Cognitive failure susceptibility and personality:
Self-directedness predicts everyday cognitive failure

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Abstract:

Susceptibility to everyday cognitive failure is often assessed in clinical and vocational settings to estimate the effectiveness of interventions or to predict performance and performance decline in stressful situations. Comparatively little is known about the relationship between cognitive failure susceptibility as quantified by the Cognitive Failure Questionnaire (CFQ) and personality factors. We examined the relationships between the CFQ and the seven personality dimensions as assessed by the Temperament and Character Inventory (TCI). Through regression analyses with out-of-sample prediction, we explained 14.8 to 17.4% of the variance in cognitive failure from the personality scores. We established the character trait self-directedness as the main inversely related predictor of everyday cognitive failure. High cognitive failure thus seems to reflect low levels of self-confidence, self-acceptance, and responsibility for one's own actions which are the key aspects of self-directedness. This result provides evidence for the previously stated 'complaint' hypothesis that cognitive failure results from a poor self-image rather than a vulnerability to stress.

1. Introduction:

Everyday cognitive failures reflect minor lapses in attention, memory, and psychomotor coordination such as missing a traffic sign, forgetting an appointment, or stumbling into something. Usually, cognitive failure does not result from a general deficit in cognitive or psychomotor ability, but from temporary and reversible blunders (Brootbent et al., 1982; Wilhelm et al., 2010). The cognitive failure questionnaire (CFQ) has been developed to quantify the frequency by which such lapses happen in everyday life, i.e. outside of the experimental laboratory. Even though attention, memory, perception and psychomotor functions are independent cognitive functions, cognitive failure susceptibility as measured by the CFQ seems to reflect a single higher-order factor of failure across cognitive domains (Brootbent et al., 1982; Wagle et al., 1999).

In cognitive psychology, the term executive control refers to a set of cognitive functions atop of the cognitive architecture (Norman & Shallice, 1982; Baddeley, 1986). Executive functions are control functions such as working memory, inhibitory control, and cognitive flexibility (Miyake et al., 2000) that are thought to exert goal-directed control over attention, memory, and sensorimotor function in the service of an ongoing task. This perspective suggests that CFQ scores reflect the efficiency by which executive functioning controls everyday behavior. But even though some studies report negative correlations between cognitive failure susceptibility and behavioral indices of executive control obtained from laboratory experiments (Berggren et al., 2011; Foster & Lavie, 2007; Groome & Grant, 2005; Tipper & Baylis, 1987), others have failed to do so (Borella et al., 2008; Das-Smaal et al., 1993; Ishigami et al., 2009; Kane

et al., 1994). These inconsistencies could potentially stem from a weak link between cognitive failure susceptibility and executive control that is diluted by emotional and motivational factors, similar to other cognition-related personality traits (Reynolds et al., 2006; Buchanan, 2016).

Dispositional differences in emotional and motivational factors are the central subject of personality taxonomies. Only a few studies have looked at the relationship between the CFQ and personality. Wallace et al. (2004) report associations between CFQ scores and each construct of the big five taxonomy. High levels of cognitive failure susceptibility relate to low levels of openness, conscientiousness, extraversion, and agreeableness but high levels of neuroticism. Particularly, the link with neuroticism has been corroborated by other studies (Matthews et al., 1990; Mahone et al., 1998; Klockner & Hicks, 2015; Sindermann et al., 2018). Wilhelm et al. (2010) have specified two hypotheses on the relationship between neuroticism and cognitive failure. The stress-vulnerability hypothesis contents that neuroticism acts as dispositional vulnerability that - in the presence of acute stressors - leads to a breakdown of efficient coping and results in cognitive failure. The complaint-hypothesis, on the other hand, holds that dispositional low self-consciousness, a poor self-image, and lack of confidence lead to an overrepresentation of failure episodes in memory. In this view, elevated CFQ scores reflect complaints over cognition and cognitive failure rather than objective failure frequency or intensity.

