Psychometric properties of the Icelandic NEO-FFI in a general population sample compared to a sample recruited for a study on the genetics of addiction

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Abstract

Personality traits are major determinants of social behavior influencing various diseases including addiction. Twin and family studies suggest personality and addiction to be under genetic influence. Identification of DNA susceptibility variants relies on valid and reliable phenotyping approaches. We present results of psychometric testing of the Icelandic NEO-FFI in a population sample (*N*=657) and a sample recruited for a study on addiction genetics (*N*=3,804). The Icelandic NEO-FFI demonstrated internal consistency and temporal stability. Factor analyses supported the five-factor structure. Icelandic norms were compared to American norms and language translations selected for geographical and cultural proximity to Iceland. Multiple discriminant function analysis using NEO-FFI trait scores and gender as independent variables predicted membership in recruitment groups for 47.3% of addiction study cases (*N*=3,804), with accurate predictions made for 69.5% of individuals with treated addiction and 43.3% of their first-degree relatives. Correlations between NEO-FFI scores and the discriminant function suggested a combination of high neuroticism, low conscientiousness and low agreeableness predicted membership in the *Treated* group.

Keywords

NEO-FFI; psychometrics; addiction

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1. Introduction

According to the Diagnostic and Statistical Manual of Mental disorders (4th ed., text rev.; DSM-IV-TR; American Psychiatric Association, 2000, p.686) personality traits are "enduring patterns of perceiving, relating to, and thinking about the environment and oneself that are exhibited in a wide range of social and personal contexts." This trait approach is one of the major theoretical areas in the study of personality; research demonstrating that personality traits are stable within individuals over time and across situations, and common to individuals of different cultures and languages (Eysenck, 1990; Costa & McCrae, 1992; McCrae, 2004). Heritability estimates of the five domains most frequently used to describe human personality; neuroticism (N), extraversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C), are 41%, 53%, 61%, 41%, and 44% respectively (Jang & Livesley, 1996). However, gene discovery has proven difficult; results indicating that personality traits may be influenced by many variants each with small effects (deMoor et al., 2012; Terracciano et al., 2010).

Addiction, like personality, is considered a heritable neurobiological trait with considerable inter-individual variability (Uhl et al, 2008). Unlike personality, addiction evolves and changes with time. It is currently recognized as a multi-factorial disease process in which substance of addiction, social environment, and personality interact with genetic factors influencing brain neurobiology and pathophysiology (Uhl et al, 2008). Converging evidence supports moderate to high heritability, with estimates ranging from 30 to 70% (Agrawal & Lynskey, 2008). A recent study of familiality in an Icelandic treatment sample observed that first-degree relatives (parent, sibling, offspring) of probands with alcohol or substance addiction had a relative risk of the same addiction ranging from 2.2 (alcohol) to 7.3 (amphetamine) (Tyrfingsson et al., 2010). Despite strong indications of genetic and familial influence, identification of addiction susceptibility variants has also proven difficult (Uhl et al, 2008).

Researchers have long recognized the association between personality and addiction. In the DSM-I published in 1952, alcoholism was considered a personality disorder (Schuckit, Nathan, Helzer, Woody, & Crowley, 1991). Although no longer classified as such, research continues to indicate that individuals susceptible to developing substance addictions can be distinguished from relevant comparison groups on several measured personality traits, in particular higher neuroticism (Uhl et al., 2008), but also lower openness, agreeableness, and conscientiousness (Bottlender & Soyka, 2005; Fridberg, Vollmer, O'Donnell, & Skosnik, 2011; Martin & Sher, 1994; Terracciano & Costa, 2004; Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008;). Hence, recent approaches of genetic studies of addiction have attempted to include interaction with personality measures (Kreek, Nielsen, Butelman, & LaForge, 2005). Identification of genetic susceptibility variants associated with the complex and interacting traits of addiction and personality relies on valid and reliable phenotyping approaches in discovery and replication samples of different populations. While diagnostic criteria for addiction can be defined according to DSM-IV-TR (2000), various personality measures exist. One of the most widely used is the NEO-FFI, a 60-item short form of the 240-item NEO-PI-R (Costa & McCrae, 1992). It has been translated and tested in different languages and populations worldwide demonstrating validity, reliability, and utility in a number of contexts, including genetics (de Moor et al., 2012) and addiction (Bottlender & Soyka, 2005). While the Icelandic NEO-PI-R and a less used short form (NEO-FFI-R) (McCrae, & Costa, 2004) had been linguistically validated (Jonsson & Bergthorsson, 2004; Jonsson, 2005), Icelandic norms and psychometric test results were not available for the NEO-FFI prior to this study.

