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Psychometric properties of the French versions of the BIS/BAS scales and the SPSRQ

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Abstract

One of the most recurrent criticisms formulated against Gray's Reinforcement Sensitivity Theory is the lack of a sound structural model of the postulated dimensions, i.e. 'Anxiety' and 'Impulsivity' reflecting the behavioural inhibition and approach systems, respectively. Although valuable efforts have been made and several instruments been published in the past fifteen years, most of the publications conclude that refinements are needed. This is the first paper that presents the psychometric properties of the French version of Carver and White's BIS/BAS scales and Torrubia et al.'s SPSRQ in a sample of students. The reliabilities and the pattern of scores intercorrelations are in line with the literature. For both instruments, exploratory factor analyses reveal a two-order structure with higher-order factors representing BIS-SP and BAS-SR. The structure of the primary factors is discussed with regards to studies in non-French speaking samples. These findings add to the cross-cultural data for the BIS/BAS scales and the SPSRQ, which is an underestimated aspect of scales' development.

Keywords: Reward sensitivity theory; BIS; BAS; Sensivitity to punishment; Sensitivity to reward; Psychometric properties; Factor analysis; Cross-cultural

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1. Introduction

For the past forty years, Jeffrey Gray and colleagues developed the most influential motivation-based theory of personality traits: the Reinforcement Sensitivity Theory (RST) (Gray & McNaughton, 2003). It postulates the existence of two major and orthogonal dimensions of personality, namely Anxiety and Impulsivity, regulated by the Behavioural Inhibition System (BIS) and the Behavioural Approach System (BAS), respectively. In the latest version of the RST, BAS is responsive to all positively valenced stimuli (presentation of reward or termination/omission of punishment) and BIS is responsive to conflicting goals (e.g. approaching an appetivite stimulus in the presence of a punishment cue). Recently, a Joint Subsystem Hypothesis has been proposed in which the BIS and BAS are no longer independent (Corr, 2001, 2002).

One of the main problems with Gray's theory is that sound psychometric measures have not yet been developed in spite of valuable efforts (Caseras, Avila, & Torrubia, 2003; Corr, 2001). Furthermore, cross-cultural properties have not been extensively studied (Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001; Müller & Wytykowska, 2005). Indeed, Gray's development is more comprehensive for BIS than for BAS. Since Gray's theory initially appeared as a modification of Eysenck's, some authors have been inclined to use Extraversion and Neuroticism measures as proxy for Impulsivity and Anxiety, respectively (Caseras et al., 2003). Others have created instruments among which Carver and White's BIS/BAS scales are the most widely used (Carver & White, 1994), but interest is deserved as well for the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia, Avila, Molto, & Caseras, 2001), the Appetitive Motivation Scale (Jackson & Smillie, 2004), the General Reward And Punishment Expectancies (GRAPES) (Ball & Zuckerman, 1990), and the Gray-Wilson Personality Questionnaire (GWPQ) (Wilson, Gray, & Barrett, 1990). Most if not all available instruments were developed before 2000, that is on the basis of an earlier version of the RST. This point is more relevant for studies aimed at testing the validity of the theory, than for those regarding the psychometric properties of a given instrument. Only the GWPQ takes into consideration the third system postulated in the latest revision of the model: the Fight-Flight System (FFS). Each brain/behavioural system is divided in two subfactors, Activation is measured by Approach and Active Avoidance, Inhibition by Passive Avoidance and Extinction, and Fight/Flight by Defensive Aggression and Flight. Factor analysis provided only limited support to this two-order structure.

