Title

The German Three Factor Impulsivity Index: Confirmatory factor analysis and ties to demographic and health-related variables

Authors

Javelle, F
Wiegand, M
Joormann, J
et al.

Publication Date

2021-03-01

DOI

10.1016/j.paid.2020.110470

Peer reviewed

HHS Public Access

Author manuscript

Pers Individ Dif. Author manuscript; available in PMC 2022 February 18.

Published in final edited form as:

Pers Individ Dif. 2021 March ; 171: . doi:10.1016/j.paid.2020.110470.

The German Three Factor Impulsivity Index: Confirmatory factor analysis and ties to demographic and health-related variables

F. Javelle[a,*], **M. Wiegand**[b], **J. Joormann**[c], **K.R. Timpano**[d], **P. Zimmer**[a,e], **S.L. Johnson**[f]

[a]Clinical Exercise-Neuroimmunology Group, Department for Molecular and Cellular Sports Medicine, Institute for Cardiovascular Research and Sports Medicine, German Sport University, Cologne, Germany

[b]Department of Psychology, University of Cologne, Germany

[c]Department of Psychology, Yale University, United States

[d]Department of Psychology, University of Miami, United States

[e]Department for Performance and Health (Sports Medicine), Institute for Sport and Sport Science, Technical University Dortmund, Dortmund, Germany

[f]Department of Psychology, University of California Berkeley, United States

Abstract

A growing body of research has focused on the differentiation of emotion-related versus non-emotion-related impulsivity, assessed by the Three-Factor Impulsivity (TFI) index. The goal of this study is to develop a German TFI index, and to validate the emotion-related impulsivity subscales against indices of substance abuse, physical or psychological disorder, physical exercise, BMI, and hours of sleep. 395 native-German speakers completed the German TFI index and questions on validity indicators online. Factor analyses supported the three-factor structure, including Pervasive Influence of Feelings, Lack of Follow Through, and Feelings Trigger Action. Correlations between factors were higher than in the original work. Both emotion-related impulsivity subscales correlated significantly with psychological disorder, engagement in and minutes of physical exercise per week. When included in multivariate regression models, the three factors explained 3.1%, and 29.2% of variance in amount of exercise per week and psychological disorder, respectively. In sum, findings indicated that the German TFI index has a robust three-factor structure that showed expected links to validity indicators, and novel effects in relation to physical exercise.

[*]Corresponding author at: Nawi Medi Building, 1st floor, Room 155, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany. f.javelle@dshs-koeln.de (F. Javelle).

CRediT authorship contribution statement

F.J did the conceptualization of the study and the project administration. M.W and J.J did the translation – back translation of the Three Factor Impulsivity index. F.J and M.W did the data curation. F.J, M.W and S.J did the data analysis. F.J, M.W, J.J, S.J, P.Z and K.T wrote, reviewed and edited the manuscript.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2020.110470.

Declaration of competing interest

All authors disclose no conflict of interest.

Keywords

Impulsivity; Emotion; Three-factor impulsivity index; German translation; Health

1. Introduction

Impulsivity affects many facets of daily life, and shows links to personality disorders (Mulder et al., 1999), aggression (Barratt et al., 1999), bipolar disorder (Swann et al., 2001), drug abuse and addiction (Whiteside & Lynam, 2003), depression (Carver et al., 2008), and even suicide (Corruble et al., 1999). Almost all definitions of impulsivity recognize its multidimensional nature (e.g., Costa & McCrae, 1990; Gerbing et al., 1987).

Although older impulsivity scales tended to focus on problems with planning, deliberation and attention (Barratt, 1965; Dickman, 1990), newer research documents the importance of impulsivity that occurs in response to states of high emotion, including both negative and positive emotions. In a large-scale study, researchers identified one factor of the UPPS scale, Urgency that reflected the tendency to respond impulsively in the face of negative emotions (Whiteside & Lynam, 2001). This work was followed by the development of the Positive Urgency scale, which covers impulsive responses to positive emotions (Cyders & Smith, 2008). Multiple studies suggest that the Positive and Negative Urgency scales are distinct from other self-rated forms of impulsivity (Cyders et al., 2007; Cyders & Smith, 2008; Johnson et al., 2016). Because the scales form one higher-order factor without regard to valence (Carver et al., 2011; Cyders & Smith, 2008), researchers have used the phrase emotion-related impulsivity (Carver et al., 2008, 2011; Zorrilla & Koob, 2019). Emotion-related impulsivity appears more robustly tied to psychopathology, suicidality and aggression, than are other forms of impulsivity (Berg et al., 2015; Carver & Johnson, 2018; Smith & Cyders, 2016).

One model focuses on failures of top-down control over emotion as a possible mechanism driving emotion-related impulsivity (Carver et al., 2008). Within this model, researchers suggest that the regrettable behavior may reflect reflexive responding to strong emotions (Carver et al., 2008). These reflexive responses are theorized to differ by type of emotion. While reflexive responses to anger may encompass impulsive aggression, reflexive, unconstrained responses to sadness may involve passivity and loss of motivation (Carver et al., 2008).

