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Review article

Factor structure of ten psychoactive substance addictions and behavioural addictions

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ABSTRACT

Over the past two decades, many problematic/excessive behaviours have increasingly been conceptualized as addictions due to their similarity with more traditional psychoactive substance addictions. The primary aim of the present study was to simultaneously examine the factor structure of three psychoactive substance addictions (alcohol use, cigarette smoking, and substance use) and seven behavioural addictions (sex, social media use, shopping, exercise, online gambling, internet gaming, and internet use), using exploratory factor analysis (EFA; $N = 481$) and confirmatory factor analysis (CFA; $N = 487$). A total of 968 participants completed an online survey including ten psychometric scales assessing the ten different potentially addictive behaviours. EFA supported a two-factor solution, with different factors for the psychoactive substance and behavioural addictions (excluding exercise addiction). CFA supported the two-factor model in a separate sample. There was good support for the concurrent and discriminant validities of the CFA latent factors and the reliability of the behavioural latent factor in the two-factor CFA model. While there was support for the concurrent and discriminant validities of the psychoactive substance latent factor, there was insufficient support for its reliability. The taxonomic, theoretical, and clinical implications of the findings are discussed.

1. Introduction

An addiction has been defined as an ongoing failure to continually and persistently resist impulses or urges to engage in specific behaviours, despite experiencing repeated harm from such engagement (American Society of Addiction Medicine, 2019; Grant, Potenza, Weinstein, & Gorelick, 2010). Scholars have identified a range of common behaviours with a propensity for addiction, including excessive psychoactive substance use (e.g., alcohol, nicotine), as well as non-substance behaviours (e.g., gambling, gaming, eating, sex, exercise, shopping, internet use, social media use, and even work; Derevensky, Hayman, & Gilbeau, 2019; Griffiths, 2005; Rozgonjuk et al., 2021; Rumpf et al., 2019; Sussman, Lisha, & Griffiths, 2011). The latter have been more widely referred to as "behavioural" addictions (in the past also known as "process" addictions; Schaef, 1987) sharing many commonalities with psychoactive addictions such as the

time-persisting and repetitive nature, and being unable to reduce/restrict the behaviour despite the everyday life harm (Kardefelt-Winther et al., 2017). It has been suggested that scholars should emphasize the similarities of such behaviours with substance addiction to acknowledge their addictive nature, with several studies adopting this approach (Griffiths, 2017; Gomez, Stavropoulos, Brown, & Watson, 2022; Rozgonjuk et al., 2021; Zarate, Ball, Montag, Prokofieva, & Stavropoulos, 2022). Nevertheless, concerns have also been expressed concerning the risk of pathologizing common behaviours and inaccurately tailoring new diagnostic categories based on substance use disorder criteria (Kardefelt-Winther et al., 2017). Such practices may neglect to view the functionality of a behaviour in the context it is expressed and, in some cases, an individual's own will to engage with it (Kardefelt-Winther et al., 2017).

However, even scholars who acknowledge excessive everyday behaviours as being potentially addictive appear to disagree about their associations and differences (Baggio et al., 2018; Montag et al., 2021; Rumpf et al., 2021; Starcevic et al., 2021). Some literature supports that these tend to be normally distributed in the general population on a continuum ranging from minimum to maximum, implying the occurrence of an addictive dimension (Stavropoulos, Gomez, & Griffiths, 2021). Others suggest that addictive behaviours should be theorized as independent constructs or syndromes composed of distinct networks of symptoms (Zarate et al., 2022). It has been proposed (although still debated) that different addiction subgroups and/or dimensions comprising substance, behavioural, and even technological activities (i.e., when a behavioural addiction exclusively focuses on the abuse of technological means; Singerson et al., 2017) should be included under the broader addiction umbrella (Aagaard, 2021; Grant et al., 2010; Potenza et al., 2006; King et al., 2020; Zarate et al., 2022).

Addressing such issues has important taxonomic, diagnostic, assessment, prevention, and intervention implications. More specifically, it would help researchers better understand whether different types of potentially addictive behaviours should be classified and/or included under the same broader category/family of disorders (Brand et al., 2020; Starcevic et al., 2021). This is particularly important in the light of studies suggesting that behavioural addictions, due to not being officially acknowledged, tend to be either underdiagnosed (i.e., and individual does not receive the treatment they need) or later diagnosed (i.e., treatment may be significantly delayed; Wölfling et al., 2021). Furthermore, given that potentially addictive behaviours tend to be comorbid, with one often perpetuating another (e.g., drinking alcohol to cope with gambling losses) and in other cases succeeding each other (e.g., cross-addiction, where an individual replaces one form of addiction with another; Zarate et al., 2022), information about their inter-associations and subgroups would underpin more efficient prevention and intervention protocols. To contribute to this area, the present study applied factor analysis to ascertain the latent structure of a group of ten common substance and behaviour addictions together while taking concurrently into consideration personality, distress, and coping features commonly related to their aetiology (Brand et al., 2019; Brandtner et al., 2021).

1.2. Conceptualization of addictions

Considering the definitions and conceptualizations of addiction(s), a debate regarding their categorical nature (i.e., the presence of a specific number of symptoms/behaviours satisfies the provision of a diagnosis; "*What an individual presents with*" approach) and/or dimensional nature (i.e., all behaviours are present in all individuals at varying levels, with the excess of specific thresholds marking the provision of the diagnosis; "*How much an individual presents with a behaviour*" approach), as well as their potential subgroups (i.e., substance, behavioural,

and technological) has attracted interest (Earleywine, Denson, & Altman, 2021; Montag et al., 2021; Starcevic et al., 2021; Stavropoulos et al., 2021a; Wu, Lin, & Lin, 2021). Discrepancies persist with formal diagnostic classification manuals aligning more with the categorical approach whereas more recent evidence advocating a more dimensional view (the Diagnostic and Statistical Manual for Mental Disorders, fifth edition [DSM-5]; American Psychiatric Association [APA], 2013; International Classification of Diseases, 11th revision [ICD-11]; World Health Organization [WHO], 2019; Yücel et al., 2021; Perales et al., 2020). Historically, the DSM-1 (APA, 1952) and DSM-II (APA, 1968) categorically conceptualized substance use disorder ("drug addiction" and "alcoholism") as secondary, arising from a primary personality disorder (APA, 1952). Similarly, the DSM-III (APA, 1980), guided by the medical diagnostic model, introduced a set of atheoretical and consensus-based addiction criteria, which separately diagnosed "substance abuse" and "substance dependence" disorders from each other as well as from other mental disorders. However, this was retained in the DSM-IV (APA, 1994), covering a broad range of substances. The current DSM-5 (APA, 2013), alongside its most recent revision DSM 5-TR (2022), appear to enrich the traditional categorical view of addictions with dimensional aspects. More specifically, nine types of substance addictions (alcohol; caffeine; cannabis; hallucinogens; inhalants; opioids; sedatives, hypnotics, and anxiolytics; stimulants; and tobacco) are linked to excess activation of an individual's brain reward system (Nathan et al., 2016; Robinson & Adinoff, 2016) are included in the DSM-5 (APA, 2013; 2022). Furthermore, the abuse-dependence distinction has been abandoned (i.e., their criteria are combined into a single unified category), while symptom severity is "dimensionally" assessed on a continuum (APA, 2013; 2022). It should also be noted that the DSM-5 and DSM5-TR (APA, 2013; 2022) have formally accepted gambling disorder as a behavioural addiction while acknowledging

Internet Gaming Disorder (IGD) as a behavioural addiction requiring further clinical and research attention. Related to these, in the ICD-11 (WHO, 2019), gambling disorder and gaming disorder are listed together with substance use disorders as addictions. Discrepancies expand regarding the potential technology addictions subgroup as a distinct form of behavioural addictions related to the abuse of technological means (e.g., online gaming and online gambling; Sigerson et al., 2017). Some scholars suggest that technology use, as a means of expression of an addictive behaviour, does not suffice to distinguish a subgroup from the rest of behavioural addictions (Panova & Carbonell, 2018). This dialogue continues with the proposal of a novel categorization of Internet Use Disorders (IUDs; i.e., excessive activities facilitated via the internet), which have been suggested to inform the so-called "predominantly online addictive behaviours", distinguished between "mobile" and "non-mobile" subtypes, depending on whether they involve the use of mobile web access (Montag et al., 2021; Rumpf et al., 2021). Despite preliminary findings supporting the notion that internet-mediated excessive behaviours present as an addictive spectrum comprising distinguishable presentations (Baggio et al., 2018; Gomez et al., 2022; Zarate et al., 2022), their "mobile" vs "non-mobile" distinction has been contested as being diagnostically inflationary and lacking sufficient evidence (Griffiths, 2020; Starcevic et al., 2021). The different taxonomic ideas have continued by highlighting the additional diagnostic consideration of the content of an online application (Wu, Lin, & Lin, 2021).

