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Citation: Krupić, D., Corr, P. J., Ručević, S., Križanić, V. & Gračanin, A. (2016). Five reinforcement sensitivity theory (RST) of personality questionnaires: Comparison, validity and generalization. *Personality and Individual Differences*, 97, pp. 19-24. doi: 10.1016/j.paid.2016.03.012

This is the accepted version of the paper.

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Permanent repository link: <https://openaccess.city.ac.uk/id/eprint/15891/>

Link to published version: <https://doi.org/10.1016/j.paid.2016.03.012>

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Five RST questionnaires

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

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12 Abstract

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

27

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

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

38 Reinforcement sensitivity theory (RST) provides a neuropsychological account of the
39 major systems that underlie personality, namely, the Behavioural Approach System (BAS), and
40 two defensive systems, the Behavioural Inhibition System (BIS) and the Fight-Flight-Freeze
41 System (FFFS) (Corr, 2008). The BAS mediates reactions to reward and non-punishment. Its
42 outputs are positive emotions, the motivation to approach biological reinforcers, and to engage in
43 activities that lead to consummatory behaviour (Gray & McNaughton, 2003). The FFFS is
44 responsible for the active avoidance and escape from aversive stimuli, while the BIS is
45 responsible for passive avoidance and the detection and resolution of goal-conflict. In its long
46 history, RST has encouraged the development of a number of different questionnaires (for a
47 summary, see Torrubia, Avila, & Caseras, 2008; Corr, 2016). In the last six years alone, three
48 new questionnaires have been developed: the Jackson 5 (J5; Jackson, 2009), Reinforcement
49 Sensitivity Theory Personality Questionnaire (RST-PQ; Corr & Cooper, 2016), and the
50 Reinforcement Sensitivity Questionnaire (RSQ; Smederevac, Mitrović, Čolović, & Nikolašević,
51 2014). In fact, more recently, there is a fourth revised RST questionnaire (Reuter, Cooper,
52 Smillie, Markett, & Montag, 2015), which we do not discuss further because it postdates the
53 collection of data reported in this article. Together with two of the most frequently used
54 questionnaires -- BIS/BAS Scales (Carver & White, 1994) and Sensitivity to Punishment and
55 Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) -- there
56 are now six personality questionnaires that compete to provide a viable operational account of
57 RST's three major neuropsychological systems.

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

62 **RST Questionnaires**

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

69 SPSRQ was also developed upon original RST. It contains Sensitivity to Punishment (SP)
70 and Sensitivity to Reward (SR) scales. Several studies show problematic psychometric properties
71 of the translated versions of this questionnaire. In order to achieve a two-factor structure, many
72 researchers have had to adjust translated versions by excluding items. In this way, the original
73 Spanish version contains 48 items (Torrubia et al., 2001), French version 35 (Lardi, Billieux,
74 d'Acremont, & Linden, 2008), and English 39 (Cogswell, Alloy, Dulmen, & Fresco, 2006); and,
75 without excluding items, the Romanian version has a three-factor solution (Sava & Sperneac,
76 2006) – in addition to sensitivity to reward and punishment, there was a BAS 'financial' factor
77 relating to earning money but this was correlated 0.67 with the Reward factor. Aluja and Blanch
78 (2011) developed a short version of SPSRQ (SPSRQ-20) in order to enhance its psychometric
79 properties. Besides problems of construct validity, the main issue with this questionnaire is that it
80 is based upon the original version of RST, where impulsivity is assumed to be the underlying

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

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

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

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

114 Available data on convergent validity of the RST questionnaires are limited to
115 comparison of two questionnaires (e.g., Caci, Deschaux, & Baylé, 2007; Cogswell et al., 2006;
116 Davis et al., 2007; Dufey, Fernández, & Mourgues, 2011; Knyazev, Slobodskaya, & Wilson,
117 2004; Krupić & Corr, 2014; Sava & Sperneac, 2006; Smillie, Jackson, & Dalgleish, 2006;
118 Wallace, Malterer, & Newman, 2009), or three questionnaires (Caseras, Avila, & Torrubia, 2003;
119 Smederevac et al., 2014; Smillie & Jackson, 2005). Authors of recent RST questionnaires
120 provide most of the development and validation data within their publications, but there has been
121 a noticeable absence of any attempt to provide convergent validation evidence with all of them in
122 the same study – what is the purpose of this study.

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

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

137 **Method**

138 **Participant and materials**

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

143 **Measures**

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

148 SPSRQ-20 (Aluja & Blanch, 2011) is short 20-item version of SPSRQ (Torrubia et al.,
149 2001) containing two 10-items scales: the Sensitivity to Punishment (SP) and the Sensitivity to
150 Reward (SR) with yes/no response format.

