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1 Trait Self-Control and Self-Discipline: Structure, Validity, and Invariance Across
2 National Groups

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Abstract

The aim of the present study was to test the validity of the Brief Self-Control Scale (BSCS; Tangney, Baumeister and Boone 2004) including its dimensional structure based on competing one- and two-factor models, discriminant validity from the conceptually-related self-discipline construct, invariance across multiple samples from different national groups, and predictive validity with respect to health-related behaviors. Samples of undergraduate students (total $N = 1282$) from four national groups completed the brief self-control scale, the self-discipline scale from the NEO-PI-R, and self-report measures of binge drinking, exercise, and healthy eating. Confirmatory factor analytic models supported a two-factor structure of self-control encompassing restraint and non-impulsivity components. The model exhibited good fit in all samples and invariance of factor loadings in multi-sample analysis. The restraint and non-impulsivity components exhibited discriminant validity and were also distinct from self-discipline. Structural equation models revealed that non-impulsivity predicted binge drinking in three of the samples, and restraint predicted exercise in two samples, with no role for self-discipline. Results point to a multi-dimensional structure for trait self-control consistent with previous theory separating impulsive- and control-related components.

Keywords: Self-control; self-discipline; self-regulation; restraint; impulsivity

1 Interest in self-control has been spurred by a burgeoning body of research that has
2 positively linked self-control and associated constructs with adaptive outcomes in
3 multiple domains. Good self-control is linked with better performance in school,
4 university, and the workplace, better social functioning and cohesive relationships, less
5 psychopathology and susceptibility to crime, delinquency, and drug abuse, and better
6 physical and mental health (de Ridder et al., 2012; Hamilton, Fleig, & Hagger, 2018;
7 Tangney et al., 2004). Analogously, poor self-control is associated with poorer
8 functioning and maladaptive outcomes.

9 Despite the proliferation of evidence demonstrating correlations between self-
10 control and adoptive outcomes, there is considerable variability in the conceptualization
11 and measurement of self-control. An ongoing debate in the scientific literature is whether
12 self-control is unidimensional or comprises multiple domains, and this has been reflected
13 in measures developed to tap self-control (de Vries and van Gelder 2013(de Vries & van
14 Gelder, 2013; Maloney, Grawitch, & Barber, 2012; Tangney et al., 2004; Williams,
15 Fletcher, & Ronan, 2007). Furthermore, there are a number of terms that have been
16 applied to the domain of self-control and have often been used synonymously such as
17 willpower, self-discipline, response inhibition, and impulse control. These issues present
18 problems when attempting to ascertain the true nature of associations between self-
19 control and key outcomes, and, by implication, the development of fit-for-purpose tests
20 of the mechanisms by which self-control impacts behavior, and interventions or
21 recommendations for practitioners.

22 An important endeavor in research on self-control is to ensure that measures exhibit
23 adequate construct validity, internal consistency, discriminant validity from conceptually
24 related but distinct constructs, and predictive and nomological validity, particularly
25 relative to behavior. The purpose of the current study is to assess the validity of the Brief

1 Self-Control Scale (BSCS; Tangney et al., 2004), a leading self-report measure of trait
2 self-control. We will test the construct and factorial validity of the measure, its
3 dimensional nature including uni- and multidimensional conceptualizations based on
4 theories of self-control, its discriminant validity from the conceptually-related measure
5 of self-discipline from the conscientiousness scale of the revised NEO personality
6 inventory (NEO-PI-R; McCrae & Costa Jr, 2004), its generalizability across multiple
7 samples from different national groups, and the predictive validity of the measure with
8 respect to health-related behaviors. The research will add to the literature by
9 demonstrating whether or not the measure exhibits adequate validity and is fit-for-
10 purpose when it comes to assessing self-control in multiple samples and behavioral
11 contexts.

12 *Trait self-control measurement*

13 Self-control has typically been conceptualized as a generalized tendency to engage
14 in conscious, deliberative control over actions and suppress impulsive, habitual, well-
15 learned dominant responses that occur with little thought or conscious intervention. These
16 conceptualizations are reflected in a number of theories and models of self-control.
17 Metcalfe and Mischel's (1999) 'hot' and 'cool' pathways to action and Strack and
18 Deutch's (2004) 'impulsive' and 'reflective' processes are two examples. The 'hot' or
19 'impulsive' components reflect emotive, spontaneous responses to stimuli driven by well-
20 learned cue-response pairings with little conscious control. In contrast, the 'cool' or
21 'reflective' components reflect reasoned, deliberative processes that involve effortful,
22 conscious control over actions. Individuals with high trait self-control tend to be more
23 effective in enacting the 'cool' or 'reflective' pathway and, therefore, exert effective
24 control over actions. Theories of self-control also suggest that individuals with high trait
25 self-control are also more effective in structuring their environment so as to reduce the

1 potential for derailing circumstances such as cues to impulsive behaviors or competing
2 courses of action to interfere with goal-directed behaviors. For example, Gottfredson and
3 Hirschi (1990) suggest that the mechanism by which these traits lead to more effective
4 self-control is through better capacity to organize and structure long-term goals, and
5 recognize and predict the benefits and costs of acting. Consistent with this proposal,
6 research has indicated that individuals high in trait self-control ironically tend to exert
7 less self-control than those low in trait self-control, suggesting that individuals with high
8 self-control structure their goals and behaviors in such a way to reduce the use of self-
9 control by avoiding temptations and relying on habitual enactment of goal-directed
10 behaviors (Ent, Baumeister, & Tice, 2015; Galla & Duckworth, 2015). Importantly, trait
11 self-control, like many personality and individual difference constructs, has been
12 conceptualized as domain-general and, therefore, the benefits of good self-control and
13 maladaptive consequences of poor self-control are likely to generalize across multiple
14 contexts and behaviors. Effects of self-control are also expected to generalize across
15 multiple populations and national groups.

16 Several prominent self-report measures of trait self-control have been developed.
17 Some have conceptualized self-control as a unitary generalized construct (e.g.,
18 Forstmeier, Drobetz, & Maercker, 2011; Marcus, 2003; Tangney et al., 2004), while
19 others have developed multi-dimensional measures that identify specific facets that
20 pertain to the overall self-control construct (e.g., Grasmick, Tittle, Bursik Jr., & Arneklev,
21 1993; Neal & Carey, 2005). Although many measures align with different theoretical
22 perspectives on self-control, there are frequent overlaps among item content, and
23 correlations among the measures have suggested considerable shared variance. Recent
24 analyses have indicated that even though many of the unidimensional self-control scales
25 purport to contain items that capture the essence of a global self-control construct, factor

1 analyses have indicated that separable underlying dimensions clearly exist (e.g., Allom,
2 Panetta, Mullan, & Hagger, 2016; de Ridder, de Boer, Lugtig, Bakker, & van Hooft, 2011;
3 Maloney et al., 2012). The identification and isolation of the components of self-control
4 may shed light on its conceptualization, how it may be operationalized in theory and
5 empirical research and provide further evidence for the mechanisms and pathways by
6 which it relates to behavioral outcomes.

7 Recently, research has examined the dimensionality of the brief version of the self-
8 control scale, a measure that has been frequently used to assess self-control in the extant
9 literature (e.g., Lindner, Nagy, & Retelsdorf, 2015). Maloney et al. (2012) proposed a
10 two-dimensional structure with one factor comprising items that reflected disciplined
11 control over responses and actions, termed *restraint*, and another factor that reflected the
12 tendency to be spontaneous or to act on the basis of intuition, heuristics, and well-learned
13 cue-response tendencies, termed *impulsivity*. While both capacity for restraint and
14 impulsive tendency are both defining characteristics of self-control, researchers using the
15 Tangney et al. (2004) BSCS recognized differential associations with conceptually
16 related constructs. From a theoretical perspective, the restraint and impulsivity
17 conceptualization is consistent with the ‘hot’ vs. ‘cool’ distinction, which suggests
18 affective- and cognitive-mediated pathways to action, such that good self-control is
19 dependent on the extent to which the cognitive restraint system is able to ‘put the brakes
20 on’ affectively-driven impulsive tendencies (Carver, 2005; Hofmann et al., 2009).
21 Maloney et al. (2012) found support for their proposed two factor structure, that made a
22 clear distinction between items reflecting the *restraint* and *impulsivity* components.
23 Furthermore, they found differential prediction of the scales with impulsivity predicting
24 poor workplace practices and restraint predicting emotional exhaustion. This pattern of

1 results is consistent with Metcalfe and Mischel's (1999) distinction and those suggested
2 by others.