1.1. BIS/BAS scales

Many authors consider that Carver and White published one of the best attempts to measure Gray's dimensions. Regardless of language and scale's length, the reliabilities range between 0.58 for RR (Müller & Wytykowska, 2005) and 0.83 for DRIVE (Heubeck, Wilkinson, & Cologon, 1998). Regardless of language and sample sizes, the mean scale intercorrelations are about +0.35 except for unsignificant values between BIS and DRIVE, and BIS and FUN. With regard to the Kaiser criterion, Carver and White (1994) extracted four factors though a 5-factor structure might have been viable (Heubeck et al., 1998; Müller & Wytykowska, 2005). Unfortunately the test authors did not report all the values of the rotated pattern matrix, preventing any comparison with other published material. They found that all BAS-related scale scores define a second-order factor. The correlation between BIS and RR unweighted scores has been consistently replicated

(Heubeck et al., 1998; Müller & Wytykowska, 2005; O'Connor, Colder, & Hawr, 2004). In all these exploratory studies, item cross-loadings made the structure not simple, and Confirmatory Factor Analyses (CFA) showed that a simple 4-factor structure did not fit the data in terms of significant χ^2 (Cogswell, Alloy, van Dulmen, & Fresco, 2006; Heubeck et al., 1998; Müller & Wytykowska, 2005; Ross, Millis, Bonebright, & Bailley, 2002) unless item parcelling was used (Leone et al., 2001). Interestingly, the factorial and measurement invariances were established in the latter study across English- and Italian-speaking samples. That is, the same latents are measured in the same way in both samples. Unfortunately the authors did not mention what items they summed in each parcel nor did they give the covariance matrices for reproduction purposes. In this partial disaggregation model however, the BIS and RR latent variables correlated in all three samples, and with DRIVE in the Italian sample only (−0.33). Besides this clever attempt, the cross-cultural validity of the BIS/BAS scales remains unclear.

1.2. The SPSR questionnaire

Quite recently, Spanish authors proposed a questionnaire to measure Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) which are related to BIS and BAS, respectively (Torrubia et al., 2001). A scree test after Principal Component Analysis (PCA) on a large sample ($N = 1563$) suggested to extract two components in both genders. Several items loaded poorly but were kept for future investigation. The reliability is slightly lower for SR ($\alpha = 0.75$) than SP ($\alpha = 0.82$) in both genders, a result replicated later (Caseras et al., 2003; O'Connor et al., 2004). An Exploratory Factor Analysis (EFA) with the English version found many items with small loadings and a small but significant correlation between the factors but not between unweighted scores (+0.18 and −0.01, respectively, $N = 603$) (O'Connor et al., 2004). This study found no support for the two-factor structure using CFA in three independent samples even after removing 13 of the 48 items. A similar conclusion was drawn in another CFA study on two independent samples (Cogswell et al., 2006). These findings suggest that the SPSRQ should undergo psychometric refinement: "bad" items, additional factors, high-order structure, cross-cultural validity and/or translation accuracy between Catalan and English are cited as possible issues.

This is the first paper to present the reliability, factor structure and validity of the French version of the BIS/BAS scales and the SPSRQ. Since these instruments are grounded in a strong theoretical biological basis, a fair replication of published works is expected. Furthermore, we postulate a second-order structure for both instruments, and a simple high-order structure with the BIS and SP scales loading on the same factor, and the BAS and SR scales loading on an almost orthogonal factor. This could initiate a sound refinement of both instruments in future studies.

2. Methods

2.1. Participants

Before leaving the classroom at the end of a course, students at the University of Nice Sophia Antipolis were asked to fill out a booklet. They participated anonymously and were volunteers.

One hundred and forty seven questionnaires were collected but one subject did not give his date of birth. Three subjects did not answer all the valid items of the BIS/BAS ($n = 144$, 109 females) and eleven subjects did not answer all the SPSRQ items ($n = 136$, 100 females).

2.2. Measures

The SPSRQ and the BIS/BAS scales were translated into French by the first author and then back-translated into English by a bilingual University collaborator naive to psychology concepts. The 24 BIS/BAS items are scored on a 4-point Likert-type scale (from 1 = Strongly agree to 4 = Strongly disagree) arranged in four scales: BIS (7 items), BAS-Reward Responsiveness (5 items), BAS-Drive (4 items) and BAS-Fun Seeking (4 items). There are four filler items and two BIS items are reversed. The SP and SR are two 24-item scales with dichotomously scored items. None is reversed, even items form the SR scale and odd items the SP scale. In this study, the items were slightly reworded to allow their scoring on a 4-point Likert-type (from 1 = Totaly true to 4 = Totaly wrong) to reduce the bias of correlation coefficients (Bollen & Barb, 1981), and because a joint factor analysis is planned in our future studies. The original scoring keys were used.

