Five reinforcement sensitivity theory (RST) of personality questionnaires: Comparison, validity and generalization.

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Abstract

There are six purpose-built Reinforcement Sensitivity Theory (RST) personality questionnaires currently in use to measure the fight-flight-freeze system (FFFS), the behavioural inhibition system (BIS), and the behavioural approach system (BAS). They differ in their conceptualizations and operational constructs, and this poses a problem for their differential validity and the generalizability of results, and comparison of results from different studies. This paper examined the psychometric properties of five of these RST questionnaires, with a total sample of 821 participants, taken from the factor structures for the Croatian translations of BIS/BAS scales, SPSRQ, Jackson-5, RSQ and RST-PQ. Data were analysed by correlational and confirmatory factor analyses. We found some of these questionnaires achieved marginal to adequate fit indices, and they showed ambiguity in terms of convergent validity for all three general behavioural systems. These findings highlight the difficulties with generalization and comparison of results with the use of different RST questionnaires. Based on these findings, as well as the ongoing debate concerning how best to measure RST constructs, we provide information on how to interpret results from the studies conducted with different RST scales.

***Keywords*: Reinforcement Sensitivity Theory; exploratory and confirmatory factor analysis; generalizability**

Five Reinforcement Sensitivity Theory (RST) of Personality Questionnaires: Comparison, Validity and Generalization

Reinforcement sensitivity theory (RST) provides a neuropsychological account of the major systems that underlie personality, namely, the Behavioural Approach System (BAS), and two defensive systems, the Behavioural Inhibition System (BIS) and the Fight-Flight-Freeze System (FFFS) (Corr, 2008). The BAS mediates reactions to reward and non-punishment. Its outputs are positive emotions, the motivation to approach biological reinforcers, and to engage in activities that lead to consummatory behaviour (Gray & McNaughton, 2003). The FFFS is responsible for the active avoidance and escape from aversive stimuli, while the BIS is responsible for passive avoidance and the detection and resolution of goal-conflict. In its long history, RST has encouraged the development of a number of different questionnaires (for a summary, see Torrubia, Avila, & Caseras, 2008; Corr, 2016). In the last six years alone, three new questionnaires have been developed: the Jackson 5 (J5; Jackson, 2009), Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ; Corr & Cooper, 2016), and the Reinforcement Sensitivity Questionnaire (RSQ; Smederevac, Mitrović, Čolović, & Nikolašević, 2014). In fact, more recently, there is a fourth revised RST questionnaire (Reuter, Cooper, Smillie, Markett, & Montag, 2015), which we do not discuss further because it postdates the collection of data reported in this article. Together with two of the most frequently used questionnaires -- BIS/BAS Scales (Carver & White, 1994) and Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) -- there are now six personality questionnaires that compete to provide a viable operational account of RST's three major neuropsychological systems.

When planning a study within RST, researchers have to choose among competing RST questionnaires. This raises question: do the results of the study depends on choice of the questionnaire? At present, there is a lack of empirical work examining the structural and psychometric properties of these questionnaires. This study aims to remedy this state of affairs.

RST Questionnaires

The most widely used RST questionnaire, the BIS/BAS Scales (Carver & White, 1994), was designed upon original (unrevised) RST (Gray, 1982). This scale has several shortcomings within the context of revised RST model (Corr, 2016; Corr & McNaughton, 2008; 2012; McNaughton & Corr, 2008). It emphasized the BIS and BAS, and did not differentiate the FFFS as a separate system of personality (although items capturing variance associated with the FFFS are scattered across the BIS scale; Corr & McNaughton, 2008).

SPSRQ was also developed upon original RST. It contains Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) scales. Several studies show problematic psychometric properties of the translated versions of this questionnaire. In order to achieve a two-factor structure, many researchers have had to adjust translated versions by excluding items. In this way, the original Spanish version contains 48 items (Torrubia et al., 2001), French version 35 (Lardi, Billieux, d'Acremont, & Linden, 2008), and English 39 (Cogswell, Alloy, Dulmen, & Fresco, 2006); and, without excluding items, the Romanian version has a three-factor solution (Sava & Sperneac, 2006) – in addition to sensitivity to reward and punishment, there was a BAS 'financial' factor relating to earning money but this was correlated 0.67 with the Reward factor. Aluja and Blanch (2011) developed a short version of SPSRQ (SPSRQ-20) in order to enhance its psychometric properties. Besides problems of construct validity, the main issue with this questionnaire is that it is based upon the original version of RST, where impulsivity is assumed to be the underlying

trait of the BAS. Several studies suggest that extraversion, rather than impulsivity, should be considered as underlying the BAS dimension (Depue & Collins, 1999; Smillie, Pickering, & Jackson, 2006). For this reason, the clearest statistical difference between BIS/BAS Scales and SPSRQ is found between BAS subscales and SR.