In support of this theory, Carver et al. (2011) assembled a broad set of items assessing emotion-related impulsivity, reflexive and unconstrained responses to emotion, and non-emotion-related impulsivity. Exploratory and confirmatory factor analysis (CFA) revealed three distinct factors. Feelings Trigger Action reflects rash and regrettable speech and behavior in response to positive and negative emotions (mostly items from the Positive and Negative Urgency scales; Cyders & Smith, 2008). Pervasive Influence of Feelings, though, is more unique among impulsivity scales, in that it reflects the tendency for one's (mostly negative) emotions to influence motivation, self views, and cognitions about the world in an unconstrained manner. Lack of Follow Through covers impulsive responding without regard to emotion, including being distracted easily and failing to complete tasks. Both

emotion-related factors have been validated as related to early trauma, a polymorphism of the serotonin transporter gene, and to internalizing disorders, externalizing disorders, suicidality, and aggression (Auerbach et al., 2017; Carver et al., 2011; Johnson et al., 2017).

Despite increased use of this index, no German version is available. Although other impulsivity scales, including the UPPS (Babayan et al., 2019), exist in German, the Three-Factor Impulsivity (TFI) index, and particularly the Pervasive Influence of Feelings scale, provide more complete coverage of failures of constraint. Thus, our goal was to develop and validate a German TFI index. To do so, we translated and back-translated the items and administered the German translation of the questionnaire to a large German sample. We examined the factor structure of the translated scale via CFA. We validated the scale against variables known to relate to impulsivity, including gender (Weafer & de Wit, 2014), BMI (Sanchez-Roige et al., 2019), age (Eysenck et al., 1985), sleep disturbance (Miller & Rucas, 2012), substance abuse (Whiteside & Lynam, 2003) and psychological disorders (Berg et al., 2015).

Finally, we tested novel links of emotion-related impulsivity with fitness levels, given ties of impulsivity and fitness to serotonergic and dopaminergic systems (Cho et al., 2014; Heijnen et al., 2016). Pilot investigations have shown significant correlations of self-rated impulsivity and behavioral indices of impulsivity (delay discounting) on lack of physical exercise (Sofis et al., 2017) but such work has not considered emotion-related impulsivity. We hypothesized that people who reported higher impulsivity would report less engagement in physical exercise.

2. Materials and methods

All procedures were in accordance with the Declaration of Helsinki and were approved by the University Institutional Review Board before data was collected. Raw data can be requested by emailing the corresponding author. Participants were recruited through online advertising and flyers distributed in Cologne and surroundings and completed online informed consent before beginning study procedures. No rewards were provided. The only inclusion criterion was to be a native-German speaker. Questionnaires were administered online via Qualtrics.

2.1. Participants

Two catch items were embedded within the questionnaire (e.g., “Please answer *I agree* to this item”) to capture random responding. Out of the 421 participants, 26 who answered one or both of these items incorrectly were excluded from analyses. The analyses include 395 native-German speakers (53.6% University students, Table 1).

2.2. Three-Factor Impulsivity index (Carver et al., 2011)

The TFI index consists of 54 items drawn from previously validated subscales (Carver et al., 1988; Cyders et al., 2007; Whiteside & Lynam, 2001) with some newly written items. Items (11 reverse-coded) are rated on a scale ranging from 1 (*I agree a lot*) to 5 (*I don’t agree at all*). Higher scores reflect more impulsivity. In the validation article, three factor scores were drawn from an oblique factor analysis of the subscale scores in a large

sample of undergraduates, and the factor structure was confirmed using structural equation modelling (Carver et al., 2011). After using the scale across multiple samples, the authors recommended the removal of items with significant cross-loadings (Carver, 2017).

Factor one, Pervasive Influence of Feelings includes items drawn from previously validated scales for Negative Generalization (the tendency to overgeneralize from one failure) (Carver et al., 1988), Negative Urgency (Whiteside & Lynam, 2001), and items to capture Sadness Paralysis (lethargy in response to sadness) and Emotions Color Worldview (extremely negative thoughts of self and the world in response to negative emotions). Factor two, Lack of Follow Through, includes items from previously validated scales designed to cover Lack of Perseverance (Whiteside & Lynam, 2001) and Distractibility. The third factor, Feelings Trigger Action, includes items from the previously validated scales for Negative Urgency (Whiteside & Lynam, 2001), Positive Urgency (Cyders et al., 2007), and items to capture Reflexive Reaction to Feelings. In the original validation study, factors showed small to moderate correlations, $r_{Factor\ 1\ and\ 2} = 0.36$; $r_{Factors\ 1\ and\ 3} = 0.34$ *and* $r_{Factors\ 2\ and\ 3} = 0.16$ (Carver et al., 2011). The factor-analytically derived subscales were validated across multiple indices of psychopathology, aggression, and suicidality (Auerbach et al., 2017; Johnson et al., 2013; Johnson et al., 2017).

To develop the German version of the TFI index, two authors translated (MW) and back-translated (JJ) items. Both were fluent in the primary and target languages, and knowledgeable about the questionnaire content (one co-authored the initial scale), and both cultures.

2.3. Demographic variables

Participants were asked to report their age (years), gender (female, male or non-binary/ other), weight (kg) and height (cm).

