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Latent profiles of family background, personality and mental health factors and their association with behavioural addictions and substance use disorders in young Swiss men

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Abstract

Background:

Recent theories suggest that behavioural addictions and substance use disorders may be the result of the same underlying vulnerability. The present study investigates profiles of family background, personality and mental health factors and their associations with seven behavioural addictions (to the internet, gaming, smartphones, internet sex, gambling, exercise and work) and three substance use disorder scales (for alcohol, cannabis and tobacco).

Methods:

The sample consisted of 5287 young Swiss men (mean age = 25.42) from the Cohort Study on Substance Use Risk Factors (C-SURF). A latent profile analysis was performed on family background, personality and mental health factors. The derived profiles were compared with regards to means and prevalence rates of the behavioural addiction and substance use disorder scales.

Results:

Seven latent profiles were identified, ranging from profiles with a positive family background, favourable personality patterns and low values on mental health scales to profiles with a negative family background, unfavourable personality pattern and high values on mental health scales. Addiction scale means, corresponding prevalence rates and the number of concurrent addictions were highest in profiles with high values on mental health scales and a personality pattern dominated by neuroticism. Overall, behavioural addictions and substance use disorders showed similar patterns across latent profiles.

Conclusion:

Patterns of family background, personality and mental health factors were associated with different levels of vulnerability to addictions. Behavioural addictions and substance use disorders may thus be the result of the same underlying vulnerabilities.

Keywords: Substance use disorders; Behavioural addictions; Affective disorders; Attention Deficit -

Hyperactivity Disorder (ADHD); Borderline personality disorder; Stress

1. Introduction

Schaffer et al. [1] proposed that substance use disorders (SUDs) and behavioural addictions (BAs) may be expressions of an underlying *addiction syndrome* related with several distal neurobiological, genetic, psychological and social risk factors. In this line of thinking, the present study investigates the link between clusters of individuals with different family backgrounds, personality and mental health factors, with seven BAs (to the internet, gaming, smartphones, internet sex, gambling, exercise and work) and three SUDs (for alcohol, cannabis and tobacco), in a large sample of young Swiss men, among whom substance use [2] and other potentially addictive behaviours [3, 4] are widespread. There is an ongoing debate about whether some of the so-called behavioural addictions should actually be pathologized as "addictions" [5]. Currently, only gambling is an accepted disorder in DSM-5[6], and Internet gaming will likely be included in ICD-11[7]. However, for ease of presentation, all included potential problematic behaviours will be labelled as behavioural addictions in this paper. In contrast to measuring quantity or frequency of use only, measures for SUDs and BAs are based on symptoms of problematic use like tolerance, withdrawal, salience as well as personal and social consequences[8]. The main research question was whether there are distinct profiles of family background, personality and mental health factors associated with SUDs or BAs.

There are many studies about correlates of BAs and SUDs. Family-related variables (good family relationships and management) have been shown to be associated with lower substance use in young adults [9], and there is also evidence for parental monitoring being associated with lower prevalence rates of BAs, such as problematic gambling [10] and internet addiction [11]. In the field of personality, a meta-analysis by Kotov et al. [12] found that the traits of neuroticism and disinhibition were positively related to SUDs, whereas the trait of conscientiousness was negatively related to SUDs. Extraversion was found to be negatively related to drug use only, and agreeableness was negatively related to drug and mixed substance use. In a study involving 218 university students, Andreassen et al. [13] found that 6%–17% of the variance in seven BAs was explained by the five-factor model of personality. Finally, for mental health factors, there is a broad range of studies linking mental disorders to SUDs [1, 14, 15]. As an example for BAs, Ko et al. [16] found that internet addiction was

related to attention-deficit hyperactivity disorder (ADHD), depressive disorder and social phobia. However, the association between mental functioning and addiction is complex: mental health factors may increase the risk for addictions or vice versa, or they may share some risk factors [15, 17].

Shaffer et al. [1] identified shared psychological manifestations and sequelae of different addictions (e.g. feelings of guilt, shame, tolerance and withdrawal), parallel natural histories (patterns of onset, improvement, relapse and remission), object non-specificity, concurrent manifestations of addictions and treatment non-specificity and they therefore put forward the idea of an *addiction syndrome*. In this interpretation, addictive disorders are seen less as the consequences of exposure to a specific substance or behaviour, but may instead be seen as expressions of an underlying vulnerability.

Comparing BAs to SUDs, Grant et al. [18] found common features, notably in natural history (e.g. chronic, relapsing patterns), phenomenology (e.g. craving, resulting positive mood state) and adverse consequences (e.g. financial or marital problems); they also found that they may respond to similar psychological treatments and pharmacological treatments. A recent study assessing four substance and six behavioural addictions also found that the 10 scales loaded highly on a single component, providing thus evidence for an underlying addiction construct[19].