One of the recent RST questionnaires, J5 (Jackson, 2009) contains five scales: BAS, BIS, Fight, Flight, and Freezing. The author's validation data of this questionnaire show some theoretically ambiguous results. First, the BAS and BIS correlate positively – this is not surprising given that some of the 'BIS' items seem to have a definite BAS flavour reflecting social comparison or competition (item example "*I aim to do better than my peers*"). Second, the Fight scale is not correlated with the putative FFFS-related Flight and Freezing scales, which makes forming a unidimensional FFFS scale inappropriate. However, this result is consistent with evidence that fight and aggression (both reactive and proactive) are related to the BAS (for more detail see Corr, 2013, 2016; Corr & Cooper, 2016).

The shortcomings of these RST questionnaires motivated other authors to develop new, and preferably better, ones. RSQ (Smederevac et al., 2014) contains five scales, the same as J5. In contrast, it shows more theoretically congruent BIS and FFFS scales, but shares the same problem of Fight scale with J5. Finally, RST-PQ (Corr & Cooper, 2016) has six scales: BAS (with four subscales), BIS and FFFS, accompanied by a seventh separate measure of Defensive Fight. The four BAS subscales are Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity. The RST-PQ was specifically modelled on revised RST, taking into account previous findings concerning the problematic (i.e., cross-loading) nature of Fight with the BAS. Item examples of the questionnaires can be found in *Supplementary material*.

The key assumption for a valid RST questionnaire is that the scale scores should reflect stable individual differences in activity of the brain behavioural circuits responsible for approach and avoidance motivation (e.g. Tal Gonen, Pearlson, & Hendler, 2014). When comparing the criterion validity of the questionnaires, the BIS/BAS Scales and SPSRQ had been widely studied, while newer psychometric measures, particularly RST-PQ and RSQ, awaits for more extensive validation. Studies have related the BAS with higher activity on the left frontal cortex (e.g., Amodio, Master, Yee, & Taylor, 2008; Harmon-Jones & Allen, 1997), and the BIS with septo-hippocampal circuits (e.g., Gray & McNaughton, 2003; Levita et al., 2014). For the sake of continuity of the research within RST, it is important to establish the relations between new RST questionnaires with the earlier ones. In other words, it is important to establish the convergent validity of the new RST questionnaires with the BIS/BAS Scales and SPSRQ.

Available data on convergent validity of the RST questionnaires are limited to comparison of two questionnaires (e.g., Caci, Deschaux, & Baylé, 2007; Cogswell et al., 2006; Davis et al., 2007; Dufey, Fernández, & Mourgues, 2011; Knyazev, Slobodskaya, & Wilson, 2004; Krupić & Corr, 2014; Sava & Sperneac, 2006; Smillie, Jackson, & Dalgleish, 2006; Wallace, Malterer, & Newman, 2009), or three questionnaires (Caseras, Avila, & Torrubia, 2003; Smederevac et al., 2014; Smillie & Jackson, 2005). Authors of recent RST questionnaires provide most of the development and validation data within their publications, but there has been a noticeable absence of any attempt to provide convergent validation evidence with all of them in the same study – what is the purpose of this study.