2.4. Health-related variables

Participants were asked if they had chronic disease and if so, what disease. Experimenters categorized these open-ended responses as psychological or physical disorders. Participants were asked to report their long-term medications, average daily number of hours of sleep in the past month, if they smoked, and engagement (yes/no), number of minutes per week, and intensity (low, moderate, high) of physical exercise in the past month.

2.5. Statistical analysis

Analyses were conducted using SPSS software, version 23.0 (IBM, Armonk, New York) and AMOS. Descriptive statistics (including normalcy and linearity), and adequacy of Cronbach's alpha were examined. To parallel the original validation article (Carver et al., 2011), subscale means were subjected to CFA. Previous work has validated these subscales multiple times in English, as well as the two Urgency and Perseverance subscales in German, and so our goal was not to examine the structure of the subscales, but rather, whether subscales intercorrelations mirrored the English validation article.

Confirmatory factor analysis CFA was conducted with AMOS using maximum likelihood analysis. Comparative Fit Index (CFI), Goodness of Fit Index (GFI) and Root Mean Square Error of Approximation (RMSEA) were used as fit indices, with RMSEA < 0.06 considered very good, and <0.10 acceptable (Schermelleh-Engel et al., 2003). For validity analyses, bivariate correlations, independent *t*-tests and one-way ANOVA/ANCOVA were used to evaluate how TFI factors related to continuous, binary and non-binary categorical variables, respectively, with Bonferonni alpha correction applied family-wise to variable sets of exercise (exercise engagement, amount of exercise and intensity), and disease-related (disease, medication, physical and psychological disorders) and were considered significant at $p < .017$ ($p/n_{\text{overlapping variables}}$). Non-linear age effects were tested with quadratic regressions. Multiple linear (i.e. amount of exercise) and bivariate logistic regression models (i.e. psychological disorder) were constructed using R (version 1.2.1335) to assess the unique and conjoint effects of each impulsivity factor (Field, 2013). The three factors met requirements for multicollinearity (variance inflation factor values<2), tolerance (values>0.2), independence (all Durban-Watson tests results between 1 and 3), and linearity (qqplot, scatterplot and histogram of studentized residuals; Menard, 2011). Semi-partial correlations were used to confirm the unique effect of each predictor.

3. Results

Descriptive statistics, representative items, analysis sample size, and Cronbach's alphas for each subscale are listed in Table 2, and for other variables in Supplementary material A. Psychological disorder, cigarette and drug use variables were binary and so kurtosis estimates reflect this. BMI showed high skew and leptokurtosis and so was examined using nonparametric correlations.

3.1. Confirmatory factor analysis

Communalities all surpassed 0.75, and so no subscales were removed for low communalities.

The first model showed an inadequate fit with an RMSEA>0.10 but both CFI and GFI > 0.90. Two minor corrections were applied. First, because the error terms of two subscales, Positive Urgency and Reflexive Reaction to Feelings (from Feelings Trigger Action), were highly correlated, we integrated this covariance in the model. Second, the original model suffered from a Heywood case (loading scores>1 for the Distraction subscale). Accordingly, as has been recommended when forming a factor with two indicators, items from the Distraction subscale were divided into two parcels, which led to reasonable and high factor loading scores (Fig. 1) (Chen et al., 2001).

With these modifications, the fit indices of this revised model of the German TFI index were deemed acceptable and indicative of good fit (*GFI*: 0.945, *CFI*: 0.954, *RMSEA*: 0.094). Although the CFI was significant ($p < .001$), this was most likely due to the large sample size (Hooper et al., 2008). Correlations among the factor scores were stronger than those observed in the validation article for the English version, with a moderate correlation between the two emotion-related factors, $r_{Factors\ 1vs3} = 0.55$, $p < .001$, $r_{Factors\ 1vs2} = 0.45$, $p < .001$, and $r_{Factors\ 2vs3} = 0.45$, $p < .001$. As the English-language validation sample was

comprised of university students, we tested correlations among factor scores with students only (n = 184); correlations were comparable to our full sample, r's = 0.49 to 0.55.

We also considered a two-factor solution, merging Pervasive Influence of Feelings and Feelings Trigger Action into one emotion-related factor. Although the fit indices were not substantively different from the three factor model (*GFI*: 0.97, *CFI*: 0.98, *RMSEA*: 0.08), the subscale loadings were lower for the emotion-related factor: Generalization = 0.58, Sadness paralysis = 0.55, Reflexive reaction to feelings = 0.51, Emotions color worldview = 0.66, Positive urgency = 0.72, Urgency = 0.88. Accordingly, the three-factor solution is preferable.

3.2. Correlations with demographic and health-related variables

The relation of the TFI factors with demographic and health-related variables is reported in Table 3. Higher Feelings Trigger Action was significantly related to female gender, more psychological disorder, less engagement in, intensity of, and minutes of physical exercise, age, higher BMI and less hours of sleep. Pervasive Influence of Feelings showed a similar profile of significant effects excepting hours of sleep and BMI, and significantly more drug use and long-term medication use for high scorers. As has been shown repeatedly with the English-language TFI, non-emotion-related impulsivity related significantly to fewer outcomes, although tied to more psychological disorder, more drug use, lack of engagement in and minutes of physical exercise.