Although there are several studies linking individual risk factors to specific addictions, to the best of our knowledge, there are no studies linking patterns of potential risk factors to multiple addictions. We therefore investigated profiles of family background, personality and mental health factors that may contribute to the occurrence or co-occurrence of addictions using latent profile analysis (LPA). LPA is a person-centred, model based clustering approach (in contrast to e.g. k-means clustering; see [20] for a comparison of LCA/LPA with other clustering approaches) capable of assembling participants into distinct profiles, based on their expressions on a number of variables, whereby allowing the inclusion of covariates and the handling of non-normal data [21]. The aim of this study was therefore not to test associations between specific variables and addictions as in a variable-centred approach, but to identify groups of individuals sharing similar characteristics (person-centred approach). Within this framework, we investigated whether a) different profiles of potential risk factors (namely, family background, personality and mental health factors) could be identified, b) addictions scales differed

across the profiles identified; and c) differences between profiles were associated with different types of addictions (i.e. BAs and SUDs).

2. Method

2.1 Sample

The present work's sample came from the Cohort Study on Substance Use Risk Factors (C-SURF; for an overview see [2]), a longitudinal study designed to examine use patterns and associated factors in young Swiss men. Enrolment for the baseline measurement occurred between August 2010 and November 2011 in three of Switzerland's six military recruitment centres, located in Lausanne (French-speaking: 57.4% of the final sample), Windisch and Mels (German-speaking: 42.6%), during the military recruitment procedures which are mandatory for all Swiss men. Written consent to participate in the study was given by 7556 young men; 5987 (79.2%) returned the baseline questionnaire between September 2010 and March 2012; 5362 returned the second follow-up questionnaire between April 2016 and September 2017. Questions about family background were asked at baseline only and assumed to be stable across waves; the personality, mental health and addiction measures stem from the second follow-up questionnaire. Data from first follow-up were not used. The final sample of 5287 included all participants who had replied to the second follow-up questionnaire. 75 Individuals were excluded because of more than four missing values across variables used in the latent profile model. Mean age at baseline was 19.97 years (SD = 1.22) and 25.42 years (SD=1.23) at the second follow-up. The research protocol was approved by the Human Research Ethics Committee of the Canton Vaud (Protocol No. 15/07).

2.2 Measurements

2.2.1 Family background

Family situation was assessed with a question about how participants lived most of the time before they were 18 years old. Responses were "grew up with both parents, or one parent and one step-

parent", and "grew up with one parent or no parents". Parental divorce before 18 years old was assessed using a yes/no question. These questions were adapted from the Alcohol Use Disorder and Associated Disabilities Interview Schedule IV (AUDADIS IV) [22]. Participant's satisfaction with his relationship with parents before the age of 18 was averaged across mother and father on a 5-point scale ranging from "not at all satisfied" to "very satisfied". Parenting during childhood was measured using six statements (two each for parental regulation, monitoring and support at the age of 15) with five-point Likert scale-type response options ranging from "almost never" to "almost always". These questions were adapted from the European School Survey Project on Alcohol and Other Drugs [23].

2.2.2 Personality

Three of five subscales from the Zuckermann–Kuhlmann Personality Questionnaire [24] were used: a) aggression/hostility, b) sociability and c) neuroticism/anxiety. Each subscale was measured using ten true/false questions. Sensation seeking was measured using the Brief Sensation Seeking Scale [25] with eight items on a five-point Likert scale ("strongly agree" to "strongly disagree").

2.2.3 Mental health

Stress symptoms during the last month were measured using the Perceived Stress Scale 10 (PSS10) [26], consisting of ten statements describing stressful situations in life using five-point Likert scale-type response options ranging from "never" to "very often".

Social anxiety symptoms during the last week were measured using the Clinically Useful Social Anxiety Disorder Outcome Scale [27], consisting of 12 statements rated using five-point Likert scale-type response options ranging from "almost never true" to "almost always true".

Borderline personality disorder symptoms were measured using the Mclean Screening Instrument for Borderline Personality Disorder [28, 29], consisting of ten true/false statements.

Adult attention-deficit hyperactivity disorder (ADHD) symptoms during the last 12 months were measured using the six-item five-point Likert scale (from "never" to "very often") screener version of the Adult ADHD Self-Report Scale [30].

Bipolar disorder (lifetime) was measured using the Mood Disorder Questionnaire [31] (French version adapted from [32]). Participants had to endorse at least seven of the 13 symptoms [31], and some symptoms had to occur in the same time frame and had to cause at least moderate problems. Due to this coding practice, this scale was used only as a dichotomous indicator for the main analysis.

Major depression symptoms in the last two weeks were measured using the Major Depressive Inventory (WHO-MDI) [33], consisting of 12 six-point Likert-type statements ranging from "never" to "always".