Four models will be tested. In the first model, labelled the BAS, BIS and FFFS (see Figure 1), the approach dimension should be constituted by BAS scales and subscales, one (passive) avoidance dimension should be constituted by BIS scales, and finally, another (active)

avoidance dimension should be constituted by (Defensive) Fight, Flight, and Freezing scales. Corr (2013) has outlined difficulties in measuring defensive fight by self-report measures. He argues that language may not be adequate to capture fine conceptual differences between instrumental and defensive aggression. Thus, the second model, labelled the BAS, BIS, Flight/Freeze, will test the three-factor solution without fight scales from RST-PQ, J5 and RSQ. Third model (the BAS, BIS, Flight/Freeze with separate Fight) will test a four-factor structure, where the Fight factor will be added along with the three factors from the previous model. Finally, Corr (2008, 2013, 2016) has outlined the importance of the BAS sub-goal processes: (a) identification of the biological reinforcer; (b) planning behaviour; (c) executing the plan; and (d) reward reactivity. Thus, the fourth model will test the model assuming the four BAS subscales, BIS, Flight/Freeze and Fight model.

Method

Participant and materials

An online-sample of $N = 821$ participants (415 males), $M_{AGE} = 22.31$, $SD = 4.16$ (age range from 16 to 54) completed five RST questionnaires, which were translated in to the Croatian language using double-blind translation procedure. Psychology students helped in recruitment of the participants in exchange for course credits.

Measures

The BIS/BAS Scales (Carver & White, 1994) contains 24 items that form BIS scale (7 items), and three subscales related to BAS functioning - Drive (4 items), Fun Seeking (4 items) and Reward Reactivity (5 items), along with four filler items. Items were answered on four-point Likert type scale (1 – very false for me, 4 - very true for me).

SPSRQ-20 (Aluja & Blanch, 2011) is short 20-item version of SPSRQ (Torrubia et al., 2001) containing two 10-items scales: the Sensitivity to Punishment (SP) and the Sensitivity to Reward (SR) with yes/no response format.

The Jackson-5 contains 30 items, equally distributed across five scales: BAS, BIS, Fight, Flight and Freezing. The answer format is a 5-point Likert-type scale (1 = completely disagree; 5 = completely agree).

The RSQ (Smederevac et al., 2014) questionnaire has 29 items distributed across five scales, namely: BAS (6 items), BIS (7 items), Fight (6 items), Flight (5 items) and Freezing (5 items). The response format is 4-point Likert scale (1- Completely disagree; 2 – Somewhat disagree; 3 – Somewhat agree; 4 – Completely agree).

Finally, the RST-PQ (Corr & Cooper, 2016) contains 73 items that comprise five scales: BAS (32 items), BIS (23 items), Flight-Freeze System (FFS 10 items), and Defensive Fight (8 items). RST-PQ defines BAS as a multidimensional construct: Reward Interest (7 items), Goal-Drive Persistence (7 items), Reward Reactivity (10 items), and Impulsivity (8 items). Items are answered on four-point Likert-type scale *("How accurately does each statement describe you?"* 1 = Not at all; 4 = Highly).

All questionnaires were previously validated and used in Croatian language (e.g. Križanić, Greblo, Knezović, 2015).

Data analytic plan

We tested the internal factor structure of the questionnaires by confirmatory factor analysis (CFA) using polychoric correlation matrices with Maximum Likelihood (ML) estimates method by EQS 6.1., while convergent validity by IBM SPSS Amos 18. As model fit indices, we

used: (a) Sattora-Bentler scaled chi-square (χ^2) (Bentler, 2006; Sattora & Bentler, 2001); (b) the root mean squared error of approximation (RMSEA; Steiger, 2000), where values of < .05 were taken as good fit, .05–.08 as moderate fit, .08–.10 as marginal fit and >.10 as poor fit (Hu & Bentler, 1999); and (c) the comparative fit index (CFI) were values between .90 and .95 indicated acceptable fit, and values above .95 indicated good fit (Hu & Bentler, 1999). In analyses that compare several alternative non-nested models, we report the Akaike information criterion (AIC) where the best model minimizes the value of the AIC (Akaike, 1987).

Results

Cronbach's alpha coefficients and correlations between all scales can be found in *Supplementary materials*. Cronbach alpha coefficients were in the range of .61 to .93. Out of 23 scales, five had reliability coefficients below .70, namely Fun Seeking, SPSRQ-SR, RST-PQ-Impulsivity and -Defensive fight and RSQ-Flight. Table 1 displays adequate goodness of fit indices for all questionnaires in the study. We tested only the models of the questionnaires from their validity papers.