As age often shows a curvilinear relationship with impulsivity, we tested curvilinear effects beyond the linear effects shown in Table 3 using quadratic regression equations. Curvilinear effects were small but significant, Pervasive Influence of Feelings (r^2 = 0.041, p <.001), Lack of Follow Through (r^2 = 0.032, p < .01), and Feelings Trigger Action (r^2 = 0.037, p < .037).

3.3. Multivariate regression models

As amount of exercise per week (continuous spectrum versus the binary information provided by exercise engagement) and psychological disorder showed significant associations across the three factors, we conducted multiple linear and binomial logistic regression models to evaluate the variance explained by the three factors.

The model with amount of exercise as the outcome explained only R^2 = 3.1% (p < .001) of the variance, with no significant effects of Pervasive Influence of Feelings (*beta* = −30.5, p =.14, *semi-partial r* = 0.08), Lack of Follow Through (*beta* = −35.1, p =.13, *semi-partial r* = 0.08), or Feelings Trigger Action (*beta* = −18.4, p =.47, *semi-partial r* = 0.04).

The model with psychological disorder as the outcome explained R^2 = 29.2% (p < .001) of the variance, with a significant effect of Pervasive Influence of Feelings (*beta* = 2.2, p < .001, *semi-partial r* = −0.21) but not for Lack of Follow Through (*beta* = −0.15, p =.75, *semi-partial r* = −0.01) or Feelings Trigger Action (*beta* = 0.53, p =.40, *semi-partial r* = −0.04).

4. Discussion

In this study, we translated and back-translated a well-validated measure of impulsivity, the TFI, subjected the subscales to factor analysis, and validated against impulsivity-related characteristics. After two minor adjustments to improve model fit (inclusion of one covariance parameter and splitting one subscale to address a Heywood case issue), the German TFI index showed a robust three-factor structure that paralleled the English version. The between-factor correlations were consistent with the English-language scale, with the exception of a stronger correlation between Lack of Follow Through and Feelings Trigger Action in the German version, across our full sample and in a student only subsample (Carver et al., 2011). Our higher correlations could be the result of excluding cross-loading items, as is now recommended (Carver, 2017).

In addition to replicating the factor structure, we validated the impulsivity factors against demographic and health-related variables. Psychological disorder, physical exercise and age were the only variables which showed significant effects across all three impulsivity factors, all in expected directions.

When considered conjointly in a regression model, Pervasive Influence of Feelings was the only significant factor and explained almost 30% of the total variance in psychological disorders. The psychological disorders reported (major depressive disorder, bipolar disorder, post-traumatic stress disorder, borderline personality disorder) often involve intense responses to emotions, and so the importance of Pervasive Influence of Feelings (unconstrained cognitive and motivational responses to emotion) makes sense. Pervasive Influence of Feelings showed also more link to long-term medication use (15% of which were antidepressants). Effects were significant despite the small number of participants who endorsed psychological diagnoses or medication use.

Since impulsivity changes developmentally, linear and curvilinear effects were examined. Impulsivity increased until 35–40 years and then decreased slightly with age.

Female participants endorsed significantly higher emotion-related impulsivity than did male participants consistent with previous effects regarding response inhibition, a key correlate of emotion-related impulsivity (Weafer & de Wit, 2014). Also consistent with previous work with English-language the Perseverance scale, non-emotion-related impulsivity scores did not differ by gender (Cyders, 2013).

Extending previous work linking non-emotion-related impulsivity to sleep disorder frequency (Miller & Rucas, 2012), we found that Pervasive Influence of Feelings related to less sleep. Nevertheless, null correlations of sleep with the two other impulsivity factors were observed, potentially due to the reliance on the number of hours of sleep per day, a poor marker of sleep quality.

Our findings that the German Feelings Trigger Action scale relates to BMI confirms findings from a large-scale study that higher BMI relates to higher UPPS-P scores, which are core to Feelings Trigger Action (Sanchez-Roige et al., 2019).

We also found novel effects of impulsivity on physical exercise. All three-impulsivity factors related to less likelihood of engagement in exercise, and to less time exercising per week. Engaging in regular physical exercise requires commitment and so the link with Perseverance is intuitive. Interestingly, though, emotion-related impulsivity also related to less exercise, and Pervasive Influence of Feelings scores related to lower intensity of exercise. Impulsivity has been tied to the monoamine pathway (Carver et al., 2011; Javelle et al., 2019), and this pathway can be strongly modulated by physical exercise (Małkiewicz et al., 2019; Metcalfe et al., 2018). Physical exercise is also commonly used as a non-pharmacological therapy to reduce impulsivity among children with attention deficit hyperactivity disorder (Cerrillo-Urbina et al., 2015), a finding that could be helpful in considering intervention for emotion-related impulsivity. Although the effect sizes for exercise were not of sufficient magnitude to be significant in a multivariate regression model, further investigations are warranted.

Overall, non-emotion-related impulsivity showed fewer correlations with outcomes than did the emotion-related impulsivity, consistent with previous work. As we were adequately powered to detect small correlations (with $N = 395$, 90% power to detect $r's = 0.16$), the null effects are not likely to reflect statistical power limitations. Rather emotion-related dimensions appear to be related to more outcomes than non-emotion-related impulsivity.