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

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

158 Finally, the RST-PQ (Corr & Cooper, 2016) contains 73 items that comprise five scales:
159 BAS (32 items), BIS (23 items), Flight-Freeze System (FFS 10 items), and Defensive Fight (8
160 items). RST-PQ defines BAS as a multidimensional construct: Reward Interest (7 items), Goal-
161 Drive Persistence (7 items), Reward Reactivity (10 items), and Impulsivity (8 items). Items are
162 answered on four-point Likert-type scale (*“How accurately does each statement describe you?”*)
163 1 = Not at all; 4 = Highly).

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

166

167 **Data analytic plan**

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

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

178 **Results**

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

185 - TABLE 1 -

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

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

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

212

213

Discussion

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

217 Blanch, 2011; Carver & White, 1994; Corr & Cooper, 2016; Jackson, 2009; Smederevac et al.,
218 2014). The second, and major aim of the paper concerns convergent validity of all RST
219 questionnaires. Overall data indicate certain problems with generalization of the studies
220 conducted with various RST questionnaires. The results of this study for convergent validity of
221 RST questionnaires are the first to show complex relation between all the questionnaires
222 currently in use. This opens space to discuss on some unresolved RST psychometrical issues.

223 **Whether the BAS can be studied as unidimensional construct?**

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

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

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

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

252

253 **Is the Fight approach or avoidance construct?**

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

261

262 Divergence and generalisability of the BIS and Flight/Freeze scales

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

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

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

285 To conclude, our study indicates acceptable internal validity for all RST questionnaires,
286 and convergent validity with few exceptions (the BIS-J5, Fun Seeking, and SR should be
287 interpreted with cautious). This reflects in lower level of generalizability of results conducted
288 with different questionnaires – an important information in interpreting results of the studies
289 within RST. Overall, we hope that our results summarized in Figure 2 would help to control
290 potential biases in the future RST studies, and to increase generalizability of the findings.
291 Currently, we can only inform which of the questionnaires differ, and in which scales are similar,
292 but we cannot tell which questionnaire is the right one. Nevertheless, much work is needed to
293 prove validity of the existing RST questionnaires.
294

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

	χ^2 (df)	CFI	RMSEA	AIC
<i>Questionnaire</i>				
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	-
<i>Models</i>				
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

445 * $p < .05$; ** $p < 0.01$

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456 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

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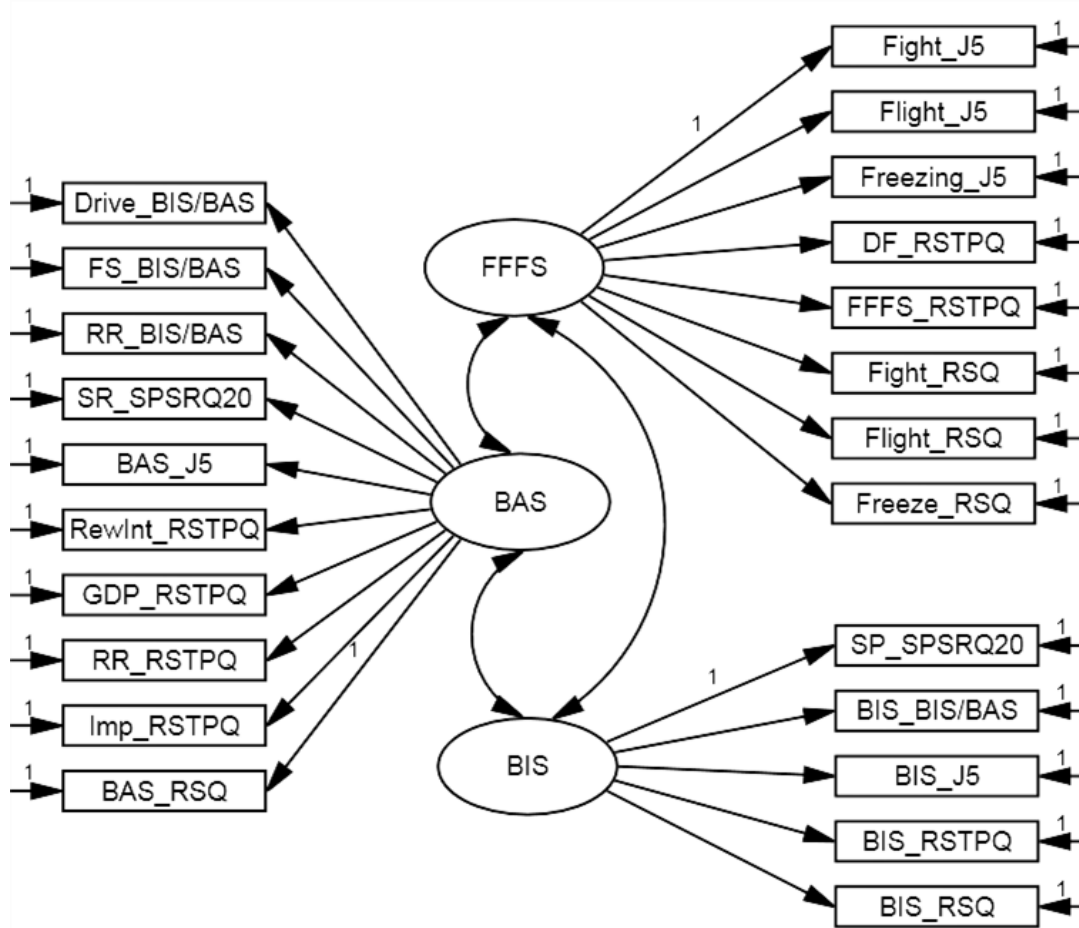
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464 Figure 1. Theory-driven RST model 1

