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Big Five Personality Traits and Alcohol, Nicotine, Cannabis, and Gambling Disorder Comorbidity

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The *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*; 5th ed.) reassignment of gambling disorder as an addictive disorder alongside the substance-related addictive disorders encourages research into their shared etiologies. The aims of this study were to examine: (a) the associations of Big Five personality dimensions with alcohol, nicotine, cannabis, and gambling disorders, (b) the comorbidity between these disorders, (c) the extent to which common personality underpinnings explain comorbidity, (d) whether results differed for men and women, and (e) the magnitude of personality differences corresponding to the 4 disorders. Participants were 3,785 twins and siblings (1,365 men, 2,420 women; M_{age} = 32 years, range = 21–46 years) from the Australian Twin Registry who completed psychiatric interviews and Big Five personality inventories. The personality profile of high neuroticism, low agreeableness, and low conscientiousness was associated with all 4 addictive disorders. All but 1 of the pairwise associations between the disorders were significant. After accounting for Big Five traits, the associations were attenuated to varying degrees but remained significant. The results were generally similar for men and women. The results suggest that the Big Five traits of neuroticism, agreeableness, and conscientiousness are associated with the general propensity to develop an addictive disorder and may in part explain their co-occurrence; however, they may be more broadly associated with the propensity for any psychiatric disorder. The effect sizes of the personality associations suggest that the diagnosis of gambling disorder as operationalized by the *DSM* may be more severe than the other addictive disorders. Calibration of the diagnosis of gambling disorder to the other addictive disorders may be warranted.

Keywords: substance use disorders, gambling disorder, comorbidity, Big Five personality, sex differences

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A substantial portion of individuals with an alcohol use, drug use, or gambling disorder (GD) have experienced another comorbid addictive disorder (Petry, Stinson, & Grant, 2005; Saha et al., 2018; Stinson et al., 2005). Due in part to these high rates of comorbidity of GD with substance use disorders (SUDs), it has been newly described alongside the SUDs under the category of substance-related and addictive disorders in the most recent edition of the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.

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[*DSM-5*]; American Psychiatric Association [APA], 2013). This reorganization of the *DSM* encourages research into the overlapping etiologic mechanisms, such as common personality underpinnings, of GD and SUDs.

Research on the personality correlates of alcohol and other SUDs has previously been synthesized in a meta-analysis that characterized these in terms of the Big Three (negative emotionality, positive emotionality, and disinhibition/low constraint) and Big Five (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) personality dimensions (Kotov, Gamez, Schmidt, & Watson, 2010).[1] Alcohol use disorder (AUD) was significantly associated with neuroticism, disinhibition, and low conscientiousness but not extraversion, openness to experience, or agreeableness. Another SUD was associated with neuroticism, disinhibition, and low conscientiousness and was also significantly associated with low extraversion and low agreeableness (Kotov et al., 2010). Follow-up analyses demonstrated that the strengths of the associations between personality and mental health disorders were stronger in patient populations than epidemiologic samples (Kotov et al., 2010), highlighting the importance of focusing on population-representative samples to accurately estimate the strength of the association of personality with mental health disorders (Krueger, Caspi, & Moffitt, 2000).

The meta-analysis described above did not include GD. Individual community-based studies examining Big Three and Big Five personality correlates of GD have yielded somewhat mixed findings. Among the studies of Big Five correlates, one found significant associations with neuroticism, low agreeableness, and low conscientiousness but not extraversion or openness to experience (Brunborg, Hanss, Mentzoni, Molde, & Pallesen, 2016), whereas another found significant associations with neuroticism, low openness to experience, and low agreeableness but not extraversion or low conscientiousness (Miller et al., 2013). Among the studies of Big Three personality correlates of GD, one found a significant association with negative emotionality but not with positive emotionality or disinhibition/constraint (Miller et al., 2013), and another found significant associations with all three dimensions (Slutske, Cho, Piasecki, & Martin, 2013). Surprisingly, in both studies, negative emotionality was the strongest personality correlate of GD, whereas the association with disinhibition/constraint was modest. Across these studies, there was consistent support for neuroticism/negative emotionality and low agreeableness, mixed support for conscientiousness, disinhibition/constraint, and openness to experience and little support for an important association with extraversion.

Comparing the results of the meta-analysis of the personality correlates of AUD (Kotov et al., 2010) and other SUDs (Kotov et al., 2010) and the individual studies of the personality correlates of GD (Brunborg et al., 2016; Miller et al., 2013; Slutske et al., 2013) suggests that neuroticism/negative emotionality is consistently associated with all three disorder types. Disinhibition/constraint and low conscientiousness are consistently associated with AUD and other SUDs, low agreeableness is consistently associated with other SUDs and GD, and low extraversion is only consistently associated with other SUDs. These results suggest that different personality traits may be a source of the comorbidity between specific pairs of addictive disorders.

