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Psychometric properties of a Swedish version of the reinforcement sensitivity theory of personality questionnaire

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Abstract

The reinforcement sensitivity theory of personality questionnaire (RST-PQ) is based on a theoretical analysis of the revised reinforcement sensitivity theory. Using a Swedish sample stratified by age and gender, the aim of this study was to test the six-factor structure of a Swedish version of the RST-PQ. Further, we examined the convergent and discriminant validity of the questionnaire. The results of the confirmatory factor analysis showed that the Swedish version did not fully provide support for the six-factor structure. An attempt to improve the model fit resulted in a significantly better model fit for a six-factor structure containing 52 items. Issues concerning the convergent validity were found, as indicated by all six factors having more than 50% of the variance due to error. The discriminant validity was satisfactory for all factors, except for goal-drive persistence and reward interest, which were highly correlated. This indicates a non-independence between these two factors in the model. Nevertheless, the RST-PQ has considerable promise and more emphasis should be put on investigating the convergent validity by using for example broader samples, stratified by country of origin, age, and gender.

KEYWORDS: confirmatory factor analysis; convergent validity; discriminant validity; reinforcement sensitivity theory

Introduction

Gray's reinforcement sensitivity theory (RST; Gray, 1970, 1982) postulated two major neuropsychological systems explaining individual difference in approach and avoidance behavior. Since then the theory has been updated and revised (rRST; Gray & McNaughton, 2000; McNaughton & Corr, 2004) and is now frequently used as a neuroscience theory of personality. An important difference between the RST and the rRST is the clear distinction between fear and anxiety (McNaughton & Corr, 2004). The rRST provides a theoretical account of the neuropsychological processes underlying three major systems: the behavioral approach system (BAS); and the two defensive systems, the fight-flight-freeze system (FFFS) and the behavioral inhibition system (BIS; Corr, 2008). According to Gray and McNaughton (2000), BAS mediates reactions to appetitive stimuli (unconditioned and conditioned) and generates approach behavior. FFFS mediates the reactions to aversive stimuli (both unconditioned

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and conditioned), and involves activation of avoidance and escape behaviors. The FFFS adds freezing to the original FFS and the behavioral output includes fight, freeze and defensive fight (Corr, 2009; Corr & Cooper, 2016). BIS is sensitive to goal-conflict of all kinds and by increasing the negative valence of stimuli via activation of the FFFS the conflict reaches resolution (Corr, 2009). BIS outputs leads to risk assessment behavior. Whereas FFFS can be conceptualized as avoidance of a clear threat, BIS can be conceptualized as approach with cautions.

One of the most widely used RST-questionnaire, the BIS/BAS scales (Carver & White, 1994), was based on the original RST (Gray, 1970, 1982). Recently, several questionnaires have been developed based on the rRST (Corr & Cooper, 2016; Jackson, 2009; Reuter, Cooper, Smillie, Markett, & Montag, 2015; Smederevac, Mitrović, Čolović, & Nikolašević, 2014). Deciding which of these questionnaires to use could be problematic because they differ with respect to their conceptualizations and operational constructs. Depending on the questionnaire, BAS is used both as an unidimensional and multidimensional construct. However, Krupić, Gračanin, and Corr (2016) showed that a coherent theoretical account of the multidimensionality of approach motivation can be provided from an evolutionary perspective. Inadequate fit indices for models assuming BAS as an unidimensional construct have been found, suggesting that questionnaires that separate BAS into subscales should be used (Krupić, Corr, Ručević, Križanić, & Gračanin, 2016). Although the different questionnaires seem to produce adequate global model fit estimates, there are issues concerning the convergent validity (Corr, 2016; Krupić et al., 2016).

