TAXOMETRIC INVESTIGATION

OF

MULTI-IMPULSIVE BULIMIA

A thesis submitted in partial fulfilment of the requirements for the

Degree

of Master of Arts in Psychology

in the University of Canterbury

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University of Canterbury

2007

Table of Contents

Acknowledgments

The author wishes to express sincere appreciation to my primary supervisor David H. Gleaves for his generosity with both resources and time, and the invaluable guidance he provided. Thank you also to Janet Latner, the secondary supervisor of this study.

I would also like to express appreciate to my family and friends for their support throughout my studies. Special thanks to Juliet Rosewall for her support and advice throughout this project: your kindness and encouragement was never faltering and is truly appreciated.

Abstract

Previous researchers have proposed that Multi-impulsive Bulimia (MIB), a constellation of self-destructive impulsive behaviours including theft, self-harm, suicide attempts, sexual disinhibition, and substance use, may be a distinct sub-type of Bulimia Nervosa (BN). Prior to this study, the validity of MIB as a subtype of BN had not been empirically examined. In the current study, taxometric procedures were used to address the question of whether MIB represents a distinct subtype or occurs on one or more continua. Participants were women (*N* = 419) diagnosed with BN seeking treatment at a residential eating disorders facility. Taxometric procedures used were mean above below minus a cut, maximum covariance, and latent mode analyses. Indicators were bulimic behaviours (bingeing and purging), theft, suicide attempts, self-harm and alcohol use. Analyses included comparisons with simulated taxonic and dimensional data. Results were inconsistent across analyses, perhaps due to problems with indicator validity. However there was some evidence of taxonicity.

Taxometric Investigation of Multi-Impulsive Bulimia

Bulimia nervosa (BN) is a disorder characterized by recurrent episodes of binge eating followed by inappropriate compensatory behaviours in order to prevent weight gain, with the BN individual evaluating his or her self-worth by body shape and weight, and tending to have low self-esteem (American Psychiatric Association [APA], 2000). An eating binge is characterised by a loss of control over eating and consumption of an abnormally large amount of food within a discreet time period, whereas compensatory behaviour may consist of purging (self-induced vomiting or laxative misuse) or non-purging behaviours, such as excessive exercise or fasting (APA, 2000).

The lifetime prevalence rate of BN is estimated to be 1% in women, and 0.1% in men (Hoek & van Hoeken, 2003). Prevalence of the disorder is consistently found higher in Western cultures, where thinness is the ideal and food plentiful (Klein & Walsh, 2003). Typically BN develops during late adolescence or early adulthood, and is usually preceded by body dissatisfaction and chronic dieting (Klein & Walsh, 2003).

BN has devastating physical and psychological effects, with eating disorders being considered some of the most debilitating psychiatric disturbances that affect young women (Agras, 2001; Klein & Walsh, 2003). Although BN has been the focus of much research, much is still to be learned about this pervasive eating disorder.

The *Diagnostic and statistical manual of mental disorders* (DSM-IV-TR; APA, 2000) specifies two subtypes of BN: purging and non-purging, and differentiate individuals on the basis of compensatory behaviours. Persons diagnosed as having BN purging subtype engage in self-induced vomiting or the “misuse of laxatives, diuretics or enemas" during the current episode (APA, 2000, p591). Those individuals diagnosed as having BN non-purging subtype, rather than regular purging, engage in alternative compensatory behaviours such as excessive exercise or restrictive dieting (APA, 2000). Little research has examined the subtypes of BN; in contrast, the subtypes of Anorexia Nervosa (AN) have been researched more extensively (Bollen & Wojciechowski, 2004; Casper & Troiani, 2001; Eddy et al., 2002; Halmi et al., 2000). Attempts have been made to identify further sub-groups within BN, and many have used cluster analyses. Wonderlich and colleagues (2005) identified in their study of 178 persons with BN three clusters of BN women: an affective-perfectionistic cluster, an impulsive cluster, and a low psychopathology cluster. The low psychopathology group had less severe eating pathology, less co-morbid psychopathology, and less maladaptive traits, and may have been identified through the inclusion of persons with sub-clinical BN (ED-NOS). The authors also found high levels of affective disturbance, obsessionality, compulsivity, and perfectionism traits often associated with AN differentiated the affective-perfectionistic cluster. The impulsive cluster was characterised by increased engagement in impulsive behaviours, with these impulsive behaviours judged as self-destructive.

Impulsivity has long been linked with BN, with a vast amount of research supporting the association. In a review of the recent literature Nederkoorn, Eijs, and Jansen (2004) reported evidence that persons with BN display more impulsivity in daily living, take more risks, and are more sensitive to reward than other eating disordered individuals and normal controls. The behaviours of bingeing and purging are often considered as impulsive in nature, with research reporting these acts a consequence of poor impulse control, suggesting persons with BN may suffer a basic inhibitory control deficit (Nederkoorn, Van Eijs, & Jansen, 2004). Moreover, researchers have reported high rates of impulsive behaviours such as self-harm, theft, sexual promiscuity and substance use within BN populations (Dawe & Loxton, 2004; Dykens & Gerrard, 1986; Holderness, 1994; Kaltiala-Heino, Rissanen, Rimpela, & Rantanen, 2003; Nagata, Kawarada, Kiriike, & Iketani, 2000; Sansone & Levitt, 2002). The observed frequencies of such behaviours lead to the suggestion of a further subgroup of the disorder: Multi-Impulsive Bulimia (MIB).

Multi-Impulsive Bulimia (MIB)

The term MIB has been prevalent in the literature since first coined by Lacey and Evans (1986) to describe persons with BN who engaged in a constellation of impulsive behaviours alongside bulimia. Lacey and Evans argued that the presence of multiple impulsive behaviours in individuals with BN represents a distinct subgroup of the disorder. These impulsive behaviours of interest, often found concomitant with BN, are substance use, self-harming behaviours, suicide attempts, theft, and sexual disinhibition (Lacey & Evans). According to Lacey and Evans, those individuals who engage in one or more of the specified impulsive behaviours alongside the bulimic behaviours of bingeing and possibly purging meet the proposed criteria of MIB. A sense of loss of control during such behaviours was also suggested necessary, whereas suppression of such behaviours is thought likely to lead to depression or anger according to the suggested criteria (Lacey & Evans). Lacey (1993) suggested that MIB individuals have more severe eating pathology, more associated psychopathology, poorer prognosis, and differing treatment needs than his or her uni-impulsive or bi-impulsive counterparts. Lacey suggests therefore it is important that MIB individuals be identified prior to treatment commencement.

Since Lacey and Evans' (1986) proposal of MIB, a modest quantity of research has examined the phenomenon, focusing mostly on prevalence rates and associated psychopathology. Prevalence studies have produced mixed results ranging from six percent (Welch & Fairburn, 1996) to 51% (Fahy & Eisler, 1993) of persons with BN also meeting MIB criteria. Most often prevalence studies report incidence of MIB in the 30 – 45% range (Lacey & Read, 1993; Matsunaga et al., 2000; Newton, Freeman, & Munro, 1993; Wonderlich, Myers, Norton, & Crosby, 2002) . Mixed results regarding prevalence are likely influenced by differing criteria used in the various studies, and variations in sample composition (e.g. inpatient versus outpatient). Number of impulsive behaviours engaged in, and within what required time period in order to meet criteria for MIB has also varied across research, as has the method of information collection (Bell & Newns, 2002).

Eating pathology was reported as more severe in MIB individuals, with an earlier age of onset and higher frequency of purging episodes reported (Bell & Newns, 2002). Associated psychopathology has been shown to be more common in MIB individuals (Fichter, Quadflieg, & Rief, 1994), with greater severity of symptoms (Bell & Newns, 2002). Levels of depression have been reported as consistently higher pre treatment and remain clinically significant after treatment specific for BN in MIB individuals (Bell & Newns, 2002).

Limited research has examined prognosis and treatment outcome for MIB individuals, however results suggest individuals with MIB have poorer prognosis (Nederkoorn et al., 2004; Sohlberg, 1991) complicated by more general psychopathology (Fichter et al., 1994), have higher rates of treatment drop out (Agras, 2001; Fichter et al., 1994; Newton et al., 1993), higher levels of depression after treatment, as well as higher rates of relapse (Bell & Newns, 2002).

Lacey and Evans (1986) proposal of MIB as a subtype of BN has been well received in the literature despite the fact it has not been empirically examined. Rather than the existence of an MIB subtype, an alternative conceptualisation might be that impulsive behaviours displayed in MIB simply occur on a continuum of impulsiveness alongside BN. Alternatively, severity of BN may be correlated with increased frequency of other problems, such as impulsiveness. In order to establish the true nature of MIB, taxometric research examining the phenomena is needed. This research examines the phenomenon of MIB through taxometric methods, which have been used in numerous studies of psychopathology to address the question of whether phenomena occur on one or more continua versus as discreet classes.

Lacey and Evans (1986) propose amongst individuals with BN the behaviours of substance use, self-harm, suicide attempts, theft, and sexual disinhibition are indicators of MIB. Whilst a moderate quantity of research has examined MIB as an entity, a much larger number of studies published have examined the occurrence of individual impulsive behaviours amongst persons with BN. This research will now be discussed.

Bingeing. An episode of binge eating is defined as the consumption of an abnormally large amount of food in a discrete period of time, during which the individual has a sense of loss of control over eating (APA, 2000). Typically, shame around bingeing behaviours occurs, and efforts are made to ensure secrecy. Although an eating binge may be pre-planned, the cognitive-behavioural model of BN explains bingeing results from a failed attempt to restrict (Spangler, 1999), therefore it is likely that many binges are impulsive in nature due to the inability to resist urges, disinhibition and loss of control over eating (Dawe & Loxton, 2004). Often an attempt to cope with negative affect (Fischer, Smith, & Anderson, 2003), the binge may leave the participant with feelings of failure, lack of self-control, and self-directed anger

(Spangler, 1999). Bingeing, therefore, may be considered an impulsive behaviour and lend support to the association between BN and impulsivity.

Bulimia Nervosa and substance use. Empirical research suggests a clear association between BN and clinically significant substance abuse (Bulik, Sullivan, Carter, & Joyce, 1997; Hatsukami, Mitchell, Eckert, & Pyle, 1986; Holderness, 1994; Hudson, Weiss, & Pope, 1992; Krahn, Kurth, Demitrack, & Drewnowski, 1992). Substance dependence has been observed among eating disordered patients at a level higher than expected in general female population (Corcos et al., 2001). With lifetime prevalence estimates of Substance Abuse or Dependence among persons with BN as high as 47% (Bulik et al., 1997) compared with the general population prevalence estimated as 8.2% (Kessler, McGonagle, Zhao, Nelson, & et al., 1994). Moreover, women diagnosed with substance dependence disorders have been found to have higher prevalence of eating disorders or engage in more eating-disordered like behaviours than controls (Grilo, Martino, Walker, Becker, & et al., 1997; Hudson et al., 1992). A meta-analysis of 51 studies conducted by Holderness, Brooks-Gunn, and Warren (1994) found the median level of alcohol dependence in samples of BN women was 23%. The level of comorbid alcohol dependence observed in BN and binge-purge AN is reported higher than in restricting AN samples (Corcos et al., 2001; Hudson, Pope, Jonas, & Yurgelun-Todd, 1983; Toner, 1986).

In a study of dieting and substance use of 1,796 undergraduate women (Krahn et al., 1992) dieting severity was found positively correlated with alcohol, marijuana, and nicotine use. Krahn and colleagues concluded severe dieters were more likely to abuse multiple substances, engage in the substance use more frequently, and also reach intoxication level more often than less severe dieters and non-dieters.

Moreover, a recent study of 391 university women (D. A. Anderson, Martens, & Cimini, 2005) examined level and frequency of substance use, as well as associated negative outcomes among women identified as purgers compared to non-purgers. Women who engaged in purging behaviour reported greater alcohol consumption, and more negative associated outcomes including injury to self and risky sexual behaviour.

A large community sample of adolescent girls found those identified as having an eating disorder, either BN or AN, were more likely to have a history of abusing substances than those without eating problems (von Ranson, Iacono, & McGue, 2002). However, the authors concluded that non-treatment seeking eating disordered women did not show as strong a relationship with alcohol abuse as previous clinical samples.