Although these cross-study comparisons of personality correlates of addictive disorders are informative, the most incisive approach is to make these comparisons within the same study (Krueger, Caspi, Moffitt, Silva, & McGee, 1996). This approach also allows for a direct test of the hypothesis that personality traits are a source of comorbidity. An example of this approach comes from a study in which Big Three personality traits assessed at age 18 years were correlated with past-year alcohol, nicotine, and cannabis dependence (diagnosed according to the *DSM–III–Revised*; APA, 1987), and GD (diagnosed using a short form of the South Oaks Gambling Screen; Lesieur & Blume, 1987), assessed at age 21 years (Slutske, Caspi, Moffitt, & Poulton, 2005). All four disorders were similarly characterized by high negative emotionality and disinhibition/constraint, and only cannabis dependence was associated with low positive emotionality. The high rates of comorbidity between the disorders were substantially reduced after controlling for individual differences in the Big Three personality traits.

The present study used a similar within-study approach as the previous study (Slutske et al., 2005) but used the most widely used personality taxonomy, the Big Five (John & Srivastava, 1999), and *DSM* diagnoses for all four of the addictive disorders. The aims were to examine: (a) the associations of the Big Five personality traits with alcohol use, nicotine use, cannabis use, and gambling disorders; (b) the comorbidity of these addictive disorders; (c) the extent to which common personality underpinnings could explain this comorbidity; (d) whether these personality associations, comorbidity patterns, and effects of personality on comorbidity differed for men and women; and (e) identification of the quantitative differences in the mean-level endorsement of each personality trait across the four disorders.

The final aim leverages the power of the within-study approach to compare the magnitude of the personality differences across the four addictive disorders. Such a comparison may provide novel insights into the relative severity of the disorders (Kotov et al., 2010). Now that GD is included among the substance use disorders in the *DSM*, an important next step may be to better calibrate the diagnoses so that they are all on the same metric of severity (Weinstock, April, & Kallmi, 2017).

Method

Participants

Participants were 3,298 individual twins and 487 singleton siblings from the Australian Twin Registry Cohort III (M_{age} = 32 years [*SD* = 3.04], range = 21–46 years, 64% female; for more information about participants, see Lynskey et al., 2012). Approximately 54% of the sample was married, 41% was single or never married, and 5% was separated, divorced, or widowed. Approximately 25% of the sample attained a high school education or less, 28% completed technical school, 27% completed undergraduate studies, and 20% completed graduate school. The majority were

[1] Results for negative emotionality and neuroticism were combined and termed neuroticism, and results for positive emotionality and extraversion were combined and termed extraversion, yielding the following six dimensions: neuroticism, extraversion, openness to experience, agreeableness, conscientiousness, and disinhibition/constraint.

employed full time (61%) or part time (16%) or were homemakers (12%); approximately 1.5% were unemployed, and the remaining participants were students (2.5%), casually employed[2] (6.5%), or on pension (approximately 0.5%).

The original data collection was approved by the Institutional Review Boards at Washington University and Berghofer Queensland Institute of Medical Research, and secondary analysis of these data was determined to be exempt by the University of Missouri Institutional Review Board.

Procedure

Participants were surveyed by computer-assisted telephone interview in 2005–2009 (participation rate = 76%; Lynskey et al., 2012) and were subsequently invited to complete a self-report questionnaire (response rate = 94%), either online (75%) or paper and pencil via postage-paid mail (25%). Each participant typically completed the questionnaire within 2 weeks of their computer-assisted telephone interview.

Measures

Personality. Big Five personality traits were assessed using an adapted NEO PI-R (Costa & McCrae, 1992a, 1992b; Few et al., 2014). The questionnaire consisted of 74 items scored on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. Scores were generated by summing the items for each scale, which were subsequently standardized via z transformation for analysis, such that $M = 0$ and $SD = 1$.

Addictive disorders. The substance use disorders assessment was drawn from the Australian version of the Semi-Structured Assessment of the Genetics of Alcoholism (Bucholz et al., 1994; Heath et al., 1997). Lifetime diagnoses were based on the *DSM–IV* criteria (APA, 1994). Diagnoses of AUD and cannabis use disorder (CUD) were obtained by combining abuse and dependence diagnoses. Lifetime nicotine use disorder was solely based on the nicotine dependence (ND) diagnosis because nicotine abuse was not included in the *DSM–IV*. Lifetime GD was assessed with the NORC *DSM–IV* Screen for Gambling Problems (Gerstein et al., 1999). The test-retest reliabilities in a similar Australian cohort of *DSM–IV* alcohol ($r = .64$), nicotine ($r = .84$), and cannabis use ($r = .82$) disorder symptom counts (Richmond-Rakerd et al., 2016) and of *DSM–IV* GD diagnoses ($\kappa = .67$, Yule's $Y = .79$; Slutske et al., 2013) were all acceptable. Because the *DSM–IV* diagnostic criteria for GD do not require that the symptoms cluster within a 12-month period, this criterion was not imposed for the three other disorders.[3] Because data were available only for lifetime GD, lifetime disorder was the primary focus of the study. Note that the severity of the four disorders was not necessarily equal, in that AUD and CUD required either 1 (for abuse) or 3 (for dependence) symptom(s), ND required 3 (for dependence), and *DSM–IV* GD required 5.[4]

Statistical Analysis

Reliabilities for the Big Five personality trait scales were estimated in R (see McNeish, 2018). All other analyses were conducted using survey data analysis procedures in SAS software, version 9.4 (SAS Institute, 2015) that took into account the nonindependence of twin pair observations. Effect sizes (interpreted using Cohen's d conventions of .20 = modest, .50 = moderate, .80 = large) were calculated[5] to examine mean differences for each personality trait between individuals with and without each disorder. This step was repeated within men and women separately. Next, sex differences in these associations were evaluated via logistic regression by regressing each disorder on each personality trait, sex, and the sex-by-personality interaction.