2.3. Data analysis

Only complete questionnaires were analysed with STATA 9.2. The polychoric inter-item correlation matrix was computed for each instrument separately. To determine the number of factors to be extracted, a scree test and a parallel analysis were conducted after a PCA. Parallel analysis consists in comparing the eigenvalues obtained in the sample to those one would expect to obtain from random data (1000 random correlation matrices in this study). This method is now recommended as the best method to assess the true number of factors (Lance, Butts, & Michels, 2006). From published work, four factors were expected for the BIS/BAS scales (BIS, FUN, RR, DRIVE) and two for the SPSRQ. Since the FUN, RR and DRIVE scales are supposed to measure a single BAS construct, we hypothesised that the structure of the SPSRQ might be more complex than just two orthogonal factors. Hence restricted EFAs were performed, resulting factors were obliquely rotated with the PROMAX criterion (with $d = 4$), and second-order EFAs were performed. Any orthogonal rotation would have prohibited a second-order EFA.

3. Results

Descriptive statistics and score correlations are presented (Tables 1 and 2, respectively). Most scores are normally distributed. The median for age is 21.11 years (135 participants were under 30 years old), and females are older than males (Mann–Whitney test: $z = 2.707$, $p < 0.007$). The effect of sex is significant on BIS only: $t(142) = 3.826$ ($p = 0.0002$). Age does not correlate with any score, BIS correlates with SP and SR in females, but with SP only in males (Table 2). The BAS scales correlate more with SR than SP in both genders with the exception of FUN in females. To gain in comparability with English versions that found SP and SR to be orthogonal and did not consider genders separately (O'Connor et al., 2004), we partialled out the +0.288 rank-order

Table 1
Descriptive statistics for the original scores : mean ± SD, range, Shapiro–Wilk test of normality (W), Cronbach's α

	Entire sample	Males	Females
Age ($N = 146$; 111 females)	23.00 ± 6.33 [16.08; 52.38] $W = 0.567^{***}$	24.95 ± 8.04 [16.08; 51.78] $W = 0.707^{***}$	22.36 ± 5.59 [18.17; 52.38] $W = 0.507^{***}$
BIS ($N = 144$; 109 females)	21.35 ± 3.69 [9; 30] $W = 0.986$ $\alpha = 0.744$	19.37 ± 3.33 [12; 26] $W = 0.982$ $\alpha = 0.608$	21.99 ± 3.58 [9; 30] $W = 0.974^{*}$ $\alpha = 0.749$
Fun seeking	11.41 ± 2.36 [5; 20] $W = 0.992$ $\alpha = 0.720$	11.17 ± 2.67 [5; 16] $W = 0.970$ $\alpha = 0.834$	11.49 ± 2.26 [5; 20] $W = 0.989$ $\alpha = 0.675$
DRIVE	9.74 ± 2.24 [5; 17] $W = 0.989$ $\alpha = 0.581$	9.69 ± 2.18 [6; 14] $W = 0.982$ $\alpha = 0.461$	9.75 ± 2.27 [5; 17] $W = 0.986$ $\alpha = 0.626$
Reward responsiveness	16.27 ± 2.36 [8; 20] $W = 0.976^{*}$ $\alpha = 0.673$	15.54 ± 2.54 [8; 20] $W = 0.965$ $\alpha = 0.702$	16.51 ± 2.26 [12; 20] $W = 0.991$ $\alpha = 0.652$
Sensitivity to punishment ($N = 136$; 100 females)	58.47 ± 11.10 [33; 104] $W = 0.977^{*}$ $\alpha = 0.870$	56.44 ± 9.41 [41; 78] $W = 0.972$ $\alpha = 0.852$	59.20 ± 11.61 [33; 104] $W = 0.974^{*}$ $\alpha = 0.880$
Sensitivity to reward	55.19 ± 10.01 [34; 108] $W = 0.945^{***}$ $\alpha = 0.847$	55.78 ± 7.75 [34; 71] $W = 0.973$ $\alpha = 0.731$	54.98 ± 10.73 [35; 108] $W = 0.933^{***}$ $\alpha = 0.870$