Bulik and colleagues (1997) compared persons with BN with and without substance dependence across a variety of measurement domains. A clear finding emerged, with BN participants with comorbid substance dependence displaying greater impulsiveness over a broad variety of domains than their non-substance dependant counterparts. Borderline personality disorder (BPD) was the sole significant variable distinguishing between the two groups, with 62% of BN and substance dependants meeting criteria, compared with only 14% of the BN only group.

Hatsukami, Mitchell, Eckert and Pyle (1986) compared patients with BN alone, BN and depression (BN+AD), and BN and substance dependency (BN+SA). Participants in the BN + SA group were found to have overall higher levels of financial and work problems, previous psychiatric treatment, and inpatient hospitalisations than their non-substance abusing counterparts. Moreover, examination of patterns of substance use within this group revealed alcohol use was found to increase after onset of BN. The BN+SA group also engaged in significantly more episodes of theft, both after and prior to onset of BN, and more suicide attempts.

Therefore the proposed relationship between BN and increased substance use, particularly alcohol consumption, is well supported by research. Lacey and Evans (1986) suggest this observed relationship may be due to MIB, and therefore high levels of alcohol use should serve as an indicator of MIB.

Bulimia Nervosa and sexual disinhibition. BN women report greater current sexual activity and higher levels of past sexual experience when compared with normal controls and repeat dieters (Abraham & et al., 1985; Coovert, Kinder, & Thompson, 1989; Dykens & Gerrard, 1986; Irving, McCluskey-Fawcett, & Thissen, 1990). On comparison with individuals diagnosed with AN, persons with BN were again found to have more sexual experience (Wiederman & Pryor, 1997). Culbert and Klump (2005) examined eating behaviours and sexual experiences in 499 female university students. The researchers found a modest, yet significant, positive correlation between bulimic compensatory behaviours and number of heterosexual partners, number of homosexual partners, and number of heterosexual acts previously experienced. None of the correlations between bingeing behaviour and the sexual experience items reached significance. Partial correlation analyses revealed that the association between compensatory behaviour and sexual behaviours could be accounted for by impulsivity.

Research examining increased sexual disinhibition amongst individuals with BN is grossly limited. However, the available research reports increased sexual experience amongst this population. Lacey and Evans (1986) propose the sexual disinhibition is explained by impulsivity, and may be indicative of MIB.

Bulimia Nervosa and deliberate self-harming behaviours. Deliberate self-harming behaviours (DSH) that are impulsive in nature, such as cutting and burning, are reported at higher rates among women with BN (Anderson, Carter, McIntosh, Joyce & Bulik, 2002). Sansone and Levitt's (2002) meta-analysis of self-harm in 574 persons with BN found reported DSH rates of 25%, a rate much higher than in the general psychiatric population where estimates range from 4 to 10% (Favazza & Conterio, 1988; Zlotnick et al, 1996). Paul and colleagues (Paul, Schroeter, Dahme, & Nutzinger, 2002) compared self-injuring AN, BN, and ED-NOS individuals with their non-self-injuring peers. Highest rates of DSH was reported in BN (34.4%) and ED-NOS (35.8%), with binge-purge AN displaying substantially higher lifetime rates of DSH (41.7%) on comparison with restricting peers, although these differences did not reach statistical significance. Cognitive impulsivity was identified to differentiate self-harmers from non-self-harmers amongst this eating disordered population.

Research has supported the notion that DSH occurs alongside multiple other impulsive or self-destructive behaviours including binge eating (Zlotnick et al, 1996; Herpertz, Sass & Favazza, 1997). Further evidence for the association between DSH and eating pathology comes from studies of self-harming women who report a high prevalence of eating disorders compared to the general population (Favaro & Santonastaso, 2002). Lacey and Evans (1986) suggest DSH amongst persons with BN may indicate MIB.

Bulimia Nervosa and suicide attempts. Women diagnosed with either of the eating disorders are at increased risk of engaging in suicidal behaviour compared with the general population (see Franko and Keel [2006] for a comprehensive review). Milos, Spindler, Hepp and Schnyder (2004) reported the prevalence of previous suicide attempts in their sample of 300 people with eating disorders as 26%, with general population estimates reported at 6%. Moreover, Bulik, Sullivan and Joyce (1999) found previous suicide attempts in participants with AN or BN was comparable to that of participants with Major Depressive Disorder, a disorder for which suicidal ideation is included in DSM-IV-TR criteria. The authors went on to say that although mortality rates associated with BN are far below that of AN (due to the physical complications of starvation), suicide risk constitutes an independent risk factor for mortality in BN (Bulik et al., 1999). Sansone and Levitt (2002) conducted a meta-analysis examining BN and suicide attempts, reporting the prevalence of attempts among 1,211 outpatients with BN 23%. Only two studies of inpatients were included in the meta-analysis, with the resulting suicide attempt prevalence reported as 39% (101 of 260 subjects). Bulik and colleagues (1997) compared suicide attempts in BN outpatients with and without alcohol dependence. The prevalence rates were 48.1% and 18.3% respectfully, supporting suggestions that substance dependence substantially increases risk for suicidal behaviour (Hatsukami et al., 1986; Sansone & Levitt, 2002).

According to Lacey and Evans (1986) the observed relationship between BN and increased suicide attempts may be explained for some individuals by impulsivity and the presence of MIB. Therefore, increased suicide attempts amongst persons with BN may indicate MIB.

Bulimia Nervosa and theft. Impulsive stealing behaviour has been noted in women with BN and binge/purge AN, both for food items and non-food items; (Norton, Crisp, & Bhat, 1985; Rowston & Lacey, 1992; Vandereycken & Van Houdenhove, 1996) . Despite being limited in number, studies have consistently shown that theft is more often associated with binge-eating, vomiting and laxative abuse than with other symptoms of the eating disorders (Norton et al., 1985;

Vandereycken & Van Houdenhove, 1996). Vandereycken and Van Houdenhove (1996) examined stealing behaviour in 155 eating disordered women, with 47.1% of participants admitting to at least one incident of stealing behaviour, half of which admitted stealing in the last year. Diagnostic comparisons revealed 48.7% of women with BN had engaged in theft compared with 35.3% of restrictive AN. More than half of women with binge/purge AN disclosed past stealing behaviour (54.8%), a significant difference from their restricting peers. The literature also notes the increased occurrence of other impulsive behaviours among those women who engage in stealing behaviour alongside her eating disorder, such as increased sexual promiscuity, and substance use (Norton et al., 1985; Rowston & Lacey, 1992). Rowston and Lacey (1992) concluded, from their study of 312 persons with BN, that stealing behaviour was significantly associated with illicit drug use. Moreover, the authors noted BN “stealers” disclosed significantly greater numbers of sexual partners than “non-stealers”. Research examining the association between BN and substance abuse has also noted the increased occurrence of stealing behaviour amongst this population (Hatsukami et al., 1986) lending further support to Lacey and Evans’ MIB suggestion.

In summary research supports Lacey and Evans (1986) suggestion that for some persons diagnosed as having BN impulsivity is problematic, with evidence for associations between BN and increased substance use, self-harm, suicide attempts, sexual disinhibition, and theft. Despite this evidence, it is unclear if MIB represents a distinct subgroup of BN. For such a conclusion to be made, taxometric research methods need to be used. These methods will now be discussed.

Taxometric Studies of Psychopathology

Development of taxometric research methods by Meehl and colleagues (Meehl, 1973, 1995; Meehl & Golden, 1982; Waller & Meehl, 1998) has allowed empirical evidence to quell the continuous versus discontinuous debate of latent variables, a debate previously left to theoretical opinion (Haslam & Kim, 2002). Taxometric methods are able to identify the presence or absence of *taxa*: non-arbitrary, naturally occurring, and objectively defined categories and therefore make empirically validated distinctions between the categorical or dimensional nature of latent variables (J. Ruscio, Haslam, & Ruscio, 2006).

Taxometric research of psychopathology has covered differing areas and provided invaluable knowledge as to the nature of mental disorders; however the field is still in its infancy. The differentiation of mental disorders as continuous or categorical provides important implications for not only the classification of disorders but also helps guide prevention, assessment and treatment. Researchers have examined personality disorders, Schizophrenia, substance use, dissociative disorders, anxiety, ADHD, as well as eating disorders (see Haslam & Kim [2002] or Schmidt, Kotov & Joiner [2004] for comprehensive reviews). Previous taxometric studies of eating disorders have focused on the continuity model of eating disorders, which proposes that eating pathology occurs at the extreme end of an eating behaviour continuum (Gleaves, Brown, & Warren, 2004). Such research has produced conflicting results; however, recent studies do not support strictly dimensional models of eating disorders (Gleaves et al., 2004). Gleaves, Lowe, Green, Cororove and Williams (2000) validated the purge and non-purge subtypes of BN through taxometric research, with a further study concluding BN is taxonic; - however both subtypes were found to exist along a continuum with the binge/purge subtype of AN

(Gleaves, Lowe, Snow, Green, & Murphy-Eberenz, 2000). Prior to the current study there has not been a published taxometric investigation examining MIB.

Despite the lack of validation, MIB has been well accepted within the literature and has been the focus of a modest amount of research. As previously stated, studies have examined *MIB individuals* and concluded these patients have poorer prognosis (Nederkoorn et al., 2004; Sohlberg, 1991), more severe associated psychopathology, higher levels of depression (Bell & Newns, 2002), and are more likely to drop out of treatment (Agras, 2001; Fichter et al., 1994; Newton et al., 1993). In order for such findings to be meaningful and applicable in everyday practice it is necessary to establish if the construct of MIB does represent a distinct subgroup of persons with BN. If so, such research has vast implications for the clinical assessment and treatment of BN. Lacey (1993) argues that MIB is a meaningful and distinct subtype of BN, however some researchers argue that the relationship between each of the impulsive behaviours and BN is separate and the proposed subtype is superfluous (Welch & Fairburn, 1996). Therefore, examining the validity of MIB as a subtype through taxometric methods will provide clarification and important theoretical knowledge. Additionally, findings may provide guidance and improvement in classification, as well as improved etiological understanding. The goal of the current study is to provide such knowledge through taxometric analyses.

Method

Participants

Archival data were used in this study, and original information can be found in Gleaves and Eberenz (1995) . The data were collected for clinical and research purposes with consent from participants given at the time of data collection, and permission to use the data set for the purposes of this study was granted from the original researcher (D.H. Gleaves). The participants were 419 women seeking treatment at a residential treatment facility for women with eating disorders in North America. All participants were diagnosed as meeting DSM-III-R (APA, 1987) criteria for BN. The diagnosis was initially made through a semi-structured interview conducted by a Master’s level admissions team member, corroborated with data collected on the intake questionnaire. A Clinical Psychologist or Psychiatrist, assigned as the participant’s individual therapist, later confirmed diagnoses. Table 1 presents descriptive information of the original sample of 497 patients including Eating Disorder Inventory (EDI) (Garner, Olmsted, & Polivy, 1983) scale scores as published in Gleaves and Eberenz (1995). The reduction in participants in this sample was due to the exclusion of those with missing data. Such exclusion was necessary due to the sensitivity of the taxometric analysis programme, which will not compute analyses if any data are omitted.

Table 1

Characteristics of the Sample

	M	*SD*
Age	23.5	5.9
Body Mass Index	21.3	3.4
Duration of illness (months)	84.0	62.9
Binges/week	17.6	19.4
Vomits/week	19.4	21.7
EDI scales		
Drive for thinness	15.6 (51)	4.8
Bulimia	13.1 (66)	4.8
Body Dissatisfaction	19.2 (51)	7.3
Ineffectiveness	13.2 (64)	6.7
Perfectionism	8.6 (56)	4.5
Interpersonal distrust	6.8 (65)	4.3
Interoceptive awareness	13.7 (70)	6.4
Maturity fears	4.6 (72)	4.5

Note. – Numbers in parentheses are approximate percentile ranks for bulimia nervosa patients (Garner, 1991).

Note. From “Validating a Multidimensional Model of the Psychopathology of Bulimia Nervosa”, by D.H. Gleaves and K.P. Eberenz, 1995, *Journal of Clinical Psychology, 51, 2,* p182.