Despite the apparent validity of the German TFI index, we note several limitations of this study. First, our measures of several validity indicators were flawed. For example, a quarter of individuals failed to respond to the question about drug use, potentially due to concerns about reporting illegal behavior despite anonymity; this profile of missing data likely skewed results. Few endorsed other externalizing syndromes, which have been tied to Feelings Trigger Action more than Pervasive Influence of Feelings in previous work. Less than a quarter of our sample was above 35, and only 16 people were obese. Further research with a sample more varied in age, weight, and psychological syndromes is warranted. Second, our reliance on dichotomous variables, and the error variance from our single item coverage of domains, likely minimized the magnitude of correlations with impulsivity. Future work would do well to include validated psychometric measures to assess the pattern of substance use, sleep, physical and psychological health, and physical exercise. Third, the use of self-report questionnaires is dependent on participant insight and willingness to disclose. Finally, even though our goal was to parallel the original TFI index validation process (Carver, 2011), some research suggest that factor analysis at item-level maximizes internal consistency and provides better reliability (Raubenheimer, 2004).

To conclude, factor analysis shows that the German TFI index has a robust three-factor structure, and was validated against key physical and psychological health outcomes. Findings indicate that the German TFI can be used to evaluate important facets of impulsivity in native German speakers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

Auerbach RP, Stewart JG, & Johnson SL (2017). Impulsivity and suicidality in adolescent inpatients. J Abnormal Child Psychology, 45(1), 91–103. 10.1007/s10802-016-0146-8.

Babayan A, Erbey M, Kumral D, Reinelt JD, Reiter AMF, Röbbig J, … Villringer A (2019). Data descriptor: A mind-brain-body dataset of MRI, EEG, cognition, emotion, and peripheral physiology in young and old adults. Scientific Data, 6(1), 1–21. 10.1038/sdata.2018.308. [PubMed: 30647409]

Barratt E (1965). Factor analysis of some psychometric measures of impulsiveness and anxiety. Psychological Reports, 16(2), 547–554. 10.2466/pr0.1965.16.2.547. [PubMed: 14285869]

Barratt ES, Stanford MS, Dowdy L, Liebman MJ, & Kent TA (1999). Impulsive and premeditated aggression: A factor analysis of self- reported acts. Psychiatry Research, 86(2), 163–173. 10.1016/S0165-1781(99)00024-4. [PubMed: 10397418]

Berg JM, Latzman RD, Bliwise NG, & Lilienfeld SO (2015). Parsing the heterogeneity of impulsivity: A meta-analytic review of the behavioral implications of the UPPS for psychopathology. Psychological Assessment, 27(4), 1129–1146. 10.1037/pas0000111. [PubMed: 25822833]

Carver C (2017). Three Factor Impulsivity Index [last revised 7-17-17]. Retrieved 9/5/2019 from https://local.psy.miami.edu/faculty/ccarver/CCimpulsivity.phtml.

Carver CS, & Johnson SL (2018). Impulsive reactivity to emotion and vulnerability to psychopathology. American Psychologist, 73(9), 1067–1078. 10.1037/amp0000387.

Carver CS, Johnson SL, & Joormann J (2008). Serotonergic function, two-mode models of self-regulation, and vulnerability to depression: What depression has in common with impulsive aggression. Psychological Bulletin, 134(6), 912–943. 10.1037/a0013740. [PubMed: 18954161]

Carver CS, Johnson SL, Joormann J, Kim Y, & Nam JY (2011). Serotonin transporter polymorphism interacts with childhood adversity to predict aspects of impulsivity. Psychological Science, 22(5), 589–595. 10.1177/0956797611404085. [PubMed: 21460340]

Carver CS, Voie LL, Kuhl J, & Ganellen RJ (1988). Cognitive concomitants of depression: A further examination of the roles of generalization, high standards, and self-criticism. J Social and Clinical Psychology, 7(4), 350–365. 10.1521/jscp.1988.7.4.350.

Cerrillo-Urbina AJ, García-Hermoso A, Sánchez-López M, Pardo-Guijarro MJ, Santos Gómez JL, & Martínez-Vizcaíno V (2015). The effects of physical exercise in children with attention deficit hyperactivity disorder: A systematic review and meta-analysis of randomized control trials. Child: Care, Health and Development, 41 (6), 779–788. 10.1111/cch.12255.

Chen F, Bollen KA, Paxton P, Curran PJ, & Kirby JB (2001). Improper solutions in structural equation models. Sociological Methods & Research, 29(4), 468–508. 10.1177/0049124101029004003.

Cho HS, Baek DJ, & Baek SS (2014). Effect of exercise on hyperactivity, impulsivity and dopamine D2 receptor expression in the substantia nigra and striatum of spontaneous hypertensive rats. J Exercise Nutrition and Biochemistry, 18 (4), 379–384. 10.5717/jenb.2014.18.4.379.

Corruble E, Damy C, & Guelfi JD (1999). Impulsivity: A relevant dimension in depression regarding suicide attempts? J Affective Disorders, 53(3), 211–215. 10.1016/S0165-0327(98)00130-X.

