

# Factor structure and psychometric properties of a French and German shortened version of the Behavioural Inhibition System/Behavioural Activation System scales

JOSEPH STUDER,<sup>1</sup> STÉPHANIE BAGGIO,<sup>2</sup> MEICHUN MOHLER-KUO,<sup>3</sup> JEAN-BERNARD DAEPPEN<sup>1</sup> & GERHARD GMEL<sup>1,4,5,6</sup>

1 Alcohol Treatment Centre, Lausanne University Hospital CHUV, Lausanne, Switzerland

2 Life Course and Social Inequality Research Centre, University of Lausanne, Lausanne, Switzerland

3 Epidemiology, Biostatistics and Prevention Institute, University of Zurich, Zurich, Switzerland

4 Addiction Switzerland, Lausanne, Switzerland

5 Centre for Addiction and Mental Health, Toronto, Ontario, Canada

6 University of the West of England, Bristol, UK

---

## Key words

BIS/BAS scales, psychometric properties, confirmatory factor analysis, exploratory factor analysis, French, German

## Correspondence

Joseph Studer, Alcohol Treatment Centre, Lausanne University Hospital CHUV, Av. Beaumont 21 bis, Pavillon 2, CH-1011 Lausanne, Switzerland.  
Telephone (+41) 21 3149033  
Fax (+41) 21 3140562  
Email: joseph.studer@chuv.ch

Received 15 December 2014;  
revised 18 March 2015;  
accepted 11 May 2015

## Abstract

The Behavioural Inhibition System/Behavioural Activation System scales (BIS/BAS scales) constitute one of the most prominent questionnaires to assess individual differences in sensitivity to punishment and reward. However, some studies questioned its validity, especially that of the French and German translations. The aim of the present study was to re-evaluate the psychometric characteristics of the BIS/BAS scales in a large sample of French- and German-speaking young Swiss men ( $N = 5872$ ). Results showed that factor structures previously found in the literature did not meet the standards of fit. Nine items had to be removed to achieve adequate fit statistics in confirmatory factor analysis, yielding a shortened version with four factors: one BIS factor comprising five items and three BAS factors, namely Reward Reactivity, Drive and Fun Seeking, each comprising two items. Convergent validity and group invariance analyses suggest that the shortened BIS/BAS scales constitute a valid and reliable instrument. Researchers interested in assessing individual differences in BIS and BAS reactivity in French- and German-speaking individuals should avoid using the BIS/BAS scales as originally specified. The shortened version may be a sound alternative at least in samples of young adults. Its shorter format may be particularly suited for surveys with constraints on questionnaire length. *Copyright © 2015 John Wiley & Sons, Ltd.*

## Introduction

Personality is rooted in a long evolutionary process and reflects the expression of different biologically-based systems that govern individuals' sensitivity to positive and negative stimuli (Eysenck, 1990; Gray, 1982). One of the most important theories of personality is the Reinforcement Sensitivity Theory (RST; Gray, 1982, 1987). In its original formulation, three motivational brain systems, namely the Behavioural Activation System (BAS), the Behavioural Inhibition System (BIS) and the Fight–Flight System (FFS) were thought to support sensitivity to positive and negative stimuli. BAS was hypothesized to mediate reactions to both conditioned and unconditioned appetitive stimuli, and to underpin anticipation of pleasure and approach behaviours. BIS was thought to control avoidance of conditioned aversive stimuli and high intensity or novel stimuli and to relate to anxiety, fear, sadness and frustration (Corr and McNaughton, 2008). FFS was assumed to mediate reactions of rage and panic in response to unconditioned aversive stimuli and to be associated with defensive aggression (fight) or escape response (flight) (Heym *et al.*, 2008).

In the most recent version, Gray and McNaughton (2000) proposed a revised model of RST (rRST). The conceptualization of BAS remained unchanged. However, freeze response was incorporated to the FFS, renamed as Fight–Flight–Freeze System (FFFS). In rRST, FFFS is assumed to mediate reactions to both conditioned and unconditioned aversive stimuli and is responsible for the detection of threats, and the avoidance and escape behaviours. Finally, the BIS is thought to mediate the detection and resolution of goal conflicts, e.g. competing reward and punishment cues (Corr *et al.*, 2013). For example, alcohol cues may activate a conflict between the desire to drink alcohol because of its positive reinforcement properties (activation of BAS) and the fear of the negative consequences of alcohol use (activation of FFFS). Activation of BIS raises attention to the potential dangers or desirable outcomes of a behaviour, resulting in enhanced anxiety and rumination, until conflict resolution occurs in favour of approach or avoidance (Corr and McNaughton, 2008; Gray and McNaughton, 2000).

Individual differences in reactivity of the BAS, FFFS and BIS are thought to underlie differences in personality. In particular, studies showed that BAS reactivity was associated with extraversion, impulsivity, sensation seeking, anger and hostility, FFFS reactivity with neuroticism and fearfulness, whereas BIS reactivity was associated with worry proneness, neuroticism and anxiety (Beck *et al.*, 2009; Corr and McNaughton, 2008; Dissabandara *et al.*,

2011; Harmon-Jones, 2003; Keiser and Ross, 2011; Quilty and Oakman, 2004; Segarra *et al.*, 2014). Moreover, RST systems are also particularly helpful to understand and explain a broad range of psychopathologies (see Bijttebier *et al.*, 2009, for review). For example, substance abuse was found to be significantly associated with high BAS sensitivity (Franken and Muris, 2006; Johnson *et al.*, 2003), whereas depression was associated with high BIS and low BAS sensitivity (Campbell-Sills *et al.*, 2004; Kasch *et al.*, 2002; McFarland *et al.*, 2006).

Several self-report questionnaires have been developed to assess individual differences in RST systems. One of the most commonly used is the Behavioural Activation System/Behavioural Inhibition System scales (BIS/BAS scales; Carver and White, 1994). BIS/BAS scales were not developed to assess FFS/FFFS reactivity, they only measure BIS and BAS reactivity as depicted in the original RST (Gray, 1982, 1987). This 20-item questionnaire comprises four inter-related scales, one of them tapping BIS reactivity and the remaining three tapping different aspects of BAS reactivity. BAS scales include the Drive scale, assessing the persistent pursuit of desired goals, the Fun Seeking (FS) scale, reflecting a desire for new rewards and a willingness to approach potentially rewarding events, and the Reward Responsiveness (RR) scale, tapping positive responses to the occurrence or anticipation of reward (Carver and White, 1994). Support for this four-factor structure was reported in several studies (Campbell-Sills *et al.*, 2004; Cogswell *et al.*, 2006; Cooper *et al.*, 2007; Demianczyk *et al.*, 2014; Franken *et al.*, 2005; Heubeck *et al.*, 1998; Knyazev *et al.*, 2004; Leone *et al.*, 2001; Müller and Wytykowska, 2005; Ross *et al.*, 2002), although suboptimal fit indices were often observed and refinements (e.g. adding cross-loadings, dropping items) frequently needed in order to achieve adequate fit to the data (see e.g. Campbell-Sills *et al.*, 2004; Cogswell *et al.*, 2006; Demianczyk *et al.*, 2014; Franken *et al.*, 2005; Knyazev *et al.*, 2004). Other studies provided support for a two-factor (BIS and BAS) rather than for a four-factor solution (e.g. Jorm *et al.*, 1998; Strobel *et al.*, 2001; Yu *et al.*, 2011).