Odds ratios of the associations between all pairs of disorders were examined using logistic regression. In Step 1, relations between each disorder pair were examined. In Step 2, a sex-by-disorder interaction was added to the model to assess potential sex differences in comorbidity pairs. In Step 3, the models were rerun controlling for all five personality scales to examine the extent to which personality differences might account for relations between each pair of disorders.

A Note on the Use of a Twin Sample

Biometric twin modeling was not conducted in this paper. General population surveys of twins can be useful for more than just answering questions about genetic and environmental underpinnings of behavior—they can also address epidemiological questions such as those posed in this paper. There are two potential concerns with the use of twins as subjects in survey research: that the inclusion of nonindependent observations may influence the estimates of variability and statistical significance testing (because twins are genetically related, their inclusion may not meet the assumption of independent observations required in standard statistical testing [McCoach & Adelson, 2010]) and whether twins are representative of the general population. The first concern can be handled by using established survey analysis procedures (described earlier) that have been developed for analyzing clustered data (SAS Institute, 2015). In regard to the second concern, it has been well established that twins are representative of the general population with respect to psychiatric symptoms (Kendler, Martin, Heath, & Eaves, 1995) and personality traits (Johnson & Krueger, Bouchard, & McGue, 2002).

Because our sample included 3,298 twins and 487 singleton siblings, we were able to directly test the representativeness of the twins in this study. The four addictive disorders were equally

[2] Casual employment is an employment status for which workers are typically paid a higher hourly rate but are neither guaranteed employment nor provided typical employment conditions (e.g., sick leave). Casually employed individuals are not obligated to ongoing work and are able to switch workplaces at their choosing.

[3] The use of alternate diagnostic approaches, including the use of clustering, is the focus of post hoc analyses.

[4] It was possible to recode the data to derive a *DSM–5* gambling disorder diagnosis that required only four symptoms and was therefore more comparable with the substance-related disorders, but the alcohol, cannabis, and (especially) the nicotine use disorder data could not be recoded to conform to a *DSM–5* diagnosis. To be consistent, *DSM–IV* diagnoses were used for all disorders. We reran all of the analyses using *DSM–5* diagnostic criteria for gambling disorder, and the results were nearly identical. There were 66 individuals who met the *DSM–IV* criteria, and 17 more (83 total) who met the *DSM–5* criteria. The Big Five personality profiles based on *DSM–5* GD diagnoses can be found in Table 2 (and Supplemental Figure 1 in the online supplemental materials).

[5] The formula used to calculate effect size was as follows: $M_1 - M_2/\sqrt{[(SD_1^2 + SD_2^2)/2]}$.

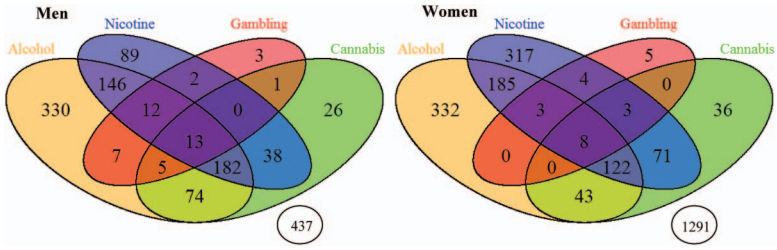

Figure 1. Co- and multimorbidity prevalence (N) in men and women. N_{men} = 1,365; N_{women} = 2,420; detached circle denotes no lifetime disorder. Each full ellipse contains all individuals meeting criteria for its corresponding disorder. Cells formed by the overlap of the four ellipses indicate the number of individuals with each co- or multimorbidity pattern; for each disorder there were eight possible diagnostic patterns. For example, among the 23 women with gambling disorder: (a) only five had no comorbid addictive disorder, (b) four had comorbid nicotine dependence only, (c) three had comorbid nicotine dependence and alcohol use disorders, (d) three had comorbid nicotine dependence and cannabis use disorder, (e) eight had comorbid nicotine dependence, alcohol use disorder, and cannabis use disorder, (f) none had comorbid cannabis use disorder only, (g) none had comorbid alcohol use disorder only, and (h) none had both comorbid alcohol and cannabis use disorders. This Venn diagram is intended to illustrate the patterns of co- and multimorbidity in the sample and does not represent the sample sizes used in the statistical analyses. The full samples of individuals with each disorder (AUD, ND, CUD, GD) were used for analyses, resulting in all analyses using no fewer than 23 cases (women with gambling disorder). See Supplemental Table 1 in online supplemental materials for disorder combinations in percentage format. See the online article for the color version of this figure.

prevalent and did not significantly differ between the twins and singletons: AUD = 38.8% versus 37.4%, ND = 31.6% versus 31.4%, CUD = 16.5% versus 15.9% and GD = 1.7% versus 1.9%. The age- and sex-adjusted means of the Big Five personality traits for twins and singletons were quite similar for neuroticism ($d = -.07$) and agreeableness ($d = .05$) and differed only slightly for openness ($d = -.12$), conscientiousness ($d = .21$), and extraversion ($d = .21$). Overall, the mean difference in Big Five traits between the twins and singletons was only about one tenth of a standard deviation.