Costa PT, & McCrae RR (1990). Personality disorders and the five-factor model of personality. J Personality Disorders, 4(4), 362–371. 10.1521/pedi.1990.4.4.362.

Cyders MA (2013). Impulsivity and the sexes: Measurement and structural invariance of the UPPS-P Impulsive Behavior Scale. Assessment, 20(1), 86–97. 10.1177/1073191111428762. [PubMed: 22096214]

Cyders MA, & Smith GT (2008). Emotion-based dispositions to rash action: Positive and negative urgency. Psychological Bulletin, 134(6), 807–828. 10.1037/a0013341. [PubMed: 18954158]

Cyders MA, Smith GT, Spillane NS, Fischer S, Annus AM, & Peterson C (2007). Integration of impulsivity and positive mood to predict risky behavior: Development and validation of a measure of positive urgency. Psychological Assessment, 19(1), 107–118. 10.1037/1040-3590.19.1.107. [PubMed: 17371126]

Dickman SJ (1990). Functional and dysfunctional impulsivity: Personality and cognitive correlates. Journal of Personality and Social Psychology, 58(1), 95–102. 10.1037/0022-3514.58.1.95. [PubMed: 2308076]

Eysenck SBG, Pearson PR, Easting G, & Allsopp JF (1985). Age norms for impulsiveness, venturesomeness and empathy in adults. Personality and Individual Differences, 6(5), 613–619.10.1016/0191-8869(85)90011-X

Field AM (2013). Discovering statistics using R. Sage Publications.

Gerbing DW, Patton JH, & Ahadi SA (1987). Toward a conceptualization of impulsivity: Components across the behavioral and self-report domains. Multivariate Behavioral Research, 22(3), 357–379. 10.1207/s15327906mbr2203_6. [PubMed: 26776381]

Heijnen S, Hommel B, Kibele A, & Colzato LS (2016). Neuromodulation of aerobic exercise-A review. Frontiers in Psychology, 22, 357–379. 10.3389/fpsyg.2015.01890.

Hooper D, Coughlan J, Mullen MR, Mullen J, Hooper D, Coughlan J, & Mullen MR (2008). Structural equation modelling: Guidelines for determining model fit structural equation modelling: Guidelines for determining model fit. Dublin Institute of Technology, 6(1), 53–60. 10.21427/d7cf7r.

Javelle F, Li D, Zimmer P, & Johnson SL (2019). Dietary intake of tryptophan tied emotion-related impulsivity in humans. Int J Vitamin and Nutrition Research, 1–8. 10.1024/0300-9831/a000608.

Johnson SL, Carver CS, Mulé S, & Joormann J (2013). Impulsivity and risk for mania: Towards greater specificity. Psychology and Psychotherapy: Theory, Research and Practice, 86(4), 401–412. 10.1111/j.2044-8341.2012.02078.x.

Johnson SL, Tharp JA, Peckham AD, Carver CS, & Haase CM (2017). A path model of different forms of impulsivity with externalizing and internalizing psychopathology: Towards greater specificity. Brit J Clinical Psychology, 56(3), 235–252. 10.1111/bjc.12135.

Johnson SL, Tharp JA, Peckham AD, Sanchez AH, & Carver CS (2016). Positive urgency is related to difficulty inhibiting prepotent responses. Emotion, 16 (5), 750–759. 10.1037/emo0000182. [PubMed: 27064288]

Małkiewicz MA, Szarmach A, Sabisz A, Cubała WJ, Szurowska E, & Winklewski PJ (2019). Blood-brain barrier permeability and physical exercise. Journal of Neuroinflammation, 16(1), 1–16. 10.1186/s12974-019-1403-x. [PubMed: 30606213]

Menard S (2011). Applied logistic regression analysis. SAGE Publications, Inc. 10.4135/9781412983433.

Metcalfe A, Koliamitra C, Javelle F, Bloch W, & Zimmer P (2018). Acute and chronic effects of exercise on the kynurenine pathway in humans – A brief review and future perspectives. Physiology and Behavior, 194, 583–587. 10.1016/j.physbeh.2018.07.015. [PubMed: 30031753]

Miller AA, & Rucas SL (2012). Sleep-wake state tradeoffs, impulsivity and life history theory. Evolutionary Psychology, 10(2), 173–186. 10.1177/147470491201000201. [PubMed: 22947632]

Mulder RT, Joyce PR, Sullivan PF, Bulik CM, & Carter FA (1999). The relationship among three models of personality psychopathology: DSM-III-R personality disorder, TCI scores and DSQ defences. Psychological Medicine, 29(4), 943–951. 10.1017/S0033291799008533. [PubMed: 10473321]

Raubenheimer J (2004). An item selection procedure to maximise scale reliability and validity. SA J Industrial Psychology, 30(4), 168–174. 10.4102/sajip.v30i4.168.