Although they did not originally comprise a FFFS scale, re-examinations of the structure of BIS/BAS scales suggests that items of the BIS scale may be used to differentiate between BIS and FFFS as depicted in the rRST (Gray and McNaughton, 2000). For example, Johnson *et al.* (2003) showed that two items of the BIS scale, i.e. “Even if something bad is about to happen to me, I rarely experience fear or nervousness” and “I have very few fears compared to my friends” loaded on a separate factor interpreted as FFFS, whereas the remaining items loaded

on another factor interpreted as a BIS-anxiety. More recently, Heym *et al.* (2008) suggested the inclusion of a third item i.e. “If I think something unpleasant is going to happen I usually get pretty worked up”, as an additional indicator of the FFFS factor. Thus, these studies suggest that a five-factor solution comprising the three original BAS factors, a BIS-anxiety and a FFFS factor may better reflect the structure of the BIS/BAS scales than a four-factor solution.

The BIS/BAS scales were translated into several different languages, including Russian (Knyazev *et al.*, 2004), Polish (Müller and Wytykowska, 2005), Italian (Leone *et al.*, 2001), Dutch (Smits and Boeck, 2006), Sinhalese (Dissabandara *et al.*, 2012), Spanish (Segarra *et al.*, 2014), German (Strobel *et al.*, 2001) and French (Caci *et al.*, 2007). More specifically, with regards to the German translation, the first evaluation of the psychometric characteristics of the questionnaire showed that the Carver and White’s (1994) four-factor structure did not adequately fit to the data, and that a two-factor solution, i.e. one BAS factor and one BIS factor achieved a better fit. A more recent examination of this translation (Müller *et al.*, 2013) compared the fit of two-, four- and five-factor solutions. The five-factor solution proposed by Johnson *et al.* (2003) yielded the best goodness-of-fit although it was not optimal as it did not meet the conventional standards of fit. With regard to the French translation of the BIS/BAS scales, Caci *et al.* (2007) found a mediocre fit in the original four-factor solution. Exploratory factor analysis (EFA) restricted to four factors revealed that only 15 items loaded on the expected factors, whereas five items (25%) did not load on any factor, or had cross-loadings. As noted by the authors, a major limitation of this study was that the sample size ( $N=144$ ) may not be sufficient to compute factor analysis. They stated that a closer look at the structure of BIS/BAS scales was needed, as well as possibly some structural refinements, in order to achieve a better measurement of the underlying constructs.

Using a large and representative sample of French- and German-speaking Swiss young males, the aim of the present study was to investigate the factorial structure and the psychometric properties of the French and German versions of the BIS/BAS scales. More specifically, fit statistics of different factor solutions proposed in previous studies (i.e. two-, four-, five-factor solutions) will be compared in order to identify the most adequate factor structure. If none of the model tested achieve the conventional standards of fit, exploratory approach will be adopted in order to specify an adequate fitting model. Convergent validity and factor loading invariance of French and German versions will be examined.

## Methods

### Study design and participants

We analysed data from the Cohort Study on Substance Use Risk Factors (C-SURF). C-SURF is a longitudinal study designed to investigate risk and protective factors of substance use in emerging adulthood. Research protocol (15/07) was approved by the ethics committee for clinical research of Lausanne University Medical School. Participants were enrolled in three of six army recruitment centres, covering 21 of 27 Swiss cantons. As army recruitment is mandatory in Switzerland for 20-year-old males, virtually all young males of this age were eligible for participation. Army recruitment centres were used to inform and enrol participants but the study was independent of the army. Questionnaires were completed at home, thus, participants were not influenced by army procedures when filling out questionnaires. More information on enrolment procedure has been described in previous studies (Studer *et al.*, 2013a, 2013b).

A total of 7556 participants gave written consent to participate and, among them, 5987 (79.2%) completed the baseline questionnaire between September 2010 and March 2012 and 6020 (79.7%) completed the follow-up questionnaire between March 2012 and April 2013. A total of 5479 (91.5% of baseline respondents) responded to both baseline and follow-up questionnaires.

BIS/BAS scales were only assessed in the follow-up questionnaire. Only participants with complete data ( $N=5872$ , 97.5% of the follow-up respondents) on the BIS/BAS scales were selected to examine the factorial structure and group invariance of the questionnaire. Convergent validity analyses were conducted on respondents to baseline and follow-up questionnaires, as some variables of interest were assessed only in the baseline questionnaire and others only in the follow-up questionnaire. Missing values were listwise deleted ( $N=4927$ , 89.9% of respondents to baseline and follow-up).

### Instruments

French (Caci *et al.*, 2007) and German (Strobel *et al.*, 2001) translations of the BIS/BAS scales (Carver and White, 1994) were used to assess individual differences in BIS and BAS reactivity. This self-report questionnaire comprised 24 items, including four filler items, evaluated on a four-point scale ranging from 1 “very true for me” to 4 “very false for me”. Items were re-coded in such a way that high values were indicative of a higher level of endorsement of the item.

French and German versions of the shortened Zuckerman–Kuhlman Personality Questionnaire (ZKPQ-50-cc; Aluja *et al.*, 2006) were used to assess individual differences in Aggression/Hostility and Anxiety/Neuroticism traits at baseline. Each personality trait was evaluated using 10 items in a true/false format. Summary scores ranging from 0 to 10 were computed. This was used to examine the convergent validity of the BIS/BAS scales. Consistent with previous studies, it is expected that Anxiety/Neuroticism will be positively related to BIS and FFFS (Beck *et al.*, 2009; Keiser and Ross, 2011; Segarra *et al.*, 2014), whereas Aggression/Hostility will be positively related to BAS, in particular to the Drive and FS scales (Harmon-Jones, 2003).

The French and German translations of the eight-item Brief Sensation Seeking Scale (BSSS; Hoyle *et al.*, 2002) were used to assess individual differences in Sensation Seeking (SS) at baseline. Each item was evaluated on a five-point scale ranging from 1 “strongly disagree” to 5 “strongly agree”. A summary score ranging from 8 to 40 was computed. Consistent with previous studies (Dissabandara *et al.*, 2011; Keiser and Ross, 2011; Quilty and Oakman, 2004), SS is expected to correlate positively with BAS scales.