These challenges related to the concurrent consideration of the different potential addiction subgroups, alongside the dimensionality of addictive behaviours, appear to align with modern taxonomic notions, such as those deriving from the Hierarchical Taxonomy of Psychopathology model (HiTOP; Kotov et al., 2017; Ruggero et al., 2019; Simms et al., 2021). Unlike the traditional clinical classification systems (for example, the DSM-5), where disorders

are conceptualized categorically, in the HiTOP model, these are conceptualized dimensionally and organized hierarchically at five different levels. At the lowest level are the most narrow-band elements signs, symptoms, and maladaptive psychopathology traits (e.g., impulsivity, avoidance, irritability, anxiousness, emotional lability). Above this level are separate groups of closely related signs, symptoms, and maladaptive traits referred to as syndromes. There are 11 syndrome groups, one of which is alcohol and other substance-use disorders (SUDs; e.g., cannabis use disorder and nicotine use disorder). Closely related groups of syndromes inform a higher level of seven subfactors, including one for SUDs. More closely associated subfactors are grouped together at the next level as spectra. There are six spectra, including a spectrum for externalizing behaviours, split into disinhibited externalizing and antagonistic externalizing behaviours (Kotov et al., 2017). At the very top is a general psychopathology factor that reflects positive covariance in all forms of psychopathology. In the HiTOP, the specific subfactor for SUDS falls under the disinhibited externalizing spectra. The key maladaptive traits for the SUDs subfactor include impulsivity, irresponsibility, distractibility, risk-taking, (low) rigid perfectionism, (low) ruminative deliberation, and (low) workaholism does is really say ‘workaholism’ or just ‘work’? (see also Mullins-Sweatt et al., 2022). Interestingly, the HiTOP model, following DSM-5, defines disinhibition as *“orientation toward immediate gratification, leading to impulsive behaviour driven by current thoughts, feelings, and external stimuli, without regard for past learning or consideration of future consequences”* (APA, 2013, p. 780).

Although the current version of the HiTOP model does not mention behavioural addictions, given the maladaptive traits linked to the SUDs subfactor and “disinhibited externalizing” being conceptualized within HiTOP, it could be argued that all forms of addiction can be conceptually placed in the SUDs subfactor and the disinhibited externalizing spectra.

Indeed, a recent study by King et al. (2020) found that in a two-factor confirmatory factor analysis (CFA) model there were separate factors for internalizing and externalizing disorders, with gambling loading within the externalizing disorders (that also included measures for acting out, impulsive, alcohol dependence, cannabis dependence, and nicotine dependence) rather than within the internalizing disorders (depression and anxiety).

Consequently, it could be argued that current addiction diagnosis challenges have evolved around three major areas: (i) embracing a more dimensional and/or hierarchical distribution of addiction symptoms; (ii) broadening the addiction umbrella to also include non-substance/behavioural addictions (led by research into gambling and gaming) and; (iii) a novel subgroup of technology addictions (also known such as IUDs behaviours) being discussed, considered and/or challenged (Montag et al., 2021; Rumpf et al., 2021; Starcevic et al., 2021).

1.3. Associations between addictions

Considering the associations between different addictions, these tend to be mainly perceived or described in relation to their shared phenomenology (i.e., presenting symptoms) and aetiology/causal factors (Brand et al., 2016; 2019; Brandtner et al., 2021; Grant et al., 2010; Griffiths, 2005; 2017; Kardefelt-Winther et al., 2017; Perales et al., 2020). More specifically, a significant body of literature supports these different addictions converging by presenting with features of salience (i.e., the addiction dominates an individual's thought, feelings, and behaviour), mood modification (i.e., an individual engages with the addiction either to feel better and/or to feel less worse), tolerance (i.e., an individual progressively needs increasing amounts of the behaviour to achieve the same outcome), withdrawal (i.e., an individual experiences unpleasant feelings/reactions when the addictive behaviour is stopped/reduced), conflict with others (i.e., an individual's family/work/social surrounding tends to develop conflicts/arguments

due to the addiction) and relapse (i.e., individuals find themselves repeating/returning to the behaviour after efforts to cease the behaviour) (Griffiths, 1996; 2005; 2017; Stavropoulos et al., 2021a; Zarate et al., 2022). Nonetheless, others suggest that such phenomenological commonalities may be misleading and that the exclusion criterion should also be considered (Kardefelt-Winther et al., 2017). Namely, an addiction-like condition should not be attributed to another primary disorder (e.g., depression/impulse control), the adverse repercussions related to the "addiction" should not constitute an individual's wilful decision, despite a lengthy and intense involvement, the behaviour should not significantly compromise an individual's life, and finally, this should not constitute a way to cope with other adversities (Kardefelt-Winther et al., 2017).

Despite the continuing debate considering the shared phenomenology of addictions, the broader consensus appears to surround their aetiological communalities, involving natural history, comorbidities, and genetic/neurobiological predispositions (Brand et al., 2016, 2019; Brandtner et al., 2021; Perales et al., 2020; Yücel et al., 2021; Stavropoulos, Motti, & Griffiths, 2022). For instance, relevant to understanding the causal links between the different types of addiction is the Interaction of Person-Affect-Cognition-Execution (I-PACE; Brand et al., 2016) model. The model, developed initially for IUDs, is now seen as a general theoretical model to explain the development and maintenance of both psychoactive and behavioural addictions. It integrates relevant personality characteristics with affective and cognitive mechanisms (Brandtner et al., 2021) whilst distinguishing between early and later stages of the addiction process (Brand et al., 2019). Core to this model is that relevant internal (e.g., stress) or external (e.g., an advertisement) "addiction" triggers precipitate cue reactivity and craving responses, underpinned by the high reactivity of the reward system. This impairs an individual's inhibitory

control processes due to a progressive conditioning cycle, which may be viewed as commonly underpinning the emergence of different addictions, the symptoms of which could dimensionally vary over time (Brandtner et al., 2021).

Such hypotheses partially align with Research Domain Criteria studies (RDoC; Yücel et al., 2021). These aim to describe the neuropsychological continua underpinning different diagnoses and have indicated a series of primary dimensions (i.e., reward sensitivity, expectancy, action choice, reward learning, habitual behaviour, response selection-inhibition, and compulsivity) being differentially associated with the onset and perseverance of addictions (Yücel et al., 2021). Indeed, the psychobiology of control has been illustrated as a central causative factor for understanding behavioural addictions (independent of whether these involve the use of technology and/or the internet; Perales et al., 2020). Accordingly, behavioural addictions have been envisaged as a spectrum of inter-related, although unique manifestations, propelled by compulsion or relative outcome significance, with the level of the functional impairment they invite, defining the diagnostic fine line (i.e., individuals losing control over the behaviour; Perales et al., 2020).