Sanchez-Roige S, Fontanillas P, Elson SL, Gray JC, De Wit H, MacKillop J, & Palmer AA (2019). Genome-wide association studies of impulsive personality traits (BIS-11 and UPPS-P) and drug experimentation in up to 22,861 adult research participants identify loci in the CACNA1I and CADM2 genes. The Journal of Neuroscience, 39(13), 2562–2572. 10.1523/JNEUROSCI.2662-18.2019. [PubMed: 30718321]

Schermelleh-Engel K, Moosbrugger H, & Müller H (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. Methods of Psychological Research Online, 8(2), 23–74.

Smith GT, & Cyders MA (2016). Integrating affect and impulsivity: The role of positive and negative urgency in substance use risk. Drug and Alcohol Dependence, 163(1), 3–12. 10.1016/j.drugalcdep.2015.08.038.

Sofis MJ, Carrillo A, & Jarmolowicz DP (2017). Maintained physical activity induced changes in delay discounting. Behavior Modification, 41(4), 499–528. 10.1177/0145445516685047. [PubMed: 28033718]

Swann AC, Anderson JC, Dougherty DM, & Moeller FG (2001). Measurement of inter-episode impulsivity in bipolar disorder. Psychiatry Research, 101(2), 195–197. 10.1016/S0165-1781(00)00249-3. [PubMed: 11286822]

Weafer J, & de Wit H (2014). Sex differences in impulsive action and impulsive choice. Addictive Behaviors, 39(11), 1573–1579. 10.1016/j.addbeh.2013.10.033. [PubMed: 24286704]

Whiteside SP, & Lynam DR (2001). The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. Personality and Individual Differences, 30(4), 669–689. 10.1016/S0191-8869(00)00064-7.

Whiteside SP, & Lynam DR (2003). Understanding the role of impulsivity and externalizing psychopathology in alcohol abuse: Application of the UPPS impulsive behavior scale. Experimental and Clinical Psychopharmacology, 11(3), 210–217. 10.1037/1064-1297.11.3.210. [PubMed: 12940500]

Zorrilla EP, & Koob GF (2019). Impulsivity derived from the dark side: Neurocircuits that contribute to negative urgency. Frontiers in Behavioral Neuroscience, 13(136), 1–15. 10.3389/fnbeh.2019.00136. [PubMed: 30697155]

