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ORIGINAL ARTICLE

Examining the shared and unique relationships among substance use and mental disorders

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Background. Co-morbidity among use of different substances can be explained by a shared underlying dimensional factor. What remains unknown is whether the relationship between substance use and various co-morbid mental disorders can be explained solely by the general factor or whether there remain unique contributions of specific substances.

Method. Data were from the 2007 Australian National Survey of Mental Health and Wellbeing (NSMHWB). A unidimensional latent factor was constructed that represented general substance use. The shared and specific relationships between lifetime substance use indicators and internalizing disorders, suicidality and psychotic-like experiences (PLEs) were examined using Multiple Indicators Multiple Causes (MIMIC) models in the total sample. Additional analyses then examined the shared and specific relationships associated with substance dependence diagnoses as indicators of the latent trait focusing on a subsample of substance users.

Results. General levels of latent substance use were significantly and positively related to internalizing disorders, suicidality and psychotic-like experiences. Similar results were found when examining general levels of latent substance dependence in a sample of substance users. There were several direct effects between specific substance use/dependence indicators and the mental health correlates that significantly improved the overall model fit but they were small in magnitude and had relatively little impact on the general relationship.

Conclusions. The majority of pairwise co-morbid relationships between substance use/dependence and mental health correlates can be explained through a general latent factor. Researchers should focus on investigating the commonalities across all substance use and dependence indicators when studying mental health co-morbidity.

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Introduction

In the general population substance use disorders are often co-morbid with other mental disorders including anxiety disorders and affective disorders (Andrews *et al.* 2003; Myrick & Brady, 2003). Understanding co-morbidity, particularly among substance use and mental disorders, is important for a variety of reasons (see Hall *et al.* 2009 for a review). Specifically, co-morbid disorders have been linked to poor treatment response (Schäfer *et al.* 2010), poor long-term prognosis (Proudfoot *et al.* 2003), greater impairment and disability (Teesson *et al.* 2009), greater social costs (Dickey & Azeni, 1996) and increased mortality rates (Dickey *et al.* 2004), particularly among adolescents and young adults (Teesson & Proudfoot, 2003). Co-morbidity also adds to the complexity of establishing a formal diagnosis and determining effective treatment options, a task that is particularly challenging given that many existing services and professional guidelines specialize in the diagnosis and treatment of either substance use disorders or mental disorders with little formal overlap (Kavanagh *et al.* 2003).

Confounding the interpretation of co-morbid substance use and mental disorders further is the large degree of co-morbidity that is also observed within substance use (e.g. alcohol use/dependence and stimulant use/dependence). Studies from general population and clinical samples have consistently shown that co-morbidity within substance use disorders is the rule rather than the exception (Hall *et al.* 1999; Stinson *et al.* 2005). Indeed, the high level of co-morbidity has led some researchers to assume that these strong relationships may be better explained or conceptualized as the manifest representation of liability factors that can be formally organized into a hierarchical meta-structure (Andrews *et al.* 2009; Krueger & South, 2009). Extensive work by Krueger and colleagues

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supports this claim. Through the use of latent variable modelling techniques, Krueger and co-workers have demonstrated the importance of an overarching dimensional factor, referred to as externalizing, when explaining the relationships among multiple disorders that involve disinhibition and antagonism (Krueger, 1999; Krueger *et al.* 2001, 2007; Krueger & Markon, 2006; Slade & Watson, 2006; Wright *et al.* 2013). Moreover, previous investigations have highlighted the hierarchical nature of externalizing behaviours, which encompass a single overarching externalizing factor and two distinct subfactors that represent callous-aggressive tendencies and substance use. The substance use subfactor can then be defined further as representing several facets that include multiple substance use and substance problems (Krueger *et al.* 2007; Derringer *et al.* 2013). The current analysis focuses on the substance use subfactor of the externalizing spectrum rather than the broad externalizing domain.