3 In a similar approach, de Ridder et al. (2011) conducted an analysis to identify
4 inhibitory and initiatory dimensions of trait self-control based on the brief self-control
5 scale. They surmised that individuals have tendencies to exert self-control for two
6 different kinds of behavioral response: those that require inhibiting automated response
7 tendencies, or *inhibition* and those that required active and deliberative engagement in
8 behaviors or *initiation*. Again, with reference to Metcalfe and Mischel's (1999) 'hot' and
9 'cool' distinction indicating that inhibiting responses is almost always to service some
10 sort of long-term, delayed goal which incurs a short term cost, not only in terms of
11 delaying immediate gratification, but also in investing effort in behaviors that will assist
12 in reaching that goal. Following a systematic classification of items from the brief self-
13 control scale, de Ridder et al. (2012) found support for a distinct factor structure and also
14 demonstrated that the inhibitory factor was more strongly related to maladaptive,
15 undesirable health-related outcomes i.e. behaviors closely linked to impulse control that
16 require desistence for improved outcomes (e.g., smoking cigarettes and binge drinking),
17 while the initiatory factor was more strongly associated with adaptive, desirable
18 behaviors i.e. behaviors in which engagement is necessary for better outcomes (e.g.,
19 physical activity and studying). It is important to note that while there seems to be
20 common theoretical underpinning and conceptual bases for the restraint or inhibition and
21 impulsivity or initiation components from Maloney et al.'s (2012) and de Ridder et al.'s
22 (2011) analyses, and considerable overlap in the items identified to delineate the two
23 components, they were not identical in terms of the exact item make up. This means that
24 the two factor structures should not be considered equivalent, and which

1 conceptualization most effectively captures the underlying structure of self-control has
2 yet to be resolved.

3 A related issue for the trait self-control scale is the problems associated with
4 redundancy across existing scales that may be tapping the same construct. This presents
5 considerable challenges for researchers seeking to identify a valid and reliable measure
6 of self-control that will be fit-for-purpose in assessing self-control. An imperative,
7 therefore, is to establish the extent to which the measure of self-control exhibits
8 discriminant validity from other measures that tap closely-related constructs. A prominent
9 candidate likely to be closely associated with trait self-control is self-discipline, a sub-
10 facet of the conscientiousness scale from NEO-PI-R (McCrae & Costa Jr, 2004). Self-
11 discipline is defined as individual's capacity to actively work toward long-term goals and
12 to resist temptations. Unsurprisingly, self-discipline shares many of the defining
13 characteristics of self-control as captured by the BSCS (Tangney et al., 2004), particularly
14 the restraint or inhibitory components outlined in Maloney et al.'s and de Ridder et al.'s
15 analyses. Similarity can also be observed at the item level. For example, items 9
16 ("Pleasure and fun sometimes keep me from getting work done") and 11 ("I am able to
17 work effectively toward long-term goals") from the BSCS bear close resemblance with
18 items 3 ("I find it difficult to get down to work") and 10 ("I tend to carry out my plans"),
19 respectively, from the self-discipline scale of the NEO-PI-R. This raises concerns as to
20 whether the potential overlap self-discipline and components of self-control represent an
21 example a 'jangle' fallacy (Block, 1995; Hagger, 2014). That is, constructs with the same
22 underlying content labelled differently. Such phenomena present problems for
23 researchers: the introduction of redundancy impedes scientific progress by causing
24 conceptual confusion. There is, therefore, a need for resolution in terms of the measures
25 of self-control and self-discipline which have ostensibly similar content but have typically

1 been tapped with different scales and referred to using different terminology (Hagger &
2 Hamilton, 2018). Examining the discriminant validity of a leading measure of self-
3 control, such as the brief self-control scale, and the facet of self-discipline will attempt to
4 identify the level of redundancy and, if substantial overlap exists, may help restore some
5 parsimony to the terminology and measurement of these constructs.

6 The purpose of the present study is to examine the construct, discriminant, and
7 predictive validity of the brief self-control and self-discipline scales in multiple samples.
8 Specifically, the research aims to identify the dimensional structure of the brief self-
9 control scale, testing the unidimensional model proposed by Tangney et al., as well as
10 alternative two-dimensional models comprising restraint and impulsivity dimensions
11 (Maloney et al., 2012) and inhibition and initiation dimensions (de Ridder et al., 2011).
12 In addition, the discriminant validity of the unidimensional and multi-dimensional scales
13 will also be tested alongside the self-discipline facet from the conscientiousness scale of
14 the NEO-PI-R. Finally, we will test the predictive validity of the scales in accounting for
15 variance in three self-reported health-related behaviors likely related to self-control:
16 binge drinking, exercise, and healthy eating. We hypothesize that the Maloney et al.
17 (2012) and de Ridder et al. (2011) two-factor solutions for the BSCS will be superior to
18 the one-dimensional model. We also expect to identify the factor structure that exhibits
19 optimal fit in multiple samples from different national groups, and for the structure to
20 exhibit invariance across samples. In addition, while we expected components of the
21 BSCS to correlate significantly with the self-discipline scale, we predicted that the scales
22 would exhibit discriminant validity. Finally, we expect the initiation or non-impulsivity
23 components of the two-factor self-control models to be positively related to adaptive
24 health-related outcomes (exercise and healthy eating) and negatively related to health
25 behaviors for which disengagement is more adaptive (binge drinking). In contrast we

1 expected the opposite pattern of effects for the inhibition or restraint components with
2 respect to these behaviors.

3 Method

4 *Participants*

5 Participants were first-year university students from Universities in Estonia (N =
6 347, M age = 28.40, SD = 7.95, 123 males and 224 females), Luxembourg (N = 207, M
7 age = 22.34, SD = 2.16, 70 males and 137 females), Spain (N = 291, M age = 22.34, SD
8 = 3.41, 106 males and 185 females), and the United Kingdom (N = 437, M age = 20.80,
9 SD = 2.55, 79 males, 337 females and 21 not reported). Students were majoring in
10 psychology and were recruited at the request of their instructors during university class
11 time.

12 *Measures*

13 Self-control and self-discipline constructs were measured using the BSCS
14 developed by Tangney et al. (2004) and the items from the self-discipline subscale of the
15 consciousness domain of the NEO-PI-R available from the International Personality Item
16 Pool (IPIP, 2017). Estonian, French (Luxembourg), and Spanish versions of the scales
17 were developed using standardized back-translation techniques (Bracken & Barona,
18 1991). An initial translation was vetted by two independent and proficient bilingual
19 translators who translated the questionnaires back into English. We then compared the
20 back-translated versions with the original English version for errors, biases, and
21 incongruences. These were removed in further back-translations by the translators in an
22 iterative process repeated until the versions were semantically identical.

23 *Trait Self-Control.* The BSCS comprises 13 items (e.g., “I am good at resisting
24 temptation”) with responses made on five-point scales (1 = *not at all* and 5 = *very much*).
25 The full scale is presented in Appendix A (supplemental materials).

1 *Self-Discipline*. The self-discipline scale comprises 10 items (e.g., “I start tasks right
2 away) with responses made on five-point scales anchored by (1 = *strongly disagree* and
3 5 = *strongly agree*). The full scale is presented in Appendix B (supplemental materials).