2.2.4 Behavioural addiction and substance use disorder scales

Internet (14 items) [34, 35], gaming (last 6 months; 7 items) [36], smartphone (10 items) [37, 38], exercise (6 items) [39] and work addiction (last 12 months; 7 items) [40] were measured using Likert-type scales. Although there is some criticism on the concept of work addiction, Griffiths et al[41] concluded that "work addiction fits very well into recently postulated criteria for conceptualization of a behavioural addiction"[41], and was seen to be "beyond the phase of proof of concept"[42]. Online sexual compulsivity was measured using the internet sex addiction scale (last 12 months) [43, 44] using six true/false statements, and gambling disorder (last 12 months) was measured using 9 yes/no items representing the DSM-5 criteria [45, 46].

Alcohol use disorder (last 12 months) was measured using 11 DSM-5 criteria [22, 45, 47] in a yes/no format. Cannabis use disorder (last 12 months) was measured using the revised version of the Cannabis Use Disorder Identification Test (10 items [48], based on [49]). Finally, tobacco dependence (last 12 months) was assessed using the Fagerström Test for Nicotine Dependence (6 items) [50].

In the main analysis, scale summary scores were used, except for measurements of family situation, parental divorce and bipolar disorder measures (dichotomous). Missing values on items were replaced by the mean of the other items in the respective scales. For participants with more than 20% of a scale's items missing, the scale score was recorded as missing.

2.3 Statistical analysis

To identify homogenous subgroups of participants with different patterns of family background, personality and mental health factors, LPA was conducted using Mplus 8 [51]. LPA models with two to eight profiles were fitted. Entropy, log-likelihood, Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) were compared across the solutions to determine the optimal number of profiles. Vuong-Lo-Mendell-Rubin likelihood ratio tests (LRT) and Lo-Mendell-Rubin adjusted LRT [52] were performed to estimate whether a model with k profiles fitted the data significantly better than a model with k - 1 profiles. The three binary variables (parental separation, family situation and bipolar disorder) were entered into the model as categorical variables. Social anxiety and borderline disorder symptoms were entered using a zero-inflated negative binomial distribution and the other variables as normally distributed continuous variables. For subjects with missing values all available information was used for profile classification [51]; model parameters did not change considerably when participants with missing data were excluded.

After identification of the optimal number of profiles, differences in means of the addiction scales across profiles were tested using the Bolck–Croon–Hagenaars (BCH) procedure [53, 54] in Mplus, taking measurement error of profile membership into account. Significance tests for prevalence rates of the addictions were done using the Lanza method for categorical data (DCAT)[55]. Profile plots across the variables used and addiction scale scores are provided, and z-standardisation (mean = 0; SD = 1) was used for the sake of comparability across scales.

3. Results

The Vuong-Lo-Mendell-Rubin LRT (p = .130 for seven versus eight profiles) and the Lo-Mendell-Rubin adjusted LRT (p = .132 for eight versus seven profiles) indicated a seven-profile solution (table

1). Table 2 shows the model results for the indicator variables in the LPA model. Figure 1 shows the z-standardised means of the indicator variables for each profile.

Overall, mental health declined on all the scales from profile 1 (labelled "privileged") to profile 7 (labelled "vulnerable"), the latter having high values indicating poor mental health on all scales, particularly major depression. For **personality traits**, two main patterns were identified as deviating from the average. The first pattern had high aggression/hostility, high neuroticism/anxiety and low sociability (profiles 5, 7 and moderately 4). The second pattern was the inverse: low aggression/hostility, low neuroticism/anxiety and high sociability (profile 1, and profile 2 to a lesser degree). Two profiles were distinguished by **family background:** a) high parental divorce rates and a family situation before the age of 18 with only one or no parent in the "parental separation" profile (2); b) a poor relationship with parents before the age of 18 and poor parenting at the age of 15 in the "family difficulties" profile (4).

Table 3 shows the means and prevalence rates of the addiction scales for each latent profile, as well as the average number of addictions and the percentage of participants with at least one addiction in the respective profiles. Figure 2 shows the z-standardised means of the addiction scales across profiles;

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significance tests for mean differences and prevalence rates between classes are shown in supplementary table 1. Table 4 presents a summary of profile characteristics and their association with the addiction scales. Addiction scale means generally increased across groups, being lowest in the "privileged" profile (1), and highest in the "vulnerable" profile (7). Similarly, 20.2% had at least one addiction in profile 1 versus 88.6% in profile 7. The difference between the extreme profiles (1 and 7) were all highly significant (p < 0.001), and often the differences were even significant between adjacent profiles (see supplementary table 1). Deviations from this general tendency of increasing addiction mean scales with increasing vulnerabilities were mainly found for profile 5 (high neuroticism) and 6 (depressive). The highly neurotic profile was particularly high on technology addiction but relatively low on cannabis and tobacco addiction, whereas the depressive profile was particularly high on gaming, work and tobacco addiction.