There are several notable advantages to using broad dimensional latent traits to understand psychopathology co-morbidity from both psychometric and public health and treatment perspectives. The use of continuous rather than categorical measures of mental disorder offers significant improvements in reliability and validity (Markon *et al.* 2011). Moreover, using broad hierarchical traits that capture multiple disorders from traditionally separate disorder clusters may result in improvements in clinical utility by simplifying the complex nature and structure of the existing classification systems (Andrews *et al.* 2009). Indeed, the recent revision of the *Diagnostic and Statistical Manual of Mental Disorders* briefly recognizes the importance of a dimensional and hierarchical structure of mental disorders (APA, 2013, pp. 12–13). From a public health perspective, incorporating higher-order dimensions in the extant nosology could encourage greater prevention programmes targeting the broader psychopathological constructs and thereby reducing the incidence of multiple related disorders (Brown & Barlow, 2005). In addition, the inclusion of broader traits can facilitate empirical exploration of shared aetiology between putatively distinct disorders as well as incorporating important biological risk factors, including genetic and environmental risk factors, when modelling levels of psychopathology (Kendler *et al.* 2003; Krueger *et al.* 2005). Finally, from a treatment perspective, incorporating broad traits of psychopathology provides greater credence to unified treatment approaches that seek to treat the commonalities shared by co-morbid mental disorders and polysubstance abuse/dependence (Brown & Barlow, 2009; Hesse, 2009; Kelly *et al.* 2012).

Prior evidence has demonstrated the utility and centrality of latent variables when describing co-morbid relationships between substance use and mental disorders. Notably, Kushner *et al.* (2012) demonstrated that the majority of the relationships between mood and anxiety disorders could be explained by a common latent trait representing internalizing liability and it was this latent trait that was strongly related to alcohol dependence rather than the influence of specific DSM-IV mood or anxiety diagnoses. Indeed, Kushner *et al.* (2012) concluded that knowledge of the overall severity of internalizing psychopathology and the commonalities across mood and anxiety disorders provides more information about whether each individual will also be alcohol dependent than does knowledge about the presence of any single mood or anxiety disorder. Finally, in two studies that investigated the development of co-morbidity across the lifespan, Kessler *et al.* (2011*a*, *b*) found that the majority of the 306 pairwise time-lagged associations among 18 disorders can be explained by a model that assumes the existence of mediating latent internalizing and externalizing variables.

The current study sought to further demonstrate the centrality of latent variables when investigating the mental health correlates of several types of substance use in the Australian general population, along with several types of substance dependence in a substance-using subsample of the population. Primarily, the current study sought to determine whether mental disorders are related generally to substance use and substance dependence or whether there remains a unique relationship between mental disorders and some of the different types of substance use and substance dependence over and above the general relationship. The mental disorders of interest examined in the current study include several mood and anxiety disorders and psychotic-like experiences (PLEs). Suicidality was also examined. Given the high degree of co-morbidity between mood and anxiety disorders, the current study modelled the mood and anxiety disorders as a more parsimonious latent dimension representing internalizing liability rather than modelling several discrete categorical variables separately. It is this internalizing liability and how it relates to general and specific types of substance use and dependence that is of interest in the current study. There may, however, be several noteworthy differences in the contribution of suicidality and PLEs that warrant detailed investigation. Therefore, the differing rates of suicidality and PLEs were modelled as separate observable categorical variables.

Method

Sample

Data for the current study were from the 2007 Australian National Survey of Mental Health and

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Wellbeing (NSMHWB), a nationally representative private household survey of the Australian population aged 16–85 years. The survey recruited participants using a multi-stage clustered sampling design to ensure representativeness. Once the sampling framework was established, the survey collected information from one randomly selected household member from each of the 8841 fully-responding households out of a possible 14 805, resulting in a response rate of 60%. Oversampling of the younger (16–24 years old) and older (65–85 years old) household members was used to generate representative estimates from these traditionally under-represented age groups. Data in the current study were weighted to correspond to the sociodemographic characteristics of the Australian population. In brief, 49.6% were male, 57% were married or in a *de-facto* relationship, 65.2% were employed, 53.9% had received no post-school qualification, and 72.9% were born in Australia. More information on the sample characteristics and design of the NSMHWB are available in Slade *et al.* (2009).

Measures

Substance use

The current study examined variables that represent the use of five broad types of substances across the respondent's lifetime: binge drinking, cannabis use, sedative use, stimulant use, and opiate use. Binge drinking was classified among the respondents in the current study as consuming five or more standard alcoholic drinks (10 g of alcohol) per day on the days they drank in the past 12 months or the period of time when their drinking was the worst. Cannabis use was classified as using cannabis, marijuana or hashish more than five times. Stimulant use was classified as using stimulants (e.g. amphetamine, speed, ice, methylphenidate, dexamphetamine) without the recommendation of a health professional more than five times. Sedative use was classified as using sedatives (e.g. Valium, Xanax, diazepam) without the recommendation of a health professional more than five times. Finally, opiate use was classified as using opiates (e.g. heroin, opium, Fentanyl, OxyContin, Suboxone) without the recommendation of a health professional more than five times.