Assessment Measures

A comprehensive intake questionnaire, administered prior to treatment, was used to measure indicators in this study. The questionnaire included items regarding engagement in specific impulsive behaviours as well as eating behaviours, and was derived largely from the Diagnostic Survey for Eating Disorders- Revised (DSED-R) (Johnson, 1985). The questionnaire required participants to rate the frequency of 5 indicator behaviours on a scale (1 = never, 5 = always). The remaining two indicators, bingeing and purging, simply asked respondents to indicate frequency of the behaviours per week. Purging referred only to self-induced vomiting in the original questionnaire.

Statistical Analyses

Taxometric research methods, developed by Paul Meehl and colleagues (Meehl, 1973; Meehl, 1995; Meehl & Golden, 1982; Meehl & Yonce, 1994, 1996) to determine the nature of the latent construct were used in this research. Analyses were computed using programs written by Ruscio (see Ruscio et al, 2006) run on the R Statistical Package, version 2.3.0 (R Development Core Team, 2006) and include Mean Above Minus Below A Cut (MAMBAC), Maximum Covariance (MAXCOV), and Latent Mode (L-Mode) analysis. The procedures all examine the relationships between indicators of a construct across a sample to uncover the latent structure. As these procedures are mathematically distinct together they provide consistency testing and increase reliability of the result (J. Ruscio et al., 2006).

Ruscio’s (2006) programme allows for simulation of comparison taxonic and dimensional data during each analysis. These simulated data sets are created using the same characteristics (number of indicators, sample size, estimated indicator validity, skewness of the indicators, estimated indicator validity or nuisance covariance) as the research data, and therefore provide valuable comparisons when examining the latent structure of the research data. By subjecting the simulated data to the same taxometric analyses as the research data, results are more easily interpreted. Indistinguishable simulated taxonic and dimensional comparison data suggest the research data are not optimal for the present analysis and interpretation may be problematic. The procedures of MAMBAC, MAXCOV, and L-Mode are outlined below:

MAMBAC. Mean above minus below a cut (MAMBAC) requires two indicators in each analysis, one serving as an input variable and the other as an output variable (see Meehl and Yonce, 1994 for comprehensive explanation). The analysis makes a series of “cuts” along the distribution of the input indicator, and measures the means on the output indicator for the two groups created by the cut (Schmidt et al., 2004). MAMBAC examines the pattern of differences between the means of groups and assumes that with the presence of two distinct groups (latent taxonic structure) an optimal cutting score for differentiation must exist. At this optimal cutting score the particular value on the indicator will distinguish between a taxon and it’s compliment class with little error. If no taxon exists then the search for an optimal cutting score will fail. MAMBAC results are plotted, and the shape of the graph is used for interpretation. If an optimal cutting score exists, the largest mean difference between groups occurs at this cut, with differences declining as cuts are made higher or lower than this point. This results in a peaked curve as can be seen in Figure 1. Should an optimal cutting score not exist, MAMBAC analysis graphs appear concave or bowl-shaped suggesting dimensional structure (J. Ruscio et al., 2006), see Figure 1.

However, the characteristic shape of a taxonic curve is vulnerable to the effect of skewed data, and differing base rates. The symmetric curve presented in Figure 1 is an error-free example where the taxon base rate (*P*) is 0.50. As the base rate becomes larger, the peak of the plot moves to the left, and conversely, as the base rate becomes smaller, the peak moves to the right (see Meehl and Yonce [1994] for a comprehensive exploration). Skewed data can also produce predictable changes to the peak of taxonic graphs, with positively skewed data also leading to a rising right peak, falsely suggesting taxonic structure (J. Ruscio et al., 2006). However, Haslam and Cleland (2002) argue MAMBAC is relatively robust to the effects of skewed data, more so than MAXCOV analyses.

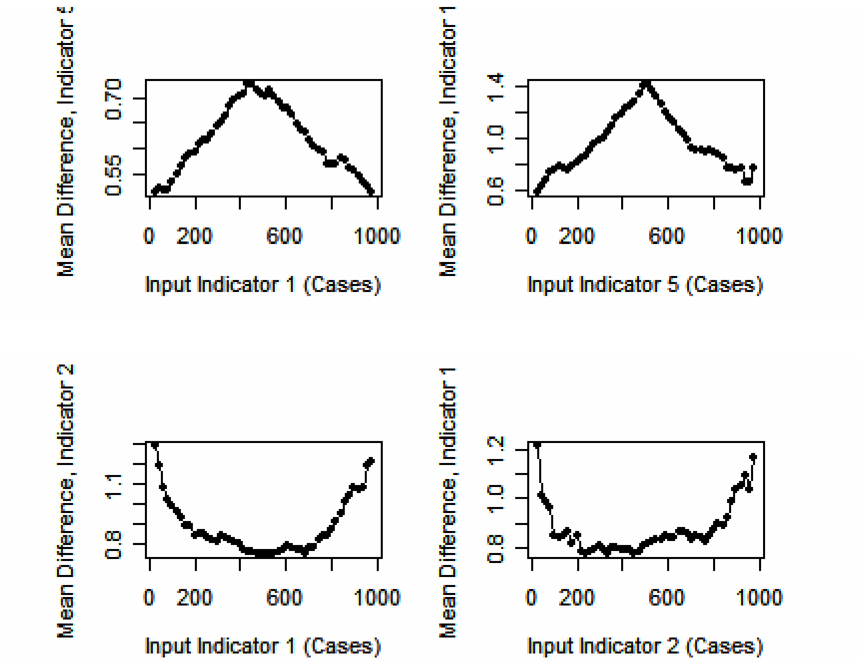

Figure 1. Typical MAMBAC plots for taxonic (top) and dimensional (bottom) data.

MAXCOV. Maximum covariance (MAXCOV) analysis is based on the General Covariance Mixture Theorem (GCMT; Meehl, 1973, 1995) that suggests that the covariance of indicators (x and y) is a function of the taxon and complement base rates and the validity of the two indicators (x and y) (J. Ruscio et al., 2006), and examines the pattern of covariance between two indicators (see Meehl and Yonce, 1996 for a comprehensive explanation). The procedure uses three indicators in each analysis, one of which must be continuously distributed (x: input variable), with the covariance of the remaining two indicators (x & y) the output variable. Covariance scores of the second and third variable are graphed, as successive cuts are made along the input variable. Conclusions are based on graph interpretation and consistency of base-rate estimates (Gleaves et al, 2004). Taxonic structures appear peaked in MAXCOV graphs; whilst dimensional structures appear generally flat (Meehl &

Yonce, 1996), see Figure 2. The location of the peak in taxonic MAXCOV graphs is also dependent on the estimated taxon base rate, with base rates of 0.50 resulting in a symmetrical bell-shaped peak (see Figure 2). Base rates smaller than 0.5 result in the taxonic peak shifting to the right, and with larger base rates the peak moves left (Meehl & Yonce, 1996).

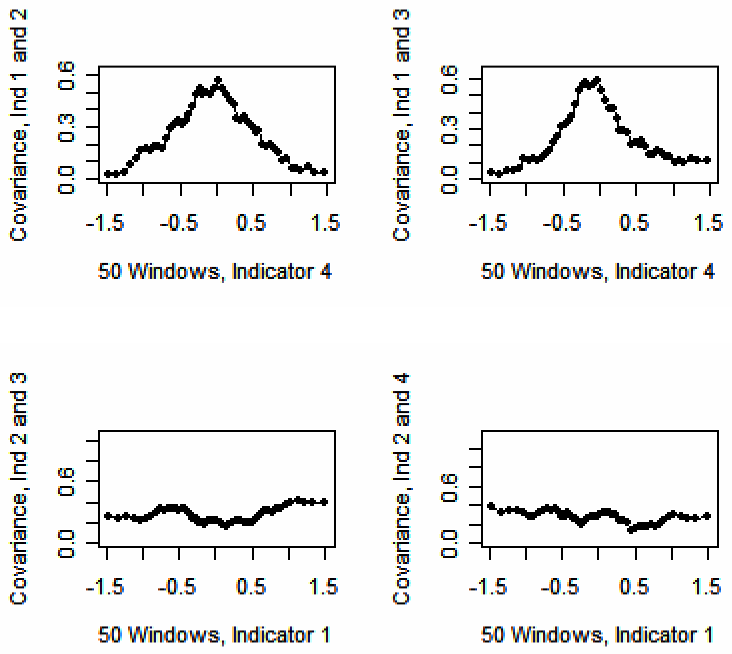

Figure 2. Typical MAXCOV plots for taxonic (top) and dimensional (bottom) data.

L-MODE. The Latent Mode (L-MODE) taxometric procedure uses factor analysis to evaluate latent structure. Again graphs are utilised, in this case the distribution of cases' estimated scored on a single latent factor are plotted. The estimated scores are calculated by factor analysis constrained to one-factor solution. These scores are more reliable at distinguishing taxon and the complement class than the indicators alone. A bimodal distribution of factors scores is indicative of taxonic structure, whereas unimodal distribution suggests a dimensional structure of the latent variable (J. Ruscio et al., 2006), see Figure 3 .

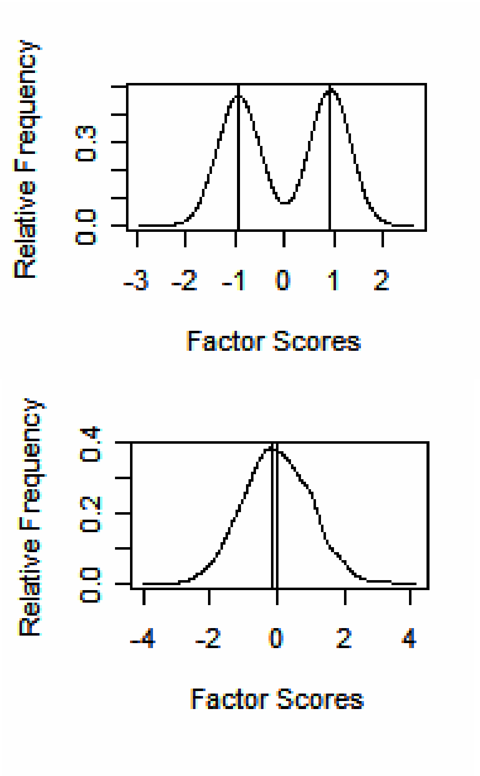

Figure 3. Typical L-Mode plots for taxonic (top) and dimensional (bottom) data.

Consistency testing. Consistency testing is an integral part of taxometric research and this study was carried out using several methods: (a) performing multiple taxometric procedures numerous times and in numerous ways, (b) evaluating estimates of latent parameters, and (c) assessing the fit of taxonic and dimensional models to results yielded by the research data as outlined in Ruscio and colleagues (2006).

Several specific techniques have been developed to estimate the consistency of taxometric results, however these have varying validity (J. Ruscio et al., 2006). Such techniques include the nose-count ratio test, Goodness-of-Fit Index (GFI), the base rate variability test, Inchworm Consistency Test, and more recently, Ruscio's Comparison Curve Fit Index (CCFI) (J. Ruscio et al., 2006).

The nose-count test involves the visual inspection of graphs, identifying those that are peaked, and those that are not. The number of peaked graphs in relation to non-peaked (either ambiguous or dimensional) is then used for checking of consistency, with much debate surrounding the ideal ratio needed before a structure may be deemed taxonic (Schmidt et al., 2004). Schmidt and colleagues (2004) suggest a ratio of 1:1 taxonic plots to non-taxonic plots is the simplest approach for identifying taxonicity. The nose-count consistency test has been reported superior to all other consistency tests in accurately identifying taxonicity (Schmidt et al., 2004).

Waller and Meehl (1998) introduced the Goodness-of-Fit Index, based on Structural Equation Modelling, which compares the indicator variance-covariance matrix predicted by a taxonic structural model, to the observed variance-covariance matrix (J. Ruscio et al., 2006; Schmidt et al., 2004). Should the model fit perfectly (GFI = 1.00, where GFI range is 0 - 1), taxonicity is strongly supported. Waller and Meehl (1998) reported taxonic data yield GFI scores greater than 0.90, and suggest 0.90 as a cut-off for supporting taxonic findings. However, Ruscio and colleagues (2006) highlight the GFI's poor validity, with subsequent studies showing both taxonic and dimensional data may produce GFI's greater than 0.90 (Haslam & Cleland, 2002) . In this study GFI scores are reported, however interpreted with caution given the questionable validity of this measure.