Results

Addictive Disorder Prevalence

Approximately 54% of the sample (68% of men, 47% of women) met criteria for at least one lifetime diagnosis. Thirty percent met criteria for one diagnosis only (i.e., pure disorder; 33% of men, 29% of women), 15% met criteria for two diagnoses (20% of men, 13% of women), 8% met criteria for three (15% of men, 5% of women), and 0.55% met criteria for all four diagnoses (0.95% of men, 0.33% of women). AUD was the most prevalent (56% of men, 29% of women),[6] followed by ND (35% of men, 29% of women), CUD (25% of men, 12% of women), and GD (3% of men, 1% of women). The comorbidity patterns for men and women presented in Figure 1 (Chen & Boutros, 2011) illustrate two important points: (a) that there were relatively few pure cases of CUD and GD and (b) that comorbidity often entailed more than two disorders in combination; that is, multimorbidity was common (see Supplemental Materials Table 1 for prevalences of the comorbidity patterns.)

Personality Profiles for Alcohol, Nicotine, Cannabis, and Gambling Disorders

Descriptive statistics for the personality traits are presented in Table 1, and associations between personality and addictive disorders are presented in Table 2 and Figure 2. All four disorders were associated with high neuroticism, low agreeableness, and low conscientiousness, with modest to moderate effect sizes for AUD, ND, and CUD and large effect sizes for GD. The personality profiles of the four disorders were similar, except that ND and CUD were modestly associated with low extraversion, CUD was moderately associated with openness, and the effect sizes were appreciably larger for GD (see Supplemental Figure 1 in the online supplemental materials for a direct comparison of the four disorders). The associations between personality traits and addictive disorders were generally comparable in men and women with two exceptions. Logistic regression models that included an interaction term showed that (a) the association of higher openness to experience and AUD was stronger in women ($d = .12$) than men ($d = -.03$) ($\chi[1] = 3.99$, $p = .05$), and (b) that the association of low extraversion and GD was marginally stronger in women ($d = -.68$) than men ($d = -.18$) ($\chi[1] = 3.50$, $p = .06$).

Personality Profiles Using Different Symptom Thresholds for Gambling Disorder

The effect sizes for *DSM–IV* GD may have been appreciably larger than for the SUDs because GD required five symptoms for diagnosis, whereas the SUDs required only one (for abuse) or three (for dependence). In an effort to calibrate the severities of all four addictive disorders, analyses were conducted to examine the effect sizes associated with less strict definitions of GD, including one, two, and three symptom count thresholds.

[6] The high rate of AUD is likely attributable to the use of lifetime unclustered diagnoses that combined abuse and dependence. The prevalence of past-year clustered AUD was 26.2% and 9.9% among men and women, respectively, and the prevalence of past-year clustered alcohol dependence was 4.8% and 1.8% among men and women, respectively.

Table 1
Big Five Scale Reliabilities, Means, and Interscale Correlations

Variables	Reliability		Means/SEs				Interscale correlations[a]				
			Men		Women		N	E	O	A	C
	α	ω	*M*	*SE*	*M*	*SE*	*r*	*r*	*r*	*r*	*r*
Neuroticism (N)	.91	.92	2.47	.02	2.66	.02	—	−.53***	.03	−.40***	−.44**
Extraversion (E)	.87	.90	3.51	.02	3.54	.01	−.53***	—	.13***	.28***	.29***
Openness to experience (O)	.78	.82	3.27	.01	3.32	.01	.09**	.12***	—	.06**	−.04*
Agreeableness (A)	.85	.88	3.61	.01	3.84	.01	−.38***	.30***	.03	—	.28***
Conscientiousness (C)	.89	.91	3.74	.02	3.89	.01	−.47***	.36***	−.07*	.22***	—

Note. Cronbach's alpha (α) and Revelle's omega total (ω) were computed based on polychoric covariance matrices.
[a] Correlations among men below the diagonal, among women above the diagonal.
* $p < .05$. ** $p < .005$. *** $p < .0001$.

Panel A in Table 2 presents the effect sizes for each threshold of GD. These results suggest that the lower cutoffs for GD yielded effect sizes much more consistent with those obtained for the SUDs. Using a cutoff of even a single GD symptom was associated with substantial personality differences relative to those with no GD symptoms.

Comorbidity Between Alcohol, Nicotine, Cannabis, and Gambling Disorders

As expected, all disorders were significantly associated with each other in men and women except for AUD and GD in women[7] (see Table 3). The associations between disorders among women generally appeared to be substantially stronger than those in men. Differences between men and women in the associations of GD with both ND and CUD appeared particularly notable, although they were not statistically significant (both $ps = .07$). It appeared that women may have been at disproportionally higher risk for these patterns of comorbidity than were men, although the limited sample size of individuals with GD restricted interpretation of this pattern.