1.4. Aims and hypotheses of the present study

Given the inconsistencies regarding the categorization and factor/dimensional structure of addictions, the present study aimed to: (i) examine the factor structure of ten common psychoactive substance and non-substance related addictions (i.e. alcohol use, cigarette smoking, substance use, sex, social media use, shopping, exercise, online gambling, internet gaming, and internet use) by subjecting them simultaneously to exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) and; (ii) examine the internal consistency reliabilities and external concurrent and discriminant validities of the factors in the optimum CFA model. Therefore, the factors were

uniquely studied in relation to the: (a) Big Five personality dimensions of extraversion, emotional stability, agreeableness, conscientiousness, and openness to experience (McCrae & Costa, 1999); (b) psychopathology symptoms of depression, anxiety, and stress; and (iii) avoidant and approach coping styles.

Considering the first aim, existing theory and literature raise the possibilities that, taken as a whole, addictions may reflect a one-factor (i.e., a general addiction factor; Yücel et al., 2021; Griffiths, 2017), two-factor (i.e., a factor for substance-related and a factor for non-substance related addictions; Schaef, 1987), three-factor (i.e., distinct factors for substance, behavioural and technology addictions; Montag et al., 2021; Singerson et al., 2017), or a bi-factor model (a general addiction factor, alongside separate factors for behavioural and substance addictions, where the general factor explains the shared variances for all the different addictions, and the specific factors explain the variances in them after accounting for the general factor; Gomez et al., 2022; Tackett et al., 2017). Indeed, preliminary support for the latter is provided by Tackett et al. (2017), who reported a good fit for a bi-factor model for alcohol use and gambling symptoms, and by Gomez et al. (2022), who examined alcohol use, gaming, and gambling addictions to also support a valid bi-factor model.

Considering the second aim, it is noted that concurrent validity can be established by showing that the factors in the target model are related to relevant external variables in theoretically meaningful ways. In contrast, discriminant validity is demonstrated when the factors in the model are not associated with external variables that do not have theoretically meaningful associations. In this context, personality traits were examined because different types of addictions have been associated differently with the different Big Five personality dimensions (Andreassen et al., 2013; Dash et al., 2019; Kotov et al., 2010; Zilberman et al., 2018). For

example, Andreassen et al. (2013) reported that while internet addiction, exercise addiction, compulsive buying, and study addiction were associated negatively with emotional stability, Facebook addiction, exercise addiction, mobile phone addiction, and compulsive buying were associated positively with extroversion. In relation to psychoactive drug addiction(s), empirical and meta-analysis studies have concluded that such addictions are consistently associated positively with neuroticism and negatively with conscientiousness, extraversion, and agreeableness (especially for alcohol use; Dash et al., 2019; Kotov et al., 2010).

In relation to depression, anxiety, and stress, past studies have shown associations with various potentially problematic behaviours including gaming (Lin et al., 2017; Loton et al., 2016; Wong et al., 2020), alcohol use (Beaufort et al., 2017), cigarette smoking (Lyvers et al., 2008), other psychoactive substance (drug) use (Beaufort et al., 2017), social media (Lin et al., 2017; Wong et al., 2020), shopping (Eraković et al., 2020), gambling (Dowling & Brown, 2010; Hopley & Nicki, 2010; Loo et al., 2010), internet use (Bodhi & Kaur, 2017; Younes et al., 2016) and exercise (Colledge et al., 2020). As for coping styles, past studies have shown that addictions are generally associated positively with avoidant coping and have little or no association with approach coping (Li et al., 2016; Milani, Osualdella, & Di Blasio, 2009; Shaw & Gant, 2004).

Based on prior literature, it was expected there would be good support for the bi-factor model with specific factors for psychoactive substance addiction and behavioural addiction; and for the two-factor first-order model, with factors for psychoactive substance addiction and behavioural addiction (Gomez et al., 2022; Griffiths, 2017; Tackett et al., 2017). Between these models, it was expected there would be better support for the latter model. Additionally, it was expected that, contingent on support for the two-factor first-order model, psychoactive substance addiction would be associated positively with extraversion (Andreassen et al., 2013; Dash et al., 2019; Kotov et al., 2010).

2. Method

2.1. Participants

Pre-screened data collected initially comprised 1097 participants. Of these, 129 were excluded from the analysis. More specifically, 84 participants were primarily preview-only registrations, five were identified as spam (i.e., systematic response inconsistencies), 11 were potential bots, 11 did not digitally confirm their consent (despite completing the survey), and 18 were excluded for not meeting the age limitation requirements as specified in the ethics approval. Therefore, responses from 968 English-speaking adults from the general community were examined. Their age ranged from 18 to 64 years (mean = 29.54 years; *SD* = 9.35 years). There were 622 men (64.3%; mean age = 29.46 years, *SD* = 8.93 years), 315 women (32.5%; mean age = 30.02 years, *SD* = 10.39 years), and 31 identified as queer/trans-non-binary/other (3.2%; mean age = 26.26, *SD* = 5.13). No significant age variations occurred between the three groups [$F_{(5, 962)} = 1.489$, $p = .191$], as well as between men and women only [$t_{(935)} = 0.846$, $p = .398$]. Slightly more than half the participants reported being employed (55.0%), and most of them reported having completed at least secondary education (98.2%).

To fulfil the study aims, the sample was randomly split into two subgroups: the calibration sample ($N = 481$) and the validation sample ($N = 487$). This was conducted using the random split function in SPSS version 20. This function does not necessarily split the whole sample into two equal halves. Supplementary Table S1 shows how these two groups compared in relation to participant characteristics, personality, psychopathology, and addiction measures.

In terms of statistical power, the sample sizes for the calibration and validation samples ($N = 481$ and 487, respectively) and the total sample ($N = 968$) in the present study were all well above the level recommended by some researchers for a factor analyses involving ten indicator

items (i.e., a minimum sample size of 10 x 10 =100 for the calibration and validation sample, and 9 x 10 = 90 for the validation sample and the combined total; Myers et al., 2011). Furthermore, the total sample greatly exceeded the minimum size of 138, as determined by *a priori* analyses involving F tests (multiple linear regression: fixed model, R^2 deviation from zero), with an effect size (f^2) equals .15, an alpha (α) error probability of .05, and power of .95, for modelling ten predictors (Faul et al., 2007). Finally, the maximum sampling error of a sample consisting of 968 participants was estimated at -/+ 3.15 at a 95% confidence level (Z = 1.96).

2.2 Measures

2.2.1. Demographics: Demographic information relating to age, gender, employment, and education level were obtained as part of the completed survey.

2.2.2. Psychometric scales assessing addiction: Scores for the different types of addictions were obtained using validated, theoretically based, and psychometrically robust addiction-specific scales, which are summarized in Table 1. Further details (e.g., developers, number of items, example items, scoring) are provided in the supplementary materials.

-Table 1 should be placed here -

2.2.3. Big Five personality traits: The Big Five personality traits (i.e., extraversion, emotional stability, agreeableness, conscientiousness, and openness to experiences) were assessed using the self-report Big Five Inventory - 10 (BFI - 10; Rammstedt & John, 2007) with two items assessing each dimension. All ten items in the scale are rated in terms of how well the statements describe the individual on a five-point scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicate higher levels of the personality trait. The BFI-10 has shown good reliability and validity (Rammstedt & John, 2007). Given that there are only two items per

dimension, the internal consistency Cronbach α values are not reported here (see Soto & John, 2017). However, the Spearman-Brown coefficient for the dimensions was calculated (Eisinga et al., 2013). They were 0.594 for extraversion, 0.213 for agreeableness, 0.467 for conscientiousness, 0.563 for emotional stability, and 0.328 for openness to experiences.

2.2.4. Depression, anxiety, and stress: The 21-item Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995) assessed depression, anxiety, and stress. Items are rated on a four-point scale (0 = *did not apply* to 3 = *applied most of the time*) regarding how often the individual experienced the behaviour during the past week. Past evidence has shown acceptable convergent and discriminant validities and high internal reliabilities for the DASS-21 sub-scales (Lovibond & Lovibond, 1995; Norton, 2007). The present study's Cronbach α for depression, anxiety and stress were .93, .87, and .88, respectively.

