multiple regression. To the authors' knowledge, this  
206 study is the first to investigate the relationship between psychopathy and impulsivity using a  
207 canonical variate analysis. For more information on this technique, see (Sherry & Henson,  
208 2005).

209

### 210 **3. Results**

211 The simple relationships between the scales of the BIS and PPI were investigated using  
212 bivariate correlations (table 1). There was a large significant correlation between BIS and PPI

213 total scores ( $r = .57, p < .01$ ). The majority of the correlations between the subscales (shown  
214 within dashed lines table 1) of the BIS and PPI were also significant, and of a medium to  
215 large effect size.

216 A canonical correlation analysis was conducted to evaluate the multivariate shared  
217 relationship between the subscales of the PPI and the BIS. The three subscales of the BIS  
218 were entered as the dependent variables and the eight variables of the PPI were entered as the  
219 canonical variables.

220 The analysis yielded three functions with squared canonical correlations ( $R_c^2$ ) of .757, .432,  
221 and .377 respectively. The full model across all functions was statistically significant  
222 (Wilks's  $\lambda = .298, F[24, 263] = 56.74, p < .001$ ). Because Wilks's  $\lambda$  represents the variance  
223 unexplained by the model,  $1 - \lambda$  yields the full model effect size in an  $r^2$  metric. Thus, for the  
224 set of three canonical functions, the  $r^2$  type effect size was .702 which indicates that the full  
225 model explained a substantial portion, 70.2%, of the variance shared between the variable  
226 sets. It is important to note that any function other than the 1<sup>st</sup> is based upon the residual  
227 variance left after that of the preceding functions is removed. Thus interpretation of these  
228 functions needs to be carried out with caution.

229 A dimension reduction analysis was used to test the hierarchal arrangement of functions for  
230 statistical significance. As noted, the full model (Functions 1-3) was statistically significant.  
231 Functions 2 to 3 and 3 to 3 were also statistically significant,  $F(14, 181) = 25.54, p < .001$ ,  
232 and  $F(6, 90) = 25.11, p < .001$ , respectively. Given the  $R_c^2$  effects for each function, all three  
233 of the functions were considered statistically meaningful in this analysis. Table 2 presents the  
234 Eigenvalues and Wilk's Lambda values for the Functions 1, 2 and 3, and Table 3 presents the  
235 standardised canonical function coefficients and structure coefficients for the three functions,  
236 as well as the squared structure coefficients and the communalities ( $h^2$ ) across the three

237 functions for each variable. It is important in CCA that these functions manifest a clear and  
238 unambiguous structure that can be theoretically supported because of the residual nature of  
239 the variance that they are based upon.

240 Looking at the Function 1 coefficients, all three criterion variables (Attentional  
241 Impulsiveness, Motor Impulsiveness, and Non-Planning Impulsiveness) were all primarily  
242 relevant (all  $r_s > .7$ ). This conclusion was supported by the squared structure coefficients.  
243 While Non-Planning Impulsiveness had a large canonical function coefficient, this value was  
244 small for Attentional and Motor Impulsiveness. This may be due to the multicollinearity that  
245 these two variables exhibited with the other criterion variables. Lastly, these three variables  
246 had structure coefficients with the same sign, indicating that they were all positively related,  
247 as expected.

248 Regarding the predictor variable set in Function 1, Non-Planfulness and Impulsive Non-  
249 Compliance were the primary contributors to the predictor synthetic variable, with secondary  
250 contribution by Machiavellian Egocentricity and Fearlessness. Again, all of the predictor  
251 variables were positively related. These results support the relationship between PPI and BIS  
252 variables where one might expect the impulse control related subscales of the PPI to correlate  
253 most highly with all of the subscales of the BIS. Important to note is that the amount of  
254 shared variance between the set of PPI scales and the BIS scales was high ( $R_c^2 = 75.7\%$ ).

