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The Evolution of the Behavioural Approach System (BAS):

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Cooperative and Competitive Resource Acquisition Strategies

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8

9 **Abstract**

10 The nature of approach motivation has not yet been adequately defined. Some authors view
11 it as a unidimensional construct, while others consider it to be multidimensional. Its
12 psychometric nature is explored in this study, which tests empirically the motivational
13 account of the Behavioural Approach System (BAS) within an evolutionary context. In a
14 sample of 394 participants, we administered the Assessment of Individual Motives
15 questionnaire (AIM-Q), the Reinforcement Sensitivity Theory Personality Questionnaire
16 (RST-PQ) and a short version of the Sensitivity to Punishment and Sensitivity to Reward
17 (SPSRQ-20). The results of set correlation analysis indicated that different BAS scales
18 relate to different motives, thus supporting the multidimensional perspective on approach
19 motivation. Specifically, Reward Interest relates to various types of motives that generally
20 reflect sensitivity to social rewards; Goal-Drive Persistence relates to social exchange;
21 Reward Reactivity to safety and commitment; while Impulsivity and Sensitivity to Reward
22 (SR) relate to competitive motives. These results are discussed within an evolutionary
23 framework for the multidimensionality of the BAS.

24 **Keywords:** reinforcement sensitivity theory, motivation, personality, evolution, set
25 correlation analysis

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29 The Evolution of the Behavioural Approach System (BAS):
30 Cooperative and Competitive Resource Acquisition Strategies

31 The Behavioural Approach System (BAS) is one of three major systems in the
32 neuropsychological theory of personality known as the reinforcement sensitivity theory
33 (RST), which includes two additional defensive systems: the Fight-Flight-Freeze System
34 (FFFS), responsible for the active avoidance of, and escape, from, aversive stimuli; and the
35 Behavioural Inhibition System (BIS), responsible for passive avoidance and the detection
36 and resolution of goal-conflict. It is assumed that the BAS represents a general domain
37 approach mechanism designed to solve the important evolutionary adaptive problem of
38 attaining critical resources, such as food, water, sex and social status (Berridge, 2004;
39 Berridge & Robinson, 2003; Kenrick & Shiota, 2008). In general terms, the BAS mediates
40 reactions to reward and non-punishment. Its outputs serve to motivate approach behaviours
41 towards biological reinforcers and to engage in activities that lead to consummatory
42 behaviour (Corr, 2008; Gray & McNaughton, 2000). Despite the popularity and long
43 history of this theory, the obvious evolutionary importance of the BAS has not yet been
44 explored empirically.

45 **1.1. Evolutionary explanations of individual differences**

46 Within evolutionary psychology, individual differences in personality and/or
47 temperament are interpreted as variations in adaptive mechanisms that evolved to provide
48 solutions to problems concerning reproduction and survival (Buss, 2008, 2009). Since
49 environmental conditions were not equal for the entire human population, it may be
50 assumed that some phenotypic variations were more adaptive in one environment than in
51 another. Thus, there is no “gold standard” for a personality trait that could provide the best

52 possible fitness in every environment (Penke, 2010; Penke, Denissen, & Miller, 2007).
53 Therefore, it is reasonable to assume the existence of a variety of resource acquisition
54 strategies which could ensure flexible and adaptive behaviour in different environmental
55 conditions.

56 We can distinguish two main groups of resource acquisition strategies developed in
57 social species: competition (e.g., stealing, trickery, aggression) and cooperation (e.g., social
58 exchange, altruism) (Buss, 1999). Competitive strategies are mostly related to questions of
59 social hierarchy, status, or power, with individuals ranking higher on the social scale
60 having access to more resources whilst facing lower risks and required effort. In contrast,
61 cooperative strategies are seen as mutually beneficial (Scott-Phillips, Dickins, & West,
62 2011). On a proximal level, cooperation can be manifested as volunteering, social
63 exchange, reciprocal altruism, and so on (Buss, 1999; Tooby & Cosmides, 1988). We can
64 assume that cooperative behaviour is driven by the need for social approval, which is a very
65 powerful incentive (e.g., Izuma, Saito, & Sadato, 2010), and it serves the function of
66 attaining social status. In economics, this is known as the ‘public good’ benefit. As such,
67 helping others may be seen as an investment or even buying insurance for future events in
68 which one would seek help from the same individuals. Which of these two strategies would
69 be used, depends upon environmental conditions and individual differences.