The reinforcement sensitivity theory of personality questionnaire (RST-PQ) was developed based on a theoretical analysis of rRST (Corr & Cooper, 2016). Theoretically driven thematic facets were used as conceptual anchors to guide item development (for a review, see Corr & Cooper, 2016). FFFS was defined by the three thematic facets flight, freeze, and active avoidance. BIS was defined by motor planning interruption, cautious risk assessment, obsessive thoughts, and behavioral disengagement. Both exploratory and confirmatory factor analyses have shown BAS should be treated as a multidimensional construct in terms of the four factors 'reward interest, goal-drive persistence, reward reactivity, and impulsivity'. Hence, Corr and Cooper (2016) suggested a six-factor structure: FFFS, BIS, and the four dimensions of BAS. The validity of different rRST questionnaires has been examined (Corr, 2016; Walker & Jackson, 2017) and it seems like there is no clear answer to which questionnaires best represents the theory. Notwithstanding, the RST-PQ has been translated into several different languages and used in published research. The validity of the RST-PQ has been assessed in several studies (Corr & Cooper, 2016; Pugnaghi, Cooper, Ettinger, & Corr, 2017; Wytykowska, Fajkowska, Domaradzka, & Jankowski, 2017), and the RST-PQ appears to have considerable promise in measuring the rRST. However, there remain limitations in the assessment of the RST-PQ's validity. First, convergent validity and discriminant validity have only been examined in terms of correlations with existing personality questionnaires. Second, the development of RST-PQ was conducted on undergraduate populations (Corr & Cooper, 2016), and there is therefore a need to use broader samples in order to establish the validity of the RST-PQ. Consequently, the purpose of the present study was to use a Swedish sample stratified by age and gender to test the six-factor structure of a Swedish version of the RST-PQ. In addition, this study looked more systematically at the convergent and discriminant validity compared to previous studies.

Table 1. Description of the proportions of participants in the different age groups.

Strata	Age[a]	Gender[b]	Total	RR (%)	RP (%)	Age ($M \pm SD$)
1	16–20	Female	122	10	8	17.9 ± 1.2
		Male	131	10	9	17.7 ± 1.6
2	21–25	Female	151	10	11	23.2 ± 1.6
		Male	161	3	11	22.0 ± 0.7
3	26–30	Female	148	6	11	27.4 ± 1.4
		Male	157	8	11	28.0 ± 1.5
4	31–35	Female	139	14	10	33.3 ± 1.5
		Male	143	7	10	31.9 ± 1.4
5	36–40	Female	140	14	10	38.1 ± 1.4
		Male	143	11	10	37.8 ± 1.3
6	41–45	Female	152	9	11	42.9 ± 1.4
		Male	158	11	11	43.0 ± 1.4
7	46–50	Female	157	9	11	48.5 ± 1.1
		Male	161	9	11	481 ± 1.5
8	51–55	Female	145	21	10	53.3 ± 1.5
		Male	150	10	10	53.7 ± 1.4
9	56–60	Female	137	16	9	58.1 ± 1.8
		Male	137	12	9	58.2 ± 1.4
10	61–65	Female	132	20	9	63.3 ± 1.6
		Male	130	13	9	63.6 ± 1.5

Total: number of persons the survey was sent to; RR: response rate; RP: resident population.
[a]Two females did not specify their age.
[b]In strata 3 one participant specified other as gender.

Method

Participants

The participants consisted of 320 (182 women, 137 men, and 1 other) individuals between 16 and 65 years of age ($M = 43.76$, $SD = 14.46$) randomly selected in Sweden. The RST-PQ questionnaire was sent to 2948 persons stratified by age and gender. Age groups were set to five-year intervals ranging from 16–65 years and were matched with respect to the proportions of male and female inhabitants in Sweden. The respondents were informed in writing about the research purpose. Questions concerning confidentiality, anonymity, and the respondent's rights were emphasized. Fifty-four questionnaires were returned due to invalid addresses. The final response rate was 11% and the proportion of participants were somewhat skewed. See Table 1 for a description of the proportions of participants in the different age groups. Higher proportions than existent in the resident population of men were evident for age groups 56–60 and 61–65 years, lower proportions were evident for age groups 21–25, 26–30, and 31–35 years. Higher proportions than existent in the resident population of women were evident for age groups 31–35, 36–40, 51–55, 56–60, and 61–66 years, lower proportions were evident in the age group 26–30 years.