2.2.5. Coping: The 28-item Brief COPE (Carver, 1997) assessed 14 different coping strategies. Participants rated each item on how they use the corresponding coping strategies for a hardship in their lives on a four-point scale, ranging from 1 (*I haven't been doing this at all*) to 4 (*I've been doing this a lot*). Higher scores indicate a higher tendency to use the corresponding coping strategies. The Brief COPE has shown good reliability and validity (Carver, 1997). Eisenberg et al. (2012) grouped the 14 strategies into approach coping and avoidant coping styles. The present study used these groups for assessing avoidance coping styles (i.e., comprising self-distraction, denial, substance use, behaviour disengagement, venting, and self-blame) and approach coping styles (i.e., active coping, positive reframing, planning, acceptance, seeking emotional support, and seeking informational support). The present study's Cronbach α for avoidant and approach coping styles were .74 and .81, respectively.

2.3 Procedure

The Human Ethics Research Committee of Victoria University (Australia) approved the study. Participants' responses were collected from November 2020 to January 2021. It was advertised widely, and the survey was conducted online. Interested participants were invited to register for the study via a *Qualtrics* link available on social media (i.e., *Facebook, Instagram, Twitter, etc.*), Victoria University websites, and digital forums (i.e., *reddit.com*). The link took them to the Plain Language Information Statement (PLIS), and interested individuals were directed to click a button to agree to informed consent. This was followed by the questions seeking sociodemographic information and the study scales.

2.4 Statistical analysis

Considering the prevalence of participants at-risk of addiction, cut-off screening scores have been recommended for most (but not all) of the addiction scales used and that were employed here (see Table 1). Nevertheless, such cut-offs are limited due to being sample-specific (Stavem et al., 2008) and may not be universal. Given this, the calculation of the various prevalence rates of addiction risk in the preliminary analyses of the present study were additionally estimated utilizing the polythetic procedure suggested by Andreassen et al. (2015). Accordingly, endorsing approximately 50% of the total set of criteria was considered enough for an individual to be classified as at risk for addiction (Andreassen et al., 2015). For example, the BSMAS has six items. Therefore, an individual's endorsement of three or more items, as ‘often’ or ‘very often’, is sufficient for classifying them as being at risk for social media addiction (see Table 1).

Considering the main study aims, the relatively large sample was randomly split into two subgroups: the calibration and validation samples. EFA was applied to the calibration sample to establish a theoretical structural addiction latent factor model. Following this, CFA was applied

to the validation sample to confirm support for the structural model suggested by the EFA. This was also conducted for the combined sample (calibration sample plus validation sample). For both samples, the corresponding bi-factor models were also tested. Additionally, and contingent on support for the theorized model, the internal consistency reliabilities of the latent factors and external validity of the factors were examined.

2.4.1. Applications of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA):

In the EFA, conducted with Mplus Version 7.3 software (Muthén & Muthén, 2012), one to three-factor solutions were tested using the calibration sample (N=481). The items in the model were the total scores for the ten addictions. For this analysis, MLR estimation with geomin (i.e., oblique) rotation was used. For the EFA model, scree plot, model fit indices, the content and interpretability of the factors, salience of item loadings, items with cross-loadings, and a number of salient items in the factors were used concurrently to ascertain the number of factors to be retained (Norris & Lecavalier, 2010). In addition, MPlus was also used to conduct parallel analysis (PA). Based on Tabachnick and Fidell (2007), loadings of .32 (around 10% variance overlap between variable and factor) or more were used as salient loadings. Where needed, items with cross-loadings (an item having loadings of .32 or more on two or more factors) were eliminated from all factors, and the minimum number of items required for an acceptable factor was set at three (Brown, 2006; Costello & Osborne, 2005; Tabachnick & Fidell, 2007). Therefore, factor models with less than three items in any one of its factors were not considered.

Following the EFA, CFA was applied to validate the EFA model deemed the optimum model. The plan was to also test for the corresponding bi-factor CFA models if there were two or more latent factors in the optimum EFA model. These models were tested in the validation

sample (*N*=487) and then on the combined sample (*N*=968). In the CFA models, items (addictions) loaded only on their designated factors, and all their error variances were freely estimated (no correlated errors). Also, the first item (Item 1) was fixed to unity for model identification in all models. Robust maximum likelihood (MLR) extraction was used in the analyses.

At the statistical level, all the CFA and EFA models were evaluated using χ^2 values (MLRχ^2 values in the current case). Additionally, model fit was examined using chi-square, with a nonsignificant value indicating a good fit. As all types of χ^2 values, including MLRχ^2, are inflated by large sample sizes, the fit of the models was also interpreted using approximate fit indices provided in MPlus (i.e., root mean square error of approximation (RMSEA), Tucker-Lewis Index (TLI), comparative fit index (CFI), and standardized root mean square residual (SRMR)). Of the approximate fit indices reported in M*plus*, Hu and Bentler (1998) have recommended a two-index approach to evaluate model fit that includes the SRMR and either the TLI, CFI, or RMSEA. This recommendation was used to evaluate model fit in the present study. According to the widely used and cited guidelines proposed by Hu and Bentler (1999), RMSEA $\leq .06$, CFI and TLI $\geq .95$, and SRMR $\leq .08$ indicate cutoff levels for good model fit. Relatedly, values of CFI between .90 and .95, RMSEA between .06 and .08, and SRMR .08 and .10 indicate adequate model fit.

2.4.2. Testing internal consistency reliabilities for the factors in the optimum CFA addiction model: The internal consistency reliabilities of the factors in the optimum CFA addiction model were estimated using the omega coefficient (ω; Zinbarg, Revelle, Yovel, & Li, 2005). For these analyses, the combined sample of 968 participants was used. The ω coefficients were computed using the reliability module provided in Jeffreys' Amazing Statistics Program (JASP) version

0.14.1.0 statistical software (JASP Team, 2018). The ω can be interpreted as an estimator of how much variance in summed (standardized) scores can be attributed to that factor (McDonald, 1999). It is considered to provide a better estimate than Cronbach's alpha as an index of internal consistency reliability (McDonald, 1999). The values range from 0 to 1, with 0 indicating no reliability and 1 reflecting perfect reliability.

2.4.3. Testing external validities for the factors in the optimum CFA addiction model: To test the external validities of the factors in the optimum addiction factor model, the latent factors in this model were regressed separately on the Big Five personality dimensions as assessed by the BFI - 10 (Rammstedt & John, 2007); psychopathology symptoms of depression, anxiety and stress as assessed by the DASS-21 (Lovibond & Lovibond, 1995); and avoidant and approach coping styles as assessed by the Brief COPE (Carver, 1997). For these analyses, the combined sample of 968 participants was used. For each analysis, age and gender were included as covariates since they are known to influence addictions (Andreassen et al., 2013; Becker et al., 2017; Cotto et al., 2010; Thege et al., 2015). Support for the external validity of the addiction factors was interpreted if the two addiction factors showed different relationship patterns with the relevant predictors.

3. Results

3.1. Missing values, descriptive statistics and intercorrelations of the study variables

Among the 968 participants, the numbers and the percentages of missing values across the 21 variables in the study are shown in Table 2. As the percentages of missing values for the variables ranged between 0 and 2.1%, they can be considered negligible. Little's MCAR (Missing Completely at Random) chi-square value (df = 731) for missing values was 753.103. As this was not significant (p = .278), the missing values can be considered missing

completely at random. Incomplete variables were imputed under expectation maximization (EM). Table 2 includes the mean and standard deviation (*SD*) scores of the study variables and the prevalence rates of those at risk for the various addictions assessed, based both on the suggested cut-off points and utilizing the polythetic approach.

- Table 2 should be placed here -

Table 3 shows the correlations among the different scales used in the study. In general, nearly all the scales were correlated in the expected direction with each other.