In answer to the poor performance of the GFI, Ruscio and colleagues (2005, as cited in Ruscio et al, 2006) created the Comparison Curve Fit Index (CCFI). The CCFI makes use of the simulation of taxonic and dimensional data (with identical characteristics of the research data) produced by Ruscio's taxometric program. The CCFI is a mathematical representation of the fit of the research data to the simulated taxonic or simulated dimensional data (for comprehensive explanation see Ruscio et al, 2006). CCFI scores range from 0 to 1, with lower scores suggesting the research data fit closer with the dimensional curve, and higher scores supportive of taxonicity. CCFI scores around 0.50 suggest equally good or equally poor support for both structures (J. Ruscio, 2006). The CCFI may be a useful supplement to visual inspection (J. Ruscio et al., 2006) and was examined in this study.

The Inchworm Consistency Test, developed by Waller and Meehl (1998) for use in MAXCOV analyses, attempts to make ambiguous results more interpretable, and therefore more consistent. By increasing the number of overlapping windows used in each MAXCOV analysis, the procedure is able to identify small taxa otherwise hidden by the analysis. With larger numbers of overlapping windows used in each analysis, previously ambiguously graphed taxonic structures begin to reveal clearly-defined peaked graphs, with dimensional latent structures remaining ambiguous or flat (J. Ruscio et al., 2006). The Inchworm Consistency Test was applied to a MAXCOV analysis in this investigation.

MAXCOV and MAMBAC analyses provide estimations of taxon base rate during each analysis. The variability of these base rate estimations can be used as a measure of consistency, with small levels of variability adding weight to the taxonic argument. Large divergence in base rate estimations provides evidence against a taxonic structure (J. Ruscio et al., 2006; Schmidt et al., 2004). However, there remains disagreement over the validity and subsequent utility of this measure.

Procedures

The Taxometric Method uses a multiple consistency, multiple hurdles approach before concluding the latent structure of a construct (Gleaves, Lowe, Snow et al., 2000). In this study three distinct taxometric analyses were used, MAMBAC, MAXCOV, and L-Mode. Moreover, a number of consistency tests were examined, the nose-count comparison test, CCFI, Inchworm consistency test, base-rate variability test, and GFI.

Multiple implementation decisions are needed in order to compute each of the taxometric analyses. In this study, multiple sub-analyses were conducted during each taxometric procedure, in order to examine results across implementation decisions. As recommended by Ruscio et al (2006), this study presents analyses that most strongly differentiate taxonic and dimensional groups (should latent structure be taxonic). However, patterns across the multiple analyses are also reported and discussed.

Smoothing of graphs in taxometric research may aid interpretation by reducing noise and therefore improve accuracy of conclusions (Ruscio et al, 2006). Where smoothing is indicated, the LOWESS method has been used, as recommended by Ruscio and colleagues (2006).

Primary indicator selection. A theoretical approach was used to select indicators for analysis. Lacey and Evans (1986) proposed criteria for MIB requires one or more “impulsive” behaviours in addition to a BN diagnosis. As previously outlined, the impulsive behaviours of interest are substance use, self-harming, suicide attempts, theft, and sexual disinhibition. The archival data used in this analysis included all but one of these proposed behaviours, sexual disinhibition. Thus, indicators initially identified for use in this study were 1) bingeing, 2) purging, 3) alcohol use, 4) suicide attempt, 5) deliberate self-harming, 6) theft – weight related, and 7) theft – miscellaneous.

A correlation matrix of the chosen indicators revealed high overlap for some indicators suggesting the current indicators were inappropriate for taxometric analyses (see Table 2).

Table 2

Indicator correlations for original 7 indicators:

	Ind 1	Ind 2	Ind 3	Ind 4	Ind 5	Ind 6	Ind 7
Ind 1	—	0.870	0.004	0.178	0.216	0.182	-0.020
Ind 2		—	0.045	0.136	0.163	0.126	0.024
Ind 3			—	0.298	-0.011	0.117	0.125
Ind 4				—	0.050	0.121	0.088
Ind 5					—	0.505	0.102
Ind 6						—	0.219
Ind 7							—

Note. Ind 1 = binge, Ind 2 = purge, Ind 3 = suicide attempts, Ind 4 = self-harm, Ind 5 = theft (weight related), Ind 6 = theft (miscellaneous), Ind 7 = alcohol use.

Subsequently, a Principal Components Analysis (PCA) was computed using SPSS (Version 14, SPSS, 2005) . The rotation method used in this analysis was the Promax with Kaiser Normalization, and factor scores were generated using the regression method. The analysis of the seven indicator variables identified four factors that accounted for 81.7% of the total variance before the rotation. The four factor scores used as indicators in the subsequent taxometric analyses were: (1) “Bulimic behaviours” (bingeing and purging), (2) “Theft” (theft – weight related and theft – miscellaneous), (3) “Self-harm” (deliberate self-harm and suicide attempts), and (4) “Alcohol use”, (see Table 3 for pattern matrix). Table 4 shows indicator correlations for the final four indicators.

Table 3.
Pattern matrix of primary seven indicators:

	Component:			
	1	2	3	4
Binge	0.957	0.041	0.005	-0.026
Purge	0.974	-0.045	-0.001	0.048
Suicide attempts	-0.095	-0.027	0.815	0.064
Self-harm	0.105	0.025	0.796	-0.087
Theft (wt)	0.024	0.896	0.087	-0.091
Theft (misc)	-0.032	0.836	0.087	0.109
Alcohol	0.022	0.005	-0.016	0.992

Note. The extraction method used was *Principal Components Analysis*. Rotation method used was *Promax*.

Table 4
Indicator Correlations for final four indicators:

	Ind 1	Ind 2	Ind 3	Ind 4
Ind 1(Bulimic beh.)	—	0.208	0.109	-0.023
Ind 2 (Theft)		—	0.099	0.172
Ind 3 (Self-harm)			—	0.154
Ind 4 (Alcohol)				—

Note. Bulimic beh. = bulimic behaviours

Taxometric analyses require low within-groups indicator correlations for the taxon and complement group (should latent structure be taxonic), with the ideal being $r = .00$ (J. Ruscio et al., 2006). High nuisance covariance, the extent to which indicators covary within-groups, may lead to the failure of taxometric programmes to detect true taxonic boundaries (J. Ruscio et al., 2006). Meehl (1995) suggests inter-indicator correlations below 0.30 are acceptable for taxometric analyses.

Moreover, indicator validity, as measured by the extent to which the proposed taxonic and dimensional distributions are separated on each indicator, is imperative to a satisfactory taxometric investigation. Without sufficient indicator validity, the analysis may again fail to identify genuine taxometric boundaries (J. Ruscio et al., 2006). Indicator validity is calculated as the mean difference between the taxon and complement, standardized by the pooled groups variance, otherwise known as “Cohen’s *d*” (J. Ruscio et al., 2006). Meehl (1995) suggests a Cohen’s *d* of 1.25 for each indicator in a taxometric analysis should yield interpretable results. Although this *d* may seem exceptionally large, taxometric investigations commonly report group separations above this score (Schmidt et al., 2004).

As this is an exploratory analysis it is not possible to measure indicator validity or nuisance covariance prior to analyses. Ruscio’s (2006) taxometric program provides an estimate of indicator validity and within-group indicator correlations for taxon and complement groups during each taxometric analyses. These estimations are calculated by assigning cases to taxon and complement groups based on the base rate estimation (whether a true taxon exists or not). Thus, those cases with the highest scores on all indicators are assigned to the taxon, and the remaining assigned to the complement group. Indicator validity and within group inter-correlations are calculated for these estimated groups and provide guidance regarding the accuracy of findings (J. Ruscio, 2006; J. Ruscio et al., 2006).

Results

Inter-rater reliability

As taxometric results are based primarily on visual inspection of graphs it is advantageous to measure inter-rater reliability of judgements. In this study the primary researcher, a Masters-level Clinical Psychology student, served as one rater. The second rater was a doctoral level Psychologist whom had previously conducted and published a number of taxometric investigations. Graphs were examined independently by each rater and determined to be (a) suggestive of taxonicity, (b) suggestive of dimensionality, or (c) ambiguous. Graphs from each method of taxometric analyses, MAMBAC, MAXCOV and L-Mode, were examined separately. Multiple sub-analyses plots were examined and reliability data are presented in Table 5. Agreement between raters was variable when examining plots without simulated comparison data, with percentage agreement ranging from 0.25 to 0.79 (κ = 0.080 to 0.859) for individual graphs. L-Mode analyses produced the poorest result, with raters agreeing only on one of the four L-Mode plots. However, when simulated comparison data were available, raters had 100% agreement across the separate taxometric methods. Most disagreements between raters occurred when one rater labelled the plot as ambiguous, and the other rater the plot as either taxonic or dimensional. From the 133 plots inspected, on only two occasions did one rater concluded the plot was taxonic, when the other rated it as dimensional. Both of these plots were MAMBAC averaged curve plots for Indicator 3 (self-harm), and were essentially the same analysis (one had the LOWESS smoothing technique applied, whereas the other had not). Rater 1 was more likely than Rater 2 to conclude a plot was taxonic, while Rater 2 was more likely to conclude a plot was ambiguous.

Table 5.
Inter-rater agreement for ratings of taxometric graphs and percentages rated as taxonic

				% rated taxonic	
Procedure	No. of plots	Agreement	κ	Rater 1	Rater 2
MAMBAC					
Individual	48	0.75	0.60	43.8%	31.3%
Averaged	8	0.75	0.50	37.5%	25%
Comparison	14	1.00	1.00	42.8%	42.8%
MAXCOV					
Individual	42	0.79	0.64	47.6%	35.7%
Comparison	10	1.00	1.00	40%	40%
L-Mode					
L-Mode plot	4	0.25	0.08	0%	0%
Comparison	7	1.00	1.00	0%	0%

Note. Individual = individual indicator plot, Averaged = averaged plot for each indicator, Comparison = plots including simulated comparison data.

MAMBAC results

Taxometric programs require multiple implementation decisions to be made when performing MAMBAC analyses. In this study, many of the implementation decisions were varied across multiple analyses. This variation allowed the researcher to examine patterns, and to identify the procedure that most clearly separated taxon and complement groups should the latent structure be taxonic. First, several analyses were performed with each indicator serving in all possible input-output pairs, producing 12 MAMBAC individual plots per analysis. Secondly, MAMBAC was performed using all indicators as separate output variables, a composite indicator, the summation of the remaining indicators, serving as the output variable. The analyses using the composite indicator produced four individual MAMBAC plots, one for each indicator. In this study, the implementation decision relating to the input indicator had a substantial effect on outcome (both taxometric statistics and visual inspection ratings of plots, see Table 6). Therefore, results are reported separately for both situations.

Table 6.
Inter-rater agreement for ratings of representative MAMBAC graphs and percentages rated as taxonic

				% rated taxonic	
Procedure	No. of plots	Agreement	κ	Rater 1	Rater 2
Single input indicator					
Individual	12	0.83	0.53	58%	33%
Averaged	4	0.75	0.50	50%	25%
Comparison	2	1.00	1.00	100%	100%
Composite input indicator					
Individual	4	1.00	1.00	0%	0%
Comparison	2	1.00	1.00	0%	0%

Note. Individual = individual indicator plot, Averaged = averaged plot for each indicator, Comparison = plots including simulated comparison data.

When individual indicators were used in all possible input-output pairs, results were reasonably consistent across multiple analyses (with differing implementation decisions). A MAMBAC analysis has been chosen as representative of these multiple analyses (as suggested by Ruscio et al, 2006), and is presented below. The representative analysis was performed using all four indicators, with 50 evenly spaced cuts beginning 25 cases from either extreme, and case numbers were used to graph the input indicator. Multiple comparison data sets (n=10, as recommended by Ruscio, 2006) for taxonic and dimensional data were also simulated. Visual inspection of the 12 individual plots produced by this analysis, (see Figure 4), revealed the curves were neither characteristically taxonic (hat-shaped), nor dimensional (dish-shaped).