4 *Health-related behaviors*. Participants completed a series of two-item measures of
5 their recent engagement in three health related behaviors relevant to the undergraduate
6 student population: frequency of binge drinking, exercise, and eating a healthy diet.
7 Participants self-reported how frequently they exceeded guideline limits of alcohol in the
8 previous four weeks on two items (e.g., “In the course of the past four weeks, how often
9 have you engaged in binge drinking (i.e., consumed over the levels of alcohol intake given
10 above in a single ‘session’)?” The items were preceded by the definition of binge
11 drinking: “Binge drinking is considered drinking 10 units of alcohol (equivalent to 5
12 ‘pints’ (approx. half-liter glasses) of normal strength beer or 10 spirits or liqueur ‘shots’
13 or measures) for men or 7 units of alcohol (equivalent to 3½ pints (approx. half-liter
14 glasses) or 7 spirits or liqueur ‘shots’ or measures) for women in any *single* ‘session’”.
15 Self-reported exercise behavior during leisure-time was measured using an adapted
16 version of Godin and Shepherd’s (1985) Leisure-Time Exercise Questionnaire (LTEQ).
17 Participants rated their four-week behavioral frequency on two items (e.g., “In the course
18 of the past two weeks, how often have you participated in vigorous physical activities for
19 more than 20 minutes at a time?”) using six-point Likert scales with scale endpoints *never*
20 (1) and *everyday* (6). Participants rated the frequency with which they had watched their
21 diet for health reasons in the previous week on two items (e.g. “In the course of the past
22 four weeks, how often have you watched your diet at mealtimes and when snacking?”)
23 using six-point Likert scales with scale endpoints *never* (1) and *everyday* (6). All three
24 behavioral measures have been used to indicate latent measures of exercise, following a
25 healthy diet, and binge drinking with high factor loadings and average variance extracted

1 in previous studies providing support for their construct validity and internal consistency
2 (Arnautovska, Fleig, O’Callaghan, & Hamilton, 2017; Hagger & Chatzisarantis, 2005;
3 Hagger et al., 2012).

4 *Procedure*

5 Clearance from the Institutional Review Boards of each university was obtained
6 prior to data collection. Data were collected during university seminars and lectures with
7 participants being asked to participate by their instructor. Prior to data collection,
8 participants were informed that they were being asked to participate in a study on
9 personality and asked to complete an informed consent form. Measures were
10 administered in sealed envelopes and participants were asked to complete all measures
11 including demographic variables. They were also informed that responses were unique to
12 individuals and asked not to confer with other students while completing the measures.

13 *Data analysis¹*

14 Confirmatory factor analysis (CFA) was conducted to test the factorial validity of
15 Tangney et al.’s (2004) one-factor model of the brief self-control scale, Maloney et al.’s
16 (2012) and de Ridder et al.’s (2011) two-factor models of the same scale, and the one-
17 factor model of the self-discipline scale. Models were estimated using the Mplus 7.31
18 (Muthén & Muthén, 2015) software using a maximum likelihood estimation method and
19 robust standard errors (Satorra & Bentler, 1988). Goodness of fit of the models with the
20 data was tested using multiple fit indices, including the scaled comparative fit index (CFI),
21 root mean square error of approximation (RMSEA) and its 90% confidence interval, and
22 standardized root mean square residual (SRMSR). The model fit was considered
23 acceptable if the CFI exceeded .90, SRMSR was equal to or below .05, and the RMSEA
24 was equal to or below .08 with narrow 90% confidence intervals (Hu & Bentler, 1999).

¹Data files, analysis scripts and output used in our data analyses are provided on the Open Science Framework Project for this study: <https://osf.io/r36jt/>

1 We also examined the solution estimates of these models including the factor loadings,
2 average variance extracted, and Cronbach alpha and composite reliability statistics. Based
3 on these statistics we identified the model for the BSCS that was most optimal in
4 representing the data across the four samples for use in subsequent analyses.

5 Measurement invariance of the selected model for the BSCS and one-factor model
6 of the self-discipline scale across national samples was tested using multi-group CFA.
7 Three levels of measurement invariance were examined by progressively constraining the
8 parameter estimates of the models to be equal cross the groups, in order to demonstrate
9 configural invariance (no equality constraints), metric invariance (factor loadings
10 constrained to equality), and strong invariance (factor loadings and intercepts constrained
11 to equality) (Byrne, Shavelson, & Muthén, 1989). Full measurement invariance was
12 supported when the fit of the restricted metric and strong invariance models did not differ
13 substantially from the configural model, marked by a change in the value of CFI by less
14 than .01 (Cheung & Rensvold, 2002). Partial metric invariance was demonstrated when
15 change in CFI was less than .01 after removing equality constraints with the highest
16 modification indices.

17 Discriminant validity of subscales from the selected two-factor model of BSCS
18 and the self-discipline factor was assessed by estimating three-factor CFA models in each
19 sample. Discriminant validity of the factors was supported if the 95% confidence interval
20 of the correlation between the factors did not encompass unity and if removal of a
21 constraint fixing the factor correlation to unity resulted in a significant change in model
22 fit according to the Wald test.

23 We examined the predictive validity of the self-control and self-discipline scales
24 using structural equation modelling. Constructs from the selected two-factor model of the
25 BSCS and the self-discipline construct were set as predictors of self-reported binge

1 drinking, exercise, and healthy eating. Specifically, latent factors representing the
2 subscales of adequately fitting two-factor model of the brief-trait self-control scale and
3 the self-control factors were set as predictors of each health-related behavior. Adequacy
4 of the models in accounting for the data was evaluated using the same criteria used to
5 evaluate the CFA models. Structural parameters with their associated confidence intervals
6 were used to evaluate the relative contribution of each factor in the prediction of each
7 health behavior.

8 Results

9 *Preliminary Analyses*

10 Distributional properties of the data set from each national sample were examined
11 prior to data analysis. Although there are no established cutoff values on the acceptable
12 percentage of missing data, rates of missing data should be kept to a minimum (e.g., 5%
13 or less; Dong & Peng, 2013). There were no missing data points in the datasets from
14 Estonia and Luxemburg, only one missing data point in the Spanish dataset, and no
15 systematic pattern of missing the in the UK dataset (missing data = 2.42%). Missing data
16 was imputed using full-information maximum likelihood estimation in Mplus. Skewness
17 and kurtosis values were within acceptable cutoff values for items from the brief self-
18 control and self-discipline scales indicating few instances of departures from normality.

19 *Factorial Validity*

20 Goodness-of-fit of the one- and two-factor CFA models of self-control for the full
21 sample and each national sample are presented in Table 1. Solution estimates for the full
22 sample and each individual sample are presented in Tables 2 and 3, respectively. The
23 Maloney et al. two-factor model consistently yielded acceptable fit with the data in the
24 full sample and each of the four national samples based on the multiple criteria for
25 goodness-of-fit (CFI range = .92 to .97; RMSEA range = .034 to .070; SRMSR range

1 = .036 to .082). By comparison, indices for the Tangney et al. (CFI range = .71 to .84;
2 RMSEA range = .079 to .099; SRMSR range = .058 to .090) and de Ridder et al. (CFI
3 range = .74 to .94; RMSEA range = .051 to .103; SRMSR range = .043 to .094) models
4 fell below acceptable values in the full sample and most of the national samples.
5 Examination of the solution estimates revealed at least two factor loadings at or below .40
6 for the Tangney et al. one-factor model in each sample. Factor loadings for Maloney et
7 al. and de Ridder et al. two-factor models were within acceptable range in most cases, but
8 on the low side in a few cases, with a few falling outside this range particularly for the de
9 Ridder model (range = .34 to .87). Reliability and AVE estimates were acceptable in most
10 samples, but fell below acceptable levels for the restraint scale for the Maloney et al.
11 model and the initiation scale for the de Ridder et al. model.

