Cloninger's Temperament Dimensions and Longitudinal Alcohol Use in Mid-life:
a Northern Finland Birth Cohort 1966 study

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Abstract

Background: Temperament is theorized to be an important factor contributing to the development of alcohol use disorder, but longitudinal studies on how temperament is related to alcohol use among general population in mid-life are scarce. Our aims were to investigate potentially reciprocal associations between temperament and changes in alcohol use from age 31 to 46 using prospective birth cohort data.

Method: Within the Northern Finland Birth Cohort 1966 alcohol use and temperament were studied at ages 31 and 46. Participants (N=5274) were classified into moderate drinkers, abstainers and heavy drinkers based on their consumption. Additionally, the drinkers were categorized as steady drinkers, reducers or increasers. Multinomial regression analyses were conducted with Cloninger's Temperament and Character Inventory (TCI) scores as factors influencing alcohol consumption using moderate and stable users as reference groups. Reciprocity of relations was assessed with cross-lagged structural equation modeling.

Results: Temperament and alcohol use are rather stable in mid-life. Novelty Seeking (NS) predicted heavy use (OR=1.4; CI:1.3-1.6 for men, OR=1.3; CI:1.1-1.5 for women) and increasing consumption (OR=1.2; CI:1.1-1.4 for men, OR=1.1; CI:1.0-1.3 for women), whereas low NS predicted abstaining among women (OR=0.7; CI:0.6-0.8). High Harm Avoidance (HA) predicted abstaining (OR=1.3; CI:1.1-1.5) for men. Low Persistence (P) among men predicted both abstaining (OR=0.9; CI:0.7-1.0) and heavy use (OR=0.9; CI:0.8-1.0). Among women, low Reward Dependence (RD) predicted reducing consumption (OR=0.8; CI:0.7-1.0) and heavy use (OR=0.8; CI:0.7-0.9). Among TCI scores only NS predicted increasing use in the cross-lagged models.

Conclusions: Temperament has a small, but important effect on alcohol consumption in mid-life. Of the TCI-dimensions, only Novelty Seeking seems to predispose to increased alcohol

consumption and problem use throughout life. Additionally, Reward Dependence among women and Persistence among men are significant factors from a life-course perspective. Cloninger's theory on alcoholism does not directly reflect to alcohol use among general population, as Harm Avoidance showed no relation to problematic alcohol use in mid-life.

Keywords: alcohol use; heavy use; temperament; birth cohort; longitudinal

Cloninger's Temperament Dimensions and Longitudinal Alcohol Use in Early Mid-life

The progression towards heavy alcohol use or dependence is a complex process composed of genetic, psychological and environmental risk factors (Milivojevic et al., 2012). Thus, the search for personality traits or temperament predisposing people to heavy alcohol use has been pursued throughout the 20th century. Although the research has not been able to identify distinguishable 'alcoholic personality', nor are there any temperament dimensions specific for heavy alcohol use, an abundance of evidence suggests that persons with alcohol use disorders (AUDs) differ in several personality traits from normal population (Mulder, 2002).

Temperament is an individual's set of automatic emotional responses to experiences (Cloninger & Svrakic, 1994). It is moderately stable throughout life (Josefsson et al., 2013), and the most hereditary component of personality (Gillespie, Cloninger, Heath, & Martin, 2003). One of the instruments to assess temperament is the Temperament and Character Inventory (TCI), a battery of queries developed by Robert Cloninger to evaluate its independent four main dimensions: Novelty Seeking (NS) is a tendency to respond with excitement to novel stimuli, which can manifest itself in impulsive decision making, extravagance, rapid loss of temper and active avoidance of frustration; Harm Avoidance (HA) is a tendency to respond to signals of aversive stimuli, thus inhibiting behaviour; Reward Dependence (RD) is a tendency to respond to signals of reward, thus maintaining behaviour particularly in a social context; and Persistence (P) is a tendency to persevere despite frustration. Temperament is also a key concept in Cloninger's typology of alcoholism, as late onset type I alcoholics are characterized by high HA and early onset type II alcoholics by high NS (Cloninger, 1987).