After controlling for the Big Five traits, associations between all disorders were reduced but remained significant (see Table 3). Among men, the associative strength between GD and both AUD and ND were substantially weakened (by 53% and 33%, respectively); attenuation of the remaining associations ranged from 2% to 14%. Among women, the association between CUD and GD was notably attenuated by 24%. All other associations were slightly weakened (2–18%) but remained significant ($p < .01$). The association between AUD and GD in women remained nonsignificant, with 45% attenuation of the odds ratio after controlling for personality. The smallest attenuation was consistently in the association between CUD and ND, indicating that factors other than personality likely contribute to this particular pattern of comorbidity.

Post Hoc Analyses Using Alternate Diagnostic Approaches

Post hoc analyses were conducted to explore possible reasons for these modest attenuations. Analyses were repeated using three stricter diagnostic definitions for the SUDs: (a) lifetime dependence, (b) lifetime clustered dependence (symptoms co-occurring within the same 12-month period), and (c) past-year clustered dependence (past-year GD was not assessed; therefore, these diagnostic alternatives could not be examined). The associations for each of these diagnostic definitions with each Big Five trait are presented in Table 2 (Panel B). These analyses revealed that the associations between the SUDs and personality, especially the traits of neuroticism and agreeableness, were consistently stronger when focusing on past-year rather than lifetime diagnoses. There were few differences in the strength of the associations between the original and the stricter lifetime diagnoses, and the differences that did emerge all involved the personality trait of neuroticism (see Supplemental Materials Tables 2 and 3 for odds ratios and attenuation magnitudes for each diagnostic definition).

Personality Traits and Multimorbidity

Given the extensive multimorbidity in this study, it may be misleading to focus on pairs of disorders; an alternate approach may be to focus on the total number of disorders for which an individual meets criteria. The similarity of the personality profiles of the four addictive disorders suggested that collapsing across disorders might reveal a cumulative effect of all disorders on personality differences. Therefore, we conducted a supplemental set of analyses in which multinomial logistic regressions were used to compare individuals meeting criteria for each number of disorders (i.e., none, one, two, three, and four; the three- and four-disorder categories were collapsed because of a low prevalence of individuals with four disorders). The no-disorder group was used as the reference group against which other morbidity groups were compared. Disorder count was regressed on each personality trait in men and women separately, and a sex-by-disorder count interaction was added to the model to assess potential sex differences.

Personality traits indeed evidenced differential patterns of morbidity, comorbidity, and multimorbidity (see Figure 3). Among men, high neuroticism, low agreeableness, and low conscientiousness were associated with having one, two, or three or more disorders in a dose-response fashion. Low extraversion was associated with having two and three or more disorders; that is, extraversion was uniquely associated with meeting criteria for multiple addictive disorders. Among women, the same pattern held with the additional association of openness to experience and

[7] AUD and *DSM–5* GD were significantly associated among women.

Table 2
Effect Sizes of the Associations Between Big Five Personality Dimensions and Gambling Disorder Using Different Gambling Disorder Symptom Thresholds (Panel A) and Post Hoc Analyses Using Alternate Diagnostic Approaches for Alcohol, Nicotine, and Cannabis Use Disorder[a] (Panel B)

		Men					Women				
Panel	Variables	N	E	O	A	C	N	E	O	A	C
A	Symptom threshold										
						Gambling					
	5+ symptoms (*DSM-IV*)	.69	−.18	−.07	−.75	−.70	1.00	−.68	−.11	−.73	−.71
	4+ symptoms (*DSM-5*)	.58	−.18	−.10	−.59	−.61	.81	−.59	−.14	−.69	−.62
	3+ symptoms	.47	−.21	−.11	−.48	−.51	.69	−.48	−.06	−.67	−.59
	2+ symptoms	.53	−.17	.03	−.55	−.47	.54	−.31	.07	−.59	−.54
	1+ symptom	.45	−.16	.06	−.46	−.38	.60	−.32	−.01	−.53	−.57
	Diagnostic approach										
						Alcohol					
B	**Lifetime use disorder**	.37	−.12	−.03	−.32	−.31	.32	−.01	.12	−.38	−.33
	Lifetime dependence	.60	−.17	.15	−.40	−.29	.66	−.20	.26	−.55	−.51
	Lifetime clustered dependence	.33	−.04	.11	−.30	−.24	.40	−.02	.26	−.46	−.35
	Past-year clustered dependence	.81	−.16	.05	−.56	−.45	.91	−.18	.52	−.70	−.67
						Nicotine[b]					
	Lifetime use disorder	—	—	—	—	—	—	—	—	—	—
	Lifetime dependence	.33	−.17	.07	−.33	−.24	.33	−.17	.07	−.30	−.32
	Lifetime clustered dependence	.41	−.21	.08	−.34	−.29	.42	−.21	.11	−.33	−.40
	Past-year clustered dependence	.50	−.30	.01	−.53	−.37	.57	−.34	.03	−.44	−.48
						Cannabis					
	Lifetime use disorder	.35	−.22	.31	−.30	−.26	.35	−.22	.34	−.34	−.40
	Lifetime dependence	.46	−.27	.33	−.27	−.31	.50	−.32	.33	−.51	−.52
	Lifetime clustered dependence	.49	−.29	.34	−.27	−.31	.47	−.31	.32	−.49	−.49
	Past-year clustered dependence	.77	−.44	.47	−.49	−.41	.76	−.66	.37	−.72	−.65