255 Moving to Function 2, the structure coefficients suggest modest relationships between the  
256 variables. Of the criterion variables only Non-Planning Impulsiveness had a structure  
257 coefficient greater than .4, and of the predictor variables Fearlessness, Impulsive Non-  
258 Compliance, Non-Planfulness, and Social Potency had structure coefficients greater than this  
259 value. Fearlessness, Impulsive Non-Compliance, and Social Potency were all inversely

260 related on this function. Non-Planning Impulsiveness from the BIS, and the two impulse  
261 control related scales and two other PPI scales, all showed similar shared variances.

262 Looking at Function 3, Motor- and Attentional Impulsiveness had the greatest structure  
263 coefficients of the criterion variables, with Attentional Impulsiveness showing an inverse  
264 relationship to this function. Of the predictor variables, Stress Immunity and Social Potency  
265 were the primary contributors (with  $r_s^2 > 45\%$ ), while Blame Externalisation made a  
266 secondary contribution, and was the only variable showing an inverse relationship to the  
267 function.

268

#### 269 **4. Discussion**

270 In the present study over 70% of the variance in psychopathy and impulsivity scores was  
271 shared, consistent with the body of research supporting a strong relationship between  
272 psychopathy and deficient impulse control (Hare, 1991). Blaszczynski, Steel, and  
273 McConaghy (1997, p.85) asserted that “impulsivity and psychopathy are one and the same  
274 thing”; while this extreme view may not be defensible, the current results suggest that  
275 generalised measures of psychopathy, such as the PPI, may be in fact be largely contaminated  
276 by impulsivity variance. It has been suggested that the power of some psychopathy measures,  
277 specifically the PCL-R to predict violence/criminality may be due largely to their tapping into  
278 impulse control (Skeem et al., 2011).

279 More recently it has been recognised that the relationship between psychopathy and impulse  
280 control is more complex. The current study addressed the need for an investigation into the  
281 complex relationship between these two constructs (e.g. Poythress & Hall, 2010) by going

282 beyond unitary measures using a multivariate technique; with the results supporting a more  
283 complex relationship between these two constructs.

284 The results supported three unique patterns of relationship between the PPI and BIS  
285 subscales. Function 1 showed that about three quarters of the variance in psychopathy scores  
286 can be accounted for by impulsiveness. This reflects other research suggesting that  
287 psychopathy scales may largely be measuring impulsive traits (Blaszczynski, Steel &  
288 McConaghy, 1997).

289 Function 2 is defined by non-planning impulsiveness (i.e. a present orientation), fearless  
290 dominance, (i.e. takes physical risks), impulsive nonconformity (i.e. reckless, rebellious),  
291 Non-planning impulsivity (i.e. lacks forethought) and Social Potency (i.e. able to manipulate  
292 and influence others). This person lives in the now, and is similar to conceptualisations of the  
293 Impulsive Antisociality subtype of the PPI or Secondary Psychopathy.

294 Function 3 describes a person who has the ability to plan ahead (low in Non-Planning  
295 impulsiveness) but can think and act quickly, where this may be beneficial (high in  
296 Attentional and Motor Impulsiveness). This person doesn't experience anxiety in tense  
297 situations, is able to influence others, and tend to blame their mistakes on others (Social  
298 Potency, Blame Externalisation, Stress Immunity). This is closer to the description of the  
299 Fearless Dominance subtype of the PPI or the Primary psychopath.

300 Overall these results add weight to previous arguments that the shared space between  
301 psychopathy and impulsivity is best understood as multidimensional. In this case three  
302 dimensions were uncovered, however this number is an artefact of the BIS having three  
303 scales, i.e. there were three dependent variables in the analysis. Accepting the division of  
304 Fearless Dominance/Primary and Impulsive Antisociality/Secondary Psychopathy, these  
305 results suggest that 'planning impulsivity' may be the key to distinguishing between the two

306 types. These sub-divisions also support the results of Ray, Poythress, Weir and Rickelm  
307 (2009) and Edens and McDermott (2010), who found different patterns of relationship, while  
308 using other statistical techniques. This research has addressed the claim by Ray (2009) that a  
309 clearer understanding of the precise relationship between impulsivity and psychopathy will  
310 be useful in identifying psychopathy subtypes.