However, many of the curves were peaked or “cusped” at the right end of the plots, a shape often found in taxonic data sets with low base rates or where data are positively skewed. Monte Carlo simulations of skewed data, and data with low taxon base rates were used for comparison when coding plots (from Meehl and Yonce, 1994). Seven of the 12 individual plots were coded as taxonic, with the remaining five deemed ambiguous. Averaged plots were generated for each indicator, and are presented in Figure 5. Two of these averaged plots were deemed taxonic (indicators 3 – self-harm and 4 - alcohol), whereas the remaining two were judged as dimensional. The simulated data sets (for both taxonic and dimensional data) were compared to the research data (see Figure 6). The research data were judged most similar to the simulated taxonic data. Base rate estimates from the 12 individual curves ranged from 0.0 to 1.0. The mean taxon base rate estimate was 0.44, with *SD* of 0.345. Comparison *M* and *SD* base rate estimates for simulated taxonic and simulated dimensional data are plotted in Figure 7. Due to the large degree of overlap between the distribution of means of the simulated taxonic and dimensional data, the base rate estimate for the research data is of little probative value (see Ruscio et al, 2006). Statistical taxometric results (presented in Table 7) revealed a CCFI of 0.781 suggesting reasonable support for latent taxonic structure. The GFI of 0.967 suggested strong support for taxonic structure, although is interpreted with caution due to the questionable validity of this measure. Nuisance covariance averaged r =-0.105 within the estimated taxon group, and r = -0.085 within the complement group, satisfying Meehl’s (1995) r = 0.30 tolerance level. Indicator validity was poor across the indicators, with only one indicator (Indicator 2 - theft) reaching Meehl’s (1995) suggested Cohen’s d of 1.25 (Indicator 2, d = 1.357). The remaining indicators ranged from d= 0.635 (Indicator 1 –bulimic behaviours) to d =1.187 (Indicator 4 – alcohol).

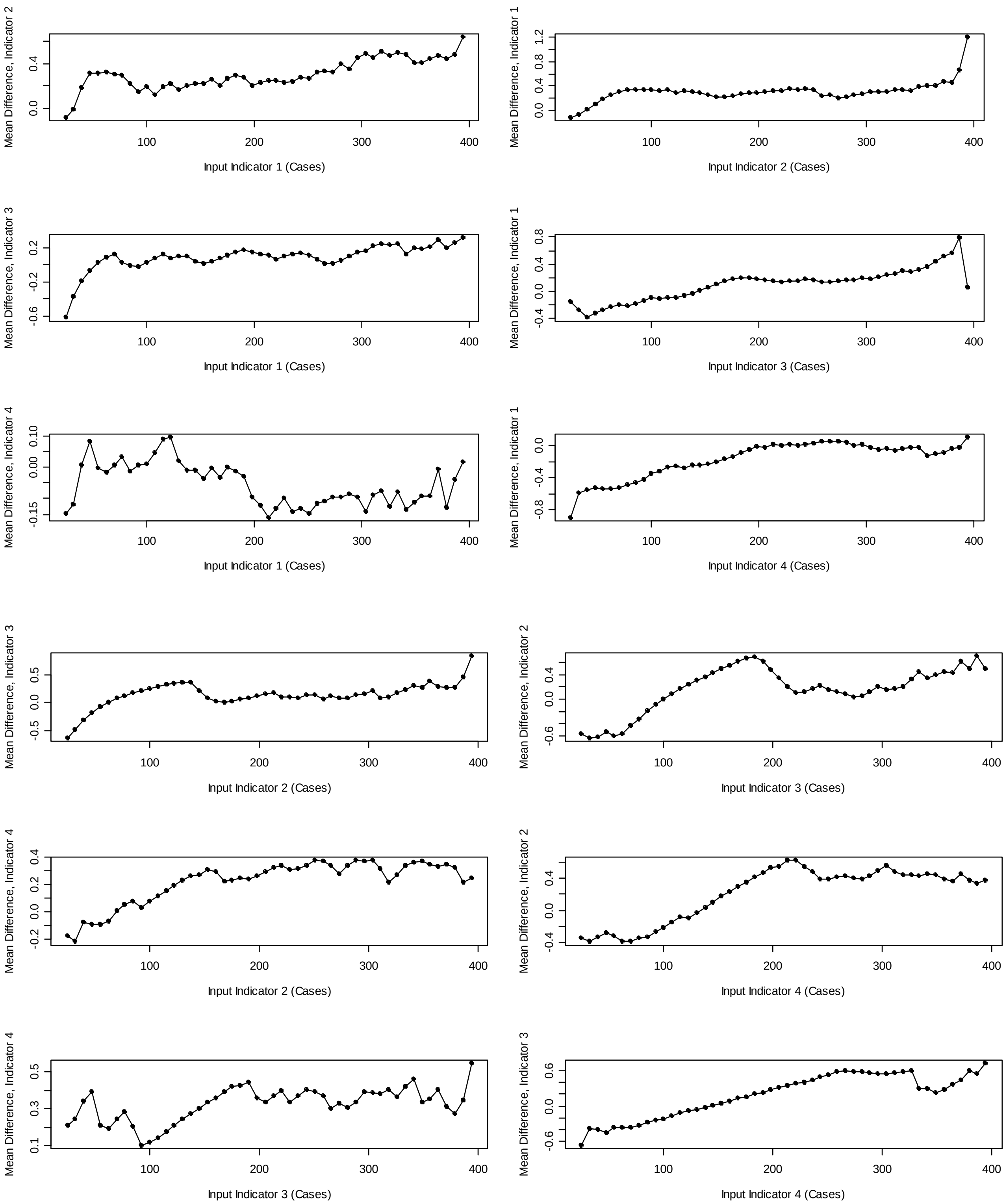

Figure 4. Individual MAMBAC plots showing indicators in all possible single indicator input-output pairs.

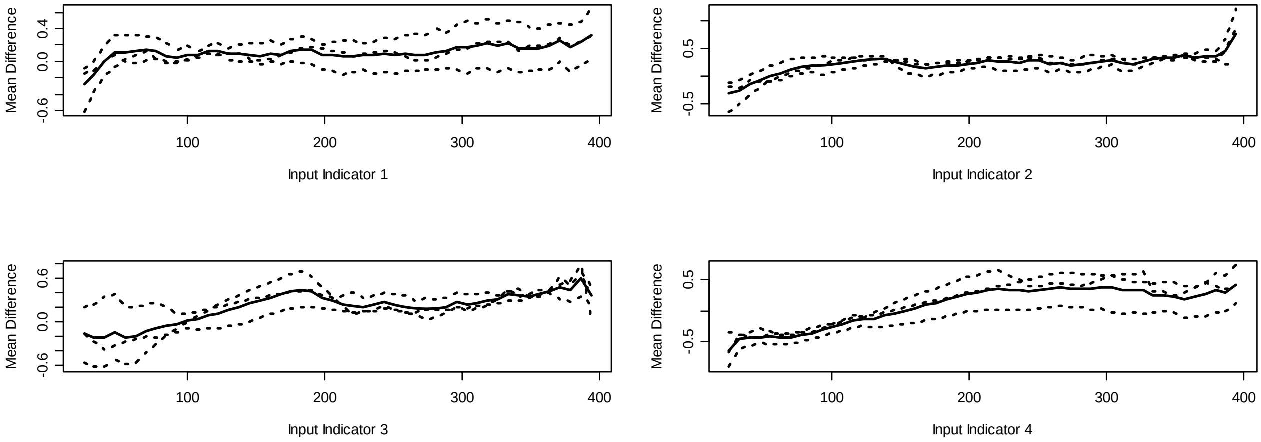

Figure 5. Representative MAMBAC averaged plots for each indicator. The analysis used indicators in all possible single indicator input-output pairs.

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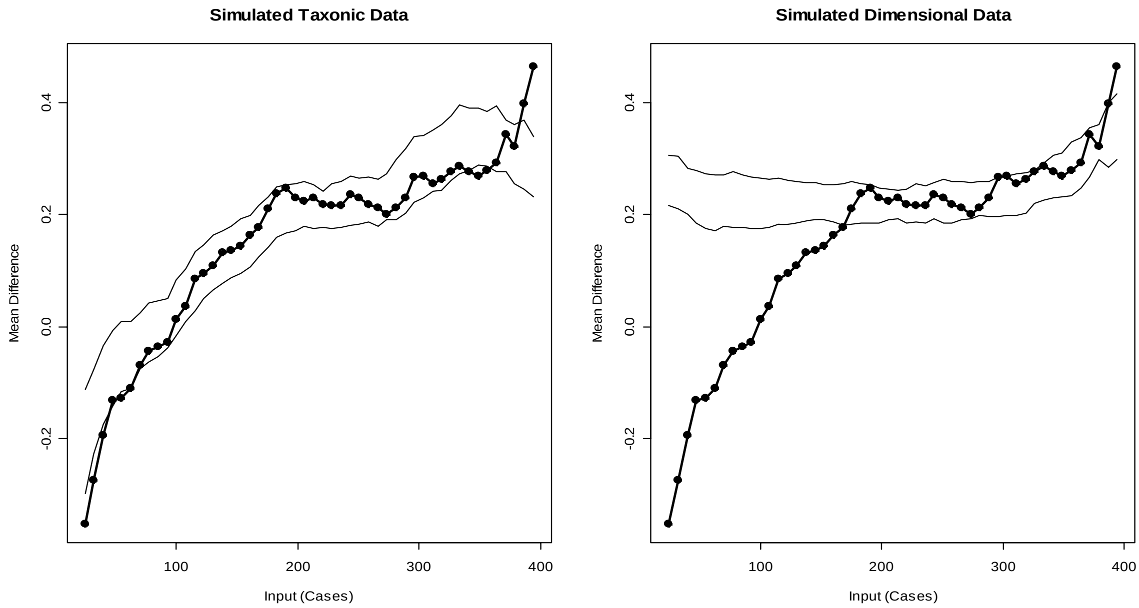

Figure 6. Representative MAMBAC plots showing simulated taxonic comparison data (left) and simulated dimensional comparison data (right) as the lighter 2 lines representing ±1*SD* from the *M* of the comparison data sets. The dark overlay plotted line represents the research data. The analysis used indicators in all possible single indicator input-output pairs.

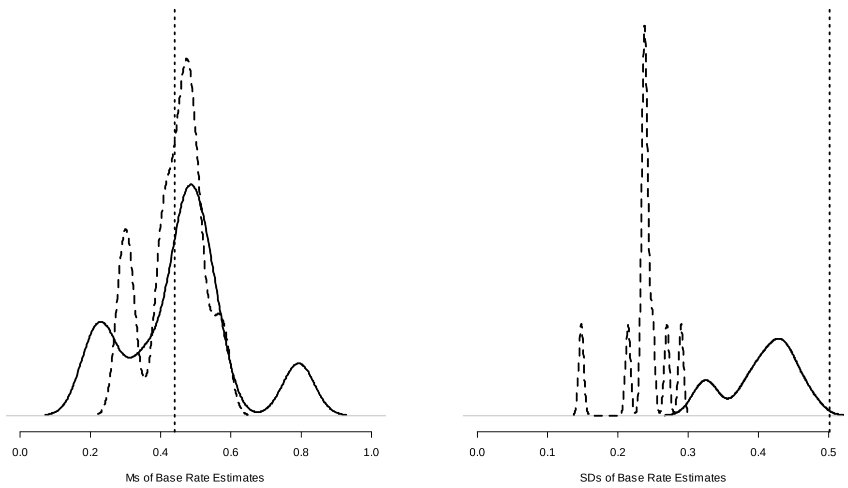

Figure 7. MAMBAC (individual indicator) sampling distributions of *M* and *SD* base rate estimates obtained in analyses of simulated taxonic (solid lines) and simulated dimensional (dashed lines) comparison data sets. Vertical (dotted) lines represent the *M*s and *SD*s obtained in analyses of the research data.