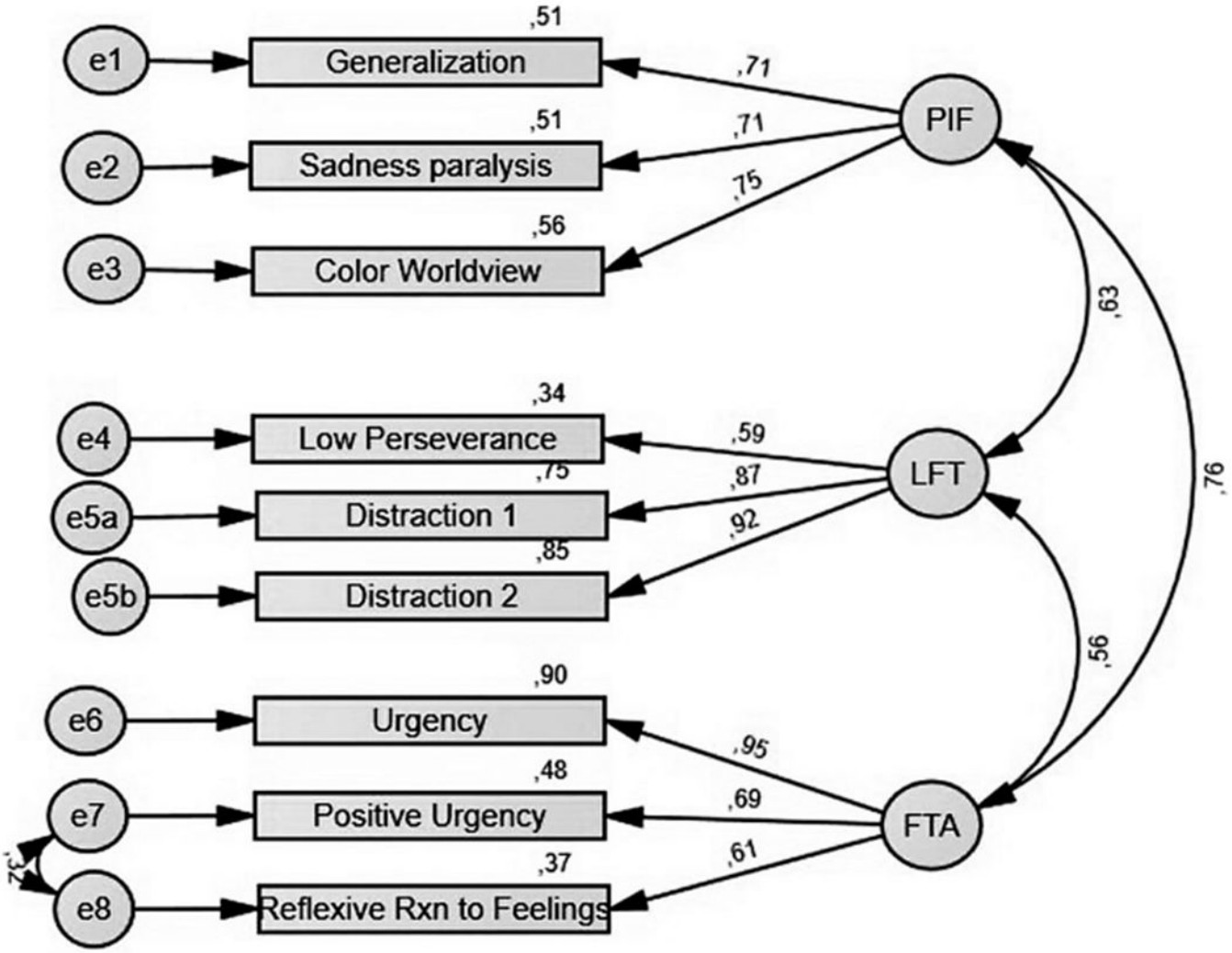

Fig. 1.
German TFI index CFA results and loading scores.

Table 1

Participant characteristics.

Categorical variables			
	Not available	**Groups**	**N**
Gender	16 (4.1%)	Females	236 (59.7%)
		Males	143 (36.2%)
Disorders	0 (0%)	Psychological	14 (21.9%)
		Physical	50 (78.1%)
Long-term medication	11 (2.8%)	Yes	55 (13.9%)
		No	329 (83.3%)
Cigarette use	6 (1.5%)	Yes	43 (10.9%)
		No	346 (87.6%)
Drug use	98 (24.8%)	Yes	12 (3%)
		No	285 (72.2%)
Physical exercise intensity	9 (3%)	High	77 (25.6%)
		Moderate	177 (58.8%)
		Low	38 (12.6%)

Continuous variables			
	Mean	**SD**	**Range**
Age (y)	31.2	12.5	17–71
BMI (kg/m^2)	23.8	4.2	16.4–55.6
Sleep (h/day)	7.3	0.96	4–10
Exercise time (minutes/week)	226.3	238.0	0–1260

Table 2

Representative items and Cronbach's alpha for the TFI index subscales.

Subscale	α	Number of items	Mean	SD	Representative item
Urgency	0.89	12	2.75	0.70	"It is hard for me to resist acting on my feelings."
Positive urgency	0.80	7	2.59	0.71	"When I am really excited, I tend not to think of the consequences of my actions."
Reflexive reaction to feelings	0.82	7	2.91	0.66	"When I have an emotional reaction to something, I often act without thinking."
Negative generalization	0.82	4	2.91	0.92	"When even one thing goes wrong I begin to wonder if I can do well at anything at all."
Sadness paralysis	0.75	2	2.72	1.00	"When I feel sad, it paralyzes me."
Emotions color worldview	0.80	3	3.09	0.91	"When I have emotional experiences, they strongly influence how I look at life."
(Lack of) perseverance	0.84	10	2.26	0.61	"I am a productive person who always gets the job done." [reverse-scored]
Distractibility	0.90	9	2.85	0.75	"I am easily distracted by stray thoughts."

Table 3

TFI subscale relations with demographic and health-related variables.

	Pervasive influence of feelings	Lack of follow through	Feelings trigger action
Binary categorial variables examined using *t*-tests			
Gender (Female>Male)	t(377) = 4.21 ** d = 0.45	t(377) = −0.92 d = 0.01	t(377) = 3.51 ** d = 0.37
Psychological disorder (Yes>No)	t(382) = 6.05 *** d = 1.78	t(382) = 3.22 *** d = 0.91	t(382) = 3.95 *** d = 1.06
Long-term medication (Yes>No)	t(382) = 2.76 ** d = 0.38	t(382) = 0.32 d = 0.02	t(382) = 1.91 d = 0.26
Cigarette use (Yes/No)	t(387) = 0.33 d = 0.05	t(387) = −0.22 d = 0.03	t(387) = −0.18 d = 0.03
Drug use (Yes>No)	t(295) = 3.45 ** d = 1.04	t(295) = 3.35 ** d = 0.94	t(295) = 1.65 d = 0.53
Physical exercise (No>Yes)	t(369) = −2.81 ** d = 0.35	t(369) = −2.98 ** d = 0.38	t(369) = −3.17 ** d = 0.39
Non-binary categorial variables examined using ANOVA			
Physical disorder[a] (Yes>No)	F(3,381) = 0.58 ηp^2=0.020	F(3,381) = 2.06 ηp^2=0.171	F(3,381) = 1.40 ηp^2=0.042
Physical exercise intensity (Low>Moderate>High intensity)	F(2,289) = 3.63 ** **ηp^2=0.025**	F(2,289) = 2.49 ηp^2=0.017	F(2,289) = 1.44 ηp^2=0.010
Continuous variables examined using r			
Age	−0.06	−0.13 *	−0.07
BMI[b]	0.02	0.09	0.13 *
Minutes of physical exercise	−0.17 ***	−0.17 **	−0.14 **
Nightly hours of sleep	0.01	0.09	−0.17 ***

* $p < .05$.

** $p < .01$.

*** $p < 0.001$ – np^2: partial eta squared.

[a] To rule out possible confounds, age and BMI were controlled using Analysis of Covariance.

[b] Given normative age and gender effects on BMI, partial r controlling for age and gender.