In the present study, we seek to relate individual CFQ scores to the dimensions of the Temperament and Character Inventory (TCI), a personality taxonomy derived from the biopsychosocial personality theory (Cloninger, 1986; 1987; Cloninger et al., 1993). Data on the relationship between the CFQ and TCI are not available so far. It is a valuable addition to the literature to investigate the role of personality in cognitive failure beyond the Big Five model, because whereas the Big Five have been derived against the background of a lexical approach, Cloninger's theory on personality is grounded on different sources including biographical and neuroscientific data. Therefore, the study of cognitive failure in the light of another personality theory might bring new insights. Among others, the TCI distinguishes between the temperament trait *harm avoidance* and the character trait *self-directedness*. This distinction is valuable to investigate the two different hypotheses on the involvement of neuroticism in cognitive failure (Wilhelm et al., 2010). Temperament traits are thought to be basic personality traits with a strong (genetic) biological underpinning that develop early in life and describe the intensity by which a person responds to stimuli of reward, punishment, and omission of reward (Cloninger, 1994). The harm avoidance temperament reflects the tendency to respond strongly to stimuli of punishment and non-reward and describes people high in anticipatory worry, fear of uncertainty, social shyness, and fatigability. In so far, it might be also a driver of neuroticism in a bottom-up-fashion, when considering that temperaments are anchored in subcortical areas of the human brain (Montag & Panksepp, 2017). Character traits, on the other hand, are thought

1 to mature later in life, in an interplay between temperament traits and the environment. Self-
2 Directedness reflects goal-directedness, self-confidence, habitual self-discipline, and an internal
3 locus of control (Kose, 2003). The conceptual distinction of temperaments and characters is
4 often blurred in lexical factor-analytically derived taxonomies. Harm avoidance and self-
5 directedness are commonly subsumed under the neuroticism umbrella which is also reflected
6 in the correlation pattern of the two traits with neuroticism (positive for harm avoidance [r
7 = .54], negative for self-directedness [r = -.63], harm avoidance and self-directedness correlate
8 negatively with [r = -.54]; De Fruyt et al., 2000). According to the stress-vulnerability hypothesis,
9 harm avoidance should relate most strongly to cognitive failure susceptibility, but according to
10 the complaints-hypothesis, self-directedness should be the better predictor. With the current
11 investigation we also intend to provide correlational evidence in favor of either account.

2. Methods

We recruited a total of $N = 1387$ participants, split into two independent samples at two assessment sites. All participants gave informed written consent. All protocols were in accordance with the Declaration of Helsinki on the treatment of human research participants and approved by the local ethics committee at the University of Bonn and Ulm University, Germany.

2.1 Sample 1

Sample 1 was recruited via the Bonn Gene Brain Behavior Project at the University of Bonn, Germany. We included the $N = 731$ participants ($n = 214$ male, $n = 517$ female, mean age $M = 24.38$, $SD = 8.00$) who had filled in pen-and-paper versions of the Temperament and Character Inventory (TCI) and the Cognitive Failure Questionnaire (CFQ) and who reported to be free of past and present psychiatric and neurological disorder.

2.2 Sample 2

Sample 2 was recruited via the Ulm Gene Brain Behavior Project at Ulm University. We included the $N = 656$ participants ($n = 205$ male, $n = 451$ female, mean age $M = 23.49$, $SD = 5.42$) who had filled in online versions of the TCI and the CFQ and did not report any history of psychiatric or neurological disorder.

2.3 Questionnaires

Temperament and Character Inventory (TCI): The TCI by Cloninger et al. (1993) investigates four temperament and three character dimensions. According to Cloninger's theoretical approach, temperaments are more visible from early on in life and are also more strongly influenced by genetics. In contrast, character manifests itself later in life during adolescence and young adulthood and is assumed to be strongly influenced by learning processes.

The four temperaments are called novelty seeking (NS), harm avoidance (HA), reward dependence (RD) and persistence (P). The three character dimensions are called self-directedness (SD), cooperativeness (C) and self-transcendence (ST). The first three temperaments and the three characters are super-ordinate factors that can be decomposed into a set of sub scales to allow a more fine-grained perspective on human personality. Novelty seeking consists of the four sub scales "exploratory excitability" (NS1), "impulsiveness" (NS2), "extravagance" (NS3), and "disorderliness" (NS4). Harm avoidance can be split into "anticipatory worry" (HA1), "fear of uncertainty" (HA2), "shyness with strangers" (HA3), and "fatigability" (HA4). Reward Dependence consists of "sentimentality" (RD1), "attachment" (RD3), and "dependence on others" (RD4). RD2 reflects "persistence" which was originally considered part of reward dependence trait was later revised as its own temperament dimension. Regarding the

character dimensions, Self-Directedness is split into “responsibility” (SD1), “purposefulness” (SD2), “resourcefulness” (SD3), “self-acceptance” (SD4), and “goal-congruent habits” (SD5). Cooperativeness is divided into “social acceptance” (C1), “empathy” (C2), “helpfulness” (C3), “compassion” (C4), and “integrated conscience” (C5). Finally, Self-Transcendence consists of “creative self-forgetfulness” (ST1), “transpersonal identification” (ST2), and “spiritual acceptance” (ST3).