Previous studies have identified relationships between alcohol use and the TCI

temperament dimensions. In cross-sectional studies, high Novelty Seeking (NS) has been found to be associated with higher level of alcohol use (Chakroun, Johnson, & Swendsen, 2010; Sovio et al., 2007), binge drinking (Galen, Henderson, & Whitman, 1997), alcohol-related problems (Galen et al., 1997) and alcohol use disorder (Basiaux et al., 2001; Galen et al., 1997; Le Bon et al., 2004; Miettunen & Raevuori, 2012; Milivojevic et al., 2012). In congruence with Cloninger's theory concerning type I alcoholics, high HA has also been observed among adult alcohol-dependent patients (Le Bon et al., 2004; Milivojevic et al., 2012), and among adolescents with increased alcohol consumption (Chakroun et al., 2010). In turn, also lower level of alcohol use has been reported to be associated with high HA (Sovio et al., 2007). In longitudinal studies of alcohol-dependent patients, high NS and high HA have been identified as predictors for relapse (Müller, Weijers, Böning, & Wiesbeck, 2008), and heavier consumption during relapse phase (Foulds et al., 2016). Longitudinal studies among adolescents have found high NS and low P to be associated with earlier initiation of alcohol use (Hartman, Hopfer, Corley, Hewitt, & Stallings, 2013) and high NS with increased binge drinking in young adulthood (Wellman, Contreras, Dugas, O'Loughlin, & O'Loughlin, 2014).

As stated above, previous research has indicated a relationship between certain temperament characteristics and excessive alcohol use. However, the reciprocity between temperament and alcohol use from a life-course perspective still remains unclear. Heavy alcohol use is known to damage the developing nervous system (Spear, 2018), and in such way may also have an effect on personality. Indeed, early age alcohol use has been shown to increase negative personality traits among adolescents (Blonigen et al., 2015; White et al., 2011) and young adults (Zernicke, Cantrell, Finn, & Lucas, 2010). Also, some studies have identified reciprocal

associations with substance use and several personality traits among adolescents (Malmberg et al., 2013) and young adults (Hicks, Durbin, Blonigen, Iacono, & McGue, 2012).

General population -based longitudinal studies on how temperament is associated with heavy alcohol use in adulthood are scarce (Caspi et al., 1997; Wennberg & Bohman, 2002). To our knowledge, there are no previous longitudinal studies extending to mid-life, which have included prospectively collected information on temperament and alcohol use. To date, most information on adult alcohol use and temperament is derived from adolescent or small clinical samples, thus making it difficult to assess temperament profiles as risk factors for heavy alcohol use in mid-life. By utilizing a large prospective general population-based data from the Northern Finland Birth Cohort Study 1966 (NFBC 1966), the aim of this study was to investigate how temperament dimensions obtained using TCI scores are associated with alcohol consumption levels at age 31 and 46 years. Secondly, the aim was to study the association between temperament and changes in alcohol use longitudinally in mid-life, with a special reference on potential reciprocity of this association. Cloninger's typology of alcoholism suggests that people with high NS or HA are at greater risk of developing alcohol abuse, and thus we hypothesized that NS and HA are also linked to instability in alcohol use at a general population level. As type I alcoholism, characterized by high HA, typically has later onset in life, we expected HA to stand out among the increasers who had previously used low amounts.

Method

Study subjects

The study population was composed of the prospective Northern Finland Birth Cohort 1966 (NFBC 1966) study. The series consisted of 12,058 unselected children born alive in the two

northernmost provinces of Finland in 1966 (Rantakallio, 1988). Data for this study was obtained from the 31- and 46-year follow-up studies. Postal questionnaires were sent to all participants with known address living in Finland, and all participants were invited to a clinical study in 1997 and 2012. The numbers of attendants that provided sufficient information during the clinical examinations were 1,603 males and 2,178 females during the 31-year follow-up study and 1,916 males and 2,715 females during the 46-year follow-up study. We only used data from subjects who had replied to alcohol questions in both postal questionnaires and attended clinical study at least once during which temperament scores were obtained, and thus the final number of participants in this study was 5,274, of which 2,252 (42.7%) were men and 3,022 (57.3%) were women. All participants provided a written consent and the research plan for the follow-up studies was approved by the Ethical Committee of the University of Oulu, Faculty of Medicine.