311 There are some limitations to the CCA technique. Some authors (Marascuilo and Levin,  
312 1983; Tabachnick and Fidell, 1996) state that canonical correlation is best considered a  
313 descriptive technique or a screening procedure rather than a hypothesis-testing procedure. We  
314 concur with this view and emphasis that the analysis that is presented here is descriptive.  
315 However, it gives us a picture of how the BIS and the PPI scales relate. The use of CCA in  
316 this study had a number of advantages. Most of the previous literature in this area has used  
317 the more common univariate (one dependent variable) methods such as multiple regression  
318 and ANOVA which mean that the total score of one scale is compared with the multiple  
319 facets of the second scale individually. The CCA is an analytic method which allows for  
320 comparison of all of the subscales of two measures at once, thus allowing for the clearest  
321 picture of the relationship between the multiple facets of psychopathy and impulsivity offered  
322 thus far. In this instance, use of this procedure was appropriate given that use of CCA enabled  
323 us to account for fully 70% of the shared variance between the measures. However, future  
324 research seeking to replicate and refine these findings might make use of more familiar  
325 hypothesis-driven, analytic strategies drawn from Structural Equation Modelling. This would  
326 allow for a more detailed examination of a higher factorial dimensionality in impulse control  
327 measures.

328 These findings apply to one particular broad-based model of psychopathy as operationalised  
329 through the PPI. There are of course other models such as those exemplified in the PCL-R  
330 (Hare, 2003) although our purpose was to explore a conception of psychopathy in the general

331 population. Equally, the BIS is not the only model of impulsivity and indeed the UPPS-P  
332 (Cyders et al., 2007) appears to have a better claim as a multifaceted tool. Nevertheless, the  
333 BIS is the most commonly used and accessible tool in impulsivity research ranging from  
334 normal contexts to forensic pathology. It would be useful to examine whether the picture that  
335 emerges from these analyses might be replicated using other assessment devices and models  
336 and might serve as a basis for future SEM modelling at both the measurement and structural  
337 levels of analysis.

#### 338 *4.1 Conclusion*

339 The present findings support a complex multi-dimensional relationship between impulsivity  
340 and psychopathy, while at the same time supporting a multifaceted model of psychopathy.  
341 CCA was shown to be a useful technique for exploring multivariate shared relationship  
342 between these constructs.

343



344 **References**

- 345 Benning, S. D., Patrick, C. J., Blonigen, D. M., Hicks, B. M., & Iacono, W. G. (2005).  
346 Estimating facets of psychopathy from normal personality traits: A step toward  
347 community-epidemiological investigations. *Assessment, 12*, 3–18.
- 348 Blaszczynski, A., Steel, Z., & McConaghy, N. (1997). Impulsivity in pathological gambling:  
349 the antisocial impulsivist. *Addiction, 92*(1), 75-87.
- 350 Cleckley, H. (1941). *The mask of sanity*. Mosby: St. Louis.
- 351 Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: A meta-  
352 analysis. *Psychological Bulletin, 137*(1), 97-130.
- 353 Cyders, M. A., Smith, G. T., Spillane, N. S., Fischer, S., Annus, A. M., & Peterson, C. (2007).  
354 Integration of impulsivity and positive mood to predict risky behavior: development  
355 and validation of a measure of positive urgency. *Psychological assessment, 19*(1), 107.
- 356 Fossati, A., Di Ceglie, A., Acquarini, E., & Barratt, E. S. (2001). Psychometric Properties of  
357 an Italian Version of the Barratt Impulsiveness Scale-11 (BIS-11). *Journal of Clinical*  
358 *Psychology, 57*(6), 815-828.
- 359 Hare, R.D. & McPherson, L.M. (1984). Violent and criminal behaviour by criminal  
360 psychopaths. *International Journal of Law and Psychiatry, 7*, 33-50.
- 361 Hare, R. D., & Vertommen, H. (1991). *The Hare psychopathy checklist-revised*. Multi-Health  
362 Systems, Incorporated. Hare, R. D. (2003). *Hare Psychopathy Checklist-Revised (PCL-*  
363 *R): 2nd Edition, Technical Manual*. Toronto, ON, Canada: Multi-Health Systems.