12 Goodness-of-fit statistics and solution estimates for the one-factor model of self-
13 discipline are presented in Tables 1 and 4, respectively. The model exhibited satisfactory
14 goodness-of-fit indices in the full sample and all national samples (CFI range = .86 to .95;
15 RMSEA range = .066 to .094; SRMSR range = .036 to .075) once the error variances for
16 some items were correlated. This indicated some redundancy in the error variance across
17 items that was not accounted for by the latent factor. Examination of the solution
18 estimates revealed that overall, items 2, 4, and 10 did not perform well in terms of their
19 relative contribution to the overall factor, meaning that the self-discipline factor was
20 generally defined by a smaller subset of items.

21 *Measurement Invariance*

22 As goodness of fit statistics fell below acceptable levels for the Tangney et al. and
23 de Ridder et al. models for the brief self-control scale, we restricted our invariance tests
24 to the Maloney et al. two-factor model. Results of the invariance analyses are provided in
25 Table 5. While configural invariance for the model was established across all four

1 national samples, full metric invariance could only be confirmed across the Estonia and
2 Luxembourg samples. We did, however, find partial metric invariance across other pairs
3 of national samples, indicating that while constraining the majority of factor loadings to
4 equality led to few misspecifications in model comparisons, a select few were non-
5 invariant. Specifically, factor loadings for items 1 (“I am good at resisting temptation”)
6 and 2 (“I have a hard time breaking bad habits”) were set to be freely estimated (i.e., not
7 constrained to be invariant) across the Estonia and Spain samples, and across the UK and
8 Spanish samples, and factor loadings for items 7 (“I wish I had more self-discipline”), 8
9 (“People would say that I have iron self- discipline”), and 12 (“Sometimes I can’t stop
10 myself from doing something, even if I know it is wrong”) were set to be freely estimated
11 across the Estonia and UK samples, across the Luxembourg and Spanish samples, and
12 across the Luxembourg and UK samples. The lack of invariance for these parameters
13 notwithstanding, we found that the majority of factor loadings were equivalent across the
14 four samples.

15 We also tested the measurement invariance of the one-factor self-discipline scale
16 across samples. Results of the invariance analyses are provided in Table 6. Analyses
17 provided support for configural invariance in all tests, with the exception of the analysis
18 comparing the Luxembourg and Spanish samples, which exhibited substantial
19 misspecification in the configural model. We found support for metric invariance in all
20 samples comparisons, with the exception of the analysis for the Estonia and Spanish
21 samples. Fit of the metric invariance models was substantially improved when item 3 (“I
22 find it difficult to get down to work”) was set to be non-invariant for the analysis
23 comparing the model in the Estonia and Luxembourg samples, and marginally improved
24 item 2 (“I get my chores done right away”) was set to be non-invariant for the analyses
25 comparing the model in the Luxembourg and UK samples and the Spanish and UK

1 samples. These items had the largest modification indexes. However, in no case did we
2 find support for strong invariance in any of the analyses. Overall, results provide general
3 support for metric invariance for the self-discipline scale across samples.

4 *Discriminant Validity*

5 We tested discriminant validity of the restraint, non-impulsivity, and self-
6 discipline factors by computing latent factor correlations in three-factor CFA models for
7 the full sample and each national sample. Fit statistics for the three-factor model are
8 presented in Table 1. The models generally exhibited sub-optimal fit with the data with
9 misspecifications largely attributable to the poor performance of some items.
10 Discriminant validity statistics are presented in Table 7. Although latent factor
11 correlations among the constructs were large and statistically significant, confidence
12 intervals for each correlation did not encompass unity and the Wald test was statistically
13 significant in all cases ($ps < .001$) providing support for discriminant validity².

14 *Predictive Validity*

15 We examined the predictive validity of the self-control constructs from the
16 Maloney et al. two-factor model (restraint and non-impulsivity factors) and self-discipline
17 by simultaneously regressing scores for the three health behaviors (binge drinking,
18 exercise, and healthy eating) on the self-control and self-discipline constructs in a series
19 of structural equation models for each sample. Goodness-of-fit statistics of the models
20 and standardized parameter estimates for the proposed effects are provided in Table 8.
21 The most consistent effect was for the non-impulsivity component of self-control on

²For comparison, we provide correlations among all variables from the present study using composite (averaged) scales in Appendix C (supplemental materials). Correlations among the restraint, non-impulsivity, and self-discipline constructs using composite scales were substantially smaller (attenuated) than the correlations among the latent factors for the same variables (Table 7). This illustrates the effect of measurement error in attenuating correlations among scales constructs and the value of using latent constructs. Although correlations among the latent constructs were large, this did not alter our conclusions regarding discriminant validity of the constructs.

1 binge drinking which was large, negative, and statistically significant in the Estonia ($\beta =$
2 $-.61, p < .001$), Spanish ($\beta = -.60, p < .05$), and UK ($\beta = -.78, p < .001$) samples. The
3 effect of the restraint component of self-control on exercise was also significant in the
4 Luxembourg ($\beta = .43, p < .05$) and UK ($\beta = .24, p < .05$) samples. Finally, self-discipline
5 significantly predicted exercise ($\beta = -.22, p < .05$) and binge drinking ($\beta = .32, p < .05$)
6 in the Luxembourg and UK samples, respectively. However, neither effect was in the
7 expected direction. Examination of the correlation matrices suggest that the latter effects
8 are likely to be suppressor effects as the zero-order correlation between these factors and
9 the respective behavior was not significant and negative in the Luxembourg and UK
10 samples, respectively.

11 Discussion

12 The purpose of the present study was to examine the factor structure of the BSCS
13 and the self-discipline scale from the NEO-PI-R in four national samples, test the
14 invariance of the structure of both scales across the samples, and test the predictive
15 validity of the scales in predicting health-related behaviors related to self-control.
16 Specifically, we tested three candidate models that aimed to describe the underpinning
17 structure of the BSCS using confirmatory factor analysis: the one-factor model originally
18 proposed by Tangney et al. (2004), and the two-factor models proposed by Maloney et
19 al. (2012) and de Ridder et al. (2011). Based on our evaluation of the effectiveness of the
20 different models in accounting for scores from the brief self-control scale, we aimed to
21 assess the discriminant validity of the most appropriate model of self-control and the self-
22 discipline scale across the samples. Finally, pending support for discriminant validity, we
23 tested the validity of the self-control factor or factors and self-discipline scale in
24 predicting variance in binge drinking, exercise, and healthy eating using structural
25 equation modelling.

1 Results revealed that the Maloney et al. model exhibited the most consistent
2 goodness-of-fit statistics producing well-fitting models in the full sample and across the
3 four samples. Neither the Tangney et al. one-factor model nor the two-factor de Ridder
4 et al. model exhibited satisfactory goodness-of-fit in the full sample and national samples.
5 These models were abandoned in favor of the two-factor Maloney model, which
6 segregated the BSCS into restraint and non-impulsivity factors. The one-factor self-
7 discipline model fit the data well in all four samples, although the solution estimates
8 indicated low factor loadings for selected items. Invariance tests of the Maloney et al.
9 two-factor model and the one-factor self-discipline model indicated support for partial
10 metric invariance with factor loadings invariant across the four samples with a few
11 exceptions. Discriminant validity tests based on the intercorrelations among the non-
12 impulsivity, restraint, and self-discipline factors supported discriminant validity. Finally,
13 structural equation models in which the self-control factors from the Maloney et al. model
14 predicted binge drinking, exercise, and healthy eating indicated a prominent role for the
15 non-impulsivity factor in predicting binge drinking in all but the Luxembourg sample,
16 and restraint in predicting exercise behavior in the Luxembourg and UK samples.