Alcohol measures

The data on alcohol use of study members was obtained from the NFBC postal questionnaires. Frequency of use was measured on a 10-point scale (1 being never and 10 being daily). Quantities consumed on a typical occasion were asked separately for all three beverage types: mild drinks in number of 0.33 l bottles; wine in number of glasses (=16 cl) or 0.75 l bottles; and spirits in number of 4 cl shots or 0.5 l bottles. The mild drink quantity was measured on a 9-point scale (1 being none and 9 being 15 bottles or more), and for wines and spirits the typical quantity was measured similarly. We assumed one bottle of mild drink to contain one standard unit of alcohol (=12 g of ethanol), wine to contain 13% alcohol and spirits to contain 38% alcohol. From the questionnaire answers, daily consumption of ethanol was calculated by multiplying typical frequency of use by quantity, and participants were classified into classes describing their alcohol use at age 46.

Heavy usage (384 male and 246 female) was defined as average total daily consumption exceeding 30 grams of alcohol for men and 20 grams for women (Foster & Marriott, 2006). Abstainers (196 male and 313 female) were defined as having daily consumption of zero. All the rest of the study participants were classified as moderate drinkers. We also calculated the change in mean consumption from age 31 to 46 years, and based on the within-person change in daily amounts we categorized the participants into stable (change from -0.49 to 0.49 standard deviations, SD), increased (≥ 0.5 SD) or reduced (≤ -0.5 SD) consumers (Syden, Wennberg, Forsell, & Romelsjo, 2014). The standard deviations in the change of mean consumption were 24g/day for men and 12g/day for women, so a change exceeding ± 12 g/day and ± 6 g/day resulted in classifying the participants as either “increased” or “reduced”, respectively, leaving the rest to the class of “stable”.

Temperament measures

Temperament was assessed with Cloninger’s TCI from participants who attended clinical examinations at the 31-years follow-up and from all participants using the postal questionnaires at the 46-year follow-up. The character items of the TCI were not used in the survey and we only accepted measurements with no more than seven missing answers. The used questionnaire (version IX) contained 108 true or false questions, each of which evaluates one of the four main temperament dimensions (40 NS, 36 HA, 24 RD and 8 P). For Table 2 we used either a single TCI score (if only one measurement was attended) or an average of two measurements (if both were attended), and for regression analyses the values were standardized using z-scores.

Socio-demographic measures

In our previous publication, we examined the general trends in alcohol use among northern Finns entering mid-life and we tested the “maturation hypothesis” taking sociodemographic status

into account (Vladimirov et al., 2015). We found lower employment, low education and being single to be linked to problematic alcohol use. In this study, we wanted to further examine these associations by including the sociodemographic measurements along with TCI-scores in the regression analyses. Based on the answers obtained from the postal questionnaires of the 46-year follow-up study, the participants were categorized into dichotomous sociodemographic classes. The unemployed, students and retired were classified as “not employed”, and self-employed, part-time employed and full-time employed as “employed”. “Low educated” was defined as having vocational education at best and “high educated” as having at least a polytechnic education. Singles, divorced and widowed were classified as “single” and cohabiters and married were classified as “cohabiting”.