4. Discussion

The present work identified seven profiles of family background, personality and mental health factors, which were subsequently associated with increasing values on the addiction scales between profile 1 and profile 7. Profile 1 ("privileged") showed the lowest mean values on all the addiction scales, whereas profile 7 ("vulnerable") showed the highest mean values on all the addiction scales. Strikingly, this was true for all BAs (with the exception of exercise addiction) and all SUDs. This may indicate that the addictions studied share common vulnerabilities that may not be specific to SUD or BA, but rather to addiction in general. This is in line with the *addiction syndrome* concept [1], which implies that there are groups of people with a latent addiction syndrome caused by several etiological factors, leading to expressions of different forms of addictions. Further support for the addiction syndrome hypothesis comes from the fact that addictions tend to co-occur, especially in the more vulnerable profiles (4 to 7). This does, according to Shaffer et al. (p. 371) [1], "...suggest the presence of an underlying force responsible for addiction". Other concepts implying commonalities between

BAs and SUDs were also proposed by Griffiths [8] (the component model) and by Blum et al. [56], using the term Reward Deficiency Syndrome. The Reward Deficiency Syndrome, based on evidence of the importance of dopaminergic pathways in different addictions, may be a possible explanation for the link between BAs and SUDs [56].

With regards to personality, we found that a pattern of high values for the traits of neuroticism/anxiety and aggression/hostility (and high sensation-seeking values in profile 7), but low values for the trait of sociability was associated with above-average ratings on the addiction scales (profiles 7, 5 and, to a lesser degree 4). Such pattern had previously been found in a subsample of cocaine users, where it was also associated with psychiatric comorbidities [57]. Interestingly, the inverse personality pattern was found in the privileged profile, which was associated with lower than average ratings on the addiction scales. These findings provide further evidence that the well-known link between personality and SUDs [58, 59] may extend to BAs as well.

In addition to this general tendency, there were three specificities: First, the LPA showed that the "family difficulties" profile (4), with poor parental relationships before the age of 18 and poor parenting at age 15, was associated with intermediate values on the addiction scales. This was in line with other research showing that family relationships and functioning in adolescence are related to subsequent substance use in emerging adulthood [60]. In contrast, the "parental separation" profile (2), with its high parental divorce rates before the age of 18 but few familial difficulties, did not result in an increased risk of addictions, which has been reported in a previous C-SURF study for excessive alcohol consumption [61]. Research to date has found that parental separation may be a risk factor for substance use in adolescence [62], although the findings for emerging adulthood were somewhat mixed [60]. In young Swiss men, parental separation is not a risk factor for addictions unless combined with poor family functioning. This confirms work that parental divorce no longer predicted adolescent alcohol use if controlled for conflict between the parents and the adolescent. They concluded that conflicts between parents and adolescents, but not conflicts between parents, were predictive of adolescent substance use[63]. This may hold for BAs as well and extend to emerging adulthood.

Second, the "highly neurotic" profile (5), with its higher values for the traits of neuroticism/anxiety and aggression/hostility but low values for the trait of sociability combined with high social anxiety, was associated with particularly high values on the technological addiction scales (internet, gaming, smartphone, internet sex). This may point to a group of young men with problems with social interactions who more regularly seek relief or support in online activities and are more prone to addiction in online environments, as has been suggested by Caplan [64]. An association between problematic internet use and social anxiety has also been reported previously [16, 65, 66].

Third, the "depressive" profile (6) was remarkable in that it combined high values for major depression and slightly higher than average values on the perceived stress scale, whereas the other mental health factors were not particularly high and the personality traits were around average. This profile was associated with moderately increased mean values on the addiction scales, particularly work, gaming, and tobacco addiction.

4.1 Limitations

The main limitation is the restriction of the sample to men and to a restricted age range. Some addictions (e.g. internet related addictions, but also cannabis) tend to be reported more often in young age groups and men ([67, 68]; [69] for Switzerland), and scale means and prevalence rates of most addictions might be substantially lower in general population samples, which also include older people and women. Furthermore, out of the seven behavioural addictions under investigation, only gambling is currently recognized as an addiction in DSM-5 [45], with the status of the others still being subjects to some debate [5, 7, 41].

Also, clearly more research is needed on the psychometric properties of the scales and appropriate cut-offs for estimating prevalence rates. Many of the included addiction scales are currently lacking cut-offs that were properly validated against a clinical gold standard. Furthermore, the present analysis was cross-sectional and therefore it was impossible to determine the causal direction of effects, e.g. whether poor mental health increased the risk of addictions or whether it was a consequence of an

addiction. Poor mental health and addictions may also be both influenced by a third variable. Clearly, family background, personality and mental health variables are not specifically associated with addiction only. They may also influence each other and do not necessarily precede addiction.