The 11 criteria for alcohol use disorders (AUDs) according to the fifth edition of the diagnostic and statistical manual of mental disorders (DSM-5; American Psychiatric Association, 2013) were used to assess AUDs at follow-up. Questions, adapted from the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA; Hesselbrock *et al.*, 1999; Knight *et al.*, 2002), included the following criteria: (1) tolerance; (2) withdrawal symptoms; (3) using larger amounts and for longer periods than intended; (4) desire to cut down alcohol use, without success; (5) spending a great deal of time obtaining, consuming alcohol, or recovering from the effects of alcohol; (6) giving up important activities because of drinking; (7) continued drinking despite awareness that alcohol had repeatedly caused anxiety, depression or health problems; (8) drinking in hazardous situations; (9) failure to fulfil major role obligations at work/school/home; (10) continued use despite persistent or recurrent social or interpersonal problems due to drinking. At the time of the development of the questionnaire, no item for (11) cravings and urges to consume alcohol was available for a DSM-5 version. Thus, the question regarding cravings and urges was adopted from the Composite International Diagnostic Interview Short Form (CIDI-SF; Kessler *et al.*, 1998). Participants were asked whether they experienced each criterion in the previous twelve months. A summary score of AUD (range: 0–11) was constructed. The Cannabis Use Disorder Identification Test (CUDIT; Adamson and

Sellman, 2003) was used to assess cannabis use disorders (AUDs) at follow-up. This is a ten-item assessment tool asking participants about symptoms of cannabis use disorder during the previous 12 months, yielding a score of CUD ranging from 0 to 40. The Fagerström Test for Nicotine Dependence (FTND; Heatherton *et al.*, 1991) was used to assess Nicotine Dependence (ND) at follow-up. This is a six-item questionnaire yielding a continuous score of ND ranging from zero to ten. Substance use disorders will be used to assess convergent validity. Consistent with previous studies (Franken and Muris, 2006; Keough and O'Connor, 2014; O'Connor *et al.*, 2009; Voigt *et al.*, 2009), positive correlations are expected between BAS and substance use disorders, in particular the Drive and FS scales.

The Major Depressive Inventory (MDI) was used at follow-up to assess levels of depression (Bech *et al.*, 2001; Olsen *et al.*, 2003). This is a 12-item questionnaire covering symptoms of depression according to DSM-IV (American Psychiatric Association, 1994) and the tenth revision of the International Classification of Diseases (ICD-10) (World Health Organization, 1993). Participants were asked to indicate how much of the time the symptoms have been present during the past 14 days on a six-point scale from zero (never) to five (all the time). A summary score of major depression severity (MDS), ranging from 0 to 50, was computed with 10 criteria (two criteria use two items and take the higher score of any of these two, see Bech *et al.*, 2001; Olsen *et al.*, 2003). MDS will be used to assess convergent validity. Consistent with results of previous studies (Campbell-Sills *et al.*, 2004; Kasch *et al.*, 2002; McFarland *et al.*, 2006; Meyer *et al.*, 1999), MDS is expected to correlate positively with BIS and negatively with BAS scales, in particular with the RR scale.

Socio-demographic variables including age, language and highest completed level of education were assessed. Highest completed level of education consisted of three categories of schooling: primary schooling (nine years); vocational training (>9–12 years); post-secondary schooling (13 years or more including high school which can be only 12 years in some cantons). Furthermore, participants were distinguished according to their preferred language, i.e. French or German.

### Statistical analyses

A series of confirmatory factor analyses (CFAs) using weighted least squares means and variance adjusted (WLSMV) estimation was first conducted to assess the fit of different factorial structures of the BIS/BAS scales previously reported in the literature. A two-factor model was

first tested, with BIS and BAS items loading on two distinct correlated factors (Model 1). Model 2 examined a four-factor model, as proposed by Carver and White (1994), with one BIS and three BAS (i.e. RR, FS, Drive) correlated factors. Then, two five-factor models were tested, i.e. the model proposed by Heym *et al.* (2008), with one BIS-anxiety (four items), one FFFS (three items) and three BAS correlated factors (Model 3) and the model proposed by Johnson *et al.* (2003) including one BIS-anxiety (five items), one FFFS (two items) and three BAS correlated factors (Model 4). Model adequacy was assessed using the root mean square error of approximation (RMSEA), i.e. the square residuals between observed and estimated input matrices of the population approximation (Hair *et al.*, 1995) and the comparative fit index (CFI), i.e. the overall amount of the covariation among the observed variables that can be accounted for by the hypothesized model. For RMSEA, values close to 0.06 or lower, are generally considered as indicating a good fit (Hu and Bentler, 1999), although some authors suggested that values in the range of 0.06 to 0.08 indicate fair fit (Browne and Cudeck, 1993). For CFI, values close to 0.95 or higher indicate good fit (Hu and Bentler, 1999), but values greater than 0.90 are generally considered as acceptable (Kline, 2011).

As all the models failed to reach acceptable model adequacy, an exploratory approach was then adopted. The 5872 participants with complete data on the BIS/BAS scales were randomly split into an exploration sample and a validation sample of equal size ( $N = 2936$ ). First, a series of one-to-eight-factor EFAs using geomin rotation with unstandardized least squares estimation was conducted on the exploration sample. The number of factors retained was determined according to eigenvalues (i.e. eigenvalue  $> 1$ ). Then, items with low loadings ( $< 0.45$ ) as well as those loading on factors other than expected were excluded (Comrey and Lee, 1992). The solution obtained was then cross-validated in the validation sample using CFA. Then multigroup CFA was conducted to assess invariance of factor loadings between French- and German-speaking participants. The difference in fit between the two groups was evaluated according to the difference in CFI ( $|\Delta\text{CFI}|$ ) and RMSEA ( $|\Delta\text{RMSEA}|$ ) between a model constraining item loadings to be equal between groups and a model where item loadings were freely estimated in each group. According to Chen (2007),  $|\Delta\text{CFI}|$  value greater than or equal to 0.010 supplemented by  $|\Delta\text{RMSEA}|$  greater than or equal to 0.015 indicate the non-invariance of factor loadings between groups.

Finally, convergent validity of the BIS/BAS scales was examined by computing correlations of BIS/BAS scales with Aggression/Hostility, Anxiety/Neuroticism, and SS traits and with AUD, ND, CUD, and MDS scores. Due

to the large sample size ( $N = 4927$  completed cases) correlations as low as  $|r| = 0.03$  were statistically significant. However, such low correlations are not necessarily meaningful (Cumming, 2012). As a consequence, we only considered correlations close to  $|r| = 0.10$  or higher to be meaningful, in that they are indicative of at least a small but not trivial effect size (Cohen, 1988). Mplus 7.11 (Muthén and Muthén, 1998–2012) was used for factor analysis and SPSS 22 was used for descriptive characteristics of the sample, reliability and convergent validity analyses.