The aims of the present study were to analyze psychometric properties of the Icelandic NEO-FFI, establish Icelandic norms and compare to; a) American norms and language translations selected for geographical and cultural proximity to Iceland, and b) NEO-FFI data gathered within the context of a study on the genetics of addiction in Iceland.

2. Methods

2.1. Participants

NEO-FFI data from two independent samples were used. One was the population sample (*N*=657) recruited for the linguistic validation study of the 240-item parent instrument (NEO-PI-R) in 2003 (Jonsson & Bergthorsson, 2004). Survey invitations were mailed to 1,500 individuals, 18–75 years of age, randomly selected from the national registry with 44% return rate. Of respondents, 367 (55.9%) were female, 288 (43.8%) male, and gender was missing for 2 respondents. Mean age was 43.4 years (*SD*=16.1); males 45.5 years (*SD*=15.9) and females 41.7 years (*SD*=16.2). The 60 NEO-FFI items were extracted from this dataset for the present study.

The other was a sample of participants recruited for an Icelandic study on the genetics of addiction (*N*=3,804) who returned NEO-FFI surveys during 2005–2008. Three groups were recruited: a) *Treated* (*N*=1,454) were individuals with history of inpatient treatment at SAA National Center of Addiction Medicine in Reykjavik, Iceland (Tyrfingsson et al., 2010), age at first treatment ranging from 14–78 yrs, number of admissions from one to 69, and time since last admission from 0 to 340.7 months (28.4 yrs). Primary admission diagnoses of *Treated*, based on DSM-IV criteria were: alcohol dependence (303.9, 59%), cannabis dependence (304.3, 9%), and multiple substance dependence/abuse (303–305, 32%). Alcohol addiction was comorbidity in all treated, b) *Relatives (N*=418), were untreated first-degree relatives of treated addicts, defined of increased familial (genetic) risk of addiction, and c) *Smokers* (*N*=1,932) were individuals unrelated to a) and b), without history of addiction treatment but with history of smoking 15 cig/day for 1 year, most meeting the DSM-IV criteria for nicotine dependence. Participants were 18 years and older. There were 1,883 (49.5%) males, mean age 52.2 years (SD=13.4), and 1,921 (50.5%) females, mean age 49.9 years (SD=12.5). Table 1 presents further details of the addiction sample.

2.2. Measures

The NEO-FFI items were extracted from the Icelandic NEO-PI-R which was translated according to formal translation protocols at the University of Iceland (Jonsson & Bergthorsson, 2004). In both samples, the NEO-FFI was self-administered in paper forms. Each of the five personality factors is represented by 12 statements to which participants indicate their degree of agreement on a five point Likert scale (Costa & McCrae, 1992). Missing values were replaced up to a maximum of two missing items per factor; responses with more missing items were excluded.

2.3. Statistics

Internal consistency reliability was calculated using Cronbach's alpha. Test-retest reliability was assessed by within-subject comparison for 65 individuals who responded twice with only their first NEO-FFI response included for further analyses. To study cross-language and cross-cultural comparability, psychometric properties of the population sample representing Icelandic norms, were compared to norms of the American NEO-FFI and other translations. The Danish translation was selected for geographical and cultural proximity to Iceland, along with translations, from Great Britain, Spain, and Switzerland.