Questionnaire

A Swedish version of the RST-PQ (Corr & Cooper, 2016) was used in the present study. The questionnaire was translated into Swedish using the back-translation method (McKay et al., 1996). The back-translated English items were checked against the original English items by one of the developers of the RST-PQ (P. J. Corr, Personal communication, September 24, 2015). The questionnaire consists of 65 items, comprising three subscales: BAS (32 items), BIS (23 items), and FFFS (10 items). BAS is in turn a multidimensional construct that consists four dimensions: Reward interest (RI; 7 items), goal-drive persistence (GDP; 7 items), reward reactivity (RR; 10 items) and impulsivity (I; 8 items). The items are answered on four-point Likert type scale (e.g., 'How accurately does each statement describe you?', 1 = Not at all; 4 = Highly). In the Swedish version including all 65 items, the Cronbach's alpha for the three subscales of the questionnaire and the four dimensions of BAS respectively were as follows: BIS: 0.93; FFFS: 0.78; BAS: 0.89; RI: 0.80; GDP: 0.86; RR: 0.74; and I: 0.72.

Analytic approach

Using confirmatory factor analysis (CFA), we tested the RST-PQ structure by following the same rationale as in Corr and Cooper (2016). Hence, we initially tested a first-order factor model with six correlated first-order factors. Then, we tested if the structure could be represented by two correlated second-order factors, with the FFFS and BIS factors loading on a second-order punishment sensitivity factor, and the RR, GDP, RI, and I factors loading on a second-order reward sensitivity factor. A number of *a priori* assumptions guided the analyses: (1) Each item would be associated with only the factor it was designed to measure and other coefficients would be fixed to zero; (2) all factors would be allowed to covary, allowing for an oblique factor model; and (3) modifications should be kept at a minimum and be based on statistical as well as theoretical concerns, and should exclude the addition of factorially complex items.

There are numerous measures for evaluating the overall fit of the models with somewhat different theoretical frameworks and that addresses different components of fit (e.g., Hu & Bentler, 1995), and it is generally recommended that multiple measures should be used. To account for the ordinal nature if the data, maximum likelihood estimation with robust standard errors with Satorra-Bentler scaled test statistics (Satorra & Bentler, 2001) were used.

Apart from reporting relative chi square statistics (χ^2/df) as a measure of fit, three conventional indices of goodness of fit were calculated: The root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), and the comparative fit index (CFI). With respect to the RMSEA, values below 0.06 are considered a good-fitting model, values below 0.08 indicates an adequate fit. SRMR values around 0.08 or lower indicates a good fit to the data. For the CFI, values above 0.90 suggest an acceptable fit and values above 0.95 a close fit. See Hu and Bentler (1999) for suggested cut-off criteria for fit indices.

Next, composite reliability (CR) was used as measure of internal consistency of the factors, where values greater 0.70 is indicative of good reliability. Discriminant validity is achieved when average variance extracted (AVE) is greater than maximum shared squared variance (MSV). For convergent validity, AVE should be equal or greater than 0.50 and lower than CR. Put differently, variance explained by the construct should be greater than measurement error and greater than cross-loadings. See, Hair, Black, Babin, and Anderson (2014) for suggested thresholds for these analyses.

Furthermore, multi-group models were performed in which fits for both genders and age groups (younger $\leq$44; older $\geq$45 years) were examined simultaneously. That is, several measurement invariance tests were conducted using a sequential strategy testing the

Table 2. Estimates of confirmatory factor analyses: Model-fit indices for a six-factor and modified models.

Model	χ^2 (df)	χ^2/df	CFI	SRMR	RMSEA	$\Delta\ \chi^2$, df (*p*)
Six-factor	3737.51 (2000)	1.87	0.764	0.074	0.055	
Higher order	3860.71 (2008)	1.92	0.749	0.087	0.057	123, 8 (<0.0001)
Six-factor, finala	2406.02 (1259)	1.91	0.816	0.071	0.057	1331, 741b (<0.0001)

CFI: comparative fit index; SRMR: standardized root mean square residual; RMSEA: root mean square error of approximation.
[a]The proposed six-factor structure with 52 items.
[b]The estimate is based on comparison between the six-factor model and the reduced six-factor structure with 52 items.