* $p < 0.05$.
*** $p < 0.001$.

correlation found in our sample ($N = 136$) from each of the eight correlations between BIS/BAS scales, SP and SR. Thus BIS correlates .514 with SP (versus .53), RR correlates .543 with SR (versus .24), DRIVE correlates .467 with SR (versus .20), and FUN correlates .386 with SR (versus .34). Hence, in both languages, BIS and SP are fair indicators of the same construct, while the three BAS subscales and SR are fair indicators of another construct.

3.1. The BIS/BAS scales

Feldt statistics (not shown) indicate that the reliabilities of the BIS/BAS scales are similar to those reported by the test authors except for DRIVE that, in turn, has a value as small as that reported by the Catalan authors (Caseras et al., 2003). After Fisher transformation, we find

Table 2
Pairwise Spearman rank-order correlations

	Age	BIS	FUN	DRIVE	RR	SP	SR
Age	1	−0.107	−0.075	−0.167	−0.137	−0.198	−0.305
BIS	−0.162	1	−0.253	−0.113	0.110	0.630***	−0.051
FUN	−0.134	−0.035	1	0.083	0.286	−0.198	0.410*
DRIVE	−0.062	0.119	0.353***	1	0.304	0.220	0.620***
RR	−0.084	0.448***	0.361***	0.277**	1	0.089	0.457**
SP	0.028	0.508***	−0.222*	−0.117	0.212*	1	0.305
SR	−0.085	0.409***	0.277**	0.465***	0.525***	0.300**	1

Females are in the lower triangle ($N = 100$ except for BIS/BAS scores where $N = 109$), Males are in the upper triangle ($N = 36$ except with age or BIS/BAS scores where $N = 35$).
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

BIS and each BAS scales correlating with a similar magnitude as those reported in the literature except that the correlations are higher in the Polish sample (Müller & Wytykowska, 2005). The correlation between BAS scales are in line with the literature.

We examined the fit of the original model using CFA and three different estimators: Maximum Likelihood without (ML) and with Satorra–Bentler scaling (MLM), and Muthen's Weight Least Squares with Mean and Variance correction (WLSMV). The fit was poor with all three conditions: $\chi^2(164) = 278.043$ (CFI = 0.818, RMSEA = 0.070), $\chi^2(164) = 247.710$ (CFI = 0.845, RMSEA = 0.060), and $\chi^2(47) = 125.434$ (CFI = 0.841, RMSEA = 0.109), respectively. Hence, an exploratory approach is recommended in our sample.

The graph of the eigenvalues of the polychoric correlation matrix is straightforwardly interpreted (Fig. 1). The first six eigenvalues are greater than 1.000 (5.051, 3.311, 1.724, 1.536, 1.168, 1.038) but, according to the original structure, the parallel analysis and the scree test only the first four are extracted and rotated. The pattern matrix, uniqueness vector and factor intercor-

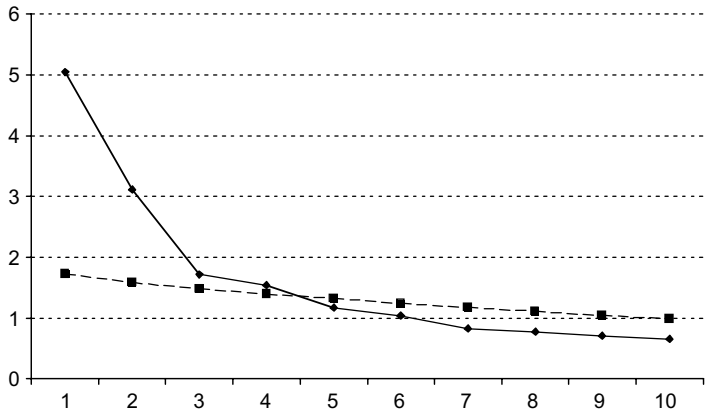

Fig. 1. Graph of eigenvalues after Principal Component Analysis of the polychoric matrix (diamonds) and after parallel analysis (squares).