4.2 Conclusions

SUDs and BAs are not isolated problems and purely a function of exposure to psychoactive substances or opportunities to engage in reinforcing behaviours. Instead, they are indeed deeply rooted in the individual's personal history, personality and vulnerability to mental health problems. This is independent of whether all of the discussed behaviours can be considered as "addictions" given the current state of research or just indicate problematic behaviours. It also seems likely that the different BAs and SUDs under investigation do share at least some common vulnerabilities. Furthermore, it is likely that at least some of the young men with mental health problems in our sample engaged in substance use or other reinforcing behaviours in order to cope with mental health problems. This also highlights the importance of treatment approaches which consider comorbid conditions and the persons general vulnerabilities, instead of focusing exclusively on a specific addictive disorder, which may leave underlying vulnerabilities unattended and thus prove unable to prevent relapse or a shift to another addiction. Examples of such treatment approaches, recently discussed in the context of addictive disorders, are integrated treatment [70, 71] and holistic treatment approaches [72].

Acknowledgments:

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Table 1. Model statistics for two-profile to eight-profile solutions used for deciding on the number of profiles

	Number of latent profiles						
	2	3	4	5	6	**7**	8
Free Parameters	44	61	78	95	112	**129**	146
Log-likelihood H0 Value	-148,477	-147,229	-146,529	-145,928	-145,325	**-144,961**	-144,723
Akaike Information Criteria (AIC)	297,043	294,581	293,214	292,046	290,874	**290,180**	289,738
Bayesian Information Criteria (BIC)	297,332	294,982	293,726	292,671	291,610	**291,028**	290,698
Adjusted BIC	297,192	294,788	293,479	292,369	291,254	**290,618**	290,234
Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LRT) p-value	<.001	.017	<.001	.033	.001	**<.001**	.130
Lo-Mendell-Rubin Adjusted LRT p-value	<.001	.017	<.001	.035	.001	**<.001**	.132
Entropy	0.881	0.826	0.833	0.797	0.825	**0.820**	0.815

Table 2. Means for continuous variables and percentages for binary indicator variables, by profile

	Profile							Total	
	1. Privileged	2. Parental separation	3. Normative	4. Family difficulties	5. High neuroticism	6. Depres-sive	7. Vulner-able	Mean / %	SD
n	1555 (29.4%)	531 (10.0%)	1801 (34.1%)	341 (6.4%)	602 (11.4%)	249 (4.7%)	208 (3.9%)		
Family background									
Family situation (% not both parents)	1.6%	84.8%	2.0%	43.5%	12.0%	16.5%	24.7%	15.6%	
Parental divorce (%)	8.2%	98.6%	9.9%	59.4%	21.9%	25.6%	31.5%	24.4%	
Relationship with parents (0–4)	3.52	2.96	3.38	1.91	3.18	3.12	2.58	3.22	0.82
Parenting (0–24)	19.78	18.46	19.19	13.20	18.86	17.98	16.70	18.72	4.05
Summary family background	best situation	separated parents	average	bad relationship with parents, poor parenting	average	average	below average		
Personality									
Neuroticism/anxiety (0–10)	0.77	1.22	1.87	2.69	5.75	2.32	6.95	2.20	2.17
Aggression/hostility (0–10)	3.04	3.46	3.90	4.60	4.61	3.98	5.13	3.78	2.15
Sociability (0–10)	5.73	5.24	4.81	4.05	4.00	5.01	3.44	4.94	2.24
Sensation seeking (0–32)	14.96	15.78	16.29	17.44	16.44	15.47	17.41	15.95	6.48
Summary personality	low N and A, high S	N below average	average	Moderately-high N and A, low S	high N and A, low S	average	high N and A, low S		
Mental health									
Bipolar disorder (%)	0.0%	0.9%	0.9%	7.9%	6.1%	5.1%	18.8%	2.6%	
ADHD (0–24)	4.54	5.74	7.22	8.78	9.58	7.45	12.22	6.86	4.21
Social anxiety (0–48)	1.21	3.31	8.43	8.83	16.11	10.40	20.57	7.55	8.26
Perceived stress (0–40)	9.09	10.81	13.42	15.52	18.74	18.41	24.43	13.29	5.96
Borderline (0–10)	0.13	0.61	1.38	3.19	3.85	2.45	6.12	1.72	2.18
Major depression (0–50)	3.92	5.85	7.31	10.97	12.02	24.30	30.04	8.64	7.40
Summary mental health	Best	below average	average	somewhat above average	high on stress, social anxiety, borderline	high on depression	poor mental health		

Note: N = Neuroticism/anxiety, A = Aggression/hostility, S = Sociability

ADHD = attention-deficit hyperactivity disorder. Values in brackets are the theoretical minimum and maximum of the scales.