invariance at different levels. In the first model, the factor structure was specified identically across groups, and all parameters were freely estimated across groups. This is a method of formally establishing configural invariance (i.e., equivalence in factor structure across the groups). Second, a metric (weak) invariance model was fitted in which the factor loadings were constrained to be equal and the fit of this model was compared to the configural (baseline) model. Invariance exists if the fit of the metric invariance model is not substantially poorer than the fit configural model. Third, a scalar (strong) invariance model was fitted in which factor loadings and item intercepts were constrained to be equal and this fit was compared against the metric measurement invariance model. Again, strong invariance exists if the fit of the scalar invariance model is not substantially poorer than the fit of the metric invariance model. Fourth, a residual (strict) invariance model was fitted in which factor loadings, intercepts, and residual variances are constrained to be equal and then compared to the scalar measurement invariance model. Even though a scaled chi-square difference test for nested models can be used to index invariance between models, it suffers from the same dependency on sample size as the minimum fit function statistic, and thus, changes in model fit according to CFI and RMSEA were used. According to the criteria suggested by Chen (2007), a decrease in CFI of ≥ -0.01 in addition to an increase in RMSEA of ≥ 0.015 corresponds to an adequate criterion indicating a decrement in fit between models for sample sizes >300.

Data analyses were carried out using the R (R Core Team, 2018) package lavaan (Rosseel, 2012).

Results

For the CFA, the goodness-of-fit indices for the models as well as the χ^2 difference test of improvements are presented in Table 2. While CFI did not reach an acceptable model fit, RMSEA, SRMR and χ^2/df suggested good global fit of the model. When testing the second-order model, apart from the CFI, the RMSEA, SRMR, and χ^2/df suggested a good global fit. The second-order model showed a significantly poorer fit than the first-order model (Table 2). For the first-order model, Table 3 shows that CR indices indicated a good reliability for all factors (all above 0.70). However, indices of convergent validity indicated validity concerns; all factors AVE were less than 0.50. Indices of discriminant validity indicated good validity for two of the six factors (FFFS, BIS), with an AVE that was higher than MSV.

Table 3. Indicators of internal consistency and validity (and factor correlations) for the six-factor structure.

Scale	CR	AVE	MSV	1	2	3	4	5	6
FFFS	0.788	0.281	0.194	–					
BIS	0.938	0.403	0.194	0.440	–				
Reward interest	0.806	0.380	0.572	−0.107	−0.199	–			
Goal-drive persistence	0.862	0.476	0.572	−0.152	−0.029	0.756	–		
Reward reactivity	0.752	0.241	0.406	0.172	0.233	0.612	0.586	–	
Impulsivity	0.739	0.269	0.406	0.160	0.186	0.548	0.216	0.637	–

CR : composite reliability; AVE: average variance extracted: MSV: maximum shared squared variance.

With respect to the six-factor model, inspection of the factor loadings showed that there were a number of loadings below 0.50. All factor loadings are presented in Tables 4 and 5. In an attempt to achieve a better model fit, all items with factor loadings below 0.50 were removed. The following 13 items were removed: item, 19, 45, and 46 (belonging to FFFS); item 64 (belonging to BIS); item 26 (belonging to RI); item 3, 4, 8, 23, and 24 (belonging to RR); item 44, 51, and 53 (belonging to I). When testing the proposed six-factor model containing 52 items, apart from the CFI, the RMSEA, SRMR, and χ^2/df suggested a good global fit of the model (Table 2). This model showed a significantly better model fit than the six-factor model with 65 items. The modification indices suggested that the inclusion of correlated errors terms in the model would only improve model fit marginally. Thus, the final six-factor structure consisted of 52 items with no correlated error terms.

For the final model, Table 6 shows that CR indices indicated a good reliability for all factors (all above 0.70). However, indices of convergent validity still indicated validity concerns; all factors AVE were less than0 .50. Indices of discriminant validity indicated good validity for three of the six factors (FFFS, BIS, and I), with an AVE that was higher than MSV.

Table 7 shows the goodness-of-fit indices for the progressively restricted models.