## Results

### Descriptive characteristics of the sample

The mean age of participants was 21.38 years [standard deviation (SD) = 1.30]. Three thousand four hundred and nineteen (58.2%) participants were French-speaking, whereas 2453 (41.8%) were German-speaking. Four hundred and seventy-five participants (8.1%) reported primary schooling as their highest completed level of education, whereas 2754 participants (46.9%) reported vocational training, and 2643 participants (45.0%) reported post-secondary schooling.

### Structure of the BIS/BAS scales

Fit indices of the different factorial structures of the BIS/BAS scales, based on suggestions in the literature, are reported in Table 1. Results indicate that among four models tested, the five-factor model proposed by Johnson *et al.* (2003) was the best fitting solution. However, the fit indices highlight that this model was far from adequately fitting the data, as were the other tested models. Therefore, the exploration sample was used to run a series of EFA. A four-factor solution was retained as the first four eigenvalues were greater than 1 (5.33, 2.78, 1.81, 1.04, 0.97). Loadings of this four-factor solution are reported in Table 2. The first

**Table 1.** Fit indices of confirmatory factor analysis (CFA) models ( $N = 5872$ )

	RMSEA	CFI
Model 1 (two factors)	0.137	0.541
Model 2 (four factors)	0.127	0.613
Model 3 (five factors, Heym <i>et al.</i> , 2008)	0.127	0.626
Model 4 (five factors, Johnson <i>et al.</i> , 2003)	0.097	0.779

Note: RMSEA, root mean square error of approximation; CFI, comparative fit index.

factor comprised two items of the RR scale and two items of the Drive scale. Factor 2 reflects BIS as all BIS items had loadings higher than 0.45, except the two items supposed to form the separate FFFS factor according to Johnson *et al.* (2003). Factor 3 and Factor 4 correspond to the Drive and FS scales, respectively, as items with loadings higher than 0.45 were expected to load on these factors. Seven items did not show loadings of 0.45 or higher on any factor. These items were not retained in the shortened solution. Similarly, the two Drive items loading on Factor 1 were excluded, so that Factor 1 corresponded to RR scale.

To confirm the adequacy of this shortened four-factor solution (i.e. BIS comprising five items; RR, FS, Drive comprising each two items), a CFA with a WLSMV estimation was conducted in the validation sample. Fit indices for this model (RMSEA = 0.074; CFI = 0.936) suggested that the fit was acceptable. Factor loadings of this model and correlations between factors are reported in Table 3. Small positive correlations were observed between BIS and Drive. Moderate correlations were found between BIS and FS, RR and BIS, RR and Drive, and RR and FS, whereas FS and Drive correlated strongly. All correlations were statistically significant (all  $p < 0.001$ , except for the correlation between BIS and Drive, which was significant at  $p = 0.017$ ). The correlations between the original BIS/BAS scales developed by Carver and White (1994) and those of the shortened version validated here were large (i.e.  $r = 0.923$  for BIS;  $r = 0.824$  for Drive;  $r = 0.805$  for RR;  $r = 0.866$  for FS).

### Multigroup analysis

Multigroup CFA were conducted on the total sample to test whether factor loadings varied between French- and German-speaking participants. Results showed that  $|\Delta\text{CFI}|$  between the unconstrained model (CFI = 0.930) and the model constraining equal factor loadings between the two groups (CFI = 0.921) did not exceed 0.010 ( $|\Delta\text{CFI}| = 0.009$ ), and that  $|\Delta\text{RMSEA}|$  (RMSEA = 0.077 for unconstrained model; RMSEA = 0.079 for constrained model) was far below 0.015 ( $|\Delta\text{RMSEA}| = 0.002$ ). In line with Chen (2007), this result suggests that the null hypothesis of invariance should not be rejected.

### Convergent validity of the BIS/BAS scales

Correlations between BIS/BAS scales and SS, Neuroticism/Anxiety, Aggression/Hostility, AUD, ND, CUD, and MDS are reported in Table 4. SS and Aggression/Hostility traits were positively associated with BAS (except for the association between Aggression/Hostility and RR that was close to

zero), with stronger correlations for Drive and FS than for RR scales, and almost unrelated with BIS (coefficients close to zero, although significant with Aggression/Hostility trait). The Neuroticism/Anxiety trait was positively related with BIS and negatively with BAS total, Drive and RR scales, although the coefficients of the latter correlations were very small. AUD was positively associated essentially with FS, and to a lesser extent with BAS total, Drive and BIS scores. ND was positively associated essentially with FS, to a lesser extent with BAS total and Drive scores, and negatively related with RR and BIS, although the size of the coefficients of the latter association were very small. CUD was positively associated with FS, and to a lesser extent with BAS total scores. MDS was positively associated with BIS, to a lesser extent with FS, and negatively associated with RR.

### Discussion

The aim of the present study was to examine the factorial structure and the psychometric properties of the BIS/BAS scales (Carver and White, 1994) in a large sample of French- and German-speaking Swiss young men. The fit of factorial structures proposed in previous researches, i.e. two-factor (Jorm *et al.*, 1998; Yu *et al.*, 2011), four-factor (Carver and White, 1994), and five-factor solutions (Heym *et al.*, 2008; Johnson *et al.*, 2003) was tested using CFA.

In line with previous studies examining the factor structure of the BIS/BAS scales (Beck *et al.*, 2009; Müller *et al.*, 2013; Poythress *et al.*, 2008), the five-factor solution as proposed by Johnson *et al.* (2003), (i.e. two items for FFFS, five items for BIS, five items for RR, four items for Drive, four items for FS) obtained better fit statistics than the two- and four-factor structures. However, the five-factor solution (as well as the two- and the four-factor solutions) clearly did not meet the conventional standards of fit. Thus, the application of previously proposed factor structure may be questionable when using the French and German versions of the BIS/BAS scales because it may not reflect the structure of the observed data properly.