Table 3. Means, standard error and prevalence (in %) for behavioural addiction and substance use disorder scales, by profile

	1. Privileged	2. Parental separation	3. Normative	4. Family difficulties	5. High neuroticism	6. Depressive	7. Vulnerable	Total
				Profile				
n / (%)	1555 (29.4%)	531 (10.0%)	1801 34.1%)	341 (6.4%)	602 (11.4%)	249 (4.7%)	208 (3.9%)	5287
Internet (0–56)								
mean	4.22	6.84	10.18	12.63	14.51	11.83	18.97	9.17
S.E.	0.17	0.35	0.24	0.68	0.48	0.81	0.92	0.12
%	0.0%	0.0%	3.9%	8.0%	12.0%	11.7%	25.1%	4.7%
Gaming (0-28)								
mean	1.61	2.96	3.35	4.58	4.8	4.95	7.37	3.28
S.E.	0.08	0.18	0.11	0.34	0.24	0.42	0.52	0.06
%	1.2%	4.2%	5.5%	13.3%	13.0%	17.4%	27.4%	6.9%
Smartphone (0-50)								
mean	4.56	6.79	9.14	9.6	12.12	8.75	12.7	8.05
S.E.	0.17	0.37	0.22	0.58	0.43	0.63	0.77	0.11
%	0.9%	5.1%	9.0%	11.2%	18.7%	8.8%	25.4%	8.1%
Internet sex (0-6)								
mean	0.29	0.4	0.62	0.91	1.05	0.79	1.2	0.6
S.E.	0.02	0.05	0.03	0.09	0.06	0.09	0.1	0.01
%	2.1%	3.9%	6.4%	14.1%	14.8%	10.5%	19.4%	7.0%
Gambling (0-9)								
mean	0.03	0.09	0.11	0.21	0.27	0.32	0.49	0.13
S.E.	0.01	0.03	0.02	0.06	0.05	0.08	0.09	0.01
%	0.2%	1.0%	0.7%	1.9%	3.7%	3.8%	6.3%	1.4%
Work (0-28)								
mean	6.39	7.39	9.05	9.86	10.89	11.82	12.49	8.63
S.E.	0.12	0.23	0.13	0.34	0.24	0.39	0.42	0.07
%	2.1%	4.3%	7.4%	7.8%	15.7%	21.1%	29.2%	8.0%
Exercise (0-24)								
mean	5.99	6.01	6.79	5.87	6.27	6.12	5.12	6.26
S.E.	0.16	0.29	0.17	0.44	0.29	0.45	0.5	0.08
%	1.7%	2.3%	3.4%	1.6%	4.2%	2.8%	5.9%	2.8%
Alcohol (0-11)								
mean	0.79	0.88	1.27	1.62	1.83	1.53	2.44	1.24
S.E.	0.03	0.07	0.04	0.13	0.1	0.15	0.21	0.02
%	2.2%	4.3%	8.6%	12.8%	18.5%	15.6%	27.7%	8.8%
Cannabis (0-40)								
mean	0.68	1.6	1.67	3.03	2.48	2.96	4.94	1.74
S.E.	0.07	0.21	0.12	0.43	0.27	0.47	0.63	0.06
%	1.7%	6.9%	8.0%	13.8%	12.7%	14.1%	21.4%	7.8%
Tobacco (0-10)								
mean	0.57	1.04	0.8	1.2	1.02	1.55	1.77	0.88
S.E.	0.04	0.09	0.05	0.13	0.09	0.14	0.18	0.02
%	10.8%	20.0%	15.1%	23.7%	17.8%	28.8%	31.5%	16.5%
Multiple addictions								
mean	0.23	0.52	0.68	1.08	1.31	1.35	2.19	0.7
S.E.	0.02	0.04	0.03	0.08	0.06	0.09	0.11	0.01
At least one addiction								
%	20.4%	40.1%	48.3%	61.0%	68.3%	67.8%	88.6%	44.9%

Note. For significance tests for differences of means and prevalence rates, see supplementary table 1. Cut-offs used for the prevalence percentage were as suggested by the literature: internet, 28; gaming, 4 items at least "sometimes"; smartphone, 21 (or 31 if items are coded from 1 to 6); gambling, 4 (DSM-5 mild); internet sex, 3 (corresponds to "risky" for the full scale [44]); exercise, 18 (or 24 if items are coded from 1 to 5); work, 4 items at least "sometimes"; alcohol, 4 (DSM-5 moderate); cannabis, 8; tobacco, 3. Values in brackets are the theoretical scale minimums and maximums.