With a composite indicator as the input indicator results were reasonably consistent across multiple analyses (these analyses differed slightly due to varying implementation decisions). A MAMBAC analysis has also been chosen as representative of these multiple analyses. The representative analysis was performed using all four indicators (one indicator served as output, input = sum of remaining three variables), with 100 evenly spaced cuts beginning 35 cases from either extreme, and case numbers were used to graph the input indicator. Multiple internal replications were performed (*n*=25). Multiple comparison data sets (*n*=25) for taxonic and dimensional data were also simulated. Visual inspection of the 4 individual plots produced by this analysis, (see Figure 8), suggested that two of the plots (indicators 3 – self harm and 4 - alcohol) appeared dimensional in shape. The remaining two plots were deemed ambiguous. The simulated data sets (for both taxonic and dimensional data) were compared to the research data (see Figure 9). The research data were judged most similar to the simulated dimensional data. Base rate estimates from the four individual curves ranged from 0.162 to 0.382. The mean taxon base rate estimate was 0.273 (*SD* 0.103). Comparison *M* and *SD* base rate estimates for simulated taxonic and simulated dimensional data are plotted in Figure 10. Again, the comparison distributions overlap almost entirely; therefore the base rate estimate of the research data provides little interpretative value. Statistical taxometric results (presented in Table 7) revealed a CCFI of 0.158 suggesting strong support for latent dimensional structure. The GFI of 0.959 suggested strong support for taxonic structure, despite all other measures indicating no evidence of taxonicity. Nuisance covariance averaged *r* =-0.156 within the estimated taxon group, and *r* = -0.051 within the complement group, satisfying Meehl's (1995) *r* = 0.30 tolerance level. Indicator validity was moderate across the indicators, with only two indicators (Indicator 2 – theft and Indicator 4 - alcohol) reaching Meehl's (1995) suggested Cohen's *d* of 1.25 (Indicator 2 - theft, *d* = 1.301; Indicator 4- alcohol, *d* = 1.574). The remaining indicators ranged from *d*= 0.800 (Indicator 1 – bulimic behaviours) to *d*= 1.134 (Indicator 3 – self-harm)

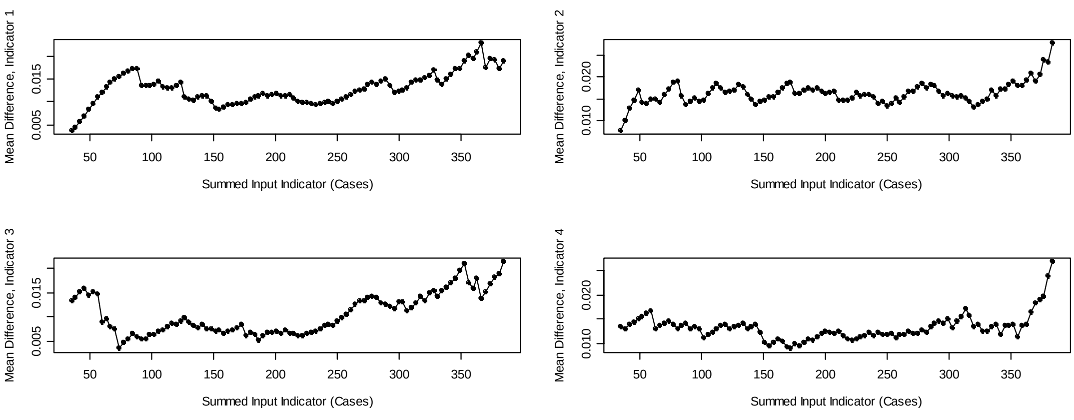

Figure 8. Representative MAMBAC plots showing each indicator as the single output indicator, with cuts along a composite input indicator (summed remaining indicators).

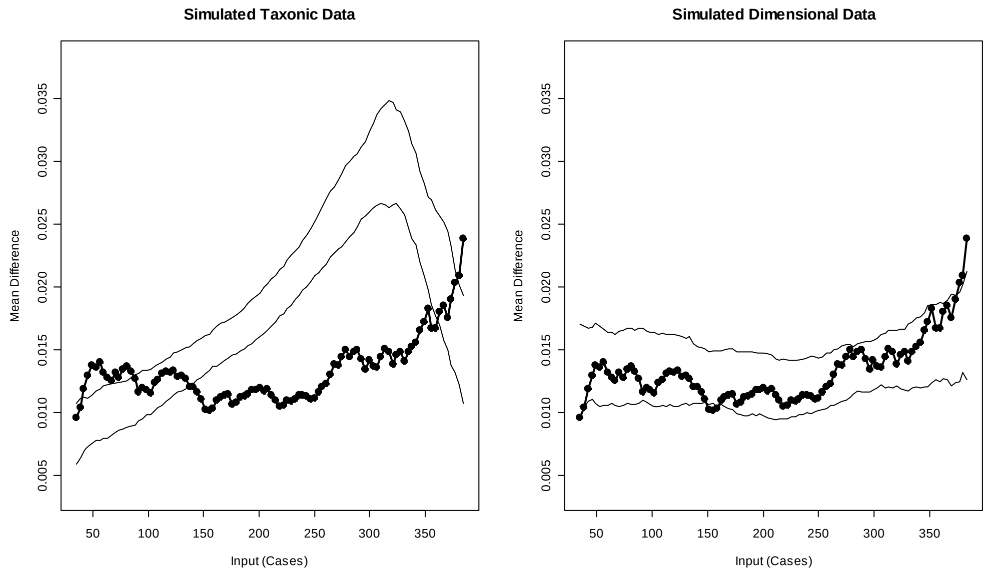

Figure 9. Representative MAMBAC plots showing simulated taxonic comparison data (left) and simulated dimensional comparison data (right) as the lighter 2 lines representing ±1*SD* from the *M* of the comparison data sets. The dark overlay plotted line represents the research data. The analysis used each indicator as single output variable, with a composite indicator (summed remaining three indicators) serving as the input variable.

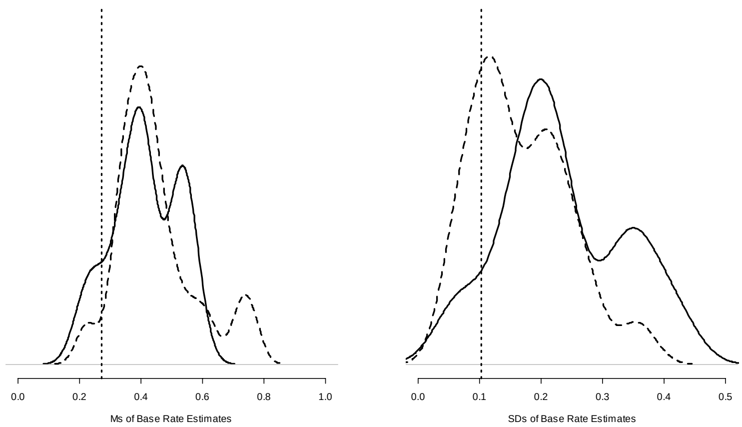

Figure 10. MAMBAC (composite indicator) sampling distributions of M and SD base rate estimates obtained in analyses of simulated taxonic (solid lines) and simulated dimensional (dashed lines) comparison data sets. Vertical (dotted) lines represent the Ms and SDs obtained in analyses of the research data.

Table 7.
Taxometric statistics for representative MAMBAC analyses:

	Input Indicator:	
	Individual	Composite
Nose-count		
Taxonic plots	10	0
Ambiguous plots	5	2
Dimensional plots	2	4
CCFI	0.781	0.158
GFI	0.967	0.959
Base-rate estimation		
M	0.44	0.273
SD	0.345	0.103

Note. CCFI = Comparison Curve Fit Index, GFI = Goodness of Fit Index.

MAXCOV results

As with the MAMBAC analyses, taxometric programs require a number of implementation decisions to be made before performing MAXCOV analyses. Again, multiple analyses were computed and examined. Results across implementation decisions for MAXCOV analyses were reasonably consistent. A representative analysis was selected from these multiple analyses. The representative analysis used all four indicators, two indicators at a time served as outputs (covariance between two indicators is the output variable in MAXCOV), and the input variable was a composite indicator (the sum of the remaining two indicators). The analysis used 50 overlapping windows (0.9 overlap) to divide cases into sub-samples along the input indicator (therefore *n*=71 cases in each interval). Multiple internal replications were performed (*n*=5), and the LOWESS smoothing technique was applied. Multiple comparison data sets (*n*=10) for taxonic and dimensional data were also simulated.

Visual inspection of the six MAXCOV plots produced by this analysis, (see Figure 11), suggested four of the plots appeared taxonic in nature. The remaining two plots, showing the covariance between indicators 2 (theft) and 3 (self-harm), and indicators 2 (theft) and 4 (alcohol), were rated as dimensional. The simulated comparison data sets were compared to the research data (see Figure 12). On visual inspection the research data were judged most similar to the simulated taxonic data. Taxometric statistics for this analysis are presented in Table 8. Base rate estimates from the six individual curves ranged from 0.093 to 0.483, with the mean estimate 0.189 (*SD* 0.157). Comparison *M* and *SD* base rate estimates for simulated taxonic and simulated dimensional data are plotted in Figure 13, and show overlapping distributions suggesting poor validity for the base-rate estimation test. The CCFI (0.454) suggested ambiguity, although the GFI (0.964) was suggestive of taxonicity according to Waller and Meehl's (1998) guidelines. Nuisance covariance averaged r =-0.178 within the estimated taxon group, and r = -0.044 within the complement group, satisfying Meehl's (1995) $r < 0.300$ tolerance level. Indicator validity was satisfactory across the indicators, with only one indicator (Indicator 1 – bulimic behaviours) failing to reach Meehl's (1995) suggested Cohen's d of 1.25 (Indicator 1, d = 1.049). The remaining indicators ranged from d= 1.274 (Indicator 3- self-harm) to 1.574 (Indicator 4 – alcohol).

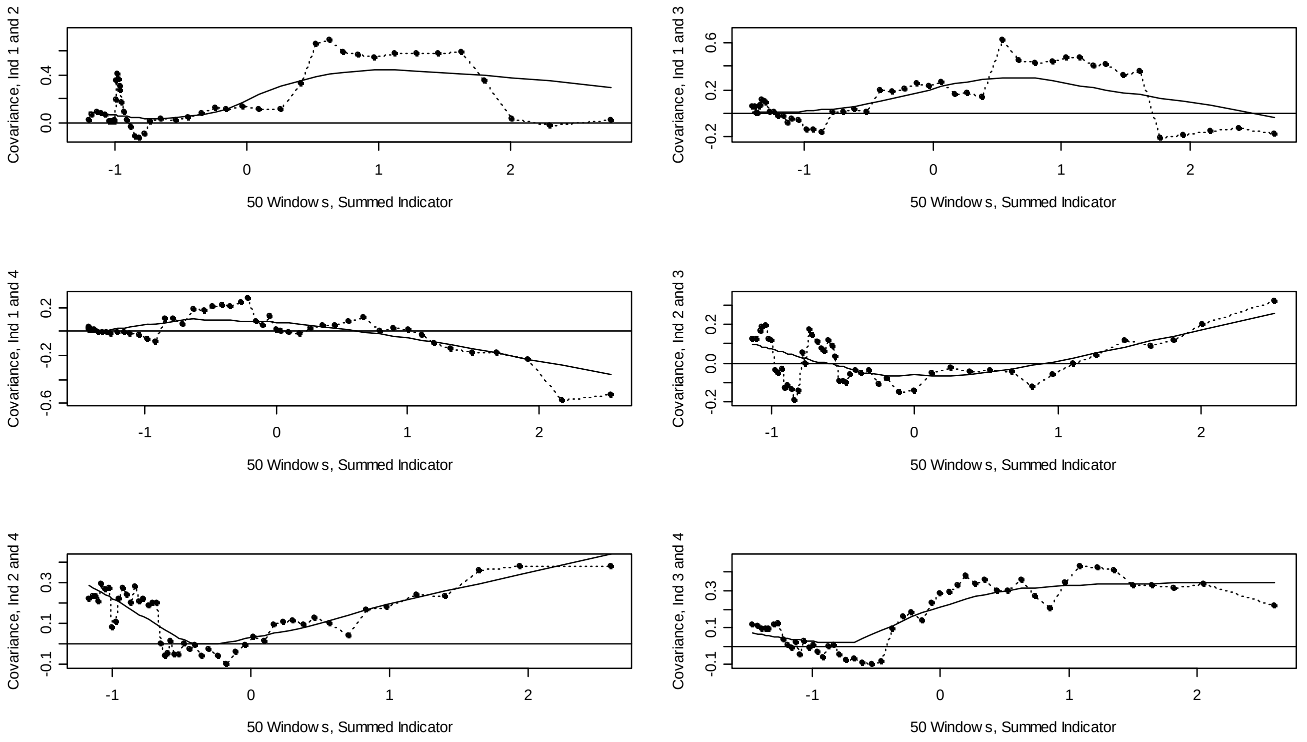

Figure 11. Representative MAXCOV plots showing the covariance between two indicators as the output indicator, and the sum of the remaining two indicators as the input variable.