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

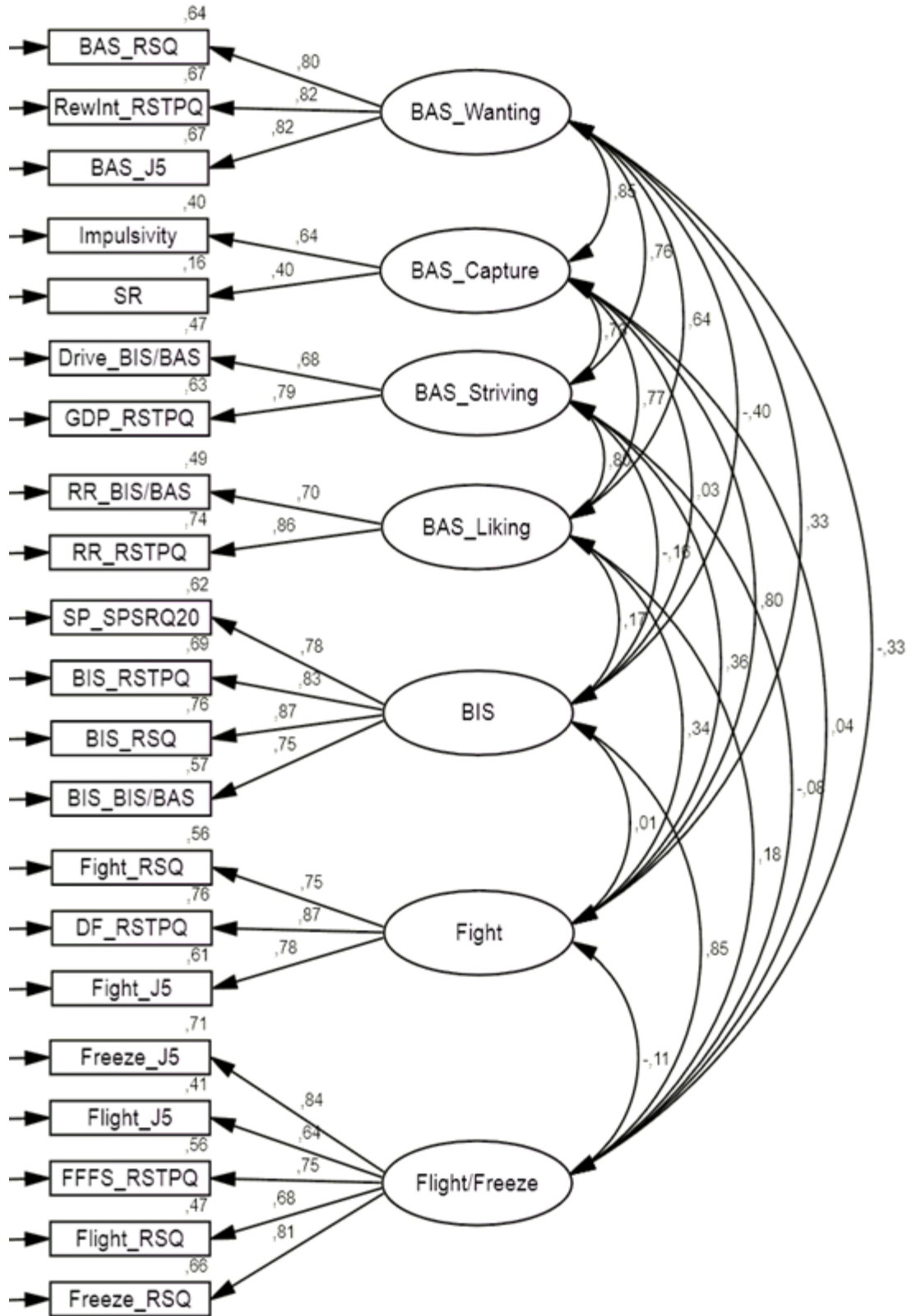
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Figure 2. The final model consisted of the five RST questionnaires