17 Current analyses provide additional support for the multi-dimensionality of trait
18 self-control based on Tangney et al.'s (2004) brief self-control scale. Our findings extend
19 previous research by (i) providing further confirmation of the inadequacy of a one-factor
20 model of self-control in multiple samples from different national groups; (ii)
21 demonstrating the effectiveness of a two-factor model based on Maloney et al.'s (2012)
22 original analysis in fitting data from multiple samples relative to the one-factor model
23 and a competing two-factor model proposed by de Ridder et al. (2011); and (iii) providing
24 evidence that the restraint and non-impulsivity factors from the Maloney et al. two-factor
25 model achieve discriminant validity. A multi-dimensional conceptualization of trait self-

1 control also fits well with contemporary and previous self-control theories. For example,
2 Metcalfe and Mischel (1999) suggest that effective behavioral control is subject to
3 restraint tendencies which may moderate or regulate the more impulsive, emotion-driven
4 pathways to action consistent a ‘hot’ vs. ‘cool’ distinction in pathways to action.
5 Interestingly, Tangney et al. conducted an exploratory factor analysis of their scale and
6 differentiated between factors they termed self-discipline and others such as ‘impulsivity’
7 and ‘work ethic’, but focused on the overall scores of the scale due to finding substantive
8 correlations among the factors. However, we argue that despite the significant inter-
9 correlations among the factors, the distinction is valid as criterion for discriminant
10 validity was satisfied in our current analysis. Although the factors are not entirely
11 orthogonal, substantial variance in each remains unexplained when examining the
12 coefficients of determination for the intercorrelations. Aggregating responses to the
13 BSCS may, therefore, mask or confound the effects of the separate components of self-
14 control in research predicting important cognitive and behavioral outcomes relating to
15 self-regulation. Our research also provides robust evidence for a two-factor structure by
16 replicating it in multiple samples from different national groups. Given the invariance in
17 factor structure across groups, we advocate differentiation of the restraint and non-
18 impulsivity constructs in future research adopting the brief self-control model. This will
19 provide better evaluation of the aspects of self-control most likely to account for variance
20 in cognitive and behavioral outcomes and provide more comprehensive tests of self-
21 regulatory processes underpinning action.

22 Tests of discriminant validity of the non-impulsivity and restraint factors from the
23 Maloney et al. two-factor model with the self-discipline scale from the NEO-PI-R is also
24 an important contribution of the current research. The presence of ‘jangle’ fallacies in
25 social and personality psychology (Block, 1995; Hagger, 2014), that is, multiple

1 constructs with similar content going by different terms, presents considerable problems
2 for researchers seeking to identify a narrow, parsimonious set of factors that predict
3 cognitive and behavioral responses. The terms self-control, self-discipline, and even
4 conscientiousness, have been used interchangeably and, in doing so, researchers have
5 implied considerable overlap or redundancy in the constructs at the conceptual level. For
6 example, definitions of self-control as a capacity to inhibit impulses, responses, urges,
7 habitual actions, and dominant responses appear also to overlap with the definition of
8 self-discipline as the capacity to begin tasks and follow them through to completion
9 despite boredom or distractions (Duckworth & Seligman, 2005). In fact, Tangney et al.
10 (2004), in their original development of their self-control scales, make explicit reference
11 to self-discipline in their definition: “More generally, breaking habits, resisting
12 temptation, and keeping good self-discipline all reflect the ability of the self to control
13 itself, and we sought to build our scale around them” (p. 275).

14 The conceptual overlaps notwithstanding, our data indicates that despite sharing
15 considerable variance, both the restraint and non-impulsivity factors were distinct from
16 the self-discipline factor. Although the range of correlations among the self-control
17 components and self-discipline were large in magnitude based on Cohen’s taxonomy of
18 effect sizes, substantial variance in the two factors remains unexplained. Coupled with
19 support for discriminant validity, current data provide little support for empirical overlap
20 in the constructs suggested by conceptual similarity. Our research suggests, therefore, that
21 multidimensional trait self-control and self-discipline likely tap different aspects of self-
22 control. Self-discipline may be a more ‘focused’ construct than self-control in that it
23 focuses on goal-directed actions that lead to better self-regulations, consistent with its
24 overarching trait of conscientiousness (Zimmerman & Kitsantas, 2014). Although the
25 BSCS, particularly the restraint component from the two-factor model, may make

1 reference to working toward distal goals, it encompasses more than just a focus on “hard
2 work” toward goals (Hagger & Hamilton, 2018). Of course, while these possible
3 conceptual distinctions and formal tests of factorial validity may point to distinctions
4 between the constructs, the high correlations may present problems for predictive validity
5 when the constructs are used to predict cognitive and behavioral outcomes.

6 An additional point worth noting is the low factor loadings for some of the items
7 for the self-discipline scale. While the focus of the current study was on the discriminant
8 and concurrent validity of the BSCS, our factor analyses also permitted an examination
9 of the factor structure of the self-discipline scale from the NEO-PI-R. Our findings
10 indicated that some of the items performed relatively poorly in indicating the latent self-
11 discipline factor in all samples. Although this is not a problem for testing discriminant
12 validity per se because the latent factor for self-discipline is largely indicated by the items
13 with adequate loadings, it does suggest that the scale items may not perform well in
14 capturing the essence of the construct. While a considerable body of research has
15 supported the factor structure and integrity of the sub-facet scales from the NEO-PI-R
16 (IPIP, 2017), current results indicate that the scales may not perform optimally across
17 samples and contexts, and points to the necessity of conducting rigorous factor analytic
18 work prior to use of these scales.

19 A further important finding is the pattern of effects for the self-control and self-
20 discipline factors in predicting behavioral outcomes. This is an important endeavor if
21 researchers are to provide an evidence base of potentially modifiable factors that will
22 serve as targets in behavior change interventions, such as intervention to promote
23 increased participation in health behaviors (c.f., Hagger, Polet, & Lintunen, 2018; Kok et
24 al., 2016; Rich, Brandes, Mullan, & Hagger, 2015). Our findings indicate that the non-
25 impulsivity component of self-control was negatively related to binge drinking behavior

1 in three samples, while restraint was positively related to exercise in two of the samples.
2 These results are consistent with our original hypotheses and recent theory that behaviors
3 requiring active engagement and working toward attaining a distal goal (i.e., exercise)
4 would be positively associated with restraint (Duckworth & Gross, 2014; Hagger &
5 Hamilton, 2018). Similarly, we expected that suppressing cues and impulses to engage in
6 a rewarding behavior (i.e., binge drinking) would be negatively associated with non-
7 impulsivity. We also expected these factors to predict healthy eating, but neither were
8 effective, perhaps indicating that eating behavior is more complex and may be accounted
9 for by specific food-related cues and dietary restraint (Hofmann, Rauch, & Gawronski,
10 2007). The restraint aspect of trait self-control is consistent with Gottfredson and
11 Hirschi's (1990) hypothesis that individuals with good self-control are highly effective in
12 recognizing the benefits and risks of their actions and the need to structure their
13 environment accordingly to achieve long-term ends. Similarly, research in impulsivity
14 and non-conscious pathways to action indicates that capacity for inhibiting impulsive
15 tendencies and cues to well-learned behaviors that have previously been highly reinforced
16 (e.g., binge drinking) is a major determinant of whether an individual will be more or less
17 successful in regulating their behavior (e.g., Christiansen, Cole, & Field, 2012; Friese &
18 Hofmann, 2009).