Substance dependence

The lifetime presence of DSM-IV substance dependence was assessed using the World Mental Health version of the World Health Organization (WHO) Composite International Diagnostic Interview (WMH-CIDI; Kessler & Ustün, 2004). The WMH-CIDI has demonstrated sound reliability and has good clinical validity in relation to a clinician-administered semi-structured diagnostic interview, the Structured Diagnostic Interview for DSM-IV (SCID-IV), which is traditionally considered as the 'gold standard' in psychiatric assessments (Kessler *et al.* 2004). The specific substance dependence diagnoses included: alcohol dependence, cannabis dependence, stimulant dependence, sedative dependence and opiate dependence.

Mental health correlates

To assess the presence of lifetime DSM-IV mental disorders, the WMH-CIDI was again used to measure each criterion and apply the diagnostic decision rules. To assess the influence of co-morbid mental disorders in the current study, the diagnostic criteria were applied without hierarchy rules, that is the presence of one disorder is not ruled out over the presence of another related disorder. However, disorders were excluded if they were attributed solely to a physical condition or medication use. Mental disorders examined in the current study included: major depressive episode, dysthymia, generalized anxiety disorder (GAD), social phobia, panic disorder, obsessive–compulsive disorder (OCD) and post-traumatic stress disorder (PTSD).

To measure non-specific rates of suicidality, the survey included several questions that were separate from the mood and anxiety modules of the WMH-CIDI. Three questions were used in the current study: the first measured general suicidal thoughts 'Have you ever seriously thought about committing suicide?', the second measured suicidal plans 'Have you ever made a plan for committing suicide?' and the third measured suicide attempts 'Have you ever attempted suicide?' Respondents were only asked about suicidal plans if they had also indicated that they had experienced suicidal thoughts and were only asked about suicide attempts if they had also indicated suicidal plans. The three questions were dummy coded, treating 'no suicidality' as the reference category.

To measure the presence of PLEs, a brief self-report screening instrument was used to determine whether the respondent had ever experienced someone or something directly controlling or interfering with their thoughts, that people were too interested in them, or that they had special powers that most people lack. This instrument has been used in previous research to investigate the correlates of PLEs in the Australian general population (Scott *et al.* 2007; Saha *et al.* 2011). The presence of PLEs was measured by summing the number of PLEs endorsed by each respondent and then dummy coded to represent the presence of no PLEs (reference category), one PLE, and two or more PLEs. Auditory or visual

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hallucinations occurring during dreams or half-asleep or under the influence of alcohol or drugs were excluded.

Analysis

The analytic approach was dividing into two stages: the first involved testing the measurement model of substance use, substance dependence and internalizing using confirmatory factor analysis (CFA); and the second involved building two Multiple Indicators Multiple Causes (MIMIC) models for substance use in the total sample and substance dependence in a subsample of substance users.

CFA modelling

Separate CFA models were used to confirm the suitability of using a unidimensional structure for substance use, substance dependence and internalizing. Absolute fit indices to measure model fit are not available when using full information maximum likelihood for categorical data. Therefore, the CFA models were estimated using tetrachoric correlation matrices and the weighted least squares mean and variance adjusted (WLSMV) estimator. The latent variables were identified by fixing the latent variance to 1.0 and estimating all factor loadings. Model fit was determined using a range of absolute fit indices, including: the comparative fit index (CFI), the Tucker–Lewis fit index (TLI), and the root mean square error of approximation (RMSEA). Good model fit was determined using recommended cut-offs established by simulation studies, for example RMSEA < 0.05, CFI > 0.95 and TLI > 0.95 (Hu & Bentler, 1998; Yu, 2002).