- TABLE 1 -

CFA yielded a very poor goodness of fit for the first three theory driven models assuming one the BAS latent factor (Table 1). In order to detect statistical and potential conceptual differences between questionnaires, we have proceeded with an exploratory approach. Regarding the most recently published RST questionnaire, the RST-PQ (Corr & Cooper, 2016), we tested the model that differentiates four separate the BAS scales (Figure 2.). According to available data provided in Corr & Cooper (2016) and content validity of the scales, we detected similarities in operational definitions of the BAS between (a) Reward Interest, BAS-RSQ and BAS-J5; (b) Goal Drive Persistence and Drive; (c) Reward Reactivity and Reward Responsiveness; (d) SR, Fun

Seeking and Impulsivity. These four latent variables were labelled as BAS-Wanting, BAS-Striving, BAS-Liking and BAS-Capture, respectively. Along with these four BAS latent variables, the BIS, Flight/Freeze and Fight latent variables are entered in the model. The goodness of fit have been significantly improved in compare to the models with one the BAS latent variable. In addition, to achieve better fit indices of the model, we tested the model without the SR, and one without Fun Seeking. The results show that the best fit indices are achieved with the model without Fun Seeking. Data presented in the Figure 2. shows that all scales are well saturated in the model, except somewhat lower saturated the SR.

For the better readability of the results, correlations between the latent variables from the Figure 2 are represented in the Table 2. The BAS latent variables are highly intercorrelated, ranging from r = .64 to .85. Notwithstanding the high correlations, they show different correlational pattern with avoidance scales, which evidences for their divergent validity. The BAS-Wanting and BAS-Striving correlates negatively, the BAS-Liking positively, and the BAS-Capture do not correlates with the BIS and Flight/Freeze factors. Further, the BAS-Capture highly correlates with Fight, while the rest of the BAS factors correlated moderately. The Fight factor do not correlate with the BIS, and correlate negatively with the Flight/Freeze factors. These results show the discrepancy between the theoretical and operational definition of the construct. Finally, the BIS and Flight/Freeze were highly correlated (r = .85)

Discussion

We had two main aims in this paper. First, examination of the factor structure for all RST questionnaires. The CFA results showed adequate model fit for all RST questionnaires used in this study. These results are generally congruent with previous validation studies (Aluja &

Blanch, 2011; Carver & White, 1994; Corr & Cooper, 2016; Jackson, 2009; Smederevac et al., 2014). The second, and major aim of the paper concerns convergent validity of all RST questionnaires. Overall data indicate certain problems with generalization of the studies conducted with various RST questionnaires. The results of this study for convergent validity of RST questionnaires are the first to show complex relation between all the questionnaires currently in use. This opens space to discuss on some unresolved RST psychometrical issues.

Whether the BAS can be studied as unidimensional construct?

None of the models assuming one BAS latent variable achieved an adequate fit indices. The confirmation of the alternative models that recognises the differences between the BAS scales suggests not to use the BAS as a unidimensional construct, which can be frequently found in studies conducted with the BIS/BAS Scales. Moreover, this is especially relevant due to differences in correlation between the four BAS factors and the avoidance scales that may lead to different conclusion in the studies conducted with different RST questionnaires.

Diversity of the BAS scales presents a challenge in further development of RST, and the nature of their differences are yet to be established. The theory should be able to explain differences in various BAS processes and provide set of testable prediction that could explain differences in findings among different scales. Corr & Cooper (2016) provide theoretical explanation of the RST-PQ-BAS scales. Reward Interest measures identification of the biological reinforcer, Goal/Drive Persistence planning behaviour, while Impulsivity captures final execution of the plan, and Reward Reactivity measures emotional reactions on receiving reward. The available data evidences the usefulness of studying the separate BAS scales (e.g. Krupić, Gračanin, & Corr, 2016).

How to interpret the findings from the previous RST studies conducted with various RST questionnaires?

In order to provide continuation of the findings from previous and future studies, it is important to detect synonymous BAS scales. Upon our data, the BAS-J5 and BAS-RSQ highly converge with Reward Interest; Drive with Goal Drive Persistence; Reward Responsiveness with Reward Reactivity; and, finally, Impulsivity with the SR. However, low square multiple correlations of the SR suggests more alienated operational definition from the rest of the BAS scales. Fun Seeking is the only excluded the BAS scales from the model. Lower convergence of Fun Seeking might result because of more narrowed content of the scales focusing on fun activities, which can be influenced by various factors such as age. Since our sample was in age range from 16 to 54, it might be that it affected the results, and decreased correlation with other the BAS scales. Taken all together, these findings may contribute to interpreting and evaluating findings of studies conducted with various RST questionnaire.