- 364 Lilienfeld, S. O. & Andrews, B. P. (1996). Development and preliminary validation of a self-  
365 report measure of psychopathic personality traits in noncriminal populations. *Journal*  
366 *of Personality Assessment*, 66, 488-524.
- 367 Lilienfeld, S. O. & Widows, M. R. (2005). Psychological assessment inventory-revised (PPI-  
368 R). Lutz, FL: Psychological Assessment Resources.
- 369 Marascuilo, L.A. & Levin, J.R. (1983) *Multivariate Statistics in the Social Sciences: A*  
370 *Researcher's Guide*.. Belmont, California: Brooks/Cole.
- 371 Moeller, F. G., Dougherty, D. M., Barratt, E. S., Schmitz, J. M., Swann, A. C., & Grabowski,  
372 J. (2001). The impact of impulsivity on cocaine use and retention in treatment. *Journal*  
373 *of Substance Abuse Treatment*, 21, 193–198.
- 374 Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt  
375 Impulsiveness Scale. *Journal of Clinical Psychology*, 51(6), 768-774.
- 376 Patrick, C. J., Hicks, B. M., Krueger, R. F., & Lang, A. R. (2005). Relations between  
377 psychopathy facets and externalizing in a criminal offender sample. *Journal of*  
378 *Personality Disorders*, 19(4), 339-356.
- 379 Ray, J. V., Poythress, N. G., Weir, J. M., & Rickelm, A. (2009). Relationships between  
380 psychopathy and impulsivity in the domain of self-reported personality features.  
381 *Personality and Individual Differences*, 46(2), 83-87.
- 382 Reise, S. P., Moore, T. M., Sabb, F. W., Brown, A. K., & London, E. D. (2013). The Barratt  
383 Impulsiveness Scale–11: Reassessment of its structure in a community  
384 sample. *Psychological assessment*, 25(2), 631.

385 Sherry, A. & Henson, R. K. (2005). Conducting and interpreting canonical correlation analysis  
386 in personality research: A user-friendly primer. *Statistical Developments and*  
387 *Applications*, 84(1), 37-48.

388 Skeem, J. L., Polaschek, D. L., Patrick, C. J., & Lilienfeld, S. O. (2011). Psychopathic  
389 personality bridging the gap between scientific evidence and public  
390 policy. *Psychological Science in the Public Interest*, 12(3), 95-162.

391 Skeem, J. L., Poythress, N. G., Edens, J. F., Lilienfeld, S. O., & Cale, E. M. (2003).  
392 Psychopathic personality or personalities? Exploring potential variants of psychopathy  
393 and their implications for risk assessment. *Aggression and Violent Behaviour*, 8, 513-  
394 546.

395 Spinella, M. (2007). Normative data and a short form of the Barratt impulsiveness scale.  
396 *International Journal of Neuroscience*, 117(3), 359-368. doi:  
397 10.1080/00207450600588881

398 Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J.  
399 H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review.  
400 *Personality & Individual Differences*, 47(5), 385-395.

401 Tabachnick, B. G., & Fidell, L. S. (1996). *Using Multivariate Statistics*. (3<sup>rd</sup> ed.). New York:  
402 Harper-Collins.

403 Von Diemen, L., Szobot, C. M., Kessler, F., & Pechansky, F. (2007). Adaptation and construct  
404 validation of the Barratt Impulsiveness Scale (BIS 11) to Brazilian Portuguese for use  
405 in adolescents. *Revista Brasileira de Psiquiatria*, 29(2), 153-156.

406 Whiteside, S. P., & Lynam, D. R. (2001). The Five Factor Model and impulsivity: using a  
407 structural model of personality to understand impulsivity. *Personality and Individual*  
408 *Differences*, 30(4), 669-689.