Statistical analyses

The mean TCI scores with standard deviations were calculated for all alcohol user subgroups separately, and in order to examine statistical differences between classes we conducted Student’s t-test for independent samples. Effect size in mean differences is presented using Cohen’s d. Cohen (Cohen, 1992) described d values up to 0.2 as being small, 0.5 as medium, and 0.8 as large effect (a negative sign indicates a smaller figure in the comparison). In order to examine the predictive properties of TCI scores on the stability and nature of alcohol use we transformed temperament traits to z-scores and conducted multinomial regression analyses from a generalized logits approach by calculating crude and adjusted odds ratios (ORs) with 95% confidence intervals (CI). We used moderate drinkers as reference group when predicting the nature of alcohol use at age 46. When predicting the longitudinal change in mean consumption stable drinkers were used as reference. ORs are interpreted as one standard deviation increases. Baseline education, employment, marital status and alcohol use were included as covariates in the

analyses. Reciprocal associations between temperament and alcohol use were estimated with cross-lagged structural equation models in MPlus 7.11 (Muthén & Muthén, 2015). All analyses were conducted by gender.

Attrition analysis

We also investigated the association between baseline TCI scores and study attrition using Student's t-test for unpaired samples. The number of participants who attended clinical examinations and adequately completed the TCI questionnaire at the 31-year study, but dropped out later, was 554 for men and 501 for women. Surprisingly, Novelty Seeking did not differ between participants and dropouts. Harm Avoidance differed significantly ($p=0.04$) between male participants ($HA=12.6$) and dropouts ($HA=13.2$). Reward Dependence scores also did not differ for either gender, and Persistence scores differed significantly ($p=0.049$) only between male participants ($P=4.53$) and dropouts ($P=4.36$). Baseline attrition has been described earlier, e.g. male gender, lower education and hospitalization due to psychiatric and substance use disorder have been related to non-participation in the whole cohort (Haapea et al., 2008). In order to take attrition into account we used inverse probability weights in our regression analyses (Haapea et al., 2011). The weights were based on a binary logistic regression model on non-participation at follow-up that included the factors predicting drop-out mentioned above.

Results

Table 1 shows the mean consumptions across all alcohol user groups and their sociodemographic distributions at age 46 years. The percentage of male heavy drinkers (17.1%) was more than twice that of women (8.1%) and abstaining among women (10.4%) was more prevalent than among men (8.1%). Among heavy users, higher consumptions are generally

observed among lower sociodemographic statuses within both genders. Among moderate drinkers, higher sociodemographic status is associated with higher consumption, although the difference in amounts between classes is virtually non-existent. Abstinence is also more strongly associated with lower sociodemographic groups compared to moderate drinkers among both sexes. When comparing the mean total alcohol consumption among low and high median split TCI groups, the only TCI dimension with a statistically significant difference in mean consumption at both time points was Novelty Seeking ($p < 0.05$). Furthermore, an increase in consumption from age 31 to 46 was observable across all TCI dimensions.

Table 2 shows mean TCI scores across all alcohol user groups at age 46. Abstainers had lower NS scores than moderate drinkers and among women this difference was statistically significant. Heavy users among both genders had significantly higher NS scores compared to moderate drinkers. Abstainers among both genders had significantly higher HA scores compared to moderate drinkers. Among women both abstainers and heavy users had significantly lower RD than moderate drinkers, whereas among men both abstainers and heavy users had significantly lower P than moderate drinkers. Effect sizes associated with these statistically significant differences ranged from 0.11 to 0.34.

Table 3 shows the results from weighted multinomial regression analysis using standardized TCI scores in predicting the nature of alcohol use at age 46. The adjusted model included sociodemographic status (marital status, employment and education) as a covariate. High NS predicted heavy use among men (OR=1.42; 95% CI: 1.27-1.59) and also among women in (OR=1.30; 95% CI: 1.13-1.49). Furthermore, low NS predicted abstaining among women (OR=0.72; 95% CI: 0.63-0.81). High HA predicted abstaining only for men (OR=1.27; 95% CI: 1.09-1.48). Among women, low RD predicted heavy use (OR=0.81; 95% CI: 0.71-0.92). Among

men, low P predicted both abstaining (OR=0.85; 95% CI: 0.73-0.98) and heavy use (OR=0.88; 95% CI: 0.79-0.98).