The TCI consists of 240 items with the dichotomous answer format yes (1) and no (0). We administered the German version by Cloninger and Richter (1999). Internal consistencies (Cronbach’s alpha) were as follows: NS: .787 (sample 1)/ .738 (sample 2); HA: .882/ .886, RD: .718/ .775, P: .715/ .702, SD: .733/ .875, C: .825/ .853, ST: .873/ .848.

Cognitive Failure Questionnaire (CFQ): The German version of the CFQ (Klumb, 1995) consists of 32 scenarios of cognitive failure from everyday life (such as forgetting an appointment, missing a traffic sign, or dropping things). Participants indicate how often each situation happened to them in the last six months. The answer format ranges from never (0) to very often (4). The higher the scores of the CFQ the higher is the self-reported experience of cognitive failures in everyday life. Internal consistency (Cronbach’s alpha) was .899 in sample 1 and .922 in sample 2.

2.4 Statistical Analyses

Visual inspection of the variables showed normal-distribution for the variables of relevance in the present study. Therefore, parametric testing procedures were applied. We first assessed the bivariate relationships between CFQ and TCI scores through linear Pearson correlations.

We also fitted separate hierarchical regression models to predict CFQ scores from TCI factors in each of the two samples. Data from the other sample were used to evaluate the regression models through out-of-sample-prediction based on the beta coefficients. The hierarchical regression models included sex and age as possible confounds in the first block. TCI variables were entered into the model in a second block using a stepwise procedure. Variables were included when the F-test’s p-value was below .05 in the order of their individual contributions to R^2 . Variables were removed from the model when their p-value exceeded .1 upon entering a further variable. We compromised between parsimoniousness and predictive power when evaluating the regression model: A model was considered the best model when inclusion of a further variable did not increase the predictive power by more than 1%. We evaluated model performance by computing linear correlations between actual CFQ scores and the predicted scores from the best regression models. All variables were centered around the mean for regression analysis.

3. Results:

Sample characteristics and personality variables

Age was negatively correlated with CFQ scores in sample 2 ($r = -.104, p = .008$) but not in sample 1 ($r = -.036, p = .327$). Women had higher CFQ scores than men in both samples (sample 1: $t(729)=4.725, p < .001$, sample 2: $t(654)=2.67, p = .008$). Age and sex were therefore treated as confounding variables and entered as a separate first block into the regression models. Table 1 shows descriptive statistics for all TCI scales and the CFQ in the complete samples as well as in the male and female subsamples, including statistical comparisons between men and women.

Table 1: Descriptive statistics (means and standard deviations) for all personality variables in the two samples and separately for the female and male subsamples. T-values reflect sex differences and are flagged with * for $p \leq .05$ and ** for $p \leq .001$.

sample	NS	HA	RD	P	SD	C	ST	CFQ
1 total	20.5 (5.9)	16.0 (7.0)	17.1 (3.7)	4.8 (2.2)	31.2 (7.7)	33.6 (5.6)	11.4 (6.4)	49.4 (14.8)
F	20.3 (5.8)	17.2 (6.7)	18.1 (3.1)	4.9 (2.1)	31.0 (7.7)	34.2 (5.1)	12.1 (6.4)	51.1 (15.1)
M	20.8 (6.2)	13.1 (6.7)	14.8 (4.2)	4.5 (2.3)	31.6 (7.9)	32.0 (6.4)	9.9 (6.3)	45.5 (13.4)
$t(729)$	-1.11	7.48**	11.64**	2.26*	-0.87	5.06**	4.15**	4.73**
2 total	19.9 (5.5)	15.7 (7.3)	16.4 (4.2)	4.5 (2.2)	30.8 (7.7)	32.7 (6.1)	12.3 (6.1)	47.3 (16.2)
F	19.8 (5.3)	17.1 (6.9)	17.5 (3.7)	4.6 (2.2)	31.0 (7.6)	33.9 (5.3)	12.7 (6.0)	48.4 (15.6)
M	20.1 (5.7)	12.6 (7.1)	13.9 (4.2)	4.3 (2.2)	30.4 (7.9)	30.0 (6.9)	11.4 (6.1)	44.8 (17.5)
$t(654)$	-0.69	7.66**	10.97**	1.57	0.99	7.91**	2.55*	2.67*

TCI and Cognitive Failures

Bivariate relationships between CFQ and TCI scores in both samples are shown in table 2. The strongest bivariate relationship in both samples was a negative correlation between cognitive failure and self-directedness.