MIMIC modelling

In brief, MIMIC models consist of three components that are built sequentially (see Gallo *et al.* 1994 for more detailed information). The first component involves a measurement model whereby a series of observed categorical indicators for substance use or substance dependence are related to a continuous and normally distributed latent variable. The second component involves a regression model whereby the continuous latent variable is regressed on a series of correlates or background variables of interest. The correlates of interest in the current study include: internalizing (measured as a continuous and normally distributed latent variable), suicidality and PLEs. Sex and age were also included as background variables to account for any differences in the latent variables attributed to these sociodemographic features. These estimates are considered 'indirect effects' because the relationships between the indicators and correlates of interest are completely mediated through the general latent trait. The third component involves identifying and estimating direct regression effects between the indicators of substance use/dependence and the mental health correlates of interest in a model that already contains the indirect effects. These 'direct effects' can be interpreted as indicating that a specific relationship exists between some indicators and the mental health correlates while controlling for mean differences in the latent trait attributed to the correlates. As the aim of the current study was to identify the specific relationships between substance indicators and mental health correlates, only the direct effects associated with internalizing, suicidality and PLEs were examined in this analysis. All MIMIC models were parameterized as two-parameter logistic item response models and fitted to the data using a full information robust maximum likelihood estimator for categorical data as implemented by Mplus version 7.2 (Muthén & Muthén, 2010).

The current study used a strategy developed by Woods *et al.* (2009). This approach has been used extensively in the prior literature to detect differential item functioning as part of routine psychometric testing. This strategy begins by identifying indicators that do not exhibit any direct effects with the correlates to form a set of 'anchors' that identify the subsequent MIMIC models (Woods, 2009). This was achieved by estimating the direct effects, in five separate models, associated with one indicator at a time while the direct effects associated with the other indicators were fixed to zero. Indicators that exhibited non-significant direct effects across all the mental health correlates of interest were allocated to the anchor set whereas indicators that had significant direct effects were allocated to the study set and were examined in subsequent MIMIC modelling.

The direct effects associated with the indicators of substance use/dependence that were assigned to the study set were then tested individually using scale-corrected likelihood ratio (LR) difference tests for nested models. For example, to test the significance of the direct effects associated with alcohol dependence, a model that estimated the direct effects for all the studied indicators was compared to a model that fixed the direct effects associated with alcohol dependence to zero. If removing the direct effects associated with alcohol dependence resulted in a significant decrease in model fit, then this would provide evidence that a specific relationship between alcohol dependence and the mental health correlates is present over and above the general relationship. Bonferroni adjustments were made to the p value to account for multiple LR difference tests. LR difference tests for nested models have been criticized for being

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overly sensitive to trivial effects, particularly in large samples, and therefore the difference in Akaike information criterion (AIC) and Bayesian information criterion (BIC) values between the fitted models is also presented. Lower AIC and BIC values indicate a better model fit when comparing two competing models (Burnham & Anderson, 2002). Therefore, positive ΔAIC and ΔBIC values indicate that the model with all the estimated direct effects provides a better fit whereas negative values indicate that the competing model without the direct effects provides a better fit.

Final MIMIC models for the substance use indicators in the total sample and substance dependence indicators in a sample of substance users were then estimated that included all the significant direct effects identified in the final step. The direct effects are presented as odds ratios (ORs) (exponentiated regression coefficients) and associated 95% confidence intervals (CIs) to assist with interpretation. Finally, the regression coefficients associated with the latent variables and the correlates of interest were estimated and compared using two models (one that did not adjust for any direct effects, that is an indirect effects model, and the final MIMIC model that adjusted for significant direct effects). Comparing these regression coefficients determines the overall impact of the direct effects on the indirect effects and provides some indication of the overall validity and utility of the general latent variables when describing the multiple relationships between substance use/dependence and mental disorders.

Results

CFA

The frequencies associated with each of the substance use, substance dependence and mental disorder indicators used in the subsequent factor models are provided in Table 1. The CFA models supported a unidimensional structure of substance use with excellent fit according to all three fit statistics (CFI = 0.989, TLI = 0.977, RMSEA = 0.049). Similarly, the CFA supported a unidimenisonal structure of substance dependence in a sample of substance users (CFI = 0.994, TLI = 0.987, RMSEA = 0.025). This confirms the use of a unidimensional measurement model to describe latent levels of general substance use and general substance dependence in subsequent analyses. A unidimensional structure of mood and anxiety disorders was also fit to both the total sample (CFI = 0.994, TLI = 0.991, RMSEA = 0.022) and a sample of substance users (CFI = 0.995, TLI = 0.992, RMSEA = 0.022), with model fit statistics indicating excellent fit.