Validity was examined in three ways; by cross-cultural comparisons to NEO-FFI norms of other populations, by factor analysis to assess construct validity, and by assessing discriminant validity of the NEO-FFI by its performance in predicting membership in the addiction sample's recruitment groups. To facilitate comparison to results of others, e.g. Egan et al (2000) and McCrae & Costa (2004), the principal components analysis method of factor extraction with Varimax rotation were applied. Discriminant validity of the NEO-FFI was assessed by a multiple discriminant function analysis using the five NEO-FFI trait scores and gender as predictor variables and the a-priori defined variable of addiction recruitment groups; *Treated*, *Relatives*, and *Smokers*, as the groups to be predicted. Study protocols were approved by The Icelandic National Bioethics Committee and The National Data Protection Authority. Data analyses were conducted using the SPSS 21.0 software for Windows.

3. Results

All addiction recruitment groups differed significantly from population norms on all personality factors except C scores for *Treated* (Table 2). Of note, however, is that mean C scores of *Treated* are significantly lower than both *Relatives* and *Smokers* (2 tailed t-test at a 99% level) and mean N scores are highest for *Treated,* whereas *Relatives* and *Smokers* both have lower N and higher C scores than the population sample.

Internal consistency of NEO-FFI factors was satisfactory in all groups; alpha coefficients ranging from .62 to .86. Test-retest results demonstrated good temporal reliability (N=.82, E=.74, O=.82, A=.77, C=.82). Average time between responses was 8 months (range 4–760 days, *M*=234 days, *SD*=170). Average age when first answering was 52.3 years (*SD*=9.4).

Compared to U.S. norms, the Icelandic N and E scores were not statistically different, whereas Icelanders are significantly less open, less agreeable and less conscientious compared to their U.S. counterparts. The effects were moderate; Cohen's *d* for O=.32, A=.10, and C=.72. Other comparisons are in line with what is known of cultural differences in personality traits (Allik & McCrae, 2004) (Table 3). Gender differences between U.S. and Icelanders are also similar (Table 4). Icelandic females score significantly higher than males on all traits but extraversion, but effect sizes were small to moderate. The largest effect was observed in that Icelandic females are moderately (*d*=.51) more agreeable than Icelandic males. Most differences between genders are comparable between Icelandic and U.S. norms (Table 4), although Icelandic women are more open than Icelandic men (*d*=.21) whereas U.S. men and women are more alike (*d*=.02)

A number of significant correlations were observed between NEO-FFI scores in both reference and addiction samples (Table 5). The negative correlation between N and C in the addiction sample (*r*=−.51) is considerably larger than in the reference sample (*r*=−.26). Indeed, all inter-correlations were higher in the addiction sample than in the reference sample except O-E and O-C. Table 5 includes correlations between personality traits and variables further characterizing the treated group; age at first treatment (T1), number of treatments (NT), and time since last treatment (TL). TL was defined 0 if within month of last admission.

Results of factor analyses in both samples are provided in supplementary material. Based on the scree plot, five, six, and seven factor solutions were examined. The five-factor solution was preferred because of; a) previous theoretical support, b) the first elbow in the scree plot appearing after five factors (explaining 35.3% of total variance), and c) the insufficient number of primary loadings within sixth and seventh factors. This procedure was repeated

for addiction sample data also resulting in a five factor solution. All five dimensions of the Icelandic NEO-FFI translation represent coherent personality traits in both samples.

The multiple discriminant function analysis resulted in two discriminant functions. Only the first was significant ($\chi2$(12, N=3,804)=811.187, p<.0005, Λ=.808) with a canonical correlation of .436 and accounting for 98.9% of the between-group variance. The predictor variables most strongly associated with this discriminant function were gender (.69), and the personality trait scores of N (−.57), C (.54), and A (.50), whereas E and O associations were weaker (< .30). Overall, 47.3% of cases were correctly classified by the discriminant function, exceeding 41.6% (1.25 × 33.3%), based on the requirement that model accuracy be 25% better than chance. At individual group level, 69.5% of *Treated* were correctly classified, 43.3% of *Relatives*, but only 31.4% of *Smokers* (Table 6).