Is the Fight approach or avoidance construct?

Our data show that the Fight factor presents rather approach than avoidance construct, since it correlates with BAS, not the Flight and Freeze scales. This may be due to poor operationalization of the scale or due to lack of language expressions that may provide a lack of differentiation between defensive and instrumental types of aggression (Corr, 2013). Furthermore, the fight scales do not correlate with Flight and Freeze, while these scales should represent the Fight/Flight/Freeze System. Thus, the data given with fight scales could suggest conclusions that are not congruent with the theory.

Divergence and generalisability of the BIS and Flight/Freeze scales

Notwithstanding correlations between the BIS and Flight/Freeze latent variable are very high (r = .85), Krupić, Križanić, & Corr, (2016) showed incremental validity of these scales in predicting defensive behaviours, which supports RST perspective of two highly correlate but still separate avoidance mechanisms (*see also* Corr & Cooper, 2016).

Concerning the generalizability of studies, BIS and Flight/Freeze scales showed a high level of congruence. However, although the BIS scales highly converge and they can be used interchangeable, the major exception is the BIS-J5. This is not a surprise, since the content validity of the scale is obviously different from the rest of RST questionnaires. Hence, generalizability of the studies conducted with different RST questionnaires may not be jeopardized with BIS (except BIS-J5) and Flight/Freeze and Fight scales.

There is an important conceptual point to be considered, which emerge from limitations of the study. We have not shown validity in terms of the association of these RST scales with external criteria. It would be a mistake to assume that the psychometric structure of different RST questionnaires can uncover the 'true' structures of RST. The most important criterion of the validity of these scales will come in the form of correlations with carefully chosen behavioural and neurophysiological data, for example, this research could entail EEG – in relation to the BIS (e.g. McNaughton, Swart, Neo, Bates, & Glue, 2013) and BAS (e.g. Cooper, Duke, Pickering, & Smillie, 2014; Gable & Harmon-Jones, 2013). All what we have shown is that the different RST questionnaire measures of personality are not isomorphic with each other. However, there is a possibility that future experimental studies may cause us to revise this conclusion. Finally, this study was conducted on questionnaires translated in Croatian, which could diminish generalizability of the findings for the RST questionnaires on other languages.

To conclude, our study indicates acceptable internal validity for all RST questionnaires, and convergent validity with few exceptions (the BIS-J5, Fun Seeking, and SR should be interpreted with cautious). This reflects in lower level of generalizability of results conducted with different questionnaires – an important information in interpreting results of the studies within RST. Overall, we hope that our results summarized in Figure 2 would help to control potential biases in the future RST studies, and to increase generalizability of the findings. Currently, we can only inform which of the questionnaires differ, and in which scales are similar, but we cannot tell which questionnaire is the right one. Nevertheless, much work is needed to prove validity of the existing RST questionnaires.

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Table 1. Goodness of fit indices for BIS/BAS, SPSRQ-20, Jackson-5, RST-PQ and RSQ and for theory-driven models for assessing convergent validity

	χ^2 (df)	CFI	RMSEA	AIC
Questionnaire				
BIS/BAS Scales (Carver & White, 1994)	592.03** (164)	.949	.056	-
SPSRQ-20 (Aluja & Blanchard, 2011)	386.89** (169)	.944	.040	-
Jackson 5 (Jackson, 2009)	1519.45** (395)	.931	.059	-
RSQ (Smederevac et al., 2014)	1198.70** (367)	.946	.053	-
RST-PQ (Corr & Cooper, 2016)	6898.90** (2000)	.931	.055	-
Models				
The BAS, BIS and FFFS	4737.90** (227)	.82	.156	4283.90
The BAS, BIS, Flight/Freeze and separate Fight	2724.81**(203)	.90	.123	2318.08
The BAS, BIS and Flight/Freeze	2377.82**(203)	.91	.114	1971.82
The BAS higher order, BIS, Flight/Freeze and Fight	1594.78**(176)	.86	.099	1704.78
Four separate the BAS subscales, BIS, Flight/Freeze and Fight (FS)	1376.42**(185)	.89	.089	1512.42
Four separate the BAS subscales, BIS, Flight/Freeze and Fight (FS-SR)	1254.54**(165)	.90	.090	1386.54
Four separate the BAS subscales, BIS, Flight/Freeze and Fight (-FS)	1168.19**(165)	.90	.086	1300.19