70 The aim of this study is to examine empirically, for the first time, which of these
71 two evolved resource acquisition strategies are related to individual differences in the BAS.
72 We expect the BAS to correlate with variation in both cooperative and competitive
73 strategies, as reflected in different motives that are expected to fuel the exertion of these
74 strategies.

75 The heterogeneity of the BAS may derive from the ‘arms race’ between predator
76 and prey. The ‘Life-Dinner Principle’ (Dawkins & Krebs, 1979) suggests that the
77 evolutionary selective pressure on the prey is much stronger than on the predator: if a
78 predator fails to kill its prey, it has lost its dinner, but if the prey fails to avoid/escape being
79 the predator’s dinner, then it has lost its life. Although defensive behaviours, principally
80 freezing, fleeing and defensive attack, are themselves relatively complex (Eilam, 2005), it
81 is nonetheless true that the behaviour of the prey is intrinsically simpler than that of the
82 predator: all it has to do is avoid/escape, making it, quite literally, life-or-death behaviour
83 (Corr, 2008). In contrast, the predator has to develop counter-strategies to meet its BAS
84 aims, which entail a higher degree of cognitive and behavioural sophistication over the
85 prey’s defensive behavioural repertoire. Another reason for the complexity of the BAS
86 comes from heterogeneity of appetitive goals (e.g., securing food and finding/keeping a
87 sexual mate), which demand a corresponding heterogeneity of BAS-related strategies

88 The putative multidimensional nature of the BAS is also grounded in the
89 neurobiology of personality, which recognises two approach related traits: impulsivity and
90 extraversion, that are related to different neurotransmitters. Impulsivity is associated with
91 dopamine, serotonin (Dalley, & Roiser, 2012), and testosterone (Montoya, Terburg, Bos, &
92 van Honk, 2012). Testosterone has been found important in attaining social status in
93 number of cross-species studies (e.g., Beaver & Amoss, 1982; Coe, Mendoza, & Levine,
94 1979; Elofsson, Mayer, Damsgård, & Winberg, 2000). In human studies, testosterone is
95 linked with domination (Sellers, Mehl, & Josephs, 2007), choice of risky carriers
96 (Sapienza, Zingales, & Maestriperi, 2009), aggression (Archer, 2006), and level of
97 reproductive effort (Alvergne, Jokela, Faurie, & Lummaa, 2010), which all correspond to

98 competitive motives. Thus, we may expect that the RST scales reflecting impulsivity (the
99 SR and RST-Impulsivity) should correlate with competitive motives.

100 Neurobiologically, nurturance/cooperativeness is based on oxytocin system
101 functions (e.g., Feldman, 2012; Yamasue et al., 2009). The second candidate for the
102 neurobiological underpinnings of nurturance/cooperation are endogenous opiates, which
103 are involved in the positive emotions that follow attainment or consumption of reward. This
104 is a key feature of Reward Reactivity, and is important in social affiliation, making opiates
105 likely candidates for a biological substrate of Extraversion and Social Closeness (Berridge,
106 2012; Depue & Morrone-Strupinsky, 2005). Thus, we may expect that the RST-PQ scales
107 designed closely to extraversion (Reward Interest, Goal-Drive Persistence, and Reward
108 Reactivity) should correlate more with the cooperative motives.

109

110 **2. Materials and Methods**

111 *2.1. Participants and procedure*

112 A total of 394 (208 male and 186 female) participants ($M_{AGE} = 27.99$; $SD = 9.70$,
113 range from 16 to 54) completed three questionnaires online using LimeSurvey web
114 application. Only complete data were recorded. The Ethics Committee of Faculty of
115 Humanities and Social Sciences in Rijeka gave approval for the study

116 *2.2. Measures*

117 We administered two RST questionnaires: Reinforcement Sensitivity Theory
118 Personality Questionnaire (RST-PQ; Corr & Cooper, 2016), and the Sensitivity to
119 Punishment and Sensitivity to Reward Questionnaire-20 (SPSRQ-20; Aluja & Blanch,
120 2011; Torrubia, Avila, Molto, & Caseras, 2001). We also administered the Assessment of

121 Individual Motives (AIM-Q; Bernard, 2013) which provides a measure for cooperative and
122 competitive resource acquisition strategies and integrity motives.