4. Discussion

The Icelandic NEO-FFI has psychometric properties comparable to the original U.S. measure and other translated versions. In addition to adequate internal consistencies for all five factors in both population and addiction samples, we observed good temporal reliability congruent with other studies on long-term stability in population samples (Murray, Rawlings, Allen, & Trinder, 2003), student samples (Costa & McCrae, 1992), and individuals with addictions (Bottlender & Soyka, 2005).

The observed differences in mean NEO-FFI scores between recruitment groups and reference sample (Table 2) are in line with previous studies. Low conscientiousness and high neuroticism are associated with tobacco smoking (Terracciano & Costa, 2004), alcohol abuse (Martin & Sher, 1994), cannabis use (Fridberg et al, 2011), heroin, and cocaine use (Terracciano et al, 2008), and family history of alcoholism (Martin & Sher, 1994). Although the difference in mean C scores between *Treated* and reference group was not significant, the mean C score of *Treated* was significantly lower than for *Relatives* and *Smokers.*

The cross-cultural comparison speaks to functional equivalence and construct validity of the Icelandic NEO-FFI. Although Iceland is geographically and culturally closer to Denmark than the U.S. and other countries selected, Icelandic norms are most similar to the American ones. A study on the geography of personality found that the most comparable NEO-PI-R factor means fell within geographical clusters (Allik & McCrae, 2004). Although Iceland was not included in the study, the cluster including other Scandinavian populations (Danes, Norwegians, Swedes) also contains Americans (Allik & McCrae, 2004).

We found significant differences between mean scores of men and women for all NEO-FFI factors, albeit with the small effect sizes noted by Costa & McCrae (1992). Only the A factor reached moderate effect size (d>.50) which is comparable to Costa & McCrae's (1992) results, where scores on A demonstrated the highest correlation with gender or r=.21. For phenotyping purposes, gender adjustments may be warranted.

Although the five-factor structure emerged from both general population and addiction datasets, the identified problems reported by Egan et al (2000) resulting in McCrae and Costa's (2004) revision of the NEO-FFI, were also observed (see supplementary material). However, of the 14 NEO-FFI items they revised, only seven fulfilled traditional instrument evaluation criteria in the present study. Thus, for practical purposes the NEO-FFI may be a better choice than revised NEO-FFI versions for researchers due to comparable psychometrics and longer history of NEO-FFI use (Costa & McCrae, 2004). Indeed, our NEO-FFI results are comparable to those reported on the Icelandic NEO-FFI-R (Jonsson, 2005). Studies of Spanish and French translations also found no evidence of NEO-FFI-R outperforming NEO-FFI (Aluja, García, Rossier, & García, 2005). For use in genetics the

NEO-FFI is superior to the NEO-FFI-R as it is more widely used providing access to a larger number of discovery and replication samples.

Finally, the discriminant function analysis showed that a combination of high neuroticism, low conscientiousness and low agreeableness are the best predictors of membership in the *Treated* group; results congruent with previous studies of personality and addiction (Bottlender & Soyka, 2005; Terracciano & Costa, 2004) and providing further support for the validity of the Icelandic NEO-FFI. Although personality factors did not significantly predict membership in the *Smokers* group, further analyses of subgroups may reveal differences, e.g. in terms of quitting success (Terracciano & Costa, 2004).

These results also suggest that when seeking genetic associations, personality phenotypes may be better represented in well-defined combinations of NEO-FFI traits, rather than along psychometrically defined factors only. Emerging data show that traits of central importance to personality theory may be combinations of two or more of the "big-five" dimensions (Cooper & Pervin, 1998; Weiss, Sutin, Duberstein, Friedman, Bagby, & Costa, 2009). Factor analysis on the other hand seeks simple structure and discrete clusters of variables that define a dimension, which may result in the identified problems of overlapping items especially within the E, A, and O factors. Whereas further studies are required to tease apart and possibly redefine overlapping personality phenotypes for genetic studies, on the basis of the present analyses of the Icelandic NEO-FFI, the N and C factors can be considered most robust of the currently defined factors.