Note. N = neuroticism; E = extraversion; O = openness to experience; A = agreeableness; C = conscientiousness. The diagnostic approach that was used in the original analyses is denoted by bold font; clustered = symptoms occurring within a 12-month period.
[a] There is no abuse versus dependence or a clustering requirement for lifetime *DSM-IV* gambling disorder, and past-year gambling disorder was not assessed; therefore, these diagnostic alternatives could not be examined. [b] There is no nicotine abuse in *DSM-IV*, and therefore, it was not possible to make a nicotine use disorder diagnosis similar to the diagnoses of alcohol and cannabis use disorders.

having three or more disorders. None of the personality trait-by-sex interactions reached significance in predicting multimorbidity (p = .21–.93).

Discussion

In line with the reorganization of the *DSM–5*, substantial comorbidity between alcohol use, nicotine use, cannabis use, and gambling disorders was observed in a large community-based sample. Consistent with the hypothesis of common personality underpinnings contributing to this comorbidity, three of the Big Five personality dimensions (neuroticism, low agreeableness, and low conscientiousness) were significantly associated with all four of these disorders, low extraversion was associated with ND and CUD, and openness to experience was uniquely associated with CUD.

The associations between personality traits and pathology likely "reflect shared roots and perhaps conceptual overlap" between the domains of personality and disorder, such that the behavioral manifestation of disorder may be an exacerbation of an existing stable trait (Kotov et al., 2010, p. 808). For example, individuals high in neuroticism are prone to negative affect (Lahey, 2009), and using psychoactive substances is one method of relieving negative affect (Cooper, 1994; Simons, Correia, Carey, & Borsari, 1998); individuals low in conscientiousness tend to be more impulsive and less engaged in health-promoting behavior and therefore may be more likely to engage in risky and potentially unhealthy behavior such as substance use (Raynor & Levine, 2009). However, this explanation does not fully account for these associations (Kotov et al., 2010). It has also been suggested that the association of certain traits with social functioning, affective states (e.g., neuroticism's association with negative affect), and self-regulation (e.g., low conscientiousness' association with impulsivity) may explain personality's role in the development of substance abuse and addictive disorders because facets such as negative affect and impulsivity are themselves risk factors (Adan, Forero, & Navarro, 2017; Lahey, 2009; Oreland et al., 2018). Along these lines, it may be the case that the unique, psychedelic effects of cannabis come into play with regard to its association with openness to experience. Particular reasons for using cannabis, such as enhancement of perceptual and cognitive experience (Simons et al., 1998), are likely to be particularly appealing to individuals high on trait openness to experience. These individuals are inclined toward seeking new experiences and engaging in introspection, which the psychedelic properties of cannabis tend to facilitate. Notably, these reasons for using cannabis are not applicable to the other substances examined here, which may explain why the strong association with openness to experience was unique to cannabis.

The associations between the addictive disorders were only slightly attenuated after accounting for the contributions of the Big Five personality traits. The largest reduction was the association

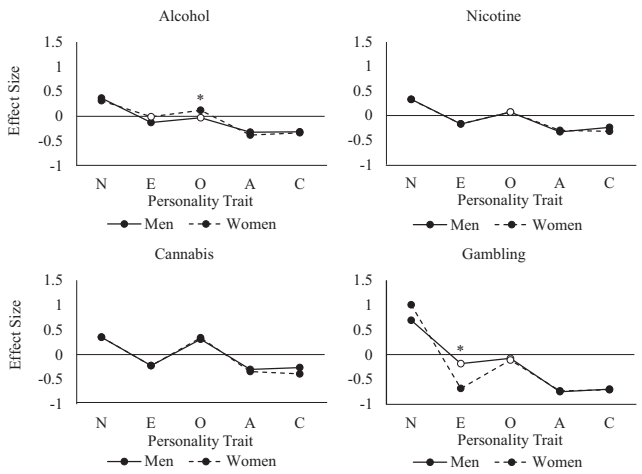

Figure 2. Associations between Big Five personality traits and addictive disorders in men and women. N = neuroticism; E = extraversion; O = openness to experience; A = agreeableness; C = conscientiousness; filled circle denotes significant association ($p \leq .0001$–$.01$) between disorder and trait, open circle denotes nonsignificant association. * Significance of test of sex difference, $p = .046$–$.061$.

between AUD and GD, suggesting that Big Five personality traits are especially important for explaining this co-occurrence. In contrast, the relation between ND and CUD was barely affected by the inclusion of personality traits in the model. There are likely to be factors other than personality explaining the comorbidity of ND and CUD, such as the common route of administration or the inclusion of tobacco in cannabis joints (Bélanger, Akre, Kuntsche, Gmel, & Suris, 2011; Richmond-Rakerd et al., 2016). These findings contrast with another within-study comparison of the Big personality correlates of these four addictive disorders in a non–treatment-seeking sample (Slutske et al., 2005), which found personality traits to make a greater contribution to comorbidity. The most likely sources of this difference are the personality inventory used (Big Three vs. Big Five) and the timeframe of the diagnostic assessment (past year vs. lifetime).