19 *Strengths and limitations*

20 The current research has a number of strengths. We adopted contemporary theory
21 on trait self-control and personality to develop our hypotheses relating to the structure
22 and validity of the BSCS and the self-discipline scale from the NEO-PI-R. We tested our
23 hypotheses using fit-for-purpose analytic techniques that enabled us to specify
24 hypothesized and competing model structures a priori and test them against our data. Our
25 data was collected in multiple samples enabling us to test our hypotheses across multiple

1 samples and national groups, and our analyses permitted formal comparisons of our
2 hypothesized models across groups. It is, however, also important to acknowledge the
3 limitations of the current research, which may constrain the generalizability of our
4 findings and offer possible alternative interpretations. First, our data are correlational and
5 cross-sectional and, therefore, do not enable us to infer the causal direction of our
6 predictions beyond theory. For example, although we specified the self-control and self-
7 discipline factors as predictors of health behaviors, the correlational data means that
8 equally-plausible alternative models from an empirical perspective could be specified and
9 would exhibit good fit with the data. Similar issues have been identified in research on
10 other social psychological theories of intention and motivation (e.g., Hagger, Chan,
11 Protogerou, & Chatzisarantis, 2016; Hagger et al., 2018; Rich et al., 2015). Cross-lagged
12 panel designs, in which measures of the self-control, self-discipline, and behavioral
13 outcomes are collected across two time periods, would permit tests of the directionality
14 or reciprocity of the proposed effects. Second, it is important to note that the factor
15 loadings for some items from the Maloney et al. two-factor model self-control were sub-
16 optimal. While two-factor structure may be optimal in terms of overall structural integrity
17 and fit with the data, some items remain problematic and point to the need for further
18 refinement and possible streamlining of items in future revisions. The poor performance
19 of the items in some of the samples may have been due to participants' misunderstanding
20 of some of the items. While the back-translation process indicated congruence in the
21 translated and back-translated versions, it is still possible that there were semantic
22 differences leading participants to respond to items differently across cultures. However,
23 this interpretation remains speculative without further evidence. This issue may be
24 resolved by conducting an additional study in which participants complete the translated
25 scale using a 'think aloud' method (e.g., Darker & French, 2009). This may capture how

1 respondents interpret scale items and highlight any misunderstandings and remains an
2 avenue for future research. Finally, the current student samples reflect a homogenous
3 group which may not be representative of the general population, and replication in a
4 general population should be considered in future.

5

6 **Conflict of interest statement**

7 On behalf of all authors, the corresponding author states that there is no conflict of
8 interest.

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29

1 Table 1
 2 *Goodness-of-Fit Statistics of the Proposed One-Factor and Two-Factor Confirmatory Factor Analytic*
 3 *Models of the Brief Self-Control and Self-Discipline Scales in the Full Sample and Four National*
 4 *Samples*

Model	χ^2_R	df	CFI	RMSEA	RMSEA 90% CI	SRMR
Full sample (N = 1282)						
Tangney	660.92	65	.78	.085	.079	.090
Maloney	140.153	19	.92	.071	.060	.082
de Ridder	352.381	34	.84	.085	.078	.094
One-factor self-discipline model	402.04	35	.89	.090	.083	.098
Modified self-discipline model ^a	211.87	32	.95	.066	.058	.075
Three-factor model	742.59	129	.89	.061	.057	.065
Estonia (N = 347)						
Tangney	206.59	65	.84	.079	.067, .092	.058
Maloney	49.84	19	.94	.068	.046, .092	.043
de Ridder	64.23	34	.94	.051	.031, .069	.043
One-factor self-discipline model	154.25	35	.89	.099	.083, .115	.051
Modified self-discipline model ^b	99.02	34	.94	.074	.057, .091	.045
Three-factor model	349.95	131	.89	.069	.061, .078	.057
Luxembourg (N = 207)						
Tangney	152.77	65	.80	.081	.064, .097	.065
Maloney	24.92	19	.97	.039	.000, .076	.039
de Ridder	77.01	34	.87	.078	.055, .101	.059
One-factor self-discipline model	110.09	35	.85	.102	.081, .124	.072
Modified self-discipline model ^c	85.36	34	.90	.085	.063, .108	.058
Three-factor model	307.09	134	.80	.079	.067, .091	.170
Spanish (N = 291)						
Tangney	202.89	65	.71	.085	.072, .099	.067
Maloney	25.39	19	.97	.034	.000, .065	.036
de Ridder	91.58	34	.82	.076	.058, .095	.060
One-factor self-discipline model	216.69	35	.69	.134	.117, .151	.090
Modified self-discipline model ^a	113.73	32	.86	.094	.075, .113	.069
Three-factor model	293.25	129	.83	.066	.056, .076	.069
UK (N = 437)						
Tangney	341.38	65	.71	.099	.088, .109	.073
Maloney	59.35	19	.92	.070	.050, .090	.042
de Ridder	192.85	34	.74	.103	.089, .118	.069
One-factor self-discipline model	144.44	35	.91	.085	.071, .099	.052
Modified self-discipline model ^b	118.43	34	.93	.075	.061, .090	.051
Three-factor model	284.09	131	.93	.052	.043, .060	.052

5 *Note.* χ^2_R = Robust chi-square statistic; df = Degrees of freedom for chi-square statistic; CFI = Comparative
 6 fit index; RMSEA = Root mean square error of approximation; CI = Confidence intervals; SRMSR =
 7 Standardized root mean square of residuals. Tangney = Tangney et al.'s (2004) one-factor model of the
 8 brief self-control scale; Maloney = Maloney et al.'s (2012) two-factor model of the brief self-control scale;
 9 de Ridder = de Ridder et al.'s (2011) two-factor model of the brief self-control scale; Three-factor model
 10 = Three factor model comprising Maloney et al.'s two factor model of the BSCS and the one-factor self-
 11 discipline model. In Maloney et al.'s (2012) two-factor model, the restraint factor comprised items 1, 2, 7,
 12 8 from the brief self-control scale, and the non-impulsivity factor comprised items 5, 9, 12, 13. In de Ridder
 13 et al.'s (2011) two-factor model, the inhibitory self-control factor comprised items 1, 2, 5, 6, 9, 12, and the
 14 initiatory self-control factor comprised items 3, 10, 11, 13; ^aitems 1 and 3, items 2 and 10, and items 6 and
 15 8, were set to be correlated; ^bitems 6 and 8 were set to be correlated; ^citems 2 and 10 were set to be correlated.

Table 2
Means, Standard Deviations, Reliability Coefficients, Average Variance Extracted, and Standardized Factor Loadings of the Proposed One- and Two-Factor Confirmatory Factor Analytic Models of the BSCS for the Full Sample

λ	Self-control	Maloney		de Ridder	
		Restraint	Non-Impulsivity	Inhibitory self-control	Initiatory self-control
SC1	.52	.56	-	.50	-
SC2	.54	.57	-	.55	-
SC3	.56	-	-	-	.59
SC4	.43	-	-	-	-
SC5	.58	-	.62	.63	-
SC6	.43	-	-	.46	-
SC7	.55	.63	-	-	-
SC8	.52	.55	-	-	-
SC9	.46	-	.39	.46	-
SC10	.45	-	-	-	.51
SC11	.30	-	-	-	.34
SC12	.57	-	.70	.61	-
SC13	.40	-	.44	-	.40
Mean	3.28	3.01	3.33	3.45	3.25
SD	.62	.80	.79	.70	.72
α	.80	.66	.61	.70	.52
ρ	.81	.67	.62	.70	.52
AVE	.63	.27	.24	.35	.17

Note. Self-control = Tangney et al.'s (2004) one-factor model of self-control; Maloney = Maloney et al.'s (2012) two-factor model of the brief self-control scale; de Ridder = de Ridder et al.'s (2011) two-factor model of the brief self-control scale; ^aFactor loading not statistically significant. α = Cronbach alpha coefficient; ρ = Composite reliability coefficient; AVE = Average variance extracted.