In conclusion, this study has established psychometric properties of the NEO-FFI in Icelandic. Although some identified problems of other translations were also observed here, overall the performance of the Icelandic NEO-FFI supports its use as a personality trait measure in both general population and addiction samples. In terms of using the NEO-FFI dimensions as phenotypes within genetic studies, we concur with the authors of the NEO-FFI (McCrae & Costa, 2004) that personality traits may extend to certain overlaps of the five factors measured by the NEO-FFI or even be characterized to the level of individual items. Thus, success at finding genotype/phenotype associations may require not only large sample sizes using current trait definitions, but also re-defining which combinations of trait scores, or even which individual item scores, represent personality traits with biological underpinnings that can further our understanding of the functions of the brain shaping personality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Highlights

- The Icelandic NEO-FFI was tested in large general population and addiction samples.

- NEO-FFI of treated addicts, untreated relatives, and ever smokers were compared.

- Factor analyses found the N and C scales most robust.

- High N, low C, and low A predicted membership in the addiction treated group.

Table 1

Descriptive statistics of participants returning NEO-FFI surveys in the addiction sample (*N*=3,804) by recruitment group.

Recruitment group	Males		Females	
	N (%)	*M (SD)*	*N (%)*	*M (SD)*
Treated (N=1,454)	1,014 (70)	52.1 (13.8)	440 (30)	47.7 (14.4)
Nr of admissions	--	6.2 (8.1)	--	4.8 (6.3)
Age (yrs) at first admission	--	34.7 (12.3)	--	34.5 (13.0)
Months since last admission	--	93.0 (89.5)	--	79.9 (82.2)
Relatives (N=418)	149 (36)	53.2 (17.2)	269 (64)	50.3 (15.6)
Smokers (N=1,932)	720 (37)	52.2 (11.9)	1,212 (63)	50.6 (10.8)
Total (N=3,804)	1,883 (50)	52.2 (13.4)	1,921 (50)	49.9 (12.5)

Table 2

Descriptive statistics of NEO-FFI factors in addiction sample (*N*=3,804) compared to population sample (*N*=657); Mean (*M*), standard deviation (*SD*) and internal consistency reliability coefficient (Cronbach's *α*). Bold indicates significant difference compared to population sample (2 tailed t-test at a 99% confidence level).

NEO-FFI	Treated (N=1,454) M (SD) α	Relatives (N=418) M (SD) α	Smokers (N=1,932) M (SD) α	Population (N=657) M (SD) α
N	**22.2 (8.9)** .86	**16.8 (7.7)** .83	**17.6 (8.0)** .82	19.3 (8.4) .84
E	**27.1 (6.9)** .80	**29.0 (6.6)** .82	**28.9 (6.5)** .79	27.8 (6.8) .81
O	**26.4 (5.6)** .62	**26.9 (5.3)** .62	**26.0 (5.4)** .63	25.1 (6.1) .69
A	**30.5 (5.6)** .68	**33.5 (5.3)** .69	**33.1 (5.3)** .67	32.3 (5.4) .69
C	30.8 (7.3) .83	**34.8 (6.2)** .82	**34.4 (6.4)** .82	30.4 (5.8) .72

Table 3

NEO-FFI factor scores, Mean (*SD*); Cronbach's Alpha, of the Icelandic general population sample compared to norms of NEO-FFI in U.S. language and published norms of four multicultural translations. Bold indicates statistically significant t-test at a 95% level.