Most of the dimensions of the Big Three map onto the dimensions of the Big Five, with the exception that the latter includes the dimension of openness to experience. Openness to experience was uniquely associated with CUD in the present study, and although the Multidimensional Personality Questionnaire includes the absorption scale, which is strongly associated with Big Five openness to experience (Church, 1994), it is not subsumed under one of the Big Three higher-order dimensions and was not included in the previous study of addictive disorders (Slutske et al., 2005). The meta-analysis by Kotov et al. (2010) did not uncover an association between openness and SUDs, although this effect may have been obscured by combining CUD and ND together for analysis.

Post hoc analyses suggested that the most likely reason for personality traits making a greater contribution to comorbidity in a previous study was that it focused on past-year rather than lifetime disorder (Slutske et al., 2005). When we compared the personality profiles of past-year to lifetime diagnoses, the effect sizes for neuroticism and agreeableness were roughly doubled and, in some instances, the contribution to comorbidity increased from about 20% to 100%. It is of interest that the meta-analysis of Kotov et al. (2010) did not detect differences in the strength of the personality correlates of past-year compared with lifetime diagnoses. It is likely that we detected such differences because we were making more incisive within-study comparisons, whereas Kotov et al. (2010) had to base their conclusions on between-study comparisons. The stronger association observed for the current disorder suggests that having an active disorder may temporarily inflate personality differences, above any influence of personality on disorder or the contribution of common causes. For this reason, some have suggested that using current diagnoses may lead to biased effect sizes (Kotov et al., 2010).[8]

The Big Five correlates of AUD, ND, and CUD were nearly the same for men and women; evidence for sex differences was primarily limited to GD. In particular, the associations of GD with neuroticism and, especially, extraversion were much larger in women than men. Similarly, although the strength of the pairwise associations of the disorders in men and women did not differ significantly, the associations of GD with ND and CUD appeared substantially larger among women than men, which replicates findings in a national U.S. sample (Petry et al., 2005). Nonetheless, there was no evidence to suggest that this was due to greater personality overlap between the addictive disorders for women than men.

Multimorbidity was common in this sample, and there was a dose-response relation between personality and multimorbidity. This is consistent with previous research demonstrating that individuals with comorbid lifetime AUD and GD endorse lower trait levels of control, traditionalism, and well-being as compared with GD-only individuals (Lister, Milosevic, & Ledgerwood, 2015). These results likely explain, in part, why personality differences are more pronounced in treatment than in general population samples. The phenomenon of multimorbidity (or even comorbidity) renders single-disorder studies incomplete and potentially misleading. For example, in a study that focuses solely on the personality correlates for GD, a significant association may arise because a trait is specifically associated with GD, because a trait is associated with a more general propensity to develop an addictive disorder, or because a trait is associated with a more general propensity for experiencing a psychiatric disorder (Caspi et al., 2014).

Limitations

This study has at least five limitations. First, it is unclear how findings from this Australian sample will generalize to other countries and cultures. Second, the age range of the sample was relatively narrow; the extent to which these results can be generalized to other age groups remains unclear. Third, some of the less common SUDs, such as stimulant, opioid, and sedative use disorders, were not included. Fourth, we did not take into consideration potential gambling disorder subtypes that may differ between men and women and in their personality profiles (Blaszczynski & Nower, 2002; Savage, Slutske, & Martin, 2014). Finally, this was a cross-sectional study. It is possible that current personality rat-

[8] This does not apply to the previous longitudinal study of Slutske et al. (2005) because past-year diagnoses at age 21 years were predicted by personality assessed 3 years earlier at age 18 years.

Table 3
Odds Ratios of the Associations Between Lifetime Addictive Disorders in Men and Women

	Alcohol		Nicotine		Cannabis	
	OR [95% CI]		*OR* [95% CI]		*OR* [95% CI]	
Variables	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Men						
Alcohol	—		—		—	
Nicotine	3.07* [2.40, 3.93]	2.78* [2.13, 3.61]	—		—	
Cannabis	4.52** [3.34, 6.12]	4.36* [3.13, 6.09]	6.86* [5.18, 9.09]	6.73* [4.94, 9.17]	—	
Gambling	4.97** [2.07, 11.91]	2.85*** [1.14, 7.14]	3.22** [1.74, 5.60]	2.48*** [1.18, 5.23]	2.48** [1.32, 4.66]	2.29*** [1.09, 4.83]
Women						
Alcohol	—		—		—	
Nicotine	2.86* [2.35, 3.48]	2.52* [2.06, 3.10]	—		—	
Cannabis	4.89* [3.79, 6.32]	4.41* [3.34, 5.82]	8.26* [6.19, 11.02]	8.13* [5.97, 11.06]	—	
Gambling	2.31 [.98, 5.43]	1.72 [.57, 5.15]	8.82* [3.54, 21.95]	7.71** [2.46, 24.22]	7.16* [2.83. 18.12]	5.67** [2.02, 15.88]