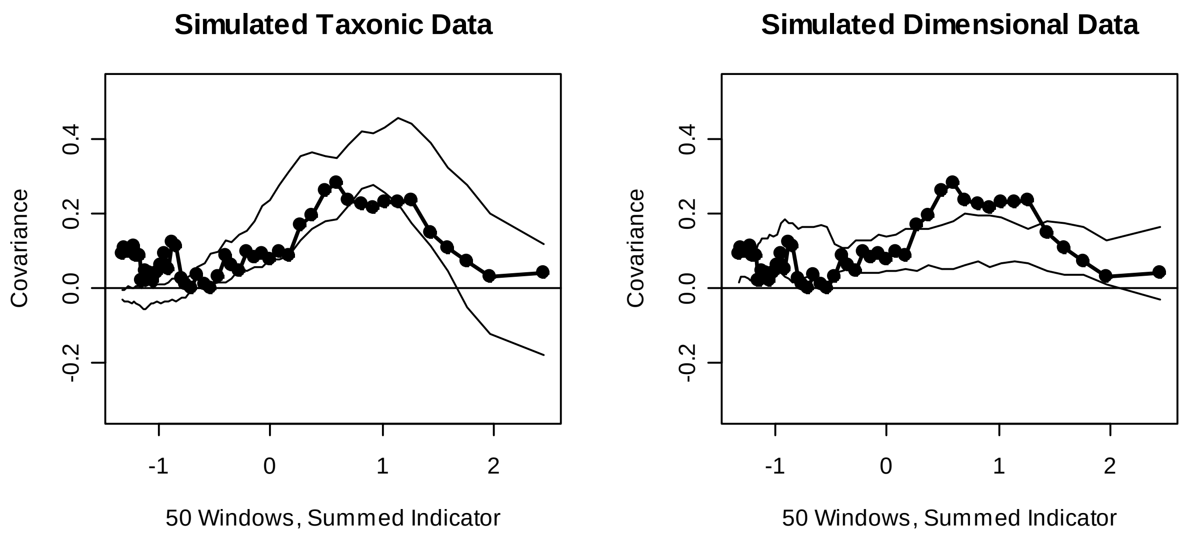

Figure 12. Representative MAXCOV plots showing simulated taxonic comparison data (left) and simulated dimensional comparison data (right) as the lighter 2 lines representing ±1*SD* from the *M* of the comparison data sets. The dark overlay plotted line represents the research data.

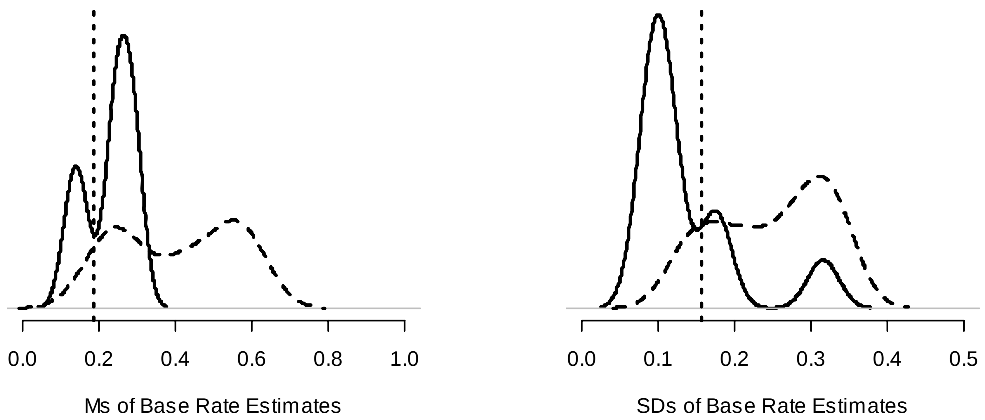

Figure 13. MAXCOV sampling distributions of *M* and *SD* base rate estimates obtained in analyses of simulated taxonic (solid lines) and simulated dimensional (dashed lines) comparison data sets. Vertical (dotted) lines represent the *M*s and *SD*s obtained in analyses of the research data.

Table 8.
Taxometric statistics for representative MAXCOV analysis:

	MAXCOV
Nose-count	
Taxonic plots	6
Ambiguous plots	0
Dimensional plots	2
CCFI	0.454
GFI	0.964
Base-rate estimation	
M	0.189
SD	0.157

Note. CCFI = Comparison Curve Fit Index, GFI = Goodness of Fit Index.

Inchworm consistency test

The Inchworm Consistency Test was applied to the research data to attempt to make results less ambiguous and therefore, more interpretable. The MAXCOV analysis that included the Inchworm Consistency Test again used all four indicators, two indicators at a time served as outputs and the input variable was a composite indicator. Four series of windows were applied (at 25, 50, 75, and 100), again with 0.9 overlap. The LOWESS smoothing technique was used. This analysis revealed definite peaks for two series of plots, which were previously less defined (although had been judged as taxonic). Figure 14 shows the Inchworm Consistency Test for the covariance between Indicators 1 (bulimic behaviours) and 2 (theft), against the composite input indicator. As windows increased, the taxonic peak identified in the original analysis becomes more obvious, and therefore strengthens reliability of this judgement.

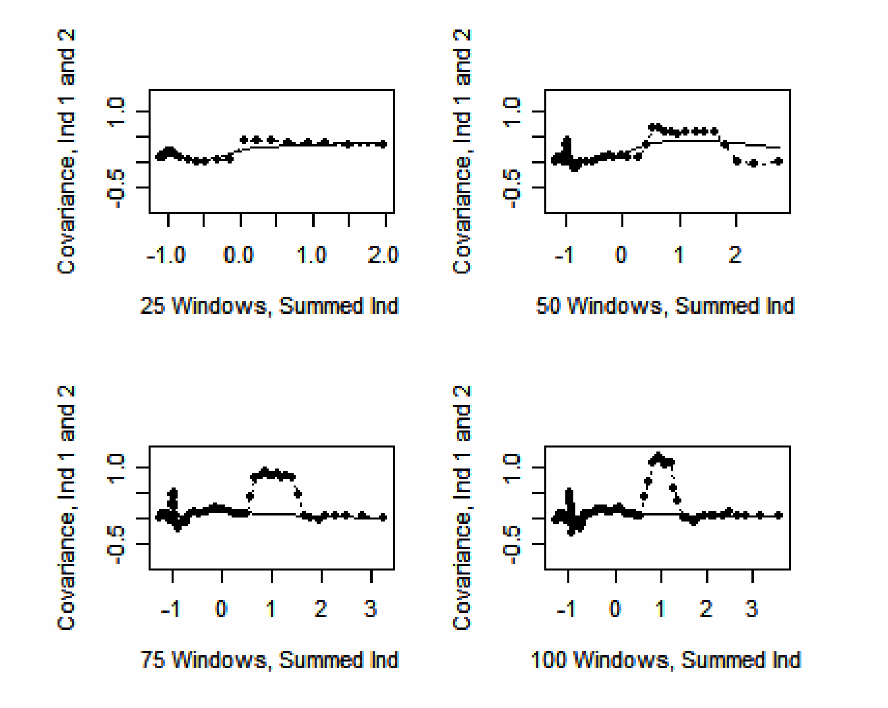

Figure 14. MAXCOV graphs showing the covariance between Indicator 1 and 2, with the remaining indicators serving as the input "Summed Indicator", using the inchworm consistency test.

Figure 15 shows the Inchworm Consistency Test for the covariance between Indicators 1 (bulimic behaviours) and 3 (self-harm), against the composite input indicator. As with the previous figure, the characteristic taxonic peak becomes more defined as the windows are increased. The Inchworm Consistency Test did not reveal additive interpretive value to the remaining indicator combinations, and therefore these plots are not displayed.

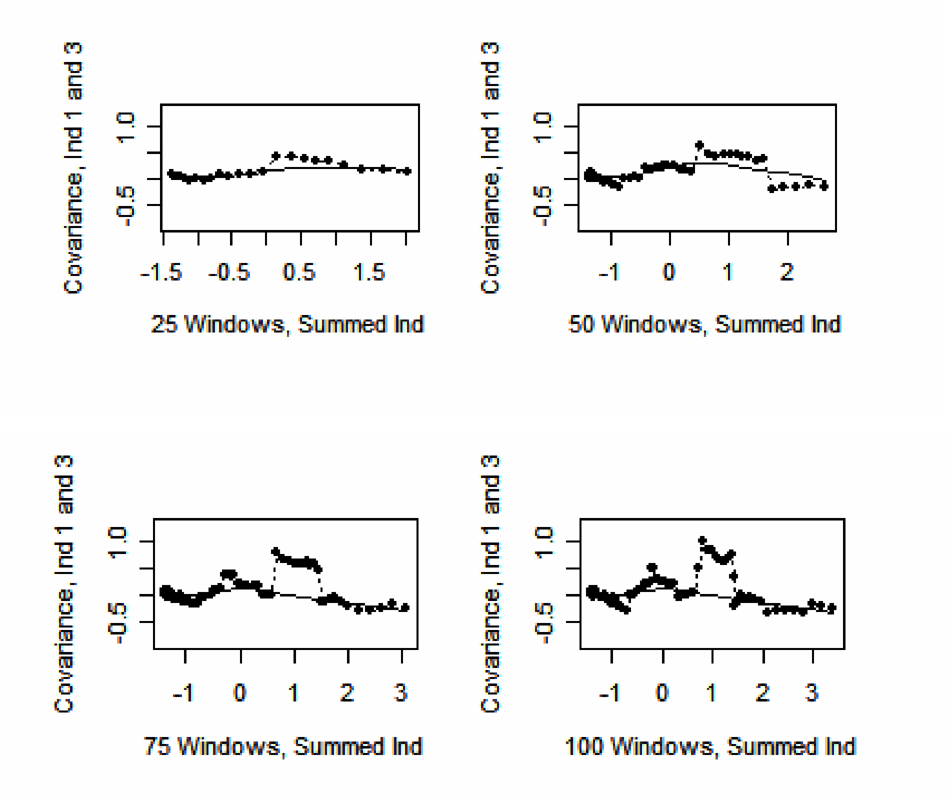

Figure 15. MAXCOV graphs showing the covariance between Indicator 1 and 3, with the remaining indicators serving as the input “Summed Indicator”, using the inchworm consistency test.

L-Mode results

L-Mode analysis is more simplistic to perform than the previously reported taxometric methods. Fewer implementation decisions are required, and each analysis produces only one graph (unless comparison data are analysed, in which case two graphs are produced). Although several L-Mode analyses were computed in this study, the results were consistent and therefore a representative L-Mode analysis is presented. The representative L-Mode analysis included all four indicators, and classified cases by nearest mode. Comparison data for taxonic and dimensional structures were also computed (number of samples = 50). The L-Mode plot (presented in Figure 16) was judged dimensional due the unimodal shape of the curve.

The simulated comparison data sets were compared to the research data (see Figure 17). On visual inspection the research data were judged most similar to the simulated dimensional data. However, the simulated taxonic and dimensional comparison data sets produced reasonably similar L-Mode plots, indicating L-Mode analysis may not provide reliable results for these research data, and therefore should be interpreted with caution. L-Mode provides two methods of base rate estimation. First, derived from the detection of the left and right mode in the distribution of factor scores, (P=0.419), and secondly an estimate derived from the L-Mode classification of cases (P =0.585), (see Ruscio et al, 2006). Dimensional L-Mode distributions tend to produce base rate estimates around P = 0.5 (A. M. Ruscio, Ruscio, & Keane, 2002), therefore the base rate estimates are consistent with the visual classification of the plot as dimensional. The GFI (0.98) was highly suggestive of taxonicity, again highlighting the inconsistency of this measure with the other indicators of taxonicity. Nuisance covariance averaged r =-0.037 within the estimated taxon group, and r = -0.046 within the complement group, satisfying Meehl's (1995) $r < 0.30$ suggested cut-off. Indicator validity was poor across the indicators, with only one indicator (Indicator 2 – theft) reaching Meehl's (1995) suggested Cohen's d of 1.25 (Indicator 2 - theft, d = 1.804). The remaining indicators ranged from d= 0.528 (Indicator 1 – bulimic behaviours) to 0.728 (Indicator 4 – alcohol).