relation matrix are presented (Table 3). Fifteen items (75%) load on their expected factor only. Items 7 (RR), 9 (DRIVE) and 18 (RR) do not load on any four factors. Item 14 (RR) cross-loads on BIS and FUN. Item 19 (BIS) cross-loads on BIS and RR. Overall, the postulated structure is mostly recovered across language and RR items are problematic. The EFA on the interfactor correlation matrix returned a simple structure with FUN and DRIVE loading on the first second-order factor, and BIS and RR loading on the other one. These higher-order factors correlated at +0.523 ($p < 0.0001$).

3.2. The SPSR questionnaire

The reliabilities of SP and SR are similar to those found in the literature (Table 1). Scores correlate at +0.30 in both genders (Table 2) whereas near zero values have been reported in Catalan (Caseras et al., 2003; Torrubia et al., 2001) and English samples (O'Connor et al., 2004).

We examined the fit of the original two-factor model and the shortened model proposed by O'Connor et al. (2004) using CFA with the ML, MLM and WLSMV estimators. The shortened

Table 3
Exploratory factor analysis restricted to four factors ($n = 144$)

Variable	Expected factor	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
		BIS	FUN	RR	DRIVE	
bisbas2	BIS	**0.689**	−0.034	−0.160	0.170	0.433
bisbas3	DRIVE	0.057	0.043	−0.136	**0.726**	0.388
bisbas4	RR	0.007	0.149	**0.690**	−0.110	0.345
bisbas5	FUN	−0.124	**0.856**	0.154	−0.147	0.165
bisbas7	RR	0.355	0.372	0.334	0.061	0.249
bisbas8	BIS	**0.591**	−0.039	0.150	0.002	0.432
bisbas9	DRIVE	−0.033	0.091	0.242	0.124	0.736
bisbas10	FUN	−0.131	**0.810**	−0.113	−0.009	0.311
bisbas12	DRIVE	0.127	0.107	0.285	**0.515**	0.385
bisbas13	BIS	**0.728**	0.136	−0.159	−0.080	0.283
bisbas14	RR	**0.417**	**0.513**	0.215	−0.258	0.208
bisbas15	FUN	0.150	**0.538**	−0.349	0.258	0.488
bisbas16	BIS	**0.778**	−0.220	0.040	0.077	0.320
bisbas18	RR	0.382	0.201	0.160	−0.081	0.616
bisbas19	BIS	**0.416**	−0.235	**0.508**	−0.031	0.316
bisbas20	FUN	−0.133	**0.561**	0.171	0.176	0.387
bisbas21	DRIVE	−0.014	−0.204	0.098	**0.797**	0.363
bisbas22	BIS	**0.474**	−0.133	−0.262	−0.065	0.499
bisbas23	RR	−0.091	0.031	**0.669**	0.195	0.386
bisbas24	BIS	**0.565**	−0.240	0.160	0.025	0.438
	Factor 2	0.181*	1			
	Factor 3	0.402**	0.298**	1		
	Factor 4	0.068	0.394**	0.149	1	

Loadings greater than 0.400 are in bold.
* $p < 0.05$.
** $p < 0.001$.

model did not fit the data by far: $\chi^2(494) = 1004.340$ (CFI = 0.621, RMSEA = 0.087), $\chi^2(494) = 942.959$ (CFI = 0.636, RMSEA = 0.082), and $\chi^2(62) = 245.684$ (CFI = 0.684, RMSEA = 0.148), respectively. The MLM and the WLSMV estimator both failed to converge when using the 48 original indicators, and the ML estimator showed an unacceptable fit: $\chi^2(1079) = 1974.113$ (CFI = 0.555, RMSEA = 0.078). Hence, an exploratory approach is recommended in our sample.