Table 4 shows the number and percentages of stable, reduced and increased groups and the results from weighted multinomial regression analysis linking standardized TCI scores with longitudinal change in mean alcohol consumption. The adjusted model included baseline alcohol use as a covariate. Over 70% of participants were classified as stable drinkers. The percentage of increasers was more than double that of reducers. High NS served as a predictor for reducing for both men and women in the crude model, but when adjusted with baseline alcohol use this effect vanished. High NS also served as a predictor for increasing both men (OR=1.23; 95% CI: 1.10-1.37) and women (OR=1.14; 95% CI: 1.03-1.26). For women, low RD served as a predictor for reducing (OR=0.84; 95% CI: 0.71-0.99).

Figure 1 shows the cross-lagged structural equation models on reciprocal relations of temperament and longitudinal alcohol use. Model fits were perfect, as we estimated fully saturated models. Both alcohol use and temperament showed high degree of stability during the study. Baseline Novelty Seeking modestly predicted higher alcohol consumption at 46 years among both sexes, but baseline alcohol consumption did not predict changes in Novelty Seeking at 46 years. Autoregressive associations between NS and alcohol use were stronger at age 31 than 46. Among men, baseline alcohol predicted slight decrease in Persistence at age 46. Among women, baseline alcohol use predicted slight increase in Harm Avoidance and decrease in Reward Dependence and Persistence.

Discussion

The aim of the present study was to examine the longitudinal associations and reciprocity between Cloninger's temperament dimensions (TCI) and alcohol consumption in mid-life utilizing

prospectively collected large data set from the Northern Finland Birth Cohort Study 1966 (NFBC 1966). As hypothesized, high Novelty Seeking (NS) associated with higher levels of alcohol use at age 31 and 46 years, and also predicted increasing alcohol consumption in mid-life among both genders. NS also predicted reducing consumption in the crude model, but when adjusting with baseline alcohol use the effect vanished. The negating effect here is reasonable, as higher baseline consumption was correlated with NS and high baseline alcohol use was in itself a predictor for reducing consumption. Alcohol use at age 31 years, in turn, did not influence Novelty Seeking scores at age 46, indicating that mid-life temperament is well-established and not susceptible to alcohol-induced changes. Against our hypothesis, Harm Avoidance (HA) had no association with increasing alcohol consumption or problem use in mid-life, it only predicted abstaining from alcohol among men.

Our results are mostly in line with those of previous research on temperament and alcohol consumption. Several studies have reported an association between high alcohol consumption and NS among adolescents and problem users (Basiaux et al., 2001; Le Bon et al., 2004; Milivojevic et al., 2012), and our results also confirm this finding among general population in mid-life. In the literature, NS has typically been discussed in conjunction with problem use at younger age, even among studies focusing on problem use at older age. This is probably due to Cloninger's theory of alcoholism suggesting that high NS leads to problematic alcohol use earlier on in life (Cloninger, 1987). From a maturational viewpoint, alcohol use is also generally believed to peak in early adulthood followed by maturing out (Johnstone, Leino, Ager, Ferrer, & Fillmore, 1996) and qualities associated with high NS, typically described as exploratory, impulsive and disorderly, are often viewed as being associated with the immaturity of adolescence or young adulthood. Schukit et al., when studying 373 men originally in their twenties over a 25-year period, reported that NS

predicted AUDs with an onset age before age 30, but not later (Schuckit & Smith, 2011). However, our results show that NS also stands out at a later age, even after adjusting with previous alcohol consumption, suggesting that NS is also significant later on. NS has previously also been identified to predict study dropout (Kravitz, Fawcett, McGuire, Kravitz, & Whitney, 1999) and attrition also tends to increase with longer follow-up times (Haapea et al., 2007). However, in our data NS did not predict drop-out. Thus, one possible explaining factor for why NS has not been identified as a predictor for late onset problematic alcohol use in other studies is that persons with high NS have already dropped out before the age of 30 years, thus not contributing to a stronger effect in the regression models, and in our analyses these persons were still included. The Nordic Countries have previously been associated with higher participation in population-based studies (Lundberg, Damström Thakker, Hällström, & Forsell, 2005), which probably partially explains why high NS did not predict dropping out with our subjects. In all, from our perspective NS cannot be viewed as a quality mainly associating with the alcohol use of immature youth. This conclusion is in line with our previous results that question the ‘maturation hypothesis’ of alcohol use over the complete life course.