- Table 3 should be placed here -

3.3. Exploratory factor analysis

The scree plot from MPlus for the EFA (see Supplementary *Figure S1*) suggested the possibility of two factors for the ten addiction variables. The parallel analysis (PA) indicated that two factors would be retained. The fit values for the 1- to 3-factor EFA solutions for the calibration sample are presented in Table 4. The one-factor model showed a poor fit in terms of the RMSEA, CFI, TLI, and SRMR values. For the two-factor model, the SRMR can be interpreted as supporting a good fit, and the RMSEA and CFI values can be interpreted as supporting an adequate fit. The three-factor model showed a good fit for all fit indices. Therefore, based on Hu and Bentler's (1998) recommended two-index approach for evaluating model fit and the cut-off scores, there was sufficient support for the two-factor model and good support for the three-factor model. Both these models were examined further for possible adoption as the optimum model.

- Table 4 should be placed here -

Table 5 shows the factor loadings of two-factor EFA solutions, and Supplementary Table S2 shows the factor loadings of three-factor EFA solutions. As shown in Table 5, only the three psychoactive substance addictions loaded significantly and saliently on Factor 1. With the exception of exercise, all the other behavioural addictions loaded significantly and saliently on Factor 2. Factors 1 and 2 were clearly psychoactive substance and behavioural addiction factors, respectively. Therefore, this model was theoretically meaningful. For the three-factor model, as shown in Supplementary Table S2, all three psychoactive substance addictions loaded on Factor 1. Factor 2 included three information technology behavioural addictions (gaming, online gambling, and internet use) and one non-information technology behavioural addiction (sex). Factor 3 included one information technology behavioural addiction (social media use) and one non-information technology behavioural addiction (shopping).

Given that the model as a whole did not make theoretical sense, and its third factor had only two items, this model was rejected in favour of the two-factor model as the possible optimum model. Therefore, the two-factor model, without exercise addiction, was adopted as the optimum addiction model. More specifically, the optimum model comprised two oblique factors, with one factor comprising the three psychoactive substance addictions (alcohol use, cigarette smoking, and substance use) and another factor comprising six of the original seven behavioural addictions (sex, social media use, shopping, online gambling, internet gaming, and internet use).

- Table 5 should be placed here -

3.4. Confirmatory factor analysis

The CFA fit values for the two-factor optimum EFA model for the validation sample and for all participants together are presented in Table 5. The corresponding bi-factor CFA models in

both groups did not converge. Several factors could result in non-convergence, such as poor starting values, an insufficient number of iterations, negative residual variances, low loadings, and small sample size (Boomsma & Hoogland, 2001; Gerbing & Anderson, 1987). Examination of the dataset and output did not provide any cue for the nonconvergence in the present study. For the CFA models for both groups, the SRMR indicated a good fit and the RMSEA (both samples) and CFI (in the validation sample) indicated an adequate fit. Again, based on Hu and Bentler's (1998) recommended two-index approach for evaluating model fit and the recommended cut-off scores, there was sufficient support for the optimum two-factor model. Table 5 also shows the factor loadings of the two-factor CFA solutions for both the validation sample and the total participants. As shown, all the three psychoactive substance addictions loaded significantly and saliently on Factor 1 (psychoactive substance addiction factor), and the six behavioural addictions loaded significantly and saliently on Factor 2 (the behavioural addiction factor). The correlations for the two factors in this model for the validation sample and the total participants were .312 and .280, respectively (see Table 5). These low correlations can be interpreted as supportive of the discriminant validity of these factors (Rönkkö & Cho, 2020).

3.5. Internal consistency reliabilities of the factors in the optimum model

The internal consistency-reliability omega values for the factor in the optimum addiction models are shown in Table 5. As shown, the behavioural addiction factor for both the validation sample and all participants together was high (.80 and .82, respectively). For both groups, the values were low for the psychoactive substance addiction factor (.42 and .46, respectively). According to Watkins (2017), there is still no universally accepted guideline for what constitutes adequate omega for clinical decisions. For Cronbach's alpha, a cut-of score of .70 has been suggested (Nunnally, 1978). Watkins (2017) has recommended that the same standard be used

for omega. Therefore, our reliability scores can be interpreted as indicating acceptable reliability for the behavioural addiction factor and insufficient reliability for the psychoactive substance addiction factor. However, as omega values increase with an increase in the number of indicators (Rodriguez et al., 2015), it is conceivable that the low omega value for the psychoactive substance addiction latent factors may be because there are only three indicators for this factor.

3.6. External validities of the factors in the optimum model

Table 6 shows the standardized beta coefficients for the predictions of the addiction latent factors by Big Five personality dimensions, psychopathology symptoms, and coping styles, controlling for age and gender. As shown, while both the psychoactive substance and the behavioural addiction factors were negatively associated with agreeableness, conscientiousness and emotional stability, the psychoactive substance addiction factor was positively associated with extraversion, and the behavioural addiction factor was negatively associated with openness to experiences. For psychopathology symptoms, both addiction factors were positively associated with depression and anxiety, with behavioural addiction also being positively associated with stress. Both addiction factors were positively associated with avoidant coping styles and had no association with approach coping. For all three analyses, age was positively associated with the psychoactive substance addiction factor and negatively with the behavioural addiction factor. Gender was not associated with either factor. Overall, as the two addiction factors showed different patterns of relationship with the external covariates (especially for personality and psychopathology dimensions), support for the external validities for both the addiction factors can be inferred.

- Table 6 should be placed here -

4. Discussion

The present study examined the factor structure of three common psychoactive substance-related addictions (alcohol use, cigarette smoking, and substance use) and seven behavioural addictions (social media use, shopping, exercise, online gambling, internet gaming, and internet use) using EFA and CFA. For the calibration sample, the findings in EFA supported a two-factor solution, with different factors for psychoactive substance and behavioural addictions (excluding exercise addiction). For the validation sample and the combined sample (validation + calibration), CFA supported the fit of the two-factor model. In both instances, there was no support for the bi-factor model. These findings can be interpreted in terms of addictions (at least those examined in the study) generally having two latent factors. The factors are psychoactive substance addiction and behavioural addiction. These two factors were supported in terms of external validities in that they were associated differently with the Big Five personality dimensions and with psychopathologies. The behaviour and substance use factors were also differentially associated with gender and age. Although there was good support for the reliability of the behavioural addiction latent factor, there was poor support for the reliability of the psychoactive substance addiction factor.

These findings appear to favour considering a dimensional view of addictions alongside their different categories (APA, 2013; 2022; Perales et al., 2020; Yücel et al., 2021). Additionally, the findings indicate the shared variance and communalities between substance-related addictions and behavioural addictions may not be sufficient to support the occurrence of a common general factor (i.e., the bi-factor model). Therefore, these two different types of addictions may need to be viewed as diagnostically distinct. Alternatively, this finding may also be viewed as indicatively supportive of the concerns related to pathologizing everyday life

behaviours, such as those comprising the behaviours loading under the current behavioural addiction factor, especially in the light of the community sample used for the present study, and exercise addiction not loading on either factor (Kardefelt-Winther et al., 2017). Moreover, the lack of sufficient internal consistency of the substance-related factor may indicate the significant differences in social tolerance/acceptability regarding the use of substances (i.e., nicotine and alcohol) in the community sample assessed (Griffiths, 2017; Stavropoulos et al., 2021a). Finally, the lack of support for a separate technology addiction factor appears to reinforce diagnostic inflation concerns and arguments suggesting that the use of a technology medium may not suffice for a specific diagnostic classification (Griffiths, 2020; Panova & Carbonell, 2018; Starcevic et al., 2021).

4.1. External correlates of the substance use addiction and behavioural addiction factors

In all three analyses involving the prediction of the latent factors by personality dimensions, psychopathology symptoms and coping styles, age was positively associated with psychoactive substance addiction and negatively associated with a behavioural addiction. Gender was not associated with either latent factor. Concerning the latent factors, the findings showed that high levels of both the psychoactive substance and behavioural addiction factors were associated with low levels of agreeableness, conscientiousness, and emotional stability. Also, high levels of psychoactive substance addiction were associated with high levels of extraversion, and low levels of openness to experiences were associated with high levels of behavioural addiction. High levels of both psychoactive substance and behavioural addictions were associated with high levels of both depression and anxiety, and high levels of stress were associated with a behavioural addiction. Stress and psychoactive substance addiction were not associated. Also, high levels of avoidant coping were associated with high levels of both

psychoactive substance addiction and behavioural addiction, and approach coping had no association with either type of addiction.