Results of the EFA conducted on the exploration sample provided support for a four-factor structure, but nine items were found to be problematic. Two items expected to load on the Drive factor were found to load on the RR factor. These items, namely “When I want something I usually go all-out to get it” and “If I see a chance to get something I want I move on it right away”, were already found as problematic in earlier examination of the French and German versions of the BIS/BAS scales (Caci *et al.*, 2007; Strobel *et al.*, 2001). Additionally, seven items had poor loadings on any of the four factors extracted. This

**Table 2.** Exploratory factor analysis (EFA) of the BIS/BAS scales conducted on the exploration sample ( $N=2936$ )

Item	Expected factor <sup>1</sup>	Standardized loadings			
		Factor 1	Factor 2	Factor 3	Factor 4
Even if something bad is about to happen to me, I rarely experience fear or nervousness	BIS	-0.443	0.307	-0.056	0.018
I go out of my way to get things I want	Drive	-0.040	0.025	<i>0.711</i>	0.018
When I'm doing well at something I love to keep at it	RR	<i>0.771</i>	0.088	-0.025	-0.185
I'm always willing to try something new if I think it will be fun	FS	0.408	-0.053	0.109	0.328
When I get something I want, I feel excited and energized	RR	<i>0.548</i>	0.155	0.175	0.074
Criticism or scolding hurts me quite a bit	BIS	-0.071	<i>0.628</i>	0.085	-0.025
When I want something I usually go all-out to get it	Drive	<i>0.615</i>	0.007	-0.057	0.032
I will often do things for no other reason than that they might be fun	FS	0.104	0.005	0.003	<i>0.649</i>
If I see a chance to get something I want I move on it right away	Drive	<i>0.584</i>	-0.065	-0.024	0.263
I feel pretty worried or upset when I think or know somebody is angry at me	BIS	0.008	<i>0.673</i>	0.020	-0.015
When I see an opportunity for something I like I get excited right away	RR	0.362	0.355	-0.062	0.260
I often act on the spur of the moment	FS	-0.084	0.071	0.278	<i>0.532</i>
If I think something unpleasant is going to happen I usually get pretty "worked up"	BIS	-0.001	<i>0.639</i>	0.016	0.064
When good things happen to me, it affects me strongly	RR	0.083	0.376	0.317	0.083
I feel worried when I think I have done poorly at something important	BIS	0.278	<i>0.622</i>	0.024	-0.094
I crave excitement and new sensations	FS	0.169	0.011	0.270	0.419
When I go after something I use a "no holds barred" approach	Drive	0.021	-0.045	<i>0.786</i>	-0.006
I have very few fears compared to my friends	BIS	-0.384	0.230	-0.286	0.009
It would excite me to win a contest	RR	0.433	0.241	0.034	0.048
I worry about making mistakes	BIS	-0.004	<i>0.686</i>	-0.152	-0.001

Note: BIS, Behavioural Inhibition System; BAS, Behavioural Activation System; RR, Reward Responsiveness; FS, Fun Seeking.

<sup>1</sup>Expected factor following Carver and White (1994). In italic typeface, loadings  $\geq 0.45$ .

was the case for the two items of the original BIS scale (i.e. "Even if something bad is about to happen to me, I rarely experience fear or nervousness" and "I have very few fears compared to my friends") that were found to belong to the FFFS factor by Johnson *et al.* (2003) and that were already found to be problematic by Cogswell *et al.* (2006). This finding suggests that these two items tap constructs other than BIS reactivity. However, we found no evidence that these two items form a single factor tapping FFFS reactivity, as proposed by Johnson *et al.* (2003). Thus, further studies should focus on the development of a valid and reliable measure of FFFS sensitivity. The two items "I'm always willing to try something new if I think it will

be fun" and "I crave excitement and new sensations", expected to tap FS, also had low loadings. They were also found to be problematic by Knyazev *et al.* (2004). Three items assumed to load on the RR scale, namely "When I see an opportunity for something I like, I get excited right away" found to be problematic by Jorm *et al.* (1998), "When good things happen to me, it affects me strongly" found to be problematic by Caci *et al.* (2007), and "It would excite me to win a contest", found to be problematic by Franken *et al.* (2005) also had poor loadings in the EFA. These nine items were excluded and the remaining items were submitted to a CFA in the validation sample to cross-validate a shortened four-factor version of the BIS/BAS

**Table 3.** Factor structure of the shortened BIS/BAS scales ( $N=2936$ )

	BIS	Drive	RR	FS
Item loadings				
I go out of my way to get things I want	—	0.719	—	—
When I'm doing well at something I love to keep at it	—	—	0.551	—
When I get something I want, I feel excited and energized	—	—	0.918	—
Criticism or scolding hurts me quite a bit	0.595	—	—	—
I will often do things for no other reason than that they might be fun	—	—	—	0.595
I feel pretty worried or upset when I think or know somebody is angry at me	0.676	—	—	—
I often act on the spur of the moment	—	—	—	0.645
If I think something unpleasant is going to happen I usually get pretty "worked up"	0.655	—	—	—
I feel worried when I think I have done poorly at something important	0.694	—	—	—
When I go after something I use a "no holds barred" approach	—	0.808	—	—
I worry about making mistakes	0.652	—	—	—
Correlations				
Drive	0.056	—	—	—
RR	0.396	0.309	—	—
FS	0.251	0.636	0.477	—
Mean (SD)	13.23 (2.87)	4.55 (2.30)	6.73 (1.16)	5.05 (1.33)

Note: BIS, Behavioural Inhibition System; BAS, Behavioural Activation System; RR, Reward Responsiveness; FS, Fun Seeking; SD, standard deviation. All factor loadings were significant at  $p < 0.001$ . All correlations between BIS, Drive, RR and FS were significant (all  $p < 0.001$ , except for the correlation between BIS and Drive,  $p = 0.017$ ).

scales, with one BIS factor comprising five items and one RR, one Drive and one FS factor, each comprising two items.

Fit statistics suggested that this model adequately reflects the structure of the observed data and that the reliability of the scales was acceptable. Correlations between Carver and White (1994) BIS/BAS scales and the shortened version were higher than 0.80, suggesting that constructs assessed by shortened BIS/BAS scales are very similar to those assessed by the original scales. Convergent validity analyses showed that, consistent with previous studies (Beck *et al.*, 2009; Keiser and Ross, 2011; Segarra *et al.*, 2014), BIS was positively related with the Neuroticism/Anxiety trait. By contrast, BAS scales (in particular the Drive and FS scales) were positively related to SS and Aggression-Hostility traits (Dissabandara *et al.*, 2011; Harmon-Jones, 2003; Quilty and Oakman, 2004). BIS and BAS scales were also related with psychopathologies. Consistent with previous studies (Franken and Muris, 2006; Johnson *et al.*, 2003), positive associations were found between BAS (in particular with the FS scale) and substance use disorders. MDS was positively related with BIS and negatively related with BAS RR scale, as previously shown (McFarland *et al.*, 2006; Meyer *et al.*, 1999).