Apart from Novelty Seeking, other TCI dimensions were not associated with increased alcohol use in mid-life, and somewhat surprisingly Harm Avoidance showed no associations with problematic alcohol consumption. Higher HA scores were observed among abstainers and HA also served as a predictor for abstaining in the regression model for men, but HA was not associated with increased consumption or problem use at any point. In a previous study of the temperament and lifestyle factors in the NFBC 1966 at the 31-year follow-up, Sovio et al. also reported a strong association between NS and alcohol consumption (Sovio et al., 2007). They also reported a negative correlation between HA and alcohol use among both genders, while our data from the 46-

year follow-up did not yield significant results between any groups. However, our analyses treated abstainers as a separate group from moderate users, thus possibly explaining why no significant differences were observed when comparing HA scores of moderate and heavy drinkers among either gender. The only alcohol user groups with a marked difference in HA scores at the follow-up were male abstainers and heavy drinkers. Although the difference was statistically significant, the calculated effect size was weak, as the score difference of 1.4 corresponded to on average only 1.5 yes answers out of 36 HA questions. Low Persistence served as a predictor for heavy use among men, but it was not associated with increased consumption at either time point. Low P also served as a predictor for abstaining among men, but when we adjusted the regression analysis with baseline heavy alcohol use the effect vanished. When comparing lifelong abstainers to those who were heavy users at 31 years, the latter group had significantly lower P scores on average (3.8 to 4.2). In our previous publication (Vladimirov et al., 2015) we reported increased use as predicting reducing and abstaining, and thus we conclude here that low P predicting abstaining is explained via its effect on heavy use.

In the original TPQ (older version of TCI) study, Cloninger et al. reported men to have higher NS and lower HA compared to women (Cloninger, Przybeck, & Svrakic, 1991). In our data, however, women scored higher scores on all scales except Persistence. In a large meta-analysis of sex differences in temperament dimensions, Miettunen *et al.* reported that women's lower NS was true in only half of the included studies and the difference in NS was not affected by location or age of the sample (Miettunen, Veijola, Lauronen, Kantojärvi, & Joukamaa, 2007). As NS has been implicated to be a predisposing trait to substance use, it is somewhat surprising that among women the difference in mean consumption at 46y between low and high NS median groups is not greater. Even after the substantial increase among women in mean consumption observed during

the study, the difference in g/day between the NS median groups at age 46 was only 36%, whereas among men it was 55%. Furthermore, when compared to men, standardized NS was among women a weaker predictor for future consumption in the regression models. Similar gender-related differences have been reported previously, as a few clinical treatment studies have identified NS as a predictor for relapse only among men (Meszaros et al., 1999; Willinger et al., 2002), although not all relapse studies have identified temperament dimensions to exhibit these properties (Arnau, Mondon, & Santacreu, 2008; Evren et al., 2013). Interestingly, instead of low Persistence, low Reward Dependence served as a predictor for abstaining, reducing and heavy consumption among women. Low RD has been previously described as a trait of practical, independent and withdrawn people, and we speculate that particularly among women alcohol consumption is greatly influenced by the surrounding social environment. In our previous publication we reported increasing alcohol consumption as a general trend among the Finnish population in mid-life (Vladimirov et al., 2015), and thus low RD could explain the tendency to change consumption in the opposite direction, as abstaining and heavy use can both be seen as deviating from the norm, and thus be associated with low RD. With these findings in mind, the relationship between women's alcohol consumption and TCI dimensions might be fundamentally different to men's.