With respect to invariance in age groups, the results showed support for configural invariance (suggesting a similar factor structure across the two age groups). There was no substantial decrease the model fit in the metric model, indicating that full metric invariance was achieved (i.e., the strength of the relationship between the items and constructs is the same across groups). Even though the change in RMSEA suggested full scalar invariance, the invariance exceeded the criteria for invariance based on change in CFI. However, based on the estimated change if the parameter were freely estimated, partial scalar invariance was achieved by removing equality constraints (releasing one constraint at the time) for six intercepts (Item 10, 17, 21, and 57 from the BIS scale, Item 30 from RR, and Item 31 GDP, see Tables 5 and 4, respectively.) The change in fit from the scalar to the residual model (fixing item loadings, intercepts, and residual variance to be equal across groups) also passed the criteria for invariance based on change in CFI and RMSEA. With respect to invariance for the genders, the results showed support for configural and metric invariance, but again the scalar invariance exceeded the criteria for invariance when the change was based on CFI. By removing the equality constraint for Item 16 (from the RR scale), partial scalar invariance was achieved. Finally, the change in fit from the scalar to the residual model also passed the criteria for invariance.

Table 4. Factor loadings of BAS items for confirmatory factor analyses (CFA) of the six-factor first-order model.

Item	Thematic facets	CFA			
		1:RI	2:GDP	3:RR	4:I
	Reward interest				
32	I am always finding new and interesting things to do.	0.66			
14	I regularly try new activities just to see if I enjoy them.	0.63			
15	I get carried away by new projects.	0.70			
26	I take a great deal of interest in hobbies.	0.37			
35	I am very open to new experiences in life.	0.67			
13	I am always 'on the go.'	0.62			
	Goal-drive persistence				
5	I put in a big effort to accomplish important goals in my life.		0.75		
12	I am motivated to be successful in my personal life.		0.72		
20	I often overcome hurdles to achieve my ambitions.		0.69		
34	I feel driven to succeed in my chosen career.		0.68		
41	I am very persistent in achieving my goals.		0.69		
54	I think it is necessary to make plans in order to get what you want in life.		0.51		
65	I will actively put plans in place to accomplish goals in my life.		0.76		
	Reward reactivity				
4	I am especially sensitive to reward.			0.37	
16	Good news makes me feel over-joyed.			0.49	
24	I love winning competitions.			0.40	
25	I get a special thrill when I am praised for something I've done well.			0.56	
30	I get very excited when I get what I want.			0.69	
36	I always celebrate when I accomplish something important.			0.52	
37	I find myself reacting strongly to pleasurable things in life.			0.57	
23	I often feel that I am on an emotional high.			0.47	
3	Sometimes even little things in life can give me great pleasure.			0.30	
8	I often experience a surge of pleasure running through my body.			0.43	
	Impulsivity				
22	I think I should 'stop and think' more instead of jumping into things too quickly.				0.57
27	I sometimes cannot stop myself talking when I know I should keep my mouth closed.				0.56
28	I often do risky things without thinking of the consequences.				0.57
38	I find myself doing things on the spur of the moment.				0.67
40	I'm always buying things on impulse.				0.52
44	I would go on a holiday at the last minute.				0.38
51	I think the best nights out are unplanned.				0.36
53	If I see something I want, I act straight away.				0.46
	1. Reward interest	–			
	2. Goal-drive persistence	0.76	–		
	3. Reward reactivity	0.61	0.59	–	
	4. Impulsivity	0.55	0.22	0.64	–

RI: reward interest; GDP: goal-drive persistence; RR: reward reactivity; I: impulsivity.

Discussion

In the current study, apart from the CFI, all global fit indices suggested good model fit for the original six-factor structure and the modified. Even though the CR indices for the model indicated good reliability, the AVE was less than 0.5 for all six factors indicating that more than

Table 5. Factor loadings of FFFS and BIS items for confirmatory factor analyses (CFA) of the six-factor first-order model.