*p< .05; ** <0.01

Table 2. Correlational matrix of the latent variables from the model of the RST questionnaires

	BAS striving	BAS liking	BAS capture	BIS	Fight	Flight/Freeze
BAS wanting	.76	.64	.85	-.40	.33	-.33
BAS striving		.80	.73	-.16	.36	-.08
BAS liking			.77	.17	.34	.18
BAS capture				.03	.80	.04
BIS					.01	.85
Fight						-.11

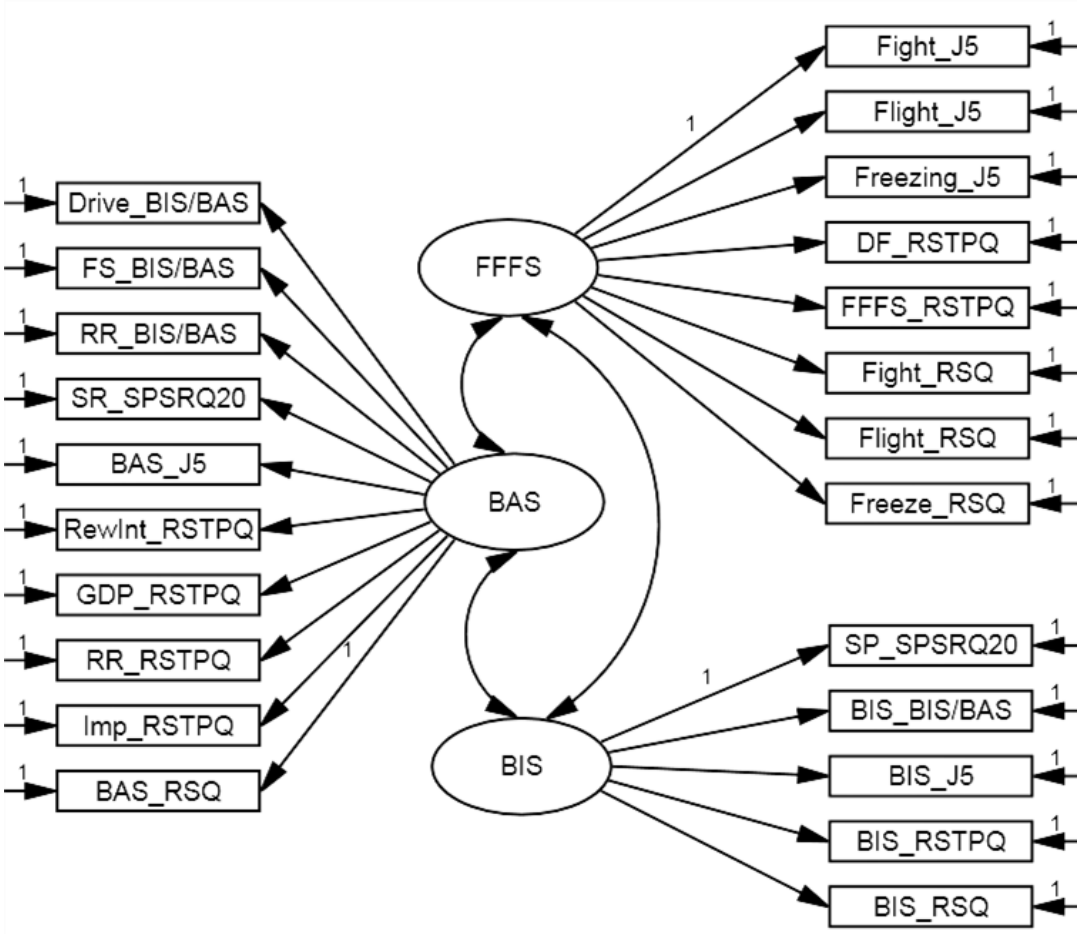

Figure 1. Theory-driven RST model 1

Note; DF – Defensive fight; SP – Sensitivity to punishment; SR; Sensitivity to reward; FS – Fun seeking; RR_BIS/BAS - Reward responsiveness; RewInt – Reward Interest; GDP – Goal Drive Persistence; RR_RST-PQ – Reward reactivity; Imp – Impulsivity.