Our study's limitations should be noted. No single set of scales captures all aspects of personality, and our results are limited to Cloninger's Temperament Scales, however widely used and interpretable. Further studies using other measures of character and personality exist remain needed. Also, during the data recording process, we noticed in some cases that the forms contained more missing answers towards the end, which led to disqualification if the requirements were not met. This might be due to the fact that the questionnaires were rather long and contained several difficult questions. As our data did not show any significant differences between alcohol user

groups, whereas previous research has identified low P as a risk factor for alcohol-related problems among alcohol abusers (Arnau et al., 2008), a potential selection bias towards the more persistent repliers must be recognized. Furthermore, people selected for clinical examinations were required to attend the clinical appointment in order to receive the TCI forms, further potentially favoring the more persistent. This study has several identifiable strengths. Firstly, the longitudinal design of NFBC 1966 with its identical measurements is well suited for studying predictors. Secondly, large longitudinal general population-based data containing information on temperament and alcohol use are scarce worldwide. Thirdly, the participants were from the same geographic area and of the same age, thus reducing the risk of uncontrolled confounders.

In conclusion, this large general population-based study examined the relationship between temperament dimensions and longitudinal alcohol use in mid-life. To our knowledge this is the first study to examine longitudinal relationships of temperament and later alcohol use in a large general population-based prospective setting in mid-life. Based on our results, the most significant TCI score that was associated both cross-sectionally and longitudinally with alcohol use was NS. Our findings suggest that from a general population standpoint, temperament is a significant factor in alcohol use among in mid-life, albeit small in effect size, and thus TCI scores could be useful in identifying risk groups among this age group for developing AUD. The inability to identify a relationship between high HA and alcohol use is a possible contradiction with Cloninger's theory of late onset AUD, and thus more research on temperament dimensions in mid-life is needed.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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Table 2. Mean TCI scores across alcohol user groups at age 46 among men and women.

	all		abstainer		moderate		heavy use		abstainer vs. moderate		heavy use vs. moderate	
	<i>score</i>	<i>SD</i>	<i>score</i>	<i>SD</i>	<i>score</i>	<i>SD</i>	<i>score</i>	<i>SD</i>	<i>Cohen's D</i>	<i>p-value*</i>	<i>Cohen's D</i>	<i>p-value*</i>
men	n=2252		n=196		n=1672		n=384					
Novelty Seeking	18.71	5.56	17.8	5.2	18.4	5.5	20.3	5.8	-0.11	0.11	0.34	<0.001
Harm Avoidance	12.56	5.99	14.1	6.6	12.4	5.9	12.7	6	0.27	<0.001	0.05	0.34
Reward Dependence	13.26	3.49	13.2	3.5	13.3	3.4	13.1	3.7	-0.03	0.76	-0.06	0.4
Persistence	4.44	1.70	4.2	1.6	4.5	1.7	4.3	1.8	-0.18	0.01	-0.11	0.02
women	n=3022		n=313		n=2463		n=246					
Novelty Seeking	20.07	5.61	18.5	5.2	20.1	5.6	21.6	6.1	-0.30	<0.001	0.26	<0.001
Harm Avoidance	14.21	5.82	14.8	5.8	14.1	5.8	14.7	6.4	0.12	0.03	0.10	0.09
Reward Dependence	15.97	3.27	15.6	3.3	16.1	3.2	15.3	3.7	-0.15	0.02	-0.23	<0.001
Persistence	4.21	1.67	4.1	1.7	4.2	1.7	4.2	1.7	-0.06	0.23	-0.00	0.6

Table 3. Weighted multinomial logistic regression analyses linking standardized TCI scores with abstaining and heavy use at 46 years among men and women.