409 Table 1

410 *Bivariate Correlations between BIS and PPI subscales and total scores*

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1												
2	.769*	1											
3	.852*	.483*	1										
4	.851*	.485*	.568*	1									
5	.569*	.402*	.551*	.396*	1								
6	.185*	.024*	.316*	.034*	.686*	1							
7	.408*	.299*	.447*	.239*	.769*	.508*	1						
8	.058*	-.087*	.055*	.086*	.631*	.306*	.323*	1					
9	.516*	.396*	.517*	.334*	.790*	.483*	.661*	.338*	1				
10	.345*	.407*	.221*	.223*	.632*	.224*	.342*	.225*	.457*	1			
11	.661*	.442*	.487*	.673*	.728*	.277*	.444*	.485*	.561*	.455*	1		
12	-.010*	-.193*	.108*	-.057	.658*	.607*	.571*	.567*	.436*	.080^	.340*	1	
13	.459*	.429*	.380*	.302*	.842*	.423*	.514*	.506*	.580*	.660*	.635*	.326*	1

411 *Notes.* 1 = BIS Total; 2 = BIS Attentional; 3 = BIS Motor; 4 = BIS Non-planning; 5 = PPI Total; 6 = PPI Social Potency; 7 = PPI Fearless Dominance; 8 = PPI  
 412 Coldheartedness; 9 = PPI Impulsive Nonconformity; 10 = PPI Blame Externalisation; 11 = PPI Nonplanfulness; 12 = PPI Stress Immunity; 13 = PPI  
 413 Machiavellian Egocentricity.

414 \*  $p < 0.01$ , ^  $p < 0.05$

Table 2  
*Canonical Correlation Between PPI and BIS subscales*

Function	Eigenvalue	%	Canonical R	Wilks's lambda
1	1.340	77.25	.757	.298*
2	0.229	13.19	.432	.698*
3	0.166	9.55	.377	.858*

\* $p < .001$

416 Table 3

417 *Canonical solution for Impulse Control predicting Psychopathy for Functions 1 to 3*

Variable	Function 1			Function 2			Function 3			
	Coef	$r_s$	$r_s^2$ (%)	Coef	$r_s$	$r_s^2$ (%)	Coef	$r_s$	$r_s^2$ (%)	$h^2$ (%)
Attentional Impulsiveness	.378	<u>-.782</u>	61.15	<u>.510</u>	.319	10.18	<u>1.011</u>	<u>.536</u>	28.73	<u>100.00</u>
Motor Impulsiveness	.331	<u>-.799</u>	63.84	<u>.776</u>	.360	12.96	<u>-.947</u>	<u>-.481</u>	23.14	<u>100.00</u>
Non-planning Impulsiveness	<u>.502</u>	<u>-.874</u>	76.39	<u>-1.166</u>	<u>-.478</u>	22.85	-.0387	-.086	0.74	<u>100.00</u>
Social Potency	.116	-.160	2.56	.189	<u>.455</u>	20.70	<u>-.617</u>	<u>-.698</u>	48.72	<u>71.98</u>
Fearlessness	.264	<u>-.497</u>	24.70	.296	<u>.483</u>	23.33	-.029	-.300	9.00	34.80
Cold-heartedness	.142	-.021	0.44	-.247	-.304	9.24	-.155	-.285	8.12	17.80
Impulsive noncompliance	.200	<u>-.638</u>	40.70	<u>.414</u>	<u>.462</u>	21.34	-.123	-.237	5.62	<u>67.66</u>
Blame externalisation	.071	<u>-.437</u>	19.10	-.028	.234	5.48	<u>.427</u>	<u>.561</u>	31.47	<u>56.05</u>
Nonplanfulness	<u>.735</u>	<u>-.871</u>	75.86	<u>-.805</u>	<u>-.461</u>	21.25	-.235	-.059	0.34	<u>97.45</u>
Stress Immunity	.220	.105	1.10	-.161	.053	0.28	-.222	<u>-.721</u>	51.98	<u>53.36</u>
Machiavellian Egocentricity	.056	<u>-.570</u>	32.49	<u>.457</u>	.325	10.56	.333	.220	4.84	<u>47.89</u>
<b><math>R_c^2</math></b>			<b>75.7</b>			<b>43.2</b>			<b>37.7</b>	

418 *Notes.* Structure coefficients ( $r_s$ ) greater than .40 are underlined. Community coefficients ( $h^2$ ) greater than 40% are underlined. Coef = standardised canonical  
 419 function coefficient;  $r_s$  = structure coefficient;  $r_s^2$  = squared structure coefficient;  $h^2$  = communality coefficient.