Note. *OR* = odds ratio; CI = confidence interval; unadjusted/adjusted = without/with controlling for all personality traits.
* $p < .0001$. ** $p < .01$. *** $p < .05$.

ings may not have aligned with the levels of personality when the retrospectively reported lifetime disorder actually occurred (Roberts, Walton, & Viechtbauer, 2006). In addition, a cross-sectional study leaves unanswered the question of temporal precedence that is required for a potential causal interpretation of the personality-addictive disorder association. Previous longitudinal research has demonstrated the temporal precedence of personality at age 18 years predicting alcohol, tobacco, cannabis, and gambling disorder at age 21 years (Slutske et al., 2005); confidence in the temporal precedence of personality was bolstered by demonstrating that behavioral observations of temperament at age 3 years (prior to the initiation of substance use and gambling) predicted alcohol use disorder at age 21 years (Caspi, Moffitt, Newman, & Silva, 1996) and disordered gambling at ages 21 and 32 years (Slutske, Moffitt, Poulton, & Caspi, 2012).

Conclusion

The four addictive disorders of AUD, ND, CUD, and GD were all characterized by the Big Five personality traits of neuroticism, low agreeableness, and low conscientiousness. Although these results might indicate a general propensity to develop an addictive disorder, results of a study that included 11 different psychiatric disorders showed that these three Big Five traits were associated with a more general propensity to meet criteria for a psychiatric disorder (Caspi et al., 2014). These three traits partially explain the frequent co-occurrence of addictive disorders and also their co-occurrence with nonaddictive disorders. On the other hand, openness to experience appeared to be a specific correlate of CUD, not related to the general propensity to meet criteria for addictive disorders nor a contributor to comorbidity.

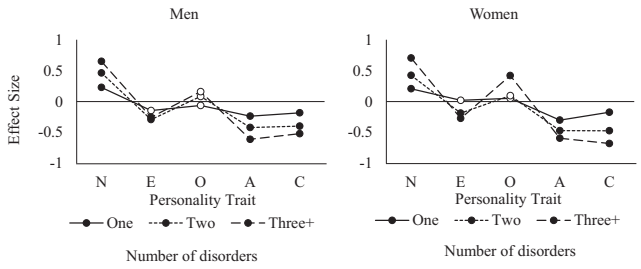

Figure 3. Associations between Big Five personality traits and comorbidity in men and women. N = neuroticism; E = extraversion; O = openness to experience; A = agreeableness; C = conscientiousness; filled circle denotes significant difference ($p \leq .0001$–.01) from no-disorder group.

Although there were robust associations between the addictive disorders and personality, only a modest amount of variance in each addictive disorder could be accounted for by the Big Five traits (7% for AUD; 4% for ND; 5% for CUD; 2% for GD). This indicates the importance of constructs other than personality in the manifestation of addictive disorders. Factors such as socioeconomic status, motives to use substances or engage in gambling behaviors, and comorbid mental health and substance use disorders not addressed in the present study are likely contributors to the manifestation of addictive disorders and their comorbidity. It has also been suggested that overlapping genetic influences between traits and addictive disorders may partially explain the associations between them (Lahey, 2009).

The main difference between the four disorders appeared to be the magnitudes of their effect sizes, reflected in the elevations of their personality profiles. The profiles for AUD and ND were relatively flat, followed by CUD, and then GD (using both *DSM–IV* and *DSM–5* criteria). GD produced the most discrepant and elevated profile. This within-study comparison of the magnitude of the personality differences corresponding to these disorders provides insight into the relative severity of the disorders as they are currently diagnosed (Kotov et al., 2010). Even compared with the stricter lifetime definitions of disorder, GD appeared to be a much more severe disorder than the other three. We found that more similar personality profiles might be obtained by equating the number of symptoms required for a diagnosis across disorders; that is, align the diagnostic criteria for GD with those for substance-related addictive disorders by requiring two to three symptoms for a mild disorder, four to five for a moderate disorder, and six or more for a severe disorder. This is consistent with research finding that subclinical GD (endorsing two to three GD symptoms) was associated with a level of psychosocial dysfunction that was comparable with that of mild SUD (endorsing two to three SUD symp-

toms; Weinstock et al., 2017). Now that GD has found its home among the other addictive disorders in the *DSM–5*, it is important to calibrate the severity of the diagnosis so that it is more in line with the others.

In addition to its potential contributions as a tool for more closely aligning the addictive disorders, personality research shows promise from a translational, clinical perspective (Costa et al., 1992a). Efficacious personality-targeted interventions for substance use behavior indicate that personality traits are a meaningful avenue to pursue in the context of addiction and its prevention and treatment (Conrod, 2016). In light of the associations of Big Five traits with addictive disorders, further investigation of the relationship between these particular traits and more complex patterns of addictive behavior may aid in further advancing intervention treatment efforts for co- and multimorbid addictive disorders.

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