Table 4. Summary of profile characteristics and mean values on the substance use disorders and behavioural addictions

| Profile description	Substance use disorders and behavioural addictions
Privileged (1) Generally favourable familial background (low rates of parental separation, good relation to parents and good parenting), low neuroticism/anxiety and aggression and high sociability personality traits as well as better than average mental health.	Lowest values on all scales.
Parental separation (2) High parental separation rates and high rates of a familial situation with no or only one parent before the age of 18, relationship with parents before the age of 18 and parenting at the age of 15 close to average, with values for personality and mental health being close to profile 1.	Higher values than profile 1, but still below profile 3 on all scales except tobacco addiction.
Normative (3) Overall around the sample average on all scales.	Around the sample average on all addiction scales.
Family difficulties (4) Bad relationships with parents before the age of 18 and low parenting at age 15 combined with moderate rates of parental separation before the age of 18. Aggression personality trait was somewhat above average, while sociability was rather low. Mental health was somewhat below average.	Values on addiction scales somewhat above profile 3.
High neuroticism (5) High values on the neuroticism/anxiety personality trait, with somewhat higher values on the aggression and lower values on the sociability traits. Mental health was somewhat worse than average.	High values on most addiction scales, particularly on technological addiction scales, but not for cannabis and tobacco addiction, which were only little above profile 3.
Depressive (6) High values on the depression scales and somewhat increased values on the stress scale, while the other variables were close to average.	Intermediary high values on addiction scales, except for smartphone addiction. Values for gaming, work and tobacco addiction were especially high.
Vulnerable (7) Worst mental health, highest neuroticism and aggression along with lowest values on sociability personality traits, and below average values for relationship with parents and parenting.	Highest values on all addiction scales, especially for internet and gaming addiction.
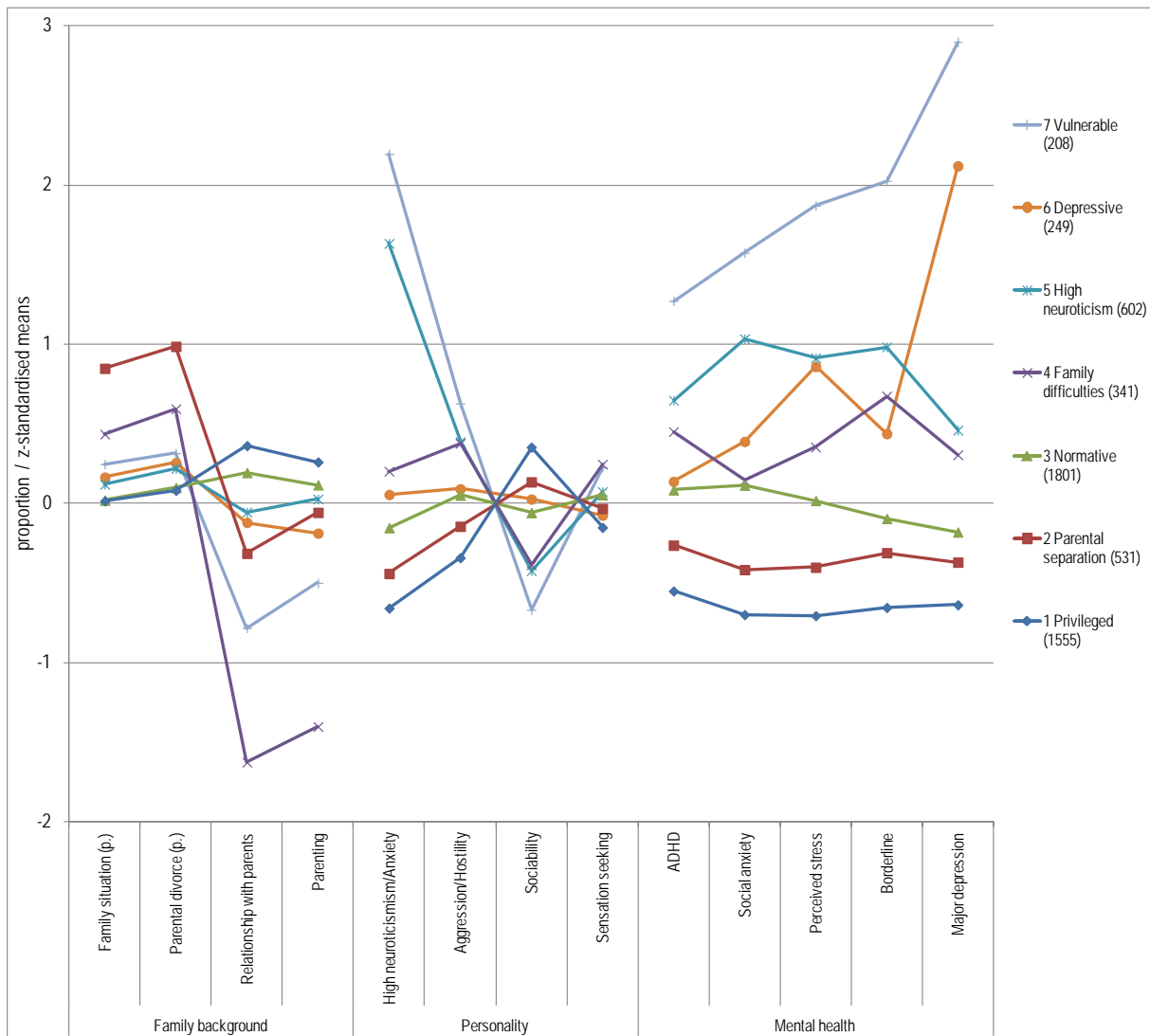
Figure 1: Graphical summary of profiles.