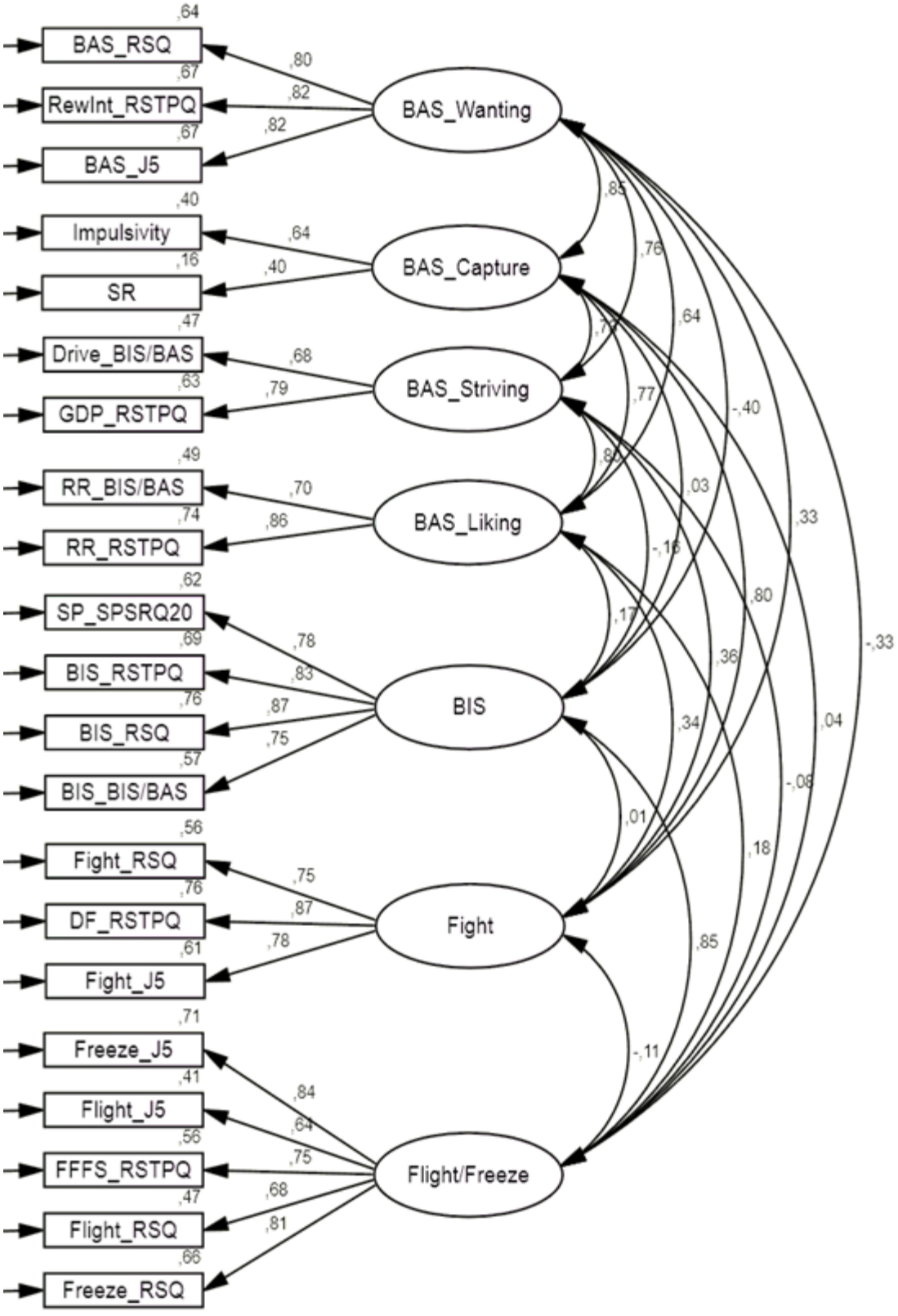

Figure 2. The final model consisted of the five RST questionnaires