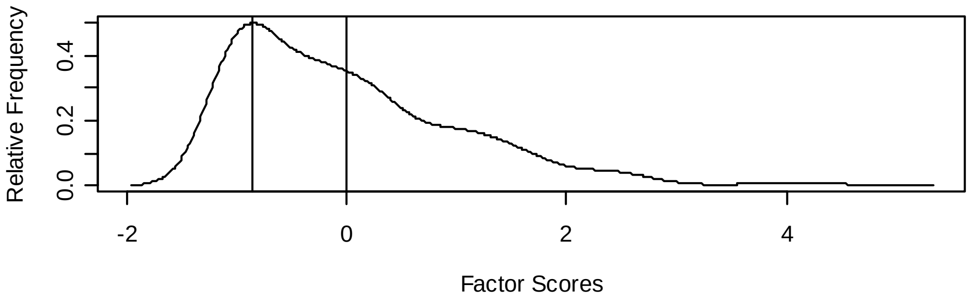

Figure 16. Representative L-Mode plot for the research data.

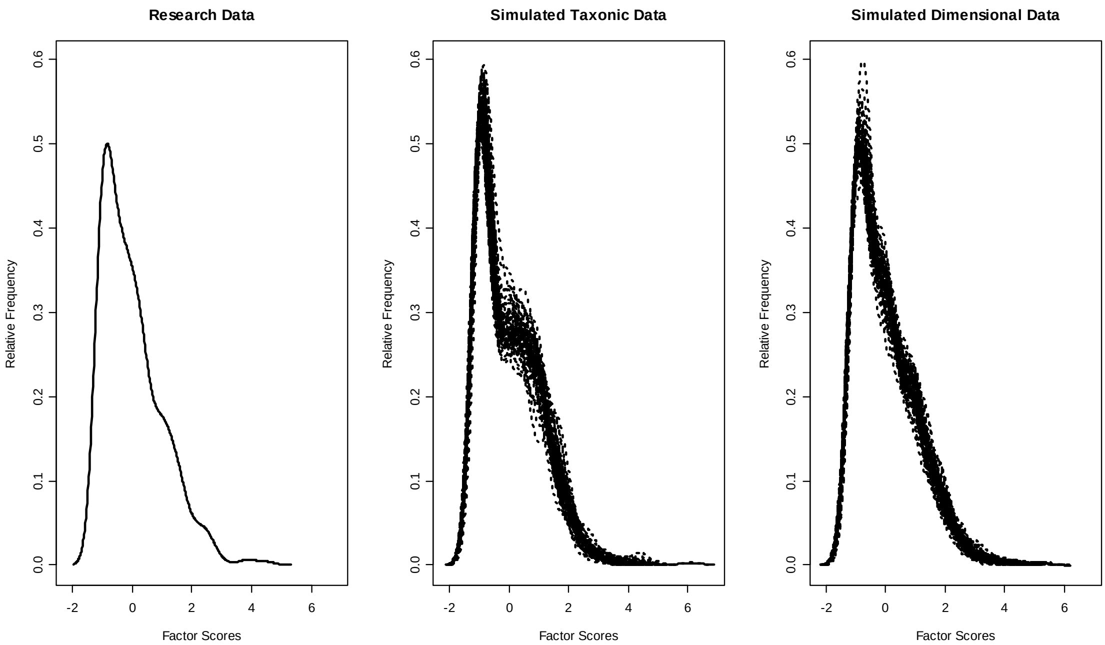

Figure 17. L-Mode analysis showing research data (left), multiple comparison simulated taxonic data (middle), and multiple simulated dimensional data (right).

Discussion

Although several studies have examined the latent structure of eating disorders, this was the first study to examine the continuity versus discontinuity of MIB. The present findings, based on taxometric research methods, were inconsistent. However there was some evidence suggestive of taxonicity. Taxometric research conclusions are based on a multiple-hurdles approach, whereby results across analyses and consistency tests are taken together to infer latent structure. In this study, inconsistencies in results mean that explicit conclusions should not be made.

MAMBAC results varied as a function of input indicator. Where each indicator was analysed in every pair-wise combination, results appeared supportive of latent taxonic structure. However, where each indicator served as output against a composite input indicator, results appeared dimensional. It is unclear why such a paradoxical finding has occurred. Individual indicator analyses may provide a more pure measure of latent structure, however the aggregation of indicators to form a composite indicator provides greater statistical power. When examining inter-rater reliability, the analyses with the highest agreement between raters also displayed the same pattern of findings.

According to Ruscio and colleagues in taxometric research pseudo-dimensionality is more likely than the detection of a pseudo-taxon (J. Ruscio et al., 2006). That is, taxometric procedures are more likely to fail to detect a true taxonic boundary when data are less than ideal, rather than falsely identifying a non-existent taxon. Thus, it is possible that the MAMBAC analyses with individual input indicators are correctly detecting a true taxonic boundary, which is undetected when using a composite input indicator.

In this study indicator skew may have affected MAMBAC plots, leading to right cusped graphs. Plots were judged as taxonic when cusped at the right, although indicator statistics revealed high positive skew. Indicator 1 (frequency of bingeing and purging) had the highest level of positive skew, likely a result of measurement where reported frequency was calculated through a free-response design. Despite the presence of strong positive skew, graph interpretations are likely to be accurate due to two factors. First, Monte Carlo MAMBAC plots of skewed data were compared to research data plots when judging the shape of the graphs. Second, the use of simulated comparison data sets negates the threat of identifying a pseudo-taxon due to indicator skew, as the comparison data have the same level of skew as the research data, and therefore interpretation is uncomplicated. It is likely the cusped peaks are due to another factor, such as low taxon base rate.

MAXCOV nose-count results suggest latent taxonic structure, with the majority of plots judged as taxonic. Visual comparison of the research data with simulated taxonic and simulated dimensional data further lends support to this deduction. However, the CCFI suggested ambiguity.

L-Mode analyses provided contradictory findings compared to the other taxometric methods, with none of the multiple L-Mode plots judged as taxonic. Complicated by the lack of Monte Carlo studies of L-Mode, inter-rater reliability was extremely poor. Simulated taxonic and dimensional comparison data were almost indistinguishable, suggesting L-Mode analysis was not suitable for the research data or vice versa. Therefore, conclusions of the dimensionality of MIB should not be drawn from L-Mode analysis of this research data.

Base-rate estimations were inconsistent across all analyses, initially providing support for the dimensionality of MIB. However, comparison simulated data base rate estimations showed the same variation for taxonic samples, suggesting this measure has poor probative value for the research data.

GFI scores were consistent across analyses, all reaching Waller and Meehl's (1998) threshold of 0.90 for taxonic data. However, GFI scores remained above 0.90 even when all other measures were indicating dimensionality. This finding provides further evidence that the validity of the GFI is questionable.

Inter-rater reliability of the nose-count test was reasonably fair for MAMBAC and MAXCOV analyses, although agreement between raters increased substantially to 100% when comparison simulated data were used. This finding suggests that with complex data, it is imperative to use simulated comparison data sets.

A number of limitations of this study may have lead to the inconsistencies in results, and therefore restricted the ability to formulate conclusions regarding the latent structure of MIB. First, archival data were used in this study, with diagnoses made according to DSM-III-R criteria (APA, 1987). As the data were collected for other purposes, indicator validity was not optimal. Sexual disinhibition, a proposed behavioural characteristic of MIB, was not measured in the original sample and therefore was omitted from this study. Estimated indicator validity was variable across the analyses, and several indicators were unable to consistently separate the proposed taxon and complement groups. Indicator 1 (bulimic behaviours) performed most poorly. However given that this indicator was measured by reported frequency per week (rather than a forced-choice scale as used for the remaining indicators) it is comprehensible why this indicator may have higher skew and provide a less clearly defined separation of the taxon and complement. The poor validity of indicators has likely lead to the inconsistencies in results. Alternatively, the inability of indicators to research satisfactory separation between groups may provide evidence of dimensional structure (Ruscio et al, 2006).

Moreover, the questionnaire used inquired solely about the frequency of the behaviours on single item questions, which may have impaired indicator validity. A future study should be conducted with an appropriately validated measure of MIB, such as the Multi-Impulsivity Scale (MIS) or the Clinical Assessment of Multi-impulsivity (CAM) (Evans, Searle, & Dolan, 1998).

A final limitation may be the sample size used in this study, (n=419), which although large for clinical sample, may be considered of moderate size for taxometric investigations. It is recommended that samples above 300 are suitable for taxometric analyses, although more commonly, published taxometric investigations are much larger (J. Ruscio et al., 2006). Future investigations may increase the likelihood of more consistent and interpretable results should a larger clinical sample size be used.

In summary the following evidence of the taxonicity of MIB has been established from this study: graphs were consistently peaked across MAMBAC (for individual input indicators) and MAXCOV analyses, research data were judged most similar to simulated taxonic comparison data in both MAMBAC and MAXCOV analyses, GFI scores were above the threshold for taxonic data in all analyses, and CFI scores were suggestive of taxonicity in MAMBAC analyses. Despite this evidence, inconsistencies in MAMBAC plot for composite input indicators, and CFI scores for MAXCOV analyses impede the conclusions that can be made from this study. However, it is important to report the majority of findings of this study were inconsistent with a strictly dimensional model of MIB. Therefore, this study lends preliminary support to Lacey and Evan’s (Lacey & Evans, 1986) proposed sub-group of persons with BN, MIB.

Should the results be considered indicative of a taxon, it is important to consider alternative explanations other than the existence of MIB. Although indicators were selected theoretically to identify the conjectured taxon of MIB, it is possible that the taxon may be explained by something other than MIB. Should a distinct sub-group of persons with BN who engage in multiple impulsive behaviours exist (as results of this study may suggest) the sub-group may be better explained by another factor, for example comorbidity. Higher prevalence of *Cluster B* personality traits are found in persons with BN, with a elevated number receiving a dual diagnosis of Borderline Personality Disorder (Herzog, Keller, Lavori, Kenny, & et al., 1992; Kennedy, McVey, & Katz, 1990; Skodol, Oldham, Hyler, Kellman, & et al., 1993; Westen & Harnden-Fischer, 2001) . The DSM-IV-TR criteria for Borderline Personality Disorder (BPD) involves impulsive behaviours, such as impulsive sex, substance abuse, binge eating, recurrent suicidal and self-harming behaviours ((APA), 2000). Subjects in this sample were not excluded based on comorbidity; given the prevalence of BPD among persons with BN, it is therefore likely some participants would have also met criteria for BPD. It may be, that rather than detecting a true MIB sub-group, this analysis is detecting a sub-group of persons with BN with comorbid BPD. This argument could account for much of the research findings that suggest MIB patients have more severe psychopathology, poorer treatment outcome, higher prevalence of comorbidity, and higher levels of relapse, findings also associated with BPD. In order to quell this uncertainty, a taxometric investigation excluding participants with comorbidity needs to be conducted. However, previous research examining the latent structure of BPD has suggested BPD is continuous in nature (Rothschild, Cleland, Haslam, & Zimmerman, 2003) providing evidence against the suggestion that this study may be detecting BPD. Despite the current BPD taxometric evidence it remains premature to conclude that this research is suggestive of MIB as a separate subgroup of BN.

Although the findings from this study are inconclusive, they are incongruent with the continuity model of MIB. Although preliminary, this finding adds to theoretical knowledge about BN, and has generated need for future research. Such research may more thoroughly answer the continuity versus discontinuity debate of MIB, and therefore add to guidance and improvement in classification, as well as improved etiological understanding of BN.

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