Since the polychoric correlation matrix was singular, we analyzed a product–moment correlation matrix. Fig. 2 shows that many eigenvalues are greater than 1.000 (the first ten eigenvalues are: 8.847, 4.275, 2.068, 1.794, 1.688, 1.640, 1.440, 1.387, 1.293). We decided to extract and rotate both a two-factor solution to keep in line with the *a priori* structure and a four-factor solution suggested by both the scree test and the parallel analysis. The pattern matrix, uniqueness vector and factor intercorrelation matrix are presented (Table 4). The two-factor solution resembles the original structure, most items loading on their expected factor. Some load poorly on their expected factor (i.e. below the arbitrary threshold of 0.400) but their secondary loading falls in the hyperplane. The four-factor solution deserves attention since factors can be named relatively easily: Fear of being rejected, Fear of the unknown, Competition and Arousal. Factor 2 is independent of both Factors 3 and 4, but other factor intercorrelations are significant. Two second-order factors could be extracted from the first-order factor correlation matrix that correlate +0.256 ($p < 0.01$). The first one encompasses the factors "Fear of being rejected" and "Fear of the unknown" while the second encompasses the factors "Competition" and "Arousal". As a means for identifying them, we computed the correlation between the factor scores and the original unweighted scale scores. The first second-order factor correlates +0.970 with SR (+0.417 with SP) while the second correlated +0.945 with SP (+0.539 with SR).

A last unshown EFA with the eight factorial scores reveals a BAS factor that encompasses FUN, DRIVE and the two SR first-order factors, and a BIS factor that encompasses BIS and

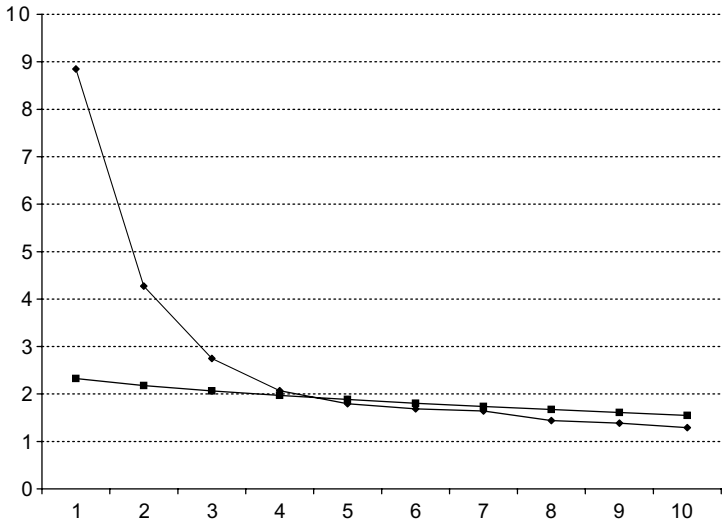

Fig. 2. Graph of eigenvalues after Principal Component Analysis of the product-moment matrix (diamonds) and after parallel analysis (squares).

Table 4
Exploratory factor analyses restricted to two and four factors ($n = 136$)