Table 1. *Weighted frequencies (%) for substance use and mental disorders in the total sample and among substance users*

	Total sample (n = 8841)	Substance users (n = 3495)
Binge drinking	33.1	–
Cannabis use	19.3	–
Stimulant use	7.2	–
Sedative use	1.6	–
Opiate use	1.9	–
Alcohol dependence	–	8.8
Cannabis dependence	–	4.7
Stimulant dependence	–	3.5
Sedative dependence	–	0.8
Opiate dependence	–	1.2
Major depressive episode	14.8	19.6
Dysthymia	3.0	3.9
Social phobia	8.4	10.4
Panic disorder	3.5	4.6
Post-traumatic stress disorder	7.2	10.2
Generalized anxiety disorder	7.9	9.5
Obsessive–compulsive disorder	3.8	4.7
Suicidality		
No suicidality	86.7	80.5
Suicidal thoughts	8.1	11.1
Suicidal plans	3.2	4.8
Suicide attempts	2.0	3.6
Psychotic-like experiences		
0	91.2	89.8
1	7.0	7.6
⩾2	1.8	2.6

MIMIC modelling

Table 2 provides the results of the model fit comparisons testing the significance of the direct effects of the mental health correlates of interest on the substance use and substance dependence indicators respectively. For the substance use indicators, opiate use formed the anchor set and was assumed to have no direct effects with the correlates of interest. After adjusting the p value for multiple comparisons, the removal of the direct effects associated with binge drinking resulted in a significant decrease in the model fit. For substance dependence indicators, stimulant dependence and opiate dependence formed the anchor set whereas the removal of the direct effects associated with alcohol dependence and sedative dependence resulted in a significance decrease in model fit. The ΔAIC values suggested that the removal of direct effects associated with cannabis use and stimulant use resulted in a

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Table 2. *Model fit comparisons testing for the direct effect between substance use and substance dependence indicators and mental health correlates in the total sample and a sample of substance users*

	$\Delta\chi^2$	df	*p* value	ΔAIC	ΔBIC
Substance use (total sample)					
Binge drinking	18.00	6	**0.006**	19	−23
Cannabis use	8.97	6	0.175	3	−40
Stimulant use	14.78	6	0.022	10	−33
Sedative use	11.27	6	0.080	−1	−44
Opiate use[a]	–	–	–	–	–
Substance dependence (substance-using sample)					
Alcohol dependence	34.04	6	**<0.001**	40	3
Cannabis dependence	3.57	6	0.734	−6	−43
Stimulant dependence[a]	–	–	–	–	–
Sedative dependence	26.71	6	**<0.001**	11	−26
Opiate dependence[a]	–	–	–	–	–

df, Degrees of freedom; ΔAIC, difference in the Akaike information criterion between a model with all direct effects included and a model with the direct effects of the studied indicator fixed to zero; ΔBIC, difference in the Bayesian information criterion between a model with all direct effects included and a model with the direct effects of the studied indicator fixed to zero; $\Delta\chi^2$, scaled χ^2 difference values of model fit between a model with all direct effects included and a model with the direct effects of the studied indicator fixed to zero.

Bold type indicates significant $\Delta\chi^2$ test of model fit after Bonferroni adjustments to the critical *p* value.

[a] Treated as an empirically selected anchor item with all direct effects fixed to zero to identify the model.

minor decrease in model fit whereas the values for the remaining substances confirmed the LR difference tests. By contrast, the ΔBIC values suggested that the removal of the direct effects associated with only alcohol dependence resulted in a decrease in model fit.

The path diagrams of the final two MIMIC models are provided in Fig. 1 with direct effects estimated for binge drinking only in the substance use model whereas direct effects for alcohol dependence and sedative dependence were estimated in the substance dependence model. ORs and 95% CIs associated with the significant direct effects (i.e. the broken arrows in Fig. 1) for both models are provided in Table 3. Controlling for the other correlates and for mean differences in latent substance use, people with higher rates of internalizing had a significantly lower probability of binge drinking (OR 0.82). Likewise, respondents with suicidal plans had a lower probability of binge drinking than people without suicidality (OR 0.64). Controlling for the other correlates and for mean differences in latent substance dependence, people with higher rates of internalizing were more likely to experience alcohol dependence (OR 1.75) and sedative dependence (OR 2.89). Those with suicidal plans were almost four times more likely to experience sedative dependence (OR 3.96) whereas those with suicide attempts were almost three times more likely to experience alcohol dependence (OR 2.89) compared to those without suicidality. Finally, respondents who report two or more PLEs were less likely to experience sedative dependence in their lifetime compared to those with no PLEs (OR 0.11).