Like the results here, the findings from several meta-analyses can be interpreted as showing that the different types of psychoactive substance addictions (such as those examined in the present study) are generally associated negatively with emotional stability, conscientiousness, and agreeableness, and positively associated with extraversion, with little or no relationship with openness to experiences (Dash et al., 2019; Kotov et al., 2010; Malouff et al., 2007). With reference to some of the different behavioural addictions examined in the present study, Andreassen et al. (2013) found that emotional stability, agreeableness, and conscientiousness were negatively associated with internet addiction and shopping, with conscientiousness also being negatively associated with videogame addiction. These findings are also consistent with the present study. However, unlike the findings here, they found that shopping (which formed part of behavioural addiction) was positively associated with extroversion. Nevertheless, given that the current community sample included more technologically-minded individuals, such as those exposed to gaming tend to be (Stavropoulos et al., 2021a), it is likely that they may be involved/refer to digital shopping I don't know what you mean, which may not necessarily require face-to-face expressed extraversion. Also, consistent with the present findings, existing data indicate that both psychoactive substance and behavioural addictions are both generally positively associated with avoidant coping (Li et al., 2016; Milani, Osualdella, & Di Blasio, 2009; Shaw & Gant, 2004), and psychopathology, including anxiety, depression, and stress (Hunt, Malhi, Cleary, Lai, & Sitharthan, 2016; Lai et al., 2015; Seki et al., 2019). Although the present study's findings are generally consistent with existing findings, they also extend existing data. Unlike previous studies that examined the relationships of the personality dimensions with

the different addictions on a one-to-one basis, the present study examined the relationships of the personality dimensions with psychoactive substance and behavioural addiction latent factors. Consequently, the findings have taxonomic, theoretical, and clinical implications for understanding addictions.

4.2. Taxonomic implications

The findings of the present study indicate that even if alcohol use, cigarette smoking, substance use, social media use, shopping, exercise, online gambling, internet gaming, and internet use are speculated to have the same basic components of salience, mood modification, tolerance, withdrawal, conflict, and relapse (Gomez et al., 2022; Griffiths, 2017; Rozgonjuk et al., 2021; Zarate et al., 2022), structurally they appear not to comprise a single group, but two groups. However, Griffiths (2005; 2017) does state that there are many idiosyncratic differences between behavioural and substance use addictions. His model stresses the similarities across all addictions while acknowledging major differences both within and between behavioural and substance abuse addictions. Given the non-significant loading of exercise addiction with the behavioural addiction factor, diagnostic inflation and everyday behaviour pathologizing concerns are also reinforced (Panova & Carbonell, 2018; Starcevic et al., 2021).

The present study's findings suggest that there is no support for a unidimensional model for addictions as a whole and/or a general addiction factor. Additionally, although some experts (e.g., Montag et al., 2021; Sigerson et al., 2017), have separated the behavioural addictions into information technology addictions (e.g., internet use and internet gaming) and non-information addictions (e.g., shopping and gambling), the findings here indicate no support for separating behavioural addictions into information technology addictions and non-information addictions groups in terms of latent factors. This means there was no support for a three-factor addiction

model (psychoactive substance use, technology-related behaviour, and non-technology-related behaviour).

The findings here also show that although excessive gambling and gaming may have similarities in phenomenology and biology to substance use disorders, and gambling has been recognized in the DSM-5 as an addiction disorder similar to substance use addictions, and both gambling and gaming disorder has been recognized by ICD-11 as addictions similar to substance use addictions, structurally, neither gambling nor gaming can be grouped with substance use addictions (alcohol use, cigarette smoking, and substance use) in terms of latent factors (APA, 2013; 2022; Brandtner et al., 2021; Perales et al., 2021; Yücel et al., 2021). Also, structurally, internet gaming is listed in the DSM-5 as an emerging condition needing further investigation as an addiction (APA, 2013), and cannot be grouped with substance use addictions in terms of a unidimensional latent factor. Given these considerations, the findings raise questions over the grouping of gambling with substance use addictions in the DSM-5 and gambling and gaming with substance use addictions in the ICD-11 (WHO, 2019). The findings here favour the separation of the relevant behavioural and substance use addictions in any future classification systems.

As mentioned earlier, the findings indicated that, as a whole, addictions have two latent factors that are separated in terms of psychoactive substance and behaviour (non-psychoactive substance) addictions. The support in the present study for separate factors for behaviour and substance use addictions is consistent with the past proposed grouping of Schaef (1987), who has suggested the division of addictions into substance use addictions (addictions involving ingestion and/or use of products especially cigarette smoking, alcohol use, and substance use) and process or behavioural addictions (addictions involving pathological behaviours such as gambling,

internet use, sex, exercise, work, and shopping). There were other findings in the present study that provided additional support for the distinction of addictions in terms of substance use and behaviour. First, as the correlation between the psychoactive substance use addiction and behavioural addiction latent factors was low (0.280 for the sample as a whole), there was support for their discriminant validity. Second, there was also support for the external validities for the behavioural addiction and psychoactive substance use addiction latent factors. These appear to also validate concerns about tailoring the diagnostic criteria of behavioural addictions, exclusively on the basis of substance use disorders, given the distinct dimensions these are associated with (Kardefelt-Winther et al., 2017).

Although the results of the present study suggest that when taken together, addictions have two latent factors that are separated in terms of psychoactive substance addiction and behaviour (non-psychoactive substance) addiction, it should be stressed that the differentiation is based purely on the structural relationships of the addictions in the model investigated. However, more than structural relationships must be considered for a taxonomic of addictions. More specifically, this requires evaluation and demonstration of parallels in their natural history, phenomenology, tolerance, comorbidity, overlapping genetic contribution, neurobiological mechanisms, and response to treatment (Robbins & Clark, 2015), which has yet to be shown (Grant et al., 2010; Kardefelt-Winther et al., 2017; Piquet-Pessôa et al., 2014). Nevertheless, the findings are important as taxonomies for addictions evolve.

The findings of the present study have additional implications for the novel HiTOP model (Kotov et al., 2017). Although the current version of the HiTOP model includes only substance use disorder (i.e., psychoactive substance addiction) as a sub-factor and makes no mention of behavioural addictions, the findings here provide some support for the inclusion of

behavioural addictions in this model. In this respect, there are two possible ways of organizing this inclusion. On one hand, behavioural addictions could be viewed as an additional sub-factor under the disinhibition spectra. On the other hand, the sub-factor for substance abuse disorder could be renamed addictions, and behavioural addictions could be listed as another symptom dimension for this group. Between these alternatives, the findings of the present study support a two-factor model (comprising psychoactive substance addiction and behavioural addictions) demonstrating both divergent and external validities as being more supportive of the first option.

4.3. Theoretical and clinical implications

Overall, the present findings and findings from past studies can be interpreted to show that the psychoactive substance addiction and the behavioural addiction factors are associated in the same way with agreeableness, conscientiousness, emotional stability, depression, anxiety, and avoidant coping but differ in their associations with extraversion, openness to experiences, and stress. More specifically, extraversion is positively associated with psychoactive substance use addiction, whereas behavioural addiction is negatively associated with openness to experiences, and positively associated with stress. Therefore, individuals prone to addictions, in general, have a tendency to experience negative emotions and thoughts; are less responsible, dependable, disciplined, and organized; and have problems getting along with others, including being less prosocial, altruistic, trusting, warm, and sympathetic. Individuals are more likely to have behavioural addictions than psychoactive substance addictions if they are younger, experience stress, and lack intellectual curiosity, creativity, aesthetic sensitivity, and hold dogmatic attitudes. In contrast, individuals are more likely to have psychoactive substance addictions than behavioural addictions if they are older, and also have a tendency to be sociable, energetic, and experience positive emotions and thoughts.