Table 2: Bivariate correlations between cognitive failure scores and TCI temperament and character scores.

	NS	HA	RD	P	SD	C	ST
CFQ Sample 1	.153***	.250***	.098*	-.132***	-.360***	-.105**	.184***
CFQ Sample 2	-.002	.302***	.054	-.101*	-.414***	-.118**	.088

* $p \leq .05$, ** $p \leq .001$, # $p \leq .007$ (Bonferroni -adjusted threshold); NS: novelty seeking, HA: harm avoidance, RD: reward dependence, P: persistence, SD: self-directedness, C: cooperativeness, ST: self-transcendence

Regression analysis and out-of-sample prediction

Hierarchical regression models for sample 1 are shown in table 3. The best prediction model included self-directedness, self-transcendence, novelty seeking, and harm avoidance as predictors after accounting for age and sex as confounding variables ($F_{(6,724)}=31.9, p < .001$). No other personality factor met the inclusion criterion of $p < .05$. Self-directedness was negatively related to cognitive failure scores. All other personality factors showed positive relationships with cognitive failure. The model explained 20.3% of variance in cognitive failure scores. We used the regression model to predict CFQ scores in sample 2. Figure 1a shows a scatterplot of actual and predicted CFQ scores with a correlation of $r = .417, p < .001$, indicating 17.4 % shared variance.

Table 3: Hierarchical regression models in sample 1. Models predicting CFQ scores from age and gender alone (model 1), and successively added predictors (Self-directedness (model 2), self-transcendence (model 3), novelty seeking (model 4), and harm avoidance (model 5) significantly explaining incremental variance.

Model	R^2	Adjusted R^2	R^2 change	F change	df1	df2	p	variables
1	.030	.027	.030	11.242	2	728	<.001	sex, age
2	.156	.152	.126	108.162	1	727	<.001	sex, age, SD
3	.179	.175	.024	21.027	1	726	<.001	sex, age, SD, ST
4	.196	.191	.017	15.332	1	725	<.001	sex, age, SD, ST, NS
5	.209	.203	.013	11.652	1	724	.001	sex, age, SD, ST, NS, HA

Hierarchical regression models for sample 2 are shown in table 4. The best prediction model included only self-directedness after accounting for age and sex as nuisance variables ($F_{(3,652)}=50.4, p < .001$). Harm avoidance and self-transcendence met the $p < .05$ criterion but contributed only a marginal increase in explained variance ($> 1\%$) and were therefore not

regarded as substantial predictors. Again, self-directedness was negatively related to CFQ scores. The model explained 18.5% of variance in cognitive failure scores. We used the regression model to predict CFQ scores in sample 1. Figure 1b shows a scatterplot of actual and predicted CFQ scores with a correlation of $r = .385$, $p < .001$, indicating 14.8 % shared variance.

Table 4: Hierarchical regression models in sample 2. Models predicting CFQ scores from age and gender alone (model 1), and after adding self-directedness as predictor (model 2).

Model	R^2	Adjusted R^2	R^2 change	F change	df1	df2	p	variables
1	.019	.016	.019	6.241	2	653	.002	sex, age
2	.188	.185	.169	136.136	1	652	<.001	sex, age, SD

Figure 1: Out-of-sample prediction of CFQ scores from temperament and character scores. (A) shows prediction accuracy from sample 1’s regression model in sample 2. (B) shows prediction accuracy from sample 2’s regression model in sample 1. Please note that all variables were centered on the mean.

Self-directedness sub-scales and cognitive failure

Across both samples, self-directedness emerged as the most reliable predictor of cognitive failures. We therefore explored bivariate correlations between CFQ scores and the five sub-scales of self-directedness. Correlations are shown in table 5. All sub-scales contributed similarly

to cognitive failure susceptibility, indicating a broad association between self-directedness and cognitive failure.

Table 5: Bivariate correlations between cognitive failure scores and self-directedness subscales (“responsibility” (SD1), “purposefulness” (SD2), “resourcefulness” (SD3), “self-acceptance” (SD4), and “goal-congruent habits” (SD5)).