NEO-FFI	Icelandic (*N*=657)	U.S. (*N*=1,539)[1]	Danish (*N*=223)[2]	British (*N*=1,025)[3]	Spanish (*N*=1,136)[4]	French (*N*=1,090)[5]
N	19.3 (8.2); .84	19.1 (7.7); .86	19.6 (8.1); .86	19.5 (8.6); .87	**20.5 (7.5)**; .82	**22.9 (8.5)**; .85
E	27.8 (6.8); .81	27.7 (5.9); .77	**30.6 (7.2)**; .85	**27.1 (5.9)**; .74	**31.7 (6.7)** ; .81	27.8 (6.1); .74
O	25.1 (6.1); .69	**27.0 (5.8)**; .73	**28.4 (7.0)**; .78	**26.5 (6.5)**; .72	**28.3 (6.7)** ; .76	**29.6 (6.3)**; .71
A	32.3 (5.4); .69	**32.8 (5.0)**; .68	**33.8 (6.3)**; .79	**29.7 (5.9)**; .74	**30.0 (5.9)** ; .71	**31.5 (6.0)**; .71
C	30.4 (5.8); .72	**34.6 (5.9)**; .81	**32.9 (6.6)**; .82	**32.1 (6.6)**; .84	30.5 (6.6) ; .81	31.0 (7.3); .83

[1] (Costa & McCrae, 1992),

[2] (Olesen, 2011),

[3] (Egan et al., 2000),

[4] (Manga et al., 2004),

[5] (Aluja et al., 2005).

Table 4

NEO-FFI subscale means and effect size (Cohen's *d*) by gender in the Icelandic reference sample (*N*=655, gender missing for 2 cases) (*df*=653) including U.S. gender norms and effect sizes. Independent-samples t-test (2-tailed) for differences in means between genders. (As *N*'s for U.S. reference group were not available, statistical tests of differences in means were not performed).

NEO-FFI subscales		Males, *N*=288	Females, *N*=367	*t*	*p*	*d*
		M (SD)	*M (SD)*			
N	Iceland	17.9 (7.6)	20.4 (8.4)	3.96	<.001	.31
	US	*17.6 (7.5)*	*20.5 (7.6)*			.38
E	Iceland	27.3 (6.6)	28.2 (6.8)	1.67	.095	.13
	US	*27.2 (5.9)*	*28.2 (5.8)*			.17
O	Iceland	24.4 (5.9)	25.7 (6.2)	2.63	.009	.21
	US	*27.1 (5.8)*	*27.0 (5.9)*			.02
A	Iceland	30.8 (5.6)	33.5 (5.0)	6.53	<.001	.51
	US	*31.9 (5.0)*	*33.8 (4.7)*			.39
C	Iceland	29.6 (5.7)	31.1 (5.8)	3.39	.001	.26
	US norms	*34.1 (6.0)*	*35.0 (5.8)*			.15

Table 5

Inter correlations (Pearson's *r*) of the Icelandic NEO-FFI factors. Correlations for addiction sample (*N*=3,804) are above diagonal line and below for the population sample (*N*=657). Significant correlations (at the .01 level, 2-tailed) in bold.

	N	E	O	A	C	TI	NT	TL
N	1	−.45	−.12	−.39	−.51	−.25	.23	−.32
E	−.34	1	.18	.24	.45	−.03	−.07	.06
O	−.05	.19	1	.14	.07	−.03	−.04	.03
A	−.29	.15	.03	1	.35	.16	−.18	.17
C	−.26	.33	.07	.14	1	.18	−.16	.21

Table 6

Actual vs. predicted membership in addiction recruitment groups (*N*=3,804). The numbers on the diagonal represent correct classifications, with off-diagonal numbers representing misclassifications.

Recruitment groups (N)	Predicted group membership, N (%)[1]		
	Smokers	**Treated**	**Relatives**
Smokers (1,932)	607 (31.4)	616 (31.9)	709 (36.7)
Treated (1,454)	223 (15.3)	1,010 (69.5)	221 (15.2)
Relatives (418)	115 (27.5)	122 (29.2)	181 (43.3)

[1] Overall, 47.3% of original grouped cases were correctly classified.