Note: The figure's scale means were z-standardised (mean = 0, SD = 1) for better readability. Binary variables (family situation and parental divorce) are shown as a proportion (p.). Bipolar disorder was included in the latent class model, but is not shown in the graphical summary, because a dichotomous measure would have distorted the figure (for values see table 2). ADHD = attention-deficit hyperactivity disorder.
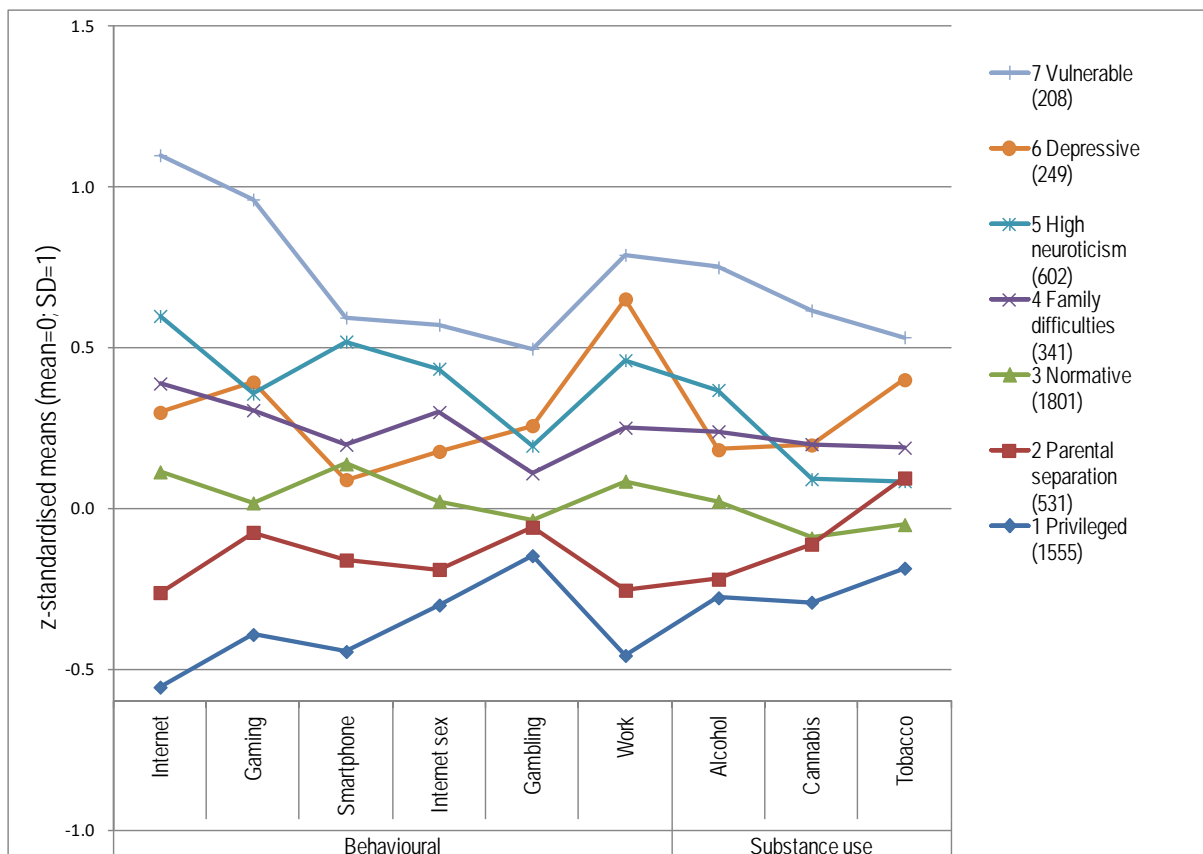
Figure 2. Z-standardised means of behavioural and substance use disorder scales across profiles

Note: z-standardised (mean = 0; SD = 1) values from Table 3; exercise addiction did not differ considerably across profiles (see Table 3; supplementary table 1 for significance tests) and was not included in the figure because it would distort the figure.