	SD1	SD2	SD3	SD4	SD5
CFQ Sample 1	-.285**	-.277**	-.289**	-.186**	-.303**
CFQ Sample 2	-.313**	-.320**	-.353**	-.208**	-.350**

** p ≤ .001

4. Discussion

The present study was designed to investigate the relationship between cognitive failure susceptibility as measured by the CFQ and the personality dimensions of the TCI. On the bivariate level, we found significant correlations between CFQ scores and all three character dimensions except for self-transcendence in sample 2 as well as all temperament dimensions except for novelty seeking and reward dependence in sample 2. The highest individual correlations were found for self-directedness (negative association), followed by harm avoidance (positive association). This is in line with previous studies that consistently report a positive relationship between CFQ scores and neuroticism, which unifies both of the two traits (Matthews et al., 1990; Mahone et al., 1998; Wallace et al., 2004; Wilhelm et al., 2010; Klockner & Hicks, 2015) by showing strong negative correlations to SD and strong positive correlations to HA. Interestingly enough, the correlation with self-directedness was nominally higher than the correlation with harm avoidance. This result was further corroborated by the stepwise regression analyses. In both samples, self-directedness had the largest individual impact on variance in cognitive failure susceptibility after controlling for age and sex. In sample 1, self-transcendence, novelty seeking, and harm avoidance had small incremental contributions. In sample 2, such influence was negligible. Importantly, the regression models from one sample predicted cognitive failure scores in the other sample, accounting for 14.8% and 17.4% of the variance respectively.

The self-directedness character trait subsumes dispositions described as self-confidence, responsibility for one's own actions, and self-acceptance. The finding of lower self-directedness in people scoring high on the CFQ is in line with the complaints-hypothesis on neuroticism (Wilhelm et al., 2010), that positions a poor self-image and a lack of self-confidence as driving force behind elevated self-reported cognitive failure levels. This is further supported by previous reports of a relationship between low self-directedness and a strong external locus of control (Langan-Fox et al., 2009). The correlations between CFQ scores and the sub-scales of self-directedness did not favor any aspect of self-directedness as the driving force but rather suggest a broad relationship between the two constructs. The self-directedness character trait has also been discussed in the context of executive functioning in the sense of an executive control component of personality. This idea is based on findings that higher levels of self-directedness relate to better performance in tasks that tap into cognitive control functions (Bergvall et al., 2003; Hori et al., 2012). Higher self-directedness could thus reflect the habitual deployment of cognitive control to stay focused on a task and to attain personal goals. Cognitive failure susceptibility has also been linked to poorer attentional control (Sindermann et al., 2018) and higher tendencies towards Internet Use Disorder, perhaps due to lower self-regulation abilities (Montag et al., 2010; Montag et al., 2011; Sariyska et al., 2014). Future work may want to address the relationship between personality (self-directedness), cognitive control capacity,

and the susceptibility to cognitive failure. Such work would also be of interest with respect to recent investigations with tools from personality network neuroscience (Markett et al., 2018). We have previously linked both individual differences in cognitive failure scores and self-directedness independently to structural and functional connectivity of the brain's salience network (Bey et al., 2015, Prillwitz et al., 2018). The salience network is a multi-purpose brain network that is not only relevant for the processing of salient information but plays also a key role in switching between the default mode network and the fronto-parietal network (Menon, 2011). The present result points towards a presumably shared neural resource of both traits that is worth to explore in future studies. Over-activation within the default mode network has been observed prior to attentional lapses in experimental settings (Weissman et al., 2006). Future work may want to focus on interactions between the default mode and the salience network in the context of habitual differences in character traits to derive a neuropsychological account for cognitive failure susceptibility that is currently missing.

The CFQ is a popular assessment tool in clinical contexts to measure treatment outcome and cognitive symptom severity (Engelberts et al., 2002; Keizer et al., 2003; Westerberg et al., 2007; Bol et al., 2010). It is also used in vocational studies to predict stress-related absences or workplace accidents (Frese, 1991; Wallace & Vodanovich, 2003; Allahyari et al., 2008; Park & Kim, 2013). The present associations between cognitive failure susceptibility and personality is of relevance for these perspectives as they point towards potential risk factors for cognitive failures but also towards measures of resilience. Harm avoidance and self-directedness have both been repeatedly discussed in the context of depression and other mood disorders (Smith et al., 2005; Joseffson et al., 2011; Melchers et al., 2015). In addition to genetic factors (Hahn et al., 2017), self-directedness depends on experience, and first evidence suggests that it can be changed by intervention (Goekopp et al., 2011). Together with the present finding, this would open up an avenue for the improvement of cognitive failure, in case that this would be desirable.

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