Variable	Scale	Factor 1	Factor 2	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
		SP	SR					
Item 1	SP	0.297	0.062	**0.410**	0.121	−0.008	−0.222	0.499
Item 2	SR	−0.045	**0.478**	−0.168	0.149	**0.591**	0.151	0.322
Item 3	SP	**0.504**	−0.099	−0.014	**0.524**	0.079	−0.044	0.437
Item 4	SR	0.170	**0.472**	**0.597**	−0.083	0.093	0.053	0.336
Item 5	SP	**0.668**	−0.030	0.183	**0.586**	0.033	−0.021	0.241
Item 6	SR	−0.132	**0.476**	0.204	−0.163	0.299	0.093	0.444
Item 7	SP	**0.607**	−0.173	−0.010	**0.602**	−0.010	−0.008	0.345
Item 8	SR	−0.108	0.282	−0.116	−0.012	0.254	0.201	0.546
Item 9	SP	0.368	0.282	**0.512**	0.132	0.003	0.041	0.319
Item 10	SR	0.233	**0.574**	**0.719**	−0.065	0.143	0.044	0.251
Item 11	SP	0.257	0.156	**0.412**	0.048	−0.089	0.025	0.585
Item 12	SR	−0.056	**0.654**	**0.556**	−0.263	0.231	0.117	0.343
Item 13	SP	0.313	0.266	**0.515**	0.072	−0.020	0.020	0.381
Item 14	SR	0.062	**0.529**	0.388	−0.083	0.193	0.200	0.373
Item 15	SP	**0.448**	−0.001	0.218	0.248	−0.340	**0.406**	0.377
Item 16	SR	0.216	**0.439**	**0.565**	−0.095	−0.148	0.384	0.361
Item 17	SP	**0.652**	−0.241	−0.330	**0.790**	0.044	0.184	0.295
Item 18	SR	−0.181	**0.454**	0.113	−0.187	0.253	0.201	0.516
Item 19	SP	0.380	0.073	−0.165	**0.505**	0.281	0.079	0.359
Item 20	SR	−0.301	**0.543**	0.297	−0.395	0.207	0.153	0.450
Item 21	SP	**0.438**	0.221	0.163	**0.414**	0.258	0.012	0.373
Item 22	SR	0.367	0.258	0.328	0.247	0.152	0.004	0.456
Item 23	SP	0.135	0.210	−0.047	0.131	0.014	**0.435**	0.439
Item 24	SR	−0.094	**0.541**	0.154	−0.086	**0.396**	0.140	0.420
Item 25	SP	**0.533**	−0.014	0.320	0.344	−0.159	0.058	0.339
Item 26	SR	0.094	**0.509**	0.144	0.093	0.364	0.220	0.331
Item 27	SP	0.287	0.082	0.155	0.272	0.212	−0.208	0.528
Item 28	SR	−0.088	0.354	0.041	−0.092	0.143	0.306	0.525
Item 29	SP	**0.638**	0.044	0.139	**0.614**	0.196	−0.085	0.288
Item 30	SR	−0.046	**0.528**	0.090	0.098	**0.771**	−0.302	0.253
Item 31	SP	0.335	0.214	0.120	0.203	−0.176	**0.598**	0.377
Item 32	SR	0.183	0.096	−0.007	0.131	−0.131	**0.421**	0.347
Item 33	SP	**0.422**	−0.037	0.172	0.315	−0.100	0.060	0.443
Item 34	SR	0.055	0.147	0.052	−0.026	−0.150	**0.412**	0.395
Item 35	SP	**0.655**	−0.240	−0.202	**0.731**	0.003	0.099	0.334
Item 36	SR	0.224	0.285	0.012	0.256	0.244	0.216	0.431
Item 37	SP	**0.543**	0.065	0.307	0.329	−0.235	0.311	0.336
Item 38	SR	−0.091	**0.560**	0.067	−0.054	0.383	0.286	0.385
Item 39	SP	**0.640**	−0.051	0.174	**0.530**	−0.082	0.101	0.394
Item 40	SR	0.123	0.294	0.132	0.007	−0.109	**0.537**	0.377
Item 41	SP	0.345	0.268	0.122	0.217	−0.143	**0.645**	0.273
Item 42	SR	−0.148	**0.512**	−0.146	0.006	**0.482**	0.288	0.345
Item 43	SP	**0.495**	0.379	**0.541**	0.281	0.165	0.000	0.254
Item 44	SR	−0.027	**0.527**	0.121	0.105	**0.777**	−0.340	0.213
Item 45	SP	0.283	0.383	0.254	0.225	0.295	0.063	0.412
Item 46	SR	0.151	**0.526**	0.266	0.145	**0.516**	−0.071	0.333

(*continued on next page*)

Table 4 (*continued*)

Variable	Scale	Factor 1	Factor 2	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
		SP	SR					
Item 47	SP	**0.682**	0.185	0.153	**0.624**	0.150	0.214	0.203
Item 48	SR	−0.080	**0.511**	0.172	−0.093	0.336	0.157	0.468
	Factor 2	0.286**	1	0.369**	1			
	Factor 3	–	–	0.268*	−0.049	1		
	Factor 4	–	–	0.247*	0.000	0.347**	1	

Loadings greater than 0.400 are in bold.
* $p < 0.01$.
** $p < 0.001$.

the two SP first-order factors. The RR factor fails to load. These factors moderately correlate at +0.273 ($p < 0.002$).