123 The RST-PQ (Corr & Cooper, 2016) contains 65 items for measuring the BAS, the
124 Behavioural Inhibition System (BIS) and Fight/Flight/Freeze System (FFFS). The BAS
125 consists of four sub-scales. People that score high on Reward Interest scale (seven items)
126 are more likely to engage in anticipatory approach, exploration of new objects, places and
127 people (e.g., *“I regularly try new activities just to see if I enjoy them”*). Goal-Drive-
128 Persistence (seven items) measures the persistence in achieving the ultimate aim of
129 obtaining a reward (e.g., *“I put in a big effort to accomplish important goals in my life”*).
130 Reward Reactivity (ten items) relates to the level of experiencing emotional reaction to
131 reward (i.e., ‘pleasure’) and provides the positive reinforcement for BAS behaviour (e.g.,
132 *“Good news makes me feel over-joyed”*). Finally, Impulsivity (eight items) refers to the
133 final stage of catching the biological reinforcer, where non-planning and fast reactions are
134 more appropriate (e.g., *“I think I should ‘stop and think’ more instead of jumping into
135 things too quickly”*). Using the criterion of Hu & Bentler (1999), the four-factor model of
136 the BAS in this study showed adequate goodness of fit indices ($\chi^2/df = 2.71$, $CFI = .903$;
137 $RMSEA = .066$). Internal reliability coefficients (Cronbach’s Alpha) are 0.75 for Reward
138 Interest, 0.83 for Goal-Drive Persistence, 0.75 for Reward Reactivity, and 0.67 for
139 Impulsivity.

140 The SPSRQ-20 (Aluja & Blanch, 2011; Torrubia et al., 2001) measures Sensitivity
141 to Reward (SR; e.g., *“Do you like being the centre of attention at a party or a social
142 meeting”*) and Sensitivity to Punishment (SP; e.g. *“Are you often afraid of new or*

143 *unexpected situations?*"); each scale containing 10 items. Reliability coefficients are 0.66
144 for SR and 0.82 for SP.

145 The Croatian translation of both questionnaires was validated earlier (Krupić,
146 Križanić, Ručević, Gračanin, & Corr, 2016). Data for the defensive BIS, FFFS, Defensive
147 fight (for the RST-PQ) and the SP (for the SPSRQ) were also collected, but as they are out
148 of scope of this study they were not analysed.

149 AIM-Q (Bernard, 2013) is a 60-item questionnaire that measures 15 human-specific
150 motives (Bernard, 2009, 2010) within the evolutionary theory of human motivation
151 (Bernard, Mills, Swenson, & Walsh, 2005). Each motive is represented by four items
152 answered on a seven point Likert-type scale. Bernard (2013) distinguishes three types of
153 motives: (a) motives facilitating individual integrity (Environmental Inquisitiveness, Threat
154 Avoidance, Illness Avoidance,); (b) motives facilitating competition for resources and
155 mates (Interpersonal Inquisitiveness, Aggression, Appearance, Mental, Physical, Wealth,
156 Sex); and (c) motives facilitating cooperation in order to gain resources (Commitment, Kin
157 Altruism, Social exchange, Legacy and Meaning). Full description of the questionnaire and
158 constructs can be found in Bernard and Lac (2014). Reliability coefficients are presented in
159 Table 1. Generally, all except Illness avoidance achieve reliability above .70.