The findings that exercise addiction did not load on either the psychoactive substance addiction factor or the behavioural addiction factors, could be interpreted to mean that the behaviour in its most excessive form may not be an addiction as such. Indeed, exercise addiction has not been universally accepted as a form of behavioural addiction (Billieux et al., 2015; Kardefelt-Winther et al., 2017). Indeed, the APA has explicitly stated that as of yet there is insufficient evidence to definitively categorize that exercise addiction is really a disorder (Potenza, 2014). However, a recent meta-review conducted by Colledge et al. (2020) compiled a list of symptoms reported in the qualitative literature in excessive exercise and compared it with the DSM-5 criteria for gambling disorder. The study found that exercise-related symptoms corresponded with seven of the nine DSM-5 criteria for gambling disorder. The authors concluded that problematic exercise may constitute a behavioural addiction, based on the criteria of the DSM-5. However, the findings here suggest that even if problematic exercise is an addiction, it may be better classified as a disorder in its own right, rather than as either a behavioural or psychoactive substance addiction.

4.4. Limitations

There are several limitations that need to be considered when interpreting the findings and the conclusions made. First, as the findings are based on a single study, there is a need for cross-validation of the findings before they can be generalized. Second, as all data were collected from participants not selected randomly, using self-report scales, the findings may have been confounded and influenced by common method variance. Related to this, the present study used a convenience sample, thereby limiting the generalizing of the findings. Third, as the participants were a community sample, the findings may not be relevant to those with a clinical diagnosis. Fourth, as cross-sectional data were collected, the findings cannot be interpreted in causal terms.

Fifth, since cultural differences were not controlled for in the present study, and as this can potentially influence ratings of the addiction and personality questionnaires (Hoffman & Unger, 2020; Triandis & Suh, 2002), it is conceivable that the findings are confounded. Sixth, latent class/profile analyses have shown subtypes for addictive behaviours included in the study (Brown et al., 2021; Stavropoulos et al., 2021a; 2012b; Ünübol et al., 2021). Although it is conceivable that subtypes could have influenced the findings of the present study, the present authors do not believe this to be so. This is because subtypes previously found differed from each across the severity of the symptoms and not types of symptoms (Brown et al., 2021; Stavropoulos et al., 2021a; 2012b; Ünübol et al., 2021). Finally, the online gambling measure employed inevitably restricted the extrapolation of the findings to gambling behaviours occurring offline. Notwithstanding these limitations, the findings in the present study provide a strong basis for further studies in this area, controlling for the limitations raised here.

4.5. Conclusions and further research

The present study provides new and novel findings on the factor structure of common addictions. In summary, the findings showed that on the whole, the different types of addiction reflected two latent factors, namely psychoactive substance and behavioural addiction factors. The findings also showed that both the psychoactive substance and behavioural addictions have good reliability and external validity. In relation to validity, the findings showed that although high levels of both the psychoactive substance and behavioural addiction factors were associated with low levels of agreeableness, conscientiousness, and emotional stability, high levels of psychoactive substance addiction were associated with high levels of extraversion, and low levels of openness to experiences were associated with high levels of the behavioural addiction. Nevertheless, as support for two factors for the separation of the different addictions is based

purely on the structural relations (derived from factor analysis) of the different addictions, it needs to be considered tentative. In addition to the study limitations highlighted above, future studies should evaluate parallels in their natural history, phenomenology, tolerance, comorbidity, overlapping genetic contribution, neurobiological mechanisms, and response to treatment (Robbins & Clark, 2015) for a complete understanding for the taxonomy of addictions (Kardefelt-Winther et al., 2017).

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Table 1. Psychometric scales used to assess addiction in the study

Addiction	Questionnaire used	Brief description [example of an item]	Likert intervals	Recommended cut-off point for screening	Polythetic score for screening	Internal Consistency Cronbach α for the present data
Shopping	Bergen Shopping Addiction Scale (BSAS; Andreassen et al., 2015)	Seven shopping addiction symptoms experienced during the past 12 months. ["I shop/buy things in order to change my mood"].	1 = 'completely disagree' to 5 = 'completely agree'.	Providing at least four agree or completely agree responses was an indication of shopping addiction (Andreassen et al., 2015).	Three items with either 4 = 'agree' or 5 = 'completely agree'.	.88
Social media use	Bergen Social Media Use Addiction Scale (BSMAS; Andreassen et al., 2012)	Six social media use addiction symptoms experienced during the past 12 months. ["Felt an urge to use social media more and more"].	1 = 'very rare' to 5 = 'very often'.	Cut-off score of 24 indicating social media addiction (Andreassen et al., 2016; Luo et al., 2021)	Three items with either 4 = 'often' or 5 = 'very often'.	.88
Sex	Bergen–Yale Sex Addiction Scale (BYSAS; Andreassen et al., 2012)	Six sex addiction symptoms experienced during the past 12 months. ["Felt an urge to masturbate/have sex more and more"].	0 = 'very rare' to 4 = 'very often'.	Providing at least four 'often' or 'very often' responses was an indication of sex addiction (Andreassen et al., 2018).	Three items with either 3 = 'often' or 4 = 'very often'.	.84
Exercise	Revised Exercise Addiction Inventory (EAI-R; Szabo et al., 2019)	Six exercise addiction symptoms being experienced. ["Exercise is the most important thing in my life"].	1 = 'completely disagree' to 5 = 'completely agree'.	Cut-off score of 30 indicating exercise addiction (Szabo et al., 2019).	Three items with either 4 = 'agree' or 5 = 'completely agree'.	.84
Online gambling	Online Gambling Disorder Questionnaire (OGD-Q); González-Cabrera et al., 2020)	11 online gambling addiction symptoms experienced during the past 12 months. ["Have you tried to control, reduce or stop gambling and have not been able to do so?"].	1 = 'never' to 5 = 'very often'.	Providing at least four 'very often' or every day responses was an indication of online gambling addiction (González-Cabrera et al., 2020).	Five items with either 4 = 'often' or 5 = 'very often'.	.94
Internet gaming	Internet Gaming Disorder Scale – Short-Form (IGDS9-SF; Pontes & Griffiths, 2015)	Nine internet gaming addiction symptoms experienced during the past 12 months. ["Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?"].	1 = never to 5 = very often.	Cut-off score of 32 to distinguish between disordered and non-disordered gaming (Aricak et al., 2018; Pontes & Griffiths, 2015).	Four items with either 4 = 'often' or 5 = 'very often'.	.89
Internet	Internet Disorder Scale–Short Form	Nine internet addiction symptoms experienced	1 ='never' to 4 = 'very often'.	Providing at least five 'very often'	Four items with either 4 =	.90

	(IDS9-SF; Pontes & Griffiths, 2016)	during the past 12 months. ["Do you feel preoccupied with your online behavior?"]		responses was an indication of internet addiction (Pontes & Griffiths, 2016).	'very often' to 5 = 'every day'	
Alcohol	Alcohol Use Disorders Identification Test (AUDIT; Babor, de la Fuente, Sauders, & Grant, 1992)	10 alcohol addiction symptoms being experienced. ["During the past year, how often have you felt guilt or remorse after drinking?"]	0 = 'never' to 4 = 4 or more times a week.	Cut-off score of 16 suggests high-risk/harmful level of alcohol use (Saunders et al., 1993).	Five items with either 3 = '2 or 3 times a week' or 4 = '4 or more times a week'.	.89
Substance use	Drug Abuse Screening Test (DAST-10; Skinner, 1982)	10 drugs addiction symptoms experienced during the past 12 months. [Are you unable to stop abusing drugs when you want to?]	Yes/No	Cut-off score of 6 indicating a substantial degree of drug abuse problems (Skinner, 1982).	Five items containing '1' (yes).	.78
Cigarettes	Cigarette Dependence Scale – 5 (CDS-5; Etter et al., 2003)	Five cigarette addiction symptoms being experienced. ["After a few hours without smoking, I feel an irresistible urge to smoke"].	1 to 5	No cut-off score identified in previous literature.	Two items with either '4' or '5' for Items 2 to 5.	.68