Moreover, results of multigroup CFA provided support for invariance of factor loadings between the French and the German versions of the questionnaire, suggesting that shortened BIS/BAS scales can be used in international studies conducted in French-speaking as well as in German-speaking samples as they measure the same constructs in both languages. In countries where other languages are spoken, other shortened versions have also been proposed, such as a 14-item (Demianczyk *et al.*, 2014) and a 16-item (Cogswell *et al.*, 2006) in the United States, and a 14-item version in Russia (Knyazev *et al.*, 2004). All the items retained in the present study were also retained in the earlier-mentioned shortened versions, except for two items. The first, i.e. "When I go after something I use a no holds barred approach", originally loading on the Drive scale was not retained in any of the three other shortened versions. The second, i.e. "I feel worried when I think I have done poorly at something important", originally loading on the BIS scale was not retained in the version of Demianczyk *et al.* (2014). Thus, as most of the items retained in the present study were also retained in other shortened versions validated in countries where other languages than French and German are spoken, the shortened BIS/BAS scales proposed



**Table 4.** Convergent validity of the shortened BIS/BAS scales ( $N=4927$ )

	Mean (SD)	BIS	BAS total	BAS Drive	BAS RR	BAS FS
Personality						
Sensation Seeking	24.37 (6.93)	-0.016	0.305***	0.256***	0.098***	0.286***
Neuroticism/Anxiety	1.97 (1.99)	0.286***	-0.037**	-0.031*	-0.065***	0.011
Aggression/Hostility	4.13 (2.21)	0.034*	0.138***	0.124***	-0.002	0.160***
Substance use disorders						
Alcohol use disorders	1.21 (1.62)	.083***	.089***	.051***	-.004	.139***
Nicotine dependence	0.88 (1.64)	-.045**	.063***	.061***	-.035*	.099***
Cannabis use disorders	1.83 (4.43)	.019	.063***	.014	-.007	.127***
Major depression severity	7.85 (7.13)	.217***	-.023	.001	-.113***	.046**

Note: BIS, Behavioural Inhibition System; BAS, Behavioural Activation System; RR, Reward Responsiveness; FS, Fun Seeking; SD, standard deviation.

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

in the present paper is also likely to reliably assess BIS/BAS sensitivity in an international context beyond French- and German-speaking countries. However, this should be confirmed in further studies.

Taken together, this suggests that the shortened BIS/BAS scales constitute a valid and reliable measure of individual differences in BIS and BAS reactivity that can be used in both French- and German-speaking populations. However, the present study is not without limitation. One limitation is that although it is representative, the sample only comprised young males. Therefore, further studies are needed in order to establish whether our findings can be extended to women and older participants. Another shortcoming is the cross-sectional design, which prevented us from exploring the stability of the factor solution over time and from assessing test-retest reliability. The use of personality traits (i.e. SS, Aggression/Hostility, Neuroticism/Anxiety) that were assessed about 15 month (i.e. at baseline) before BIS/BAS sensitivity (assessed at follow-up) to test convergent validity may also be seen as a limitation. However, this should not have strongly influenced the correlations observed in the convergent validity analysis, since personality traits are assumed to reflect the expression of genetically-determined systems (Eysenck, 1990) that are relatively stable over time (McCrae and Costa, 1994). In addition, our analyses did not support the existence of a FFFS factor based on the items of the BIS/BAS scales. Further studies are needed to develop a

valid measure to assess individual differences in FFFS reactivity.

To conclude, psychometric evaluation of the French and German versions of the BIS/BAS scales showed that the fit of previously proposed two-, four- and five-factor structures was not adequate, suggesting that the use of these models should be avoided. A satisfactory four-factor shortened solution was obtained after many modifications were made to the original factor structure (removing items with inadequate loadings). This shortened version of the BIS/BAS scales could be particularly suitable for large scale surveys where the length and number of questions in a questionnaire is a common issue. It is also recommended that researchers who are interested in assessing individual differences in BIS and BAS reactivity in French- and German-speaking individuals use this shortened version rather than previous versions, at least in samples of young adults. Using this shortened version may increase the validity and reliability of the scales and provide a better understanding of the BIS and BAS and their relations to other personality measures and psychopathologies.

### Acknowledgements

This study was funded by the Swiss National Science Foundation (FN 33CSC0-122679 and FN 33CS30-139467). The authors are grateful to Charlotte Eidenbenz for her extensive efforts in the coordination of this study.

### References

- Adamson S.J., Sellman J.D. (2003) A prototype screening instrument for cannabis use disorder: the Cannabis Use Disorders Identification Test (CUDIT) in an alcohol-dependent clinical sample. *Drug and Alcohol Review*, 22(3), 309–315, DOI: 10.1080/0959523031000154454
- Aluja A., Rossier J., García L.F., Angleitner A., Kuhlman M., Zuckerman M. (2006) A cross-cultural shortened form of the ZKPQ