Table 3

Means, Standard Deviations, Reliability Coefficients, Average Variance Extracted, and Standardized Factor Loadings of the Proposed One- and Two-Factor Confirmatory Factor Analytic Models of the BSCS in the Four National Samples

λ	Estonia ($n = 347$)					Luxembourg ($n = 207$)					Spanish ($n = 291$)					UK ($n = 437$)				
	SC	Maloney		de Ridder		SC	Maloney		de Ridder		SC	Maloney		de Ridder		SC	Maloney		de Ridder	
		Res	Non-Imp	Inhib	Init		Res	Non-Imp	Inhib	Init		Res	Non-Imp	Inhib	Init		Res	Non-Imp	Inhib	Init
SC1	.60	.61	-	.55	-	.41	.48	-	.41	-	.50	.53	-	.50	-	.51	.62	-	.44	-
SC2	.55	.52	-	.56	-	.46	.51	-	.47	-	.47	.64	-	.49	-	.34	.42	-	.29	-
SC3	.54	-	-	-	.64	.58	-	-	-	.60	.52	-	-	-	.55	.45	-	-	-	.44
SC4	.37	-	-	-	-	.40	-	-	-	-	.46	-	-	-	-	.41	-	-	-	-
SC5	.52	-	.57	.61	-	.53	-	.57	.57	-	.50	-	.53	.53	-	.49	-	.50	.51	-
SC6	.49	-	-	.57	-	.45	-	-	.44	-	.28	-	-	.30	-	.34	-	-	.34	-
SC7	.64	.73	-	-	-	.44	.54	-	-	-	.31	.32	-	-	-	.58	.71	-	-	-
SC8	.71	.80	-	-	-	.41	.44	-	-	-	.27	.20	-	-	-	.50	.58	-	-	-
SC9	.43	-	.48	.45	-	.64	-	.56	.66	-	.50	-	.44	.49	-	.61	-	.60	.65	-
SC10	.38	-	-	-	.45	.49	-	-	-	.57	.45	-	-	-	.49	.57	-	-	-	.63
SC11	.45	-	-	-	.51	.32	-	-	-	.36	.35	-	-	-	.34	.44	-	-	-	.44
SC12	.53	-	.66	.60	-	.65	-	.87	.70	-	.62	-	.77	.69	-	.49	-	.59	.53	-
SC13	.38	-	.40	-	.39	.46	-	.43	-	.49	.42	-	.49	-	.41	.48	-	.59	-	.49
Mean	3.13	2.73	3.11	3.13	3.13	3.40	3.25	3.35	3.36	3.56	3.63	3.42	3.79	3.81	3.57	3.10	2.84	3.17	3.00	3.35
SD	.61	.81	.74	.61	.71	.57	.72	.77	.68	.68	.56	.69	.73	.68	.69	.57	.75	.75	.64	.68
α	.82	.75	.60	.72	.55	.80	.56	.69	.72	.58	.75	.46	.62	.65	.47	.80	.67	.66	.65	.57
ρ	.82	.72	.61	.73	.57	.80	.56	.70	.72	.58	.75	.52	.66	.67	.50	.79	.65	.68	.62	.58
AVE	.69	.40	.23	.37	.20	.62	.19	.39	.37	.21	.52	.17	.26	.32	.21	.61	.28	.26	.27	.21

Note. SC = Tangney et al.'s (2004) one-factor model of self-control; Maloney = Maloney et al.'s (2012) two-factor model of the brief self-control scale; de Ridder = de Ridder et al.'s (2011) two-factor model of the brief self-control scale; Res = Restraint subscale; Non-Imp = Non-impulsivity subscale; Inhib = Inhibitory self-control; Init = Initiatory self-control subscale; ^aFactor loading not statistically significant. α = Cronbach alpha coefficient; ρ = Composite reliability coefficient; AVE = Average variance extracted.

Table 4
Means, Standard Deviations, Reliability Coefficients, Average Variance Extracted, and Standardized Factor Loadings for the One-Factor Model for the Self-Discipline Scale in the Full Sample and Four National Samples

National sample	<i>M</i>	<i>SD</i>	α	ρ	AVE	Standardized factor loading (λ)									
						Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Full sample (<i>N</i> = 1282)	3.20	.68	.85	.84	.71	.72	.46	.73	.41	.67	.63	.63	.55	.69	.35
Estonia (<i>n</i> = 347)	3.20	.69	.86	.86	.82	.76	.38	.72	.33	.69	.68	.71	.63	.69	.45
Luxembourg (<i>n</i> = 207)	3.18	.60	.81	.84	.66	.75	.21	.82	.36	.64	.58	.55	.58	.69	.08 ^a
Spanish (<i>n</i> = 291)	3.47	.62	.80	.84	.54	.68	.36	.57	.50	.69	.49	.49	.45	.52	.35
UK (<i>n</i> = 437)	3.04	.68	.88	.87	.82	.75	.59	.80	.52	.67	.68	.62	.56	.72	.39

Note. ^aFactor loading not statistically significant. α = Cronbach alpha coefficient; ρ = Composite reliability coefficient; AVE = Average variance extracted.

Table 5
Measurement Invariance and Overall Fit Indexes for Maloney et al.'s (2012) Two-Factor Measurement Model of the BSCS in the Four National Samples

Model	χ^2_R	<i>df</i>	CFI	Δ CFI	RMSEA	RMSEA 90% CI
Estonia – Luxembourg						
M1: Configural invariance	74.25	38	.95	–	.059	.039, .078
M2: Metric invariance	77.54	44	.96	-.004	.052	.032, .071
M3: Strong invariance	380.63	52	.56	-.398	.151	.137, .165
Estonia – Spanish						
M1: Configural invariance	75.37	38	.95	–	.056	.037, .074
M2: Metric invariance	104.74	44	.92	-.032	.066	.050, .082
M2P1: Partial metric invariance ^a	89.65	43	.94	-.013	.058	.041, .075
M2P2: Partial metric invariance ^b	77.83	42	.95	.002	.052	.033, .069
M3: Strong invariance	560.11	50	.31	-.638	.179	.166, .192
Estonia – UK						
M1: Configural invariance	109.44	38	.93	–	.069	.054, .085
M2: Metric invariance	128.21	44	.92	-.012	.070	.056, .084
M2P1: Partial metric invariance ^c	121.68	43	.92	-.007	.068	.054, .083
M3: Strong invariance	564.13	51	.50	-.426	.160	.148, .172
Luxembourg – Spanish						
M1: Configural invariance	50.30	38	.97	–	.036	.000, .061
M2: Metric invariance	62.42	44	.96	-.014	.041	.011, .063
M2P1: Partial metric invariance ^d	58.38	43	.97	-.007	.038	.000, .061
M3: Strong invariance	194.13	51	.67	-.286	.106	.091, .122
Luxembourg – UK						
M1: Configural invariance	84.52	38	.93	–	.062	.044, .079
M2: Metric invariance	101.68	44	.92	-.016	.064	.048, .080
M2P1: Partial metric invariance ^e	91.81	43	.93	-.003	.059	.043, .076
M3: Strong invariance	231.80	51	.74	-.187	.105	.091, .119
Spanish – UK						
M1: Configural invariance	85.87	38	.93	–	.059	.042, .075
M2: Metric invariance	121.58	44	.89	-.042	.070	.055, .084
M2P1: Partial metric invariance ^a	101.77	43	.92	-.015	.061	.046, .077
M2P2: Partial metric invariance ^b	94.75	42	.93	-.006	.059	.043, .075
M3: Strong invariance	413.38	50	.49	-.439	.141	.129, .154

Note. χ^2_R = Robust chi-square; *df* = Degrees of freedom; CFI = Comparative fit index; RMSEA = Root mean square error of approximation; CI = Confidence interval. Factor loading of the item with highest modification index was set to be freely estimated, including: ^aFactor loading of the item with highest modification index (item 2) was set to be non-invariant; ^bFactor loadings of the items with highest modification indexes (items 1 and 2) were set to be non-invariant; ^cFactor loading of the item with highest modification index (item 8) was set to be non-invariant; ^dFactor loading of the item with highest modification index (item 7) was set to be non-invariant; ^eFactor loading of the item with highest modification index (item 12) was set to be non-invariant.