Item	Thematic facets	CFA	
		1:FFFS	2:BIS
	Flight		
45	I would run fast if I knew someone was following me late at night.	0.45	
19	I would run quickly if fire alarms in a shopping mall started ringing.	0.32	
46	I would leave the park if I saw a group of dogs running around barking at people.	0.30	
	Active avoidance		
52	There are some things that I simply cannot go near.	0.60	
58	I would not hold a snake or spider.	0.54	
	Freezing		
9	I would be frozen to the spot by the sight of a snake or spider.	0.62	
59	Looking down from a great height makes me freeze.	0.60	
39	I would instantly freeze if I opened the door to find a stranger in the house.	0.51	
48	I would freeze if I was on a turbulent aircraft.	0.55	
62	I am the sort of person who easily freezes-up when scared.	0.68	
	Motor planning interruption		
63	I take a long time to make decisions.		0.52
55	When nervous, I find it hard to say the right words.		0.53
18	When nervous, I sometimes find my thoughts are interrupted.		0.52
64	I often find myself lost for words.		0.46
49	My behavior is easily interrupted.		0.52
	Cautious risk assessment		
47	I worry a lot.		0.78
34	People are often telling me not to worry.		0.67
43	I often worry about letting down other people.		0.59
17	The thought of mistakes in my work worries me.		0.60
42	When trying to make a decision, I find myself constantly chewing it over.		0.57
	Obsessive thoughts		
56	I find myself thinking about the same thing over and over again.		0.77
2	I am often preoccupied with unpleasant thoughts.		0.67
50	It's difficult to get some things out of my mind.		0.71
61	My mind is dominated by recurring thoughts.		0.79
29	My mind is sometimes dominated by thoughts of the bad things I've done.		0.69
57	I often wake up with many thoughts running through my mind.		0.57
33	I'm always weighing-up the risk of bad things happening in my life.		0.52
	Behavioral disengagement		
60	I often find myself 'going into my shell'.		0.69
1	I feel sad when I suffer even minor setbacks.		0.65
21	I often feel depressed.		0.77
10	I have often spent a lot of time on my own to 'get away from it all'.		0.61
6	I sometime feel 'blue' for no good reason.		0.69
7	When feeling 'down', I tend to stay away from people.		0.55
	1. FFFS	–	
	2. BIS	0.44	–

FFFS: flight-fight-freeze system; BIS: behavioral inhibition system.

Table 6. Indicators of internal consistency and validity (and factor correlations) for the final six-factor structure with 52 items.

Scale	CR	AVE	MSV	1	2	3	4	5	6
FFFS	0.787	0.349	0.204	–					
BIS	0.938	0.411	0.204	0.452	–				
Reward interest	0.813	0.421	0.564	−0.122	−0.191	–			
Goal-drive persistence	0.863	0.476	0.564	−0.170	−0.023	0.751	–		
Reward Reactivity	0.717	0.340	0.341	0.144	0.213	0.584	0.558	–	
Impulsivity	0.722	0.344	0.314	0.146	0.244	0.515	0.193	0.560	–

CR: composite reliability; AVE: average variance extracted; MSV: maximum shared squared variance.

Table 7. Results of the multi-group tests of invariance between age and gender.

Model	χ^2 (df)	$\Delta\chi^2$(df)	CFI	ΔCFI	RMSEA	ΔRMSEA
Age invariance						
Configural	3870.224 (2518)	–	0.791	–	0.058	–
Weak/metric	3931.965 (2564)	61.74 (46)	0.788	0.003	0.058	0.000
Strong/scalar	4195.022 (2610)	263.06 (46)	0.755	0.033	0.062	0.004
Partial scalar	4059.540 (2604)	111.93 (40)	0.775	0.013	0.059	0.001
Strict/residuals	4306.949 (2662)	111.73 (52)	0.745	0.010	0.062	0.000
Gender invariance						
Configural	3922.527 (2518)	–	0.788	–	0.059	–
Weak/metric	3993.357 (2564)	70.83 (46)	0.784	0.004	0.059	0.000
Strong/Scalar	4179.520 (2610)	186.16 (46)	0.763	0.021	0.061	0.002
Partial scalar	4126.461 (2609)	133.10 (45)	0.771	0.013	0.060	0.001
Strict/Residuals	4243.894 (2662)	117.43 (52	0.761	0.002	0.061	0.000

CFI: comparative fit index; RMSEA: root mean square error of approximation.
The deltas are with respect to the previous level of measurement invariance. All estimates are based on Satorra-Bentler scaled test statistics.