4. Discussion

We translated the BIS/BAS scales and the SPSRQ into French and studied their psychometric properties in a sample of students (more than 90% were under 30 years old). Overall we obtained satisfactory results in line with the literature. Females scored higher than males on BIS, and no effect of age was found on any score. Their reliability is good, except for DRIVE in males due to a near zero correlation of item 9 with the rest of the test. The observed intercorrelation pattern between scores was expected, except for the significant BIS-SR and BIS-RR correlations in females.

The size of our sample ($N = 144$ for the BIS/BAS and $N = 136$ for the SPSRQ) might be a limitation of this study, especially with regard to the EFAs. In fact, necessary sample size is dependent on several aspects of any given study and is not invariant across studies (MacCallum, Widaman, Zhang, & Hong, 1999). The median communality of the BIS/BAS items is 0.50 (range 0.08–0.79) and the variable to subject ratio is 1/7.20; for the SPSRQ 0.30 (range 0.11–0.77) and 1/2.83, respectively. Nevertheless, since the SPSRQ counts a small number of overdetermined factors the issue of sample size remains open, and calls for replication studies. A sample of at least 200 subjects of each gender would be desirable, and would additionally allow testing the cross-gender structural and measurement invariances of these instruments within a CFA framework.

As Carver and White (1994) showed for their BIS/BAS scales and what was hypothesized for the GWPQ, our results tend to support a two-order structure for the SPSRQ too. The higher-order factors presumably represent the two brain/behavioural systems postulated by Gray. For identification purposes, we showed that the eight primary factors define a two-factor space. Nevertheless, both instruments present weaknesses at the primary level; the uniqueness values suggest that there is room for additional factors and may explain why CFA analyses have failed so far.

Consistent with studies on English-speaking samples, BIS correlates with RR (e.g. Carver & White, 1994; Heubeck et al., 1998). Indeed, RR items do not measure a reliable factor, and items 7, 14 and 18 load on other primary factors. This is in line with an IRT study that found serious limitations in the RR scale (Gomez, Cooper, & Gomez, 2005). Finally, Carver and White (1994)

reported a nice two-order structure after factoring the *scale* scores, not the factor scores as we did. This may also explain why all CFA studies failed but the one that used item parcelling (Leone et al., 2001).

With regard to the SPSRQ, the patterns of loadings are similar between our oblique two-factor solution and Torrubia et al.'s (2001) orthogonal two-component solution: two thirds of the items loaded above 0.400, and eleven out of the 16 items remaining also loaded poorly in the original study (1, 9, 11, 13, 19, 23, 28, 32, 34, 36, and 40). In passing, this suggests that the polytomic item format did not harm our factor analyses. One could recommend simply discarding these items to achieve a better measurement, but we would not since a four-factor solution seems more advantageous. Admittedly, six items (8, 22, 27, 28, 36 and 45) still loaded poorly in both our solutions. On the other hand, nine items (1, 9, 11, 13, 19, 32, 34, 40, 41) loaded poorly on the two-factor solution but loaded on their expected primary factor in the four-factor solution. Also, SP items 23 and 31 loaded poorly on the two-factor solution but loaded on a SR primary factor in the four-factor solution. Therefore, constraining a two-factor solution probably may not reflect properly the true underlying structure of the SPSRQ. Confirmatory factor analyses and convergent/divergent validity studies in independent larger samples are now needed. The point is that more factors are needed to reliably measure the constructs postulated by RST.

In conclusion, regardless of language, both the BIS/BAS scales and the SPSRQ need structural refinements to achieve a better measurement of the underlying constructs. A psychometrically sound instrument for reflecting the FFS in human personality is also pending to conform to the latest version of RST.

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