The unadjusted and adjusted regression coefficients associated with differences in the mean levels of general substance use and substance dependence across the correlates are provided in Table 4. Prior to adjusting for direct effects, internalizing, aspects of suicidality, two or more PLEs, sex and age demonstrated significant positive associations with general substance use and substance dependence. The presence of two or more PLEs was related to higher rates of general substance dependence than to general substance use whereas the presence of suicidal thoughts was strongly associated to general substance use and not general substance dependence. After adjusting for the significant direct effects, the overall pattern of significance regarding the indirect effects was similar to the unadjusted models with relatively minor differences in the magnitude associated with the regression coefficients. A notable exception involved the regression coefficient associated with suicide attempts and general substance dependence. After adjusting for direct effects, the effect of suicide attempts diminished to a large extent. Similarly, but to a lesser extent, the indirect effect associated with internalizing and general substance dependence diminished after adjusting for direct effects although remained highly significant.

Discussion

The current study suggests that, for the most part, the relationship between the use of various substances and co-occurring mental disorders is shared and cumulative. Several significant direct effects associated with specific substance use and substance dependence indicators and the mental health correlates of interest were identified. However, there were inconsistencies in the model fit statistics, with the difference in BIC values suggesting that the removal of the majority of the direct effects led to significant improvements in model fit. Furthermore, the overall impact of these direct effects on the utility and validity of the general latent variables to describe differences in substance use and dependence between respondents with various mental disorders seemed to be minimal. There

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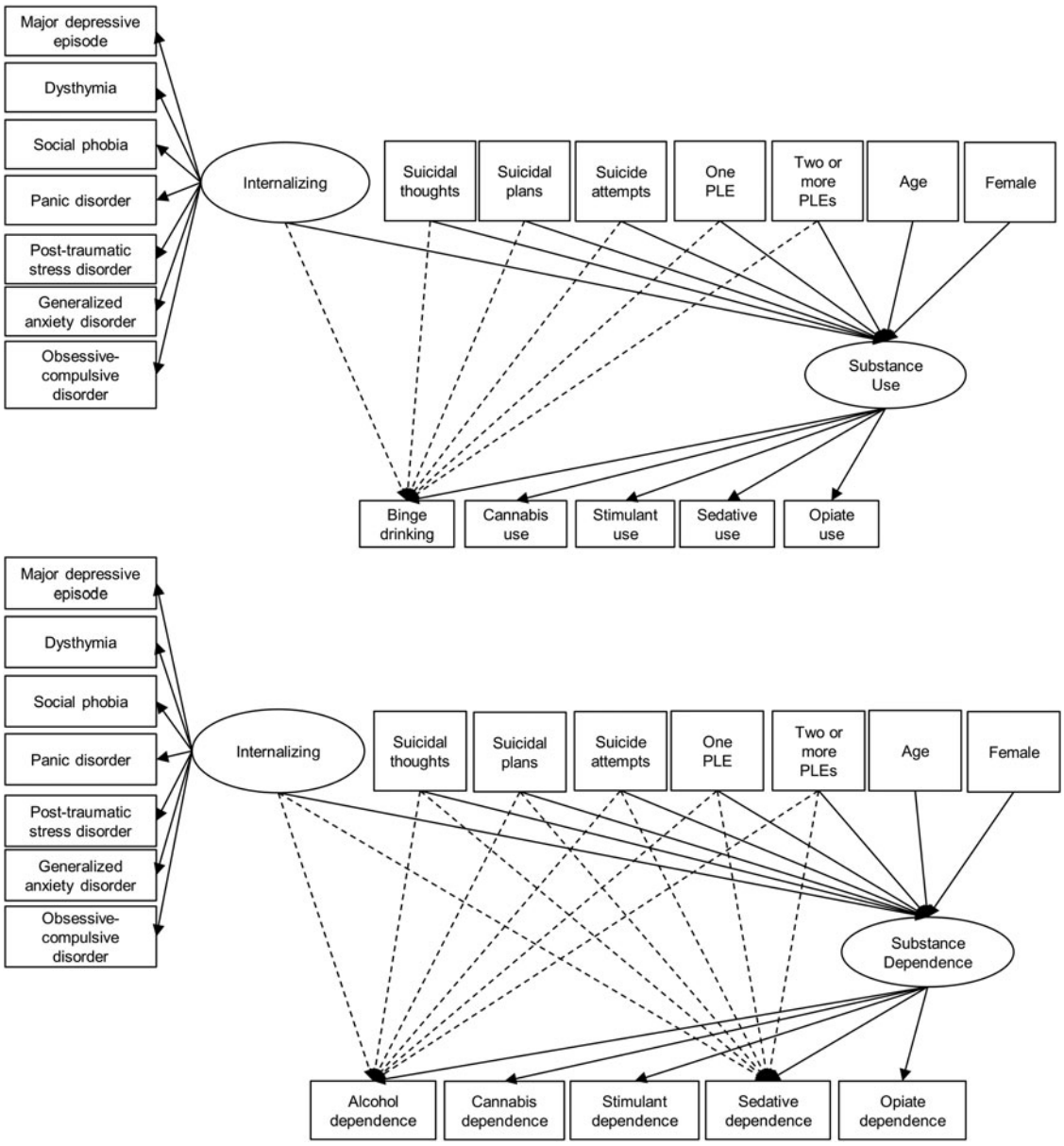