Table 2. *Mean and standard deviation scores for the study variables*

	N	Mean	Std. deviation	Missing N/%	At addiction risk of participants (N/%) as per suggested cut-offs	At addiction risk participants N/% as per polythetic approach
Age	968	29.54	9.355	0/0		
Gaming total	957	18.15	7.114	11/11	20/2.1	103/10.6
Alcohol total	963	4.47	6.004	5/.5	85/8.7	25/2.5
Smoking total	968	9.23	3.975	0/.0	N/A	142/14.7
Substance use total	967	1.69	1.670	1/.1	57/5.9	75 /7.7
Sex total	962	6.66	5.090	6/.6	70/7.2	151/15.6
Social media total	962	11.71	5.548	6/.6	33/3.4	117/12.1
Shopping total	958	13.55	5.813	10/1.0	73/7.5	145/15
Exercise total	957	14.37	6.500	11/1.1	91/9.4	242/25
Online gambling total	952	13.59	5.856	16/1.7	24/2.5	16/1.7
Internet total	958	19.96	7.956	10/1.0	28/2.9	175/18.1
Extraversion	965	5.94	3.135	3/.3		
Agreeableness	966	9.65	2.548	2/.2		
Conscientiousness	963	9.35	2.895	5/.5		
Emotional stability	962	8.42	3.151	6/.6		
Openness to experiences	967	9.86	2.535	1/.1		
Depression	955	8.07	5.927	13/1.5		
Anxiety	960	4.88	4.484	8/.9		
Stress	955	7.18	4.908	13/1.3		
Avoidant coping	960	23.42	6.528	8/.8		
Approach coping	948	28.70	7.316	20/2.1		

Note. Mean and SD scores are values after imputation of missing values.

Table 3. *Intercorrelations between the study variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Gaming (1)	-	.08*	.00	.11**	.37**	.36**	.33**	.08*	.38**	.69**	-.17**	-.24**	-.27**	-.22**	-.17**	.40**	.36**	.37**	.05	.39**
Alcohol (2)		-	.20**	.39**	.17**	.15**	.11**	.00	.20**	.11**	.18**	-.13**	-.19**	-.10**	.05	.22**	.23**	.22**	.03	.40**
Smoking (3)			-	.27**	.07*	.01	.09**	-.03	.09**	.04	.01	.02	-.06	-.05	.05	.09**	.12**	.08*	.03	.15**
Substance use (4)				-	.12**	.11**	.13**	-.04	.16**	.18**	.05	-.10**	-.24**	-.17**	.06	.24**	.29**	.22**	.08*	.34**
Sex (5)					-	.31**	.25**	.12**	.29**	.35**	.01	-.21**	-.16**	-.10**	-.04	.26**	.29**	.28**	.11**	.33**
Social media (6)						-	.44**	.15**	.28**	.52**	.07*	-.10**	-.20**	-.28**	-.02	.34**	.45**	.46**	.18**	.41**
Shopping (7)							-	.12**	.36**	.39**	.03	-.08**	-.13**	-.25**	-.04	.25**	.35**	.34**	.11**	.33**
Exercise (8)								-	.20**	.06	.11**	.00	.17**	.12**	.05	-.07*	.06	.05	.19**	.05
Online gambling (9)									-	.33**	.01	-.14**	-.09**	-.01	-.14**	.19**	.32**	.23**	.06	.24**
Internet (10)										-	-.15**	-.26**	-.33**	-.35**	-.13**	.50**	.47**	.51**	.11**	.47**
Extraversion (11)											-	.07*	.09**	.15**	.30**	-.25**	-.08*	-.06	.20**	-.07*
Agreeableness (12)												-	.19**	.21**	.17**	-.19**	-.16**	-.22**	.11**	-.21**
Conscientiousness (13)													-	.39**	.09**	-.39**	-.28**	-.31**	.07*	-.32**
Emotional stability (14)														-	.04	-.54**	-.53**	-.63**	-.02	-.48**
Openness (15)															-	-.10**	-.02	.01	.24**	-.02
Depression (16)																-	.65**	.72**	.04	.68**
Anxiety (17)																	-	.77**	.18**	.60**
Stress (18)																		-	.21**	.65**
Approach (19)																			-	.29**
Avoidant (20)																				-

Table 4. Fit of the one-factor and two-factor addiction models tested in the study

Group	df	χ^2	RMSEA		CFI	TLI	SRMR	*N*
			Estimate	90% CI				
Models with all ten addictions								
EFA one-factor (calibration sample)	35	250.934	. 113	[.100, .127]	.735	. 660	.083	481
EFA two-factor (calibration sample)	26	115.525	. 085	[.069, .101]	.890	.810	.038	481
EFA three-factor (calibration sample)	18	47.082	.058	[.038, .078]	.964	.911	.026	481
Models with nine addictions (minus exercise addiction)								
CFA two-factor (validation sample)	26	85.856	.069	[.053, .085]	.906	.869	.047	487
CFA two-factor (combined sample)	26	178.999	. 078	[.067, .089]	.888	.845	.046	968
Bi-factor CFA (validation sample)	No Convergence							
Bi-factor CFA (combined sample)	No Convergence							

Note. χ^2 = maximum likelihood χ^2, RMSEA= root mean square error of approximation; CFI = comparative fit index; TLI = Tucker Lewis index; SRMR = standardized root mean square residual; *N* = number of participants tested.

All χ^2 values were significant ($p<.01$).

Table 5. Factor loadings, factor correlations and reliabilities of the two-factor EFA, and CFA addiction models in the calibration sample (n = 481), validation sample (n = 487), and all participants together (n = 968)

	EFA (calibration sample)		CFA (validation sample)		CFA (all participants)	
Addictions	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2
Alcohol	0.705*	-0.014	0.544*		0.539*	
Smoking	0.406*	0.000	0.320*		0.369*	
Substance use	0.609*	0.083	0.632*		0.724*	
Gaming	-0.078	0.763*		0.795*		0.765*
Online gambling	0.229*	0.451*		0.427*		0.464*
Internet	-0.006	0.858*		0.846*		0.846*
Social media	0.147*	0.578*		0.573*		0.594*
Sex	0.131	0.430*		0.472*		0.466*
Shopping	0.140*	0.527*		0.443*		0.502*
Exercise	0.032	0.053	-	-	-	-
Factor correlation	0.154		0.312***		0.280***	
Omega (95% CI)	.52 (.43/.60)	.82 (.79/.84)	.42 (.30/.53)	.80 (.77/.83)	.46 (.39/.53)	.81 (.79/.83)

Note. Factor 1 and Factor 2 are substance addiction factor and behavioural addiction factor, respectively. *p<.05

Table 6. Beta coefficients in the SEM models for the predictions of the addiction latent factors by Big Five personality dimensions, psychological symptoms, and coping styles, controlling for age and gender (n=968)

	Psychoactive substance addiction	Behavioural addiction
Big Five Personality Dimensions		
Age	0.151**	-0.181***
Gender	0.060	-0.011
Extraversion	0.179***	-0.022
Agreeableness	-0.115**	-0.178***
Conscientiousness	-0.294***	-0.204***
Emotional stability	-0.132**	-0.201***
Openness to experiences	0.084	-0.079*
Demographics and psychopathology symptoms		
Age	0.063**	-0.106***
Gender	0.454	0.374
Depression	0.108**	0.168***
Anxiety	0.290***	0.257***
Stress	-0.041	.295***
Coping style		
Age	0.187***	-0.212***
Gender	0.086	0.025
Avoidance	0.623***	0.549***

Approach	-0.092	-0.020

Note. For gender, women=0 and men=1.

$^{***}p<.001$; $^{**}p<.01$; $^{*}p<.05$.