- (ZKPQ-50-cc) adapted to English, French, German, and Spanish languages. *Personality and Individual Differences*, **41**(4), 619–628, DOI: 10.1016/j.paid.2006.03.001
- American Psychiatric Association. (1994) Diagnostic and Statistical Manual of Mental Disorders (4th edition), Washington, DC, American Psychiatric Association.
- American Psychiatric Association. (2013) Diagnostic and Statistical Manual of Mental Disorders (5th edition). Arlington, VA, American Psychiatric Publishing.
- Bech P., Rasmussen N.A., Olsen L.R., Noerholm V., Abildgaard W. (2001) The sensitivity and specificity of the Major Depression Inventory, using the Present State Examination as the index of diagnostic validity. *Journal of Affective Disorders*, **66**(2–3), 159–164, DOI: 10.1016/S0165-0327(00)00309-8
- Beck I., Smits D.J.M., Claes L., Vandereycken W., Bijttebier P. (2009) Psychometric evaluation of the behavioral inhibition/behavioral activation system scales and the sensitivity to punishment and sensitivity to reward questionnaire in a sample of eating disordered patients. *Personality and Individual Differences*, **47**(5), 407–412, DOI: 10.1016/j.paid.2009.04.007
- Bijttebier P., Beck I., Claes L., Vandereycken W. (2009) Gray's Reinforcement Sensitivity Theory as a framework for research on personality–psychopathology associations. *Clinical Psychology Review*, **29**(5), 421–430, DOI: 10.1016/j.cpr.2009.04.002
- Browne M.W., Cudeck R. (1993) Alternative ways of assessing model fit. In Bollen K.A., Long J. S. (eds) *Testing Structural Equation Models*, pp. 136–162, Newpark, CA, Sage.
- Caci H., Deschaux O., Baylé F.J. (2007) Psychometric properties of the French versions of the BIS/BAS scales and the SPSSRQ. *Personality and Individual Differences*, **42**(6), 987–998, DOI: 10.1016/j.paid.2006.09.008
- Campbell-Sills L., Liverant G.I., Brown T.A. (2004) Psychometric evaluation of the Behavioral Inhibition/Behavioral Activation Scales in a large sample of outpatients with anxiety and mood disorders. *Psychological Assessment*, **16**(3), 244–254, DOI: 10.1037/1040-3590.16.3.244
- Carver C.S., White T.L. (1994) Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. *Journal of Personality and Social Psychology*, **67**, 319–333, DOI: 10.1037/0022-3514.67.2.319
- Chen F.F. (2007) Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, **14**(3), 464–504, DOI: 10.1080/10705510701301834
- Cogswell A., Alloy L.B., van Dulmen M.H.M., Fresco D.M. (2006) A psychometric evaluation of behavioral inhibition and approach self-report measures. *Personality and Individual Differences*, **40**(8), 1649–1658, DOI: 10.1016/j.paid.2005.12.008
- Cohen J. (1988) *Statistical Power Analysis for the Behavioral Sciences*, Hillsdale, NJ, Erlbaum.
- Comrey A.L., Lee H.B. (1992) *A First Course in Factor Analysis*, Mahwah, NJ, Lawrence Erlbaum Associates.
- Cooper A., Gomez R., Aucote H. (2007) The Behavioural Inhibition System and Behavioural Approach System (BIS/BAS) scales: measurement and structural invariance across adults and adolescents. *Personality and Individual Differences*, **43**(2), 295–305, DOI: 10.1016/j.paid.2006.11.023
- Corr P.J., DeYoung C.G., McNaughton N. (2013) Motivation and personality: a neuropsychological perspective. *Social and Personality Psychology Compass*, **7**(3), 158–175, DOI: 10.1111/spc3.12016
- Corr P.J., McNaughton N. (2008) Reinforcement sensitivity theory and personality. In Corr P.J. (ed.) *The Reinforcement Sensitivity Theory of Personality*, pp. 155–187, Cambridge, Cambridge University Press.
- Cumming G. (2012) *Understanding the New Statistics: Effect Sizes, Confidence Intervals, and Meta-analysis*, New York, Routledge.
- Demianczyk A.C., Jenkins A.L., Henson J.M., Conner B.T. (2014) Psychometric evaluation and revision of Carver and White's BIS/BAS scales in a diverse sample of young adults. *Journal of Personality Assessment*, **96**(5), 485–494, DOI: 10.1080/00223891.2013.870570
- Dissabandara L.O., Loxton N.J., Dias S.R., Daglish M., Stadlin A. (2011) Psychometric properties of three personality inventories translated to Sinhalese. *Sri Lanka Journal of Psychiatry*, **2**(1), 13–17.
- Dissabandara L.O., Loxton N.J., Dias S.R., Daglish M., Stadlin A. (2012) Testing the fear and anxiety distinction in the BIS/BAS scales in community and heroin-dependent samples. *Personality and Individual Differences*, **52**(8), 888–892, DOI: 10.1016/j.paid.2012.01.023
- Eysenck H.J. (1990) Biological dimensions of personality. In Pervin L.A. (ed.) *Handbook of Personality: Theory and Research*, pp. 244–276, New York, Guilford.
- Franken I.H.A., Muris P. (2006) BIS/BAS personality characteristics and college students' substance use. *Personality and Individual Differences*, **40**(7), 1497–1503, DOI: 10.1016/j.paid.2005.12.005
- Franken I.H.A., Muris P., Rassin E. (2005) Psychometric properties of the Dutch BIS/BAS scales. *Journal of Psychopathology and Behavioral Assessment*, **27**(1), 25–30, DOI: 10.1007/s10862-005-3262-2
- Gray J.A. (1982) *The Neuropsychology of Anxiety: An Inquiry into the Functions of the Septo-hippocampal System*, Oxford, Oxford University Press.
- Gray J.A. (1987) *The Psychology of Fear and Stress*, London, Cambridge University Press.
- Gray J.A., McNaughton N. (2000) *The Neuropsychology of Anxiety: An Enquiry into the Functions of the Septo-hippocampal System*, Oxford, Oxford University Press.
- Hair J.F., Anderson R.E., Tatham R.L., Black W.C. (1995) *Multivariate Data Analysis with Readings*, Upper Saddle River, NJ, Prentice-Hall.
- Harmon-Jones E. (2003) Anger and the behavioral approach system. *Personality and Individual Differences*, **35**(5), 995–1005, DOI: 10.1016/S0191-8869(02)00313-6
- Heatherington T.F., Kozlowski L.T., Frecker R.C., Fagerstrom K.-O. (1991) The Fagerström Test for nicotine dependence: a revision of the Fagerstrom Tolerance Questionnaire. *British Journal of Addiction*, **86**(9), 1119–1127, DOI: 10.1111/j.1360-0443.1991.tb01879.x
- Hesselbrock M., Easton C., Bucholz K.K., Schuckit M., Hesselbrock V. (1999) A validity study of the SSAGA – a comparison with the SCAN. *Addiction*, **94**(9), 1361–1370, DOI: 10.1046/j.1360-0443.1999.94913618.x
- Heubeck B.G., Wilkinson R.B., Cologon J. (1998) A second look at Carver and White's (1994) BIS/BAS scales. *Personality and Individual Differences*, **25**(4), 785–800, DOI: 10.1016/S0191-8869(98)00124-X
- Heym N., Ferguson E., Lawrence C. (2008) An evaluation of the relationship between Gray's revised RST and Eysenck's PEN: distinguishing BIS and FFFS in Carver and White's BIS/BAS scales. *Personality and Individual Differences*, **45**(8), 709–715, DOI: 10.1016/j.paid.2008.07.013
- Hoyle R.H., Stephenson M.T., Palmgreen P., Lorch E.P., Donohew R.L. (2002) Reliability and validity of a brief measure of sensation seeking.