50% of the variance was due to error. It is possible that the convergent validity issues found in the current study could be partly attributed to linguistic aspect. On the other hand, when inspecting factor loadings in previously reported studies (Corr & Cooper, 2016; Pugnaghi et al., 2017; Wytykowska et al., 2017) the factor loadings seem too low to reach an acceptable level of AVE. Discriminant validity was satisfactory with respect to FFFS, BIS, RR, and I but not for GDP and RI, as the MSV were higher than their corresponding AVE, suggesting a non-independence between these two factors in the model. The subscales GDP and RI were on the other hand highly correlated, which was also found in the Polish version of the RST-PQ that used a representative sample (Wytykowska et al., 2017), but not in the original version (Corr & Cooper, 2016) or in the German version (Pugnaghi et al., 2017). In the current study, the second-order model with RR, GDP, RI, and I loading on a reward sensitivity factor, and BIS and FFFS loading on a punishment sensitivity factor showed significantly poorer model fit, which is in line with previous studies (Corr & Cooper, 2016; Pugnaghi et al., 2017; Wytykowska et al., 2017). The BIS/BAS scales (Carver & White, 1994) also contain BAS subscales (Drive, Fun Seeking, and Reward Responsiveness), but even though there are similarities with respect to what they comprise, the RST-PQ has four subscales. Consequently, future research needs to investigate the factor structure in the BAS dimension further. In addition to the validation of psychometric tools like the RST-PQ, there is also a need of studies that use experimental designs that integrate self-reports and neuropsychological measurements.

The modification of the current model could be questioned, especially when three out of four global fit indices indicate good fit. However, the fit indices evaluate fit from different perspectives and decisions whether to retain a model is more complex than just the cutoff criteria's of fit indices. When looking at the global fit indices, apart from CFI the RMSEA, SRMR, and χ^2/df all suggested good global fit for the first-order model containing all 65 items. However, both the AVE and MSV (see Table 3) and the number of factor loadings below 0.5 indicated that modifications should be done in order to improve the model. These modifications resulted in an improved model fit with respect to the change in χ^2 between the six-factor model containing 52 items and the original model. On the other hand, the reduction of items did not solve the issues with convergent and discriminant validity (see Tables 3 and 6).

The invariance of the same factor structure was established, but some lack of scalar invariance was observed, in particular with respect to age. However, partial intercept invariance was achieved by releasing the equality constraint for six items (mainly BIS items) when testing for invariance for age, and one item when testing for invariance for the genders. As evidence for scalar invariance is necessary to establish that mean differences between groups are due to differences in the latent underlying construct rather than to differences that vary from item to item, caution in comparing mean levels of factors is therefore warranted. In practice, invariance is often not supported for all indicators, and this may be particularly true for complex models with many indicators and constructs. Large numbers of indicators typically lead to inadequate overall model fit (due to a large number of parameters are fixed at zero) and misleading values of the parameter estimates and standard errors. As for the BIS scale, one could argue that 23 items are a redundant number of items to measure a single construct and a reduction of the number of items is needed to reduce the complexity of the model.

In terms of limitations of the modified Swedish version of the RST-PQ one could argue that the removal of 13 items is a major modification. In the current study, the modifications were done by removing items from factors from a large battery of items. Although 13 of the 65 items were removed, all factors had at least five items per factor, which is satisfactory in terms of the statistical identification requirements (Hair et al., 2014). Another limiting factor was that the sample was somewhat skewed across different age groups. Thus, the generalisability of the results could be restricted. The downside of using a stratified sample with addressed dispatches is that the response rate tends to be low. Nonetheless, the current results emphasis the need for future work to use broader samples just as Corr and Cooper (2016) points out.

In summary, our findings showed that the Swedish version of the RST-PQ provided support for the six-factor structure suggested by Corr and Cooper (2016) to some extent. However, there was an indication of non-independence between two of the BAS factors; GDP and RI. The RST-PQ has considerable promise as it not only provides an opportunity to distinguish between the individual differences in FFFS and BIS reactivity, but also offers separate subscales for the BAS dimension. There is a need for more empirical work that investigate the convergent validity of the RST-PQ. A shorter version of the RST-PQ should be considered as well as establishing the validity using behavioral and neuroscientific data.

Disclosure statement

No potential conflict of interest was reported by the authors.

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