Fig. 1. Path diagrams for final Multiple Indicators Multiple Causes (MIMIC) models for substance use and substance dependence among a sample of substance users. Top diagram represents substance use among the total sample. Bottom diagram represents substance dependence among a sample of substance users. Reference categories: no suicidality, no psychotic-like experiences (PLEs), and male. Age and internalizing entered as continuous variables.

were two notable exceptions to this conclusion. The relatively large direct effect associated with alcohol dependence and suicide attempts sufficiently diminished the indirect relationship between general substance dependence and suicide attempts so that it was no longer significant. Therefore, a substantial proportion of the relationship between general substance dependence and suicide attempts can be explained by mechanisms that are specific to alcohol dependence. Similarly, but to a lesser extent, the direct effects associated with alcohol dependence and sedative dependence diminished the indirect relationship between internalizing and general substance dependence; however, this relationship remained significant.

It is possible to speculate on the mechanisms that might be driving the specific direct effects between alcohol dependence and suicide attempts and also those between alcohol dependence, sedative dependence and internalizing. However, these conclusions should be thought of as preliminary as more detailed research is required. These direct effects might be plausibly explained by a 'self-medication' hypothesis, which

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Table 3. *Odds ratios (95% confidence intervals) for direct effects of substance use and substance dependence indicators on mental health correlates in the final estimated MIMIC models*

	Internalizing	Suicidal thoughts	Suicidal plans	Suicide attempts	One PLE	Two or more PLEs
Substance use						
Binge drinking	**0.82 (0.72–0.93)**	1.17 (0.92–1.49)	**0.64 (0.45–0.90)**	1.01 (0.65–1.55)	1.07 (0.84–1.37)	1.02 (0.66–1.60)
Cannabis use	–	–	–	–	–	–
Stimulant use	–	–	–	–	–	–
Sedative use	–	–	–	–	–	–
Opiate use	–	–	–	–	–	–
Substance dependence						
Alcohol dependence	**1.75 (1.23–2.49)**	1.43 (0.92–2.22)	1.07 (0.62–1.85)	**2.89 (1.58–5.27)**	1.57 (0.92–2.67)	0.89 (0.50–1.60)
Cannabis dependence	–	–	–	–	–	–
Stimulant dependence	–	–	–	–	–	–
Sedative dependence	**2.64 (1.45–4.81)**	1.01 (0.22–4.64)	**3.96 (1.32–11.87)**	2.60 (0.86–7.85)	0.50 (0.13–1.92)	**0.11 (0.2–0.48)**
Opiate dependence	–	–	–	–	–	–

MIMIC, Multiple Indicators Multiple Causes; PLE, psychotic-like experience.
Bold type indicates significant at the $p < 0.05$ level.