Table 6
Measurement Invariance and Overall Fit Indexes for the Measurement Model of the One-Factor Self-Discipline Scale in the Four National Samples

Model ^a	χ^2_R	<i>df</i>	CFI	Δ CFI	RMSEA	RMSEA 90% CI
Estonia – Luxembourg						
M1: Configural invariance	118.53	58	.96	–	.061	.045, .077
M2: Metric invariance	152.51	68	.95	-.016	.067	.053, .081
M2P1: Partial metric invariance ^b	142.03	67	.95	-.010	.064	.049, .078
M3: Strong invariance	252.63	77	.89	-.076	.091	.078, .103
Estonia – Spanish						
M1: Configural invariance	140.497	49	.94	–	.077	.062, .091
M2: Metric invariance	164.00	59	.94	-.008	.075	.061, .088
M3: Strong invariance	281.93	69	.87	-.075	.098	.087, .110
Estonia – UK						
M1: Configural invariance	77.36	49	.99	–	.040	.023, .055
M2: Metric invariance	116.07	59	.98	-.012	.050	.036, .063
M3: Strong invariance	251.82	69	.92	-.066	.082	.071, .093
Luxembourg – Spanish						
M1: Configural invariance	180.02	57	.89	–	.093	.078, .109
M2: Metric invariance	199.60	67	.88	-.009	.089	.075, .104
M3: Strong invariance	275.79	77	.82	-.069	.102	.089, .115
Luxembourg – UK						
M1: Configural invariance	86.24	47	.98	–	.051	.034, .068
M2: Metric invariance	126.97	57	.96	-.017	.062	.047, .076
M2P1: Partial metric invariance ^c	100.51	56	.98	-.003	.050	.034, .065
M3: Strong invariance	253.77	66	.90	-.083	.094	.082, .106
Spanish – UK						
M1: Configural invariance	114.04	45	.96	–	.065	.050, .080
M2: Metric invariance	147.04	55	.95	-.012	.068	.055, .081
M2P1: Partial metric invariance ^c	137.10	54	.96	-.008	.065	.052, .079
M3: Strong invariance	314.35	64	.87	-.097	.104	.092, .115

Note. χ^2_R = Robust chi-square; *df* = Degrees of freedom; CFI = Comparative fit index; RMSEA = Root mean square error of approximation; CI = Confidence interval. ^aCorrelations among error variances with highest modification indexes from the single-sample CFAs were included in each model; ^bFactor loading with highest modification index (item 3) set to be non-invariant across samples; ^cFactor loading with highest modification index (item 2) set to be non-invariant across samples.

Table 7
Latent Inter-Factor Correlations and Discriminant Validity Statistics for the Restraint, Impulsivity, and Self-Discipline Factors in the Four National Samples

	Res ↔ Non-Imp	Res ↔ SD	Non-Imp ↔ SD
Estonia (<i>n</i> = 347)			
Inter-factor correlation	.68	.64	.63
CI	.56, .80	.53, .75	.51, .76
Wald test	29.07***	38.87***	34.07***
Luxembourg (<i>n</i> = 207)			
Inter-factor correlation	.73	.52	.68
CI	.54, .92	.34, .71	.52, .89
Wald test	8.81**	19.10***	19.30***
Spanish (<i>n</i> = 291)			
Inter-factor correlation	.76	.63	.71
CI	.56, .96	.44, .82	.50, .92
Wald test	6.72**	15.69***	9.02**
UK (<i>n</i> = 437)			
Inter-factor correlation	.60	.54	.77
CI	.47, .72	.43, .65	.68, .85
Wald test	28.07***	56.81***	32.45***

Note. Res = Restraint; Non-Imp = Non-impulsivity; SD = Self-discipline; CI = 95% confidence intervals of latent factor correlations. Wald = Wald test constraining value of the latent-factor correlation to zero. * $p < .05$ ** $p < .01$ *** $p < .001$

Table 8

Goodness of Fit Statistics and Standardized Parameter Estimates of Structural Equation Models Predicting Health-Related Outcomes by Self-Control Dimensions from Maloney et al.'s Two-Factor Model and Self-Discipline

Sample and behavior	Model fit						Standardized parameter estimates (β)		
	χ^2_{S-B}	df	CFI	RMSEA	RMSEA 90% CI	SRMSR	Res	Non- Imp	SD
Estonia ($n = 347$)									
Binge drinking	426.04	163	.87	.068	.060, .076	.057	.18	-.61***	.08
Exercise	378.81	163	.89	.062	.054, .070	.054	.14	.08	.23
Healthy eating	403.35	163	.89	.065	.057, .073	.056	-.05	.09	.10
Luxembourg ($n = 207$)									
Binge drinking	293.63	163	.87	.062	.051, .074	.064	-.10	-.17	.08
Exercise	284.33	163	.90	.063	.048, .071	.060	.43*	-.24	-.22*
Healthy eating	281.38	163	.90	.059	.047, .071	.061	.17	.05	.03
Spanish ($n = 291$)									
Binge drinking	342.42	161	.85	.062	.053, .071	.067	.26	-.60*	.09
Exercise	343.66	161	.88	.062	.053, .072	.067	.16	-.34	.25
Healthy eating	332.58	161	.88	.061	.051, .070	.065	.21	-.11	.17
UK ($n = 437$)									
Binge drinking	418.12	163	.92	.060	.053, .067	.054	.12	-.78***	.32*
Exercise	339.90	163	.93	.050	.042, .057	.044	.24**	-.06	.04
Healthy eating	318.26	163	.94	.047	.039, .054	.045	.04	-.03	.18

Note. χ^2_{S-B} = Robust Satorra-Bentler scaled chi-square statistic; df = Degrees of freedom for chi-square statistic; CFI = Comparative fit index; RMSEA = Root mean square error of approximation; CI = confidence interval; SRMSR = Standardized root mean square of residuals; Res = Restraint; Non-Imp = Non-impulsivity; SD = Self-discipline.

* $p < .05$ ** $p < .01$ *** $p < .01$

Supplementary materials

Appendix A

The Brief Self-Control Scale (BSCS; Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. Journal of Personality, 72, 271-324. doi: 10.1111/j.0022-3506.2004.00263.x)

	Not at all				Very much
1. I am good at resisting temptation	1	2	3	4	5
2. I have a hard time breaking bad habits	1	2	3	4	5
3. I am lazy	1	2	3	4	5
4. I say inappropriate things	1	2	3	4	5
5. I do certain things that are bad for me, if they are fun	1	2	3	4	5
6. I refuse things that are bad for me	1	2	3	4	5
7. I wish I had more self-discipline	1	2	3	4	5
8. People would say that I have iron self- discipline	1	2	3	4	5
9. Pleasure and fun sometimes keep me from getting work done	1	2	3	4	5
10. I have trouble concentrating	1	2	3	4	5
11. I am able to work effectively toward long-term goals	1	2	3	4	5
12. Sometimes I can't stop myself from doing something, even if I know it is wrong	1	2	3	4	5
13. I often act without thinking through all the alternatives	1	2	3	4	5

Note. Items 2, 3, 4, 5, 7, 9, 10, 12, and 13 are reverse keyed.

Appendix B

The Self-Discipline Scale from the NEO-PI from the International Personality Item Pool Retrieved from <https://ipip.ori.org/newNEOKey.htm#Self-Discipline>

	Strongly disagree				Strongly agree
1. I have difficulty starting tasks	1	2	3	4	5
2. I get my chores done right away	1	2	3	4	5
3. I find it difficult to get down to work	1	2	3	4	5
4. I am always prepared	1	2	3	4	5
5. I often waste my time	1	2	3	4	5
6. I start tasks right away	1	2	3	4	5
7. I tend to postpone decisions	1	2	3	4	5
8. I like to get to work at once	1	2	3	4	5
9. I need a push to get started	1	2	3	4	5
10. I tend to carry out my plans	1	2	3	4	5

Note. Items 1, 3, 5, 7, and 9 are reverse keyed