	moderate	abstainer			heavy use		
	total	total	ORcrude	ORadj	total	ORcrude	ORadj
	(%)	(%)	(95%CI) ^a	(95%CI) ^b	(%)	(95%CI) ^a	(95%CI) ^b
men	1672 (74.2)	196 (8.7)	-	-	384 (17.1)	-	-
Novelty	-	-	0.89	0.91	-	1.41***	1.42***
Seeking	-	-	(0.77-1.04)	(0.76-1.06)	-	(1.26-1.57)	(1.27-1.59)
Harm	-	-	1.30***	1.27***	-	1.04	1.03
Avoidance	-	-	(1.12-1.50)	(1.09-1.48)	-	(0.93-1.16)	(0.92-1.16)
Reward	-	-	0.99	0.99	-	0.98	0.98
Dependence	-	-	(0.85-1.15)	(0.85-1.15)	-	(0.88-1.10)	(0.88-1.10)
Persistence	-	-	0.85*	0.85*	-	0.88*	0.88*
	-	-	(0.73-0.98)	(0.73-0.98)	-	(0.79-0.98)	(0.79-0.98)
women	2463 (81.5)	313 (10.4)	-	-	246 (8.1)	-	-
Novelty	-	-	0.75***	0.72***	-	1.31***	1.30***
Seeking	-	-	(0.66-0.84)	(0.63-0.81)	-	(1.14-1.49)	(1.13-1.49)
Harm	-	-	1.12	1.08	-	1.07	1.05
Avoidance	-	-	(0.99-1.25)	(0.96-1.22)	-	(0.94-1.22)	(0.92-1.20)
Reward	-	-	0.89*	0.90	-	0.80**	0.81**
Dependence	-	-	(0.79-0.99)	(0.80-1.01)	-	(0.71-0.91)	(0.71-0.92)
Persistence	-	-	0.94	0.98	-	0.98	1.01
	-	-	(0.84-1.06)	(0.86-1.10)	-	(0.86-1.11)	(0.88-1.15)

OR = Odds Ratio, CI = confidence interval, ORs are interpreted as one standard deviation increases.

a. Crude.

b. Adjusted with baseline education, employment and marital status.

*p<0.05, **p<0.01, ***p<0.001.

Table 4. Weighted multinomial logistic regression analyses linking standardized TCI scores with stability in alcohol consumption from the age 31 to 46 years among men and women.

	stable		reduced		increased		
	total	total	ORcrude	ORadj	total	ORcrude	ORadj
	(%)	(%)	(95%CI) ^a	(95%CI) ^b	(%)	(95%CI) ^a	(95%CI) ^b
men	1614 (71.7)	207 (9.2)	-	-	431 (19.1)	-	-
Novelty	-	-	1.36***	1.01	-	1.35***	1.23***
Seeking	-	-	(1.17-1.59)	(0.85-1.21)	-	(1.21-1.50)	(1.10-1.37)
Harm	-	-	1.08	1.05	-	1.01	1.02
Avoidance	-	-	(0.94-1.25)	(0.88-1.26)	-	(0.91-1.12)	0.91-1.13)
Reward	-	-	0.86*	0.85	-	1.00	0.98
Dependence	-	-	(0.74-0.99)	(0.72-1.02)	-	(0.90-1.10)	(0.88-1.10)
Persistence	-	-	0.96	1.14	-	0.98	1.01
	-	-	(0.83-1.11)	(0.95-1.36)	-	(0.88-1.09)	(0.91-1.12)
women	2304 (76.2)	210 (6.9)	-	-	508 (16.8)	-	-
Novelty	-	-	1.31***	0.96	-	1.25***	1.14*
Seeking	-	-	(1.13-1.50)	(0.81-1.15)	-	(1.13-1.38)	(1.03-1.26)
Harm	-	-	1.11	1.08	-	1.05	1.08
Avoidance	-	-	(0.97-1.28)	(0.91-1.28)	-	(0.95-1.16)	(0.98-1.19)
Reward	-	-	0.81**	0.84*	-	0.97	0.98
Dependence	-	-	(0.71-0.93)	(0.71-0.99)	-	(0.88-1.07)	(0.89-1.08)
Persistence	-	-	1.00	1.01	-	0.98	0.99
	-	-	(0.87-1.16)	(0.85-1.20)	-	(0.89-1.08)	(0.89-1.09)

OR = Odds Ratio, CI = confidence interval, ORs are interpreted as one standard deviation increases.

a. Crude.

b. Adjusted with baseline alcohol use.

*p<0.05, **p<0.01, ***p<0.001.

Figure 1. Cross-lagged Structural Equation models for Cloninger's temperament dimensions and mean alcohol consumption at the ages of 31 and 46 years among men and women.