Table 4. *Regression coefficients for MIMIC models examining differences in mean latent substance use and substance dependence across levels of the correlates with and without adjusting for significant direct effects*

	Latent substance use (total sample)		Latent substance dependence (substance-using sample)	
Covariates	Unadjusted	Adjusted	Unadjusted	Adjusted
Internalizing	0.286***	0.336***	0.712***	0.569***
Suicidal thoughts	0.516***	0.484***	0.037	−0.073
Suicidal plans	0.809***	0.852***	0.625***	0.565**
Suicide attempts	0.945***	0.920***	0.558**	0.282
No suicidality (reference)	–	–	–	–
One PLE	0.000	−0.019	0.242	0.146
Two or more PLEs	0.361*	0.354*	0.779***	0.874***
No PLEs (reference)	–	–	–	–
Female	−0.811***	−0.822***	−0.625***	−0.610***
Male (reference)	–	–	–	–
Age	−0.029***	−0.029***	−0.026***	−0.028***

MIMIC, Multiple Indicators Multiple Causes; PLE, psychotic-like experience.
Unadjusted model fixes all direct effects between substance use/dependence indicators and mental health correlates to zero. Adjusted models include significant direct effects described in Fig. 1.
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

assumes that the maladaptive use of alcohol and/or sedatives is the result of a coping mechanism to reduce the symptoms and severity of suicidality and internalizing. Indeed, previous research has linked the use of alcohol and sedatives as a maladaptive coping mechanism for a range of suicidality, mood and anxiety disorders (Bolton *et al.* 2006; Robinson *et al.* 2009). Such reliance on the use of these substances to reduce the severity of suicidality and internalizing may evolve over time into dependence for some individuals (Swendsen *et al.* 2010). This hypothesis does assume a one-way direction whereby mental disorders are present prior to the emergence of substance dependence. It is possible, however, that the relationship could emerge in the other direction. Therefore, the specific mechanisms that attempt to explain the

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increased onset of suicidality and internalizing as a result of primarily alcohol or sedative dependence, including the associated biochemical changes that result from the extended use of these substances, warrants further investigation to determine the nature of the relationship between these specific substance and mental disorder co-morbidities.

There are several notable strengths of the current study, including the comprehensive assessment of DSM-IV criteria for multiple substance use and mental disorders, the use of a large representative sample of the Australian population, and the use of a latent variable approach to parse the general and specific relationships among substance use and mental disorders. However, these findings should also be interpreted with respect to some limitations. First, substance use and mental disorders were assessed using self-report face-to-face structured interviews. Because of the sensitive nature of the assessment, these results could have been biased due to social desirability, particularly when assessing the use of illicit substances. Furthermore, illicit substance-using individuals often represent a hidden or difficult to assess subgroup of the population and therefore these groups may be under-represented in a household survey. Consequently, the prevalence of some substance use disorders is relatively low, particularly for sedative dependence and opiate dependence. These results need to be replicated in various settings, particularly in large clinical and substance-using samples, to ensure reliability and robustness. Second, the current study was restricted to using drug and alcohol disorders to form the latent variables under investigation. Therefore, the current study was only able to examine the constituent facets of the substance use subfactor of the broader externalizing spectrum (Krueger *et al.* 2007). The current findings need to be extended by including various externalizing facets and behaviours to cover the full spectrum of externalizing. Third, because of the cross-sectional nature of the survey used by the current study, causality and the interaction among various specific co-morbidities over time in conjunction with the general latent factors were not investigated in this study. Interpretation of the general and specific relationships between substance use and mental disorders will be aided by future research that uses longitudinal or repeated measures designs.

The current study further highlights the utility of a 'macroscopic' view of disorders when predicting co-morbidity and a range of clinically relevant factors (Kessler *et al.* 2011*b*; Kushner *et al.* 2012; Eaton *et al.* 2013). Our results extend previous findings and suggest that, once the commonalities across various types of substance use and substance dependence have been entered into the model, knowledge of the specific type or types of substances present offers relatively little to our understanding of the relationship between substance use and mental disorders. These results should direct researchers and clinicians to focus on elucidating the commonalities or shared mechanisms across all the substance use disorders and determining how these commonalities are associated with mental disorders. These findings give further credence to the use of assessment tools that measure these broad dimensional constructs using item response theory (Krueger & Finger, 2001; Patrick *et al.* 2013) in addition to the use of transdiagnostic treatments that focus on treating the commonalities across putatively distinct disorders (Brown & Barlow, 2009; Hesse, 2009; Kelly *et al.* 2012). One exception to this rule was the influence of the specific relationship between alcohol dependence and suicide attempts over and above the general relationship. Future studies should also seek to identify why the probability of alcohol dependence is so high among people with suicidality in comparison to the other types of substances examined in the current study.

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Declaration of Interest

None.

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