- Personality and Individual Differences*, **32**(3), 401–414, DOI: 10.1016/S0191-8869(01)00032-0
- Hu L., Bentler P.M. (1999) Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, **6**(1), 1–55, DOI: 10.1080/10705519909540118
- Johnson S., Turner R.J., Iwata N. (2003) BIS/BAS levels and psychiatric disorder: an epidemiological study. *Journal of Psychopathology and Behavioral Assessment*, **25**(1), 25–36, DOI: 10.1023/A:1022247919288
- Jorm A.F., Christensen H., Henderson A.S., Jacomb P.A., Korten A.E., Rodgers B. (1998) Using the BIS/BAS scales to measure behavioural inhibition and behavioural activation: factor structure, validity and norms in a large community sample. *Personality and Individual Differences*, **26**(1), 49–58, DOI: 10.1016/S0191-8869(98)00143-3
- Kasch K.L., Rottenberg J., Arnow B.A., Gotlib I.H. (2002) Behavioral activation and inhibition systems and the severity and course of depression. *Journal of Abnormal Psychology*, **111**(4), 589–597, DOI: 10.1037/0021-843X.111.4.589
- Keiser H.N., Ross S.R. (2011) Carver and Whites' BIS/FFFS/BAS scales and domains and facets of the Five Factor Model of personality. *Personality and Individual Differences*, **51**(1), 39–44, DOI: 10.1016/j.paid.2011.03.007
- Keough M.T., O'Connor R.M. (2014) Clarifying the measurement and the role of the behavioral inhibition system in alcohol misuse. *Alcoholism: Clinical and Experimental Research*, **38**(5), 1470–1479, DOI: 10.1111/acer.12387
- Kessler R.C., Andrews G., Mroczek D., Ustun B., Wittchen H.-U. (1998) The World Health Organization Composite International Diagnostic Interview short-form (CIDI-SF). *International Journal of Methods in Psychiatric Research*, **7**(4), 171–185, DOI: 10.1002/mp.47
- Kline R.B. (2011) *Principle and practice of structural modeling*. New York: Guilford Press.
- Knight J.R., Wechsler H., Kuo M., Seibring M., Weitzman E.R., Schuckit M.A. (2002) Alcohol Abuse and Dependence among U.S. College Students. *Journal of Studies on Alcohol*, **63**, 263–270.
- Knyazev G.G., Slobodskaya H.R., Wilson G.D. (2004) Comparison of the construct validity of the Gray–Wilson Personality Questionnaire and the BIS/BAS scales. *Personality and Individual Differences*, **37**(8), 1565–1582, DOI: 10.1016/j.paid.2004.02.013
- Leone L., Perugini M., Bagozzi R.P., Pierro A., Mannetti L. (2001) Construct validity and generalizability of the Carver–White behavioural inhibition system/behavioural activation system scales. *European Journal of Personality*, **15**(5), 373–390, DOI: 10.1002/per.415
- McCrae R.R., Costa P.T. (1994) The stability of personality: observation and evaluations. *Current Directions in Psychological Science*, **3**(6), 173–175, DOI: 10.1111/1467-8721.ep10770693
- McFarland B.R., Shankman S.A., Tenke C.E., Bruder G.E., Klein D.N. (2006) Behavioral activation system deficits predict the six-month course of depression. *Journal of Affective Disorders*, **91**(2–3), 229–234, DOI: 10.1016/j.jad.2006.01.012
- Meyer B., Johnson S., Carver C. (1999) Exploring behavioral activation and inhibition sensitivities among college students at risk for bipolar spectrum symptomatology. *Journal of Psychopathology and Behavioral Assessment*, **21**(4), 275–292, DOI: 10.1023/A:1022119414440
- Müller A., Smits D., Claes L., de Zwaan M. (2013) Faktorenstruktur der deutschsprachigen Version der BIS/BAS-Skalen in einer Bevölkerungsstichprobe. *Fortschritte der Neurologie Psychiatrie*, **81**(02), 75–80, DOI: 10.1055/s-0032-1330482
- Müller J.M., Wytykowska A.M. (2005) Psychometric properties and validation of a Polish adaptation of Carver and White's BIS/BAS scales. *Personality and Individual Differences*, **39**(4), 795–805, DOI: 10.1016/j.paid.2005.03.006
- Muthén L.K., Muthén B.O. (1998–2012) *Mplus User's Guide*, Los Angeles, CA, Muthén & Muthén.
- O'Connor R.M., Stewart S.H., Watt M.C. (2009) Distinguishing BAS risk for university students' drinking, smoking, and gambling behaviors. *Personality and Individual Differences*, **46**(4), 514–519, DOI: 10.1016/j.paid.2008.12.002
- Olsen L.R., Jensen D.V., Noerholm V., Martiny K., Bech P. (2003) The internal and external validity of the Major Depression Inventory in measuring severity of depressive states. *Psychological Medicine*, **33**, 351–356.
- Poythress N.G., Skeem J.L., Weir J., Lilienfeld S.O., Douglas K.S., Edens J.F., Kennealy P.J. (2008) Psychometric properties of Carver and White's (1994) BIS/BAS scales in a large sample of offenders. *Personality and Individual Differences*, **45**(8), 732–737, DOI: 10.1016/j.paid.2008.07.021
- Quilty L.C., Oakman J.M. (2004) The assessment of behavioural activation – the relationship between impulsivity and behavioural activation. *Personality and Individual Differences*, **37**(2), 429–442, DOI: 10.1016/j.paid.2003.09.014
- Ross S.R., Millis S.R., Bonebright T.L., Bailey S.E. (2002) Confirmatory factor analysis of the Behavioral Inhibition and Activation Scales. *Personality and Individual Differences*, **33**(6), 861–865, DOI: 10.1016/S0191-8869(01)00196-9
- Segarra P., Poy R., López R., Moltó J. (2014) Characterizing Carver and White's BIS/BAS subscales using the Five Factor Model of personality. *Personality and Individual Differences*, **61–62**(0), 18–23, DOI: 10.1016/j.paid.2013.12.027
- Smits D.J.M., Boeck P.D. (2006) From BIS/BAS to the big five. *European Journal of Personality*, **20**(4), 255–270, DOI: 10.1002/per.583
- Strobel A., Beauducel A., Debenet S., Brocke B. (2001) Psychometrische und strukturelle Merkmale einer deutschsprachigen Version des BIS/BAS-Fragebogens [Psychometric and structural properties of a German version of the BIS/BAS scales]. *Zeitschrift für Differentielle und Diagnostische Psychologie*, **22**(3), 216–227.
- Studer J., Baggio S., Mohler-Kuo M., Dermota P., Gaume J., Bertholet N., Daepfen J.B., Gmel G. (2013a) Examining non-response bias in substance use research – are late respondents proxies for non-respondents? *Drug and Alcohol Dependence*, **132**(1–2), 316–323, DOI: 10.1016/j.drugalcdep.2013.02.029
- Studer J., Mohler-Kuo M., Dermota P., Gaume J., Bertholet N., Eidenbenz C., Daepfen J.B., Gmel G. (2013b) Need for informed consent in substance use studies – harm of bias? *Journal of Studies on Alcohol and Drugs*, **74**, 931–940.
- Voigt D.C., Dillard J.P., Braddock K.H., Anderson J.W., Sopory P., Stephenson M.T. (2009) BIS/BAS scales and their relationship to risky health behaviours. *Personality and Individual Differences*, **47**(2), 89–93, DOI: 10.1016/j.paid.2009.02.003
- World Health Organization. (1993) *The ICD-10 Classification of Mental and Behavioural Disorders. Diagnostic Criteria for Research*, Geneva, World Health Organization.
- Yu R., Branje S.J.T., Keijsers L., Meeus W.H.J. (2011) Psychometric characteristics of Carver and White's BIS/BAS scales in Dutch adolescents and their mothers. *Journal of Personality Assessment*, **93**(5), 500–507, DOI: 10.1080/00223891.2011.595745