160 2.3. Analytic plan

161 Relationships between the BAS scales and AIM-Q motives were analysed by set
162 correlation analysis (SCA), which provides the statistical control for a set of research
163 factors (in our case gender and age), when relating one set of variables (in our case the
164 BAS scales) to another (in our case 15 AIM-Q motives). In this way, confounding variables
165 are held under control, and the likelihood of Type I error is reduced, which promotes the

166 uniqueness of relationship between variables (Cohen, Cohen, Aiken, & West, 2003).
167 Statistical control of gender and age is important in determining the unique adaptive
168 account of the BAS, since they represent an important source of variation within the
169 evolutionary psychology. Additionally, we used Bonferroni correction in determining the
170 statistical significance in order to reduce further Type I error due to a larger number of
171 correlations tested.

172 **3. Results**

173 Descriptive statistics for AIM-Q and results of SCA are shown in Table 1, while zero
174 order correlation matrices between and within questionnaires are available in
175 *Supplementary materials*. All analyses were conducted using R version 3.2.2 (R
176 Development Core Team, 2013), using package psych version 1.5.8 (Revelle, 2015).

177 Using set correlation, all canonical variates in a data set were taken into account in
178 one index to provide an overall estimate of association. The overall relationship between
179 personality traits and motives using Cohen's Set Correlation was $R^2 = .82$, which was
180 statistically significant $F(6.75, 105) = 2294.39, p < 0.01$. Weak to moderate relationships
181 ($R^2 = .05$ -.32) were found between discrete motives and personality traits. Further,
182 different patterns of partial correlations for AIM-Q motives, controlled for gender and age,
183 were shown among BAS scales. In general, the SR and Impulsivity were more related with
184 competitive, while Reward Interest, Goal-Drive Persistence and Reward Reactivity were
185 more related with cooperative motives, as expected. Reward interest was related with Kin
186 Altruism, Meaning, Legacy, but also with Physical and Environmental Inquisitiveness, that
187 belongs to competitive and integrity motives, respectively. Goal-Drive Persistence was

188 related with Social exchange, while Reward Reactivity showed links with Commitment
189 from cooperative group of motives, and Threat avoidance from Integrity motives.

190 TABLE 1 –

191 4. Discussion

192 In order to provide an evolutionary account of the BAS, we examined the
193 relationships between inter-individual variation on different BAS scales and different types
194 of motives, including (a) motives facilitating individual integrity, (b) motives facilitating
195 competition for resources and mates, and (c) motives facilitating cooperation. Overall, the
196 BAS scales correlated with both resource acquisition strategies and, additionally, with the
197 integrity motives. More specifically, discrete motives are found to correlate with different
198 aspects of the BAS functioning. This suggests that different aspects of the BAS were
199 shaped throughout evolutionary history in order to confront specific adaptive problems. Put
200 it simply, while the AIM-Q detects *what* were the adaptive goals, the BAS explains *how*
201 these goals were obtained.

202 Weak to moderate relationships were found between discrete motives and
203 personality traits, which is reasonable since motives and personality traits are not
204 equivalent constructs. Motives are defined as a predisposition to behave in a directed
205 fashion, focusing on behavior solely, while personality traits are defined as a complex
206 constructs combining stable behavioral, cognitive and emotional characteristics (for details
207 see Bernard & Lac, 2014). Thus, low to moderate correlations between the BAS scales and
208 motives are expected.

209 Reward Interest correlated with the tendency of exploring the environment
210 (Environmental inquisitiveness), participating in competitions that signal gender-

211 appropriate physical ascendancy (Physical), caring for relatives (Kin Altruism), and with
212 reciprocation among non-kin (Legacy and Meaning). In general, individuals that score high
213 on Reward Interest scale show a tendency to act prosocially, or to contribute to society.

214 The next finding relates Goal-Drive Persistence with tendency to enter into
215 reciprocal, mutually beneficial exchanges of resources with non-kin (Social Exchange).
216 The cooperation is more of a long-term strategy (Barclay, 2013; Stevens, Cushman, &
217 Hauser, 2005). It takes time to build trust between people, and even then, it is not certain
218 whether it will be mutually beneficial. Therefore, it is not surprising that many studies
219 show that reward delay capacity is important in maintaining cooperative behaviour
220 (Brosnan, Salwiczek, & Bshary, 2010; Kortenkamp & Moore, 2006; Rosati, Stevens, Hare,
221 & Hauser, 2007), which is the core feature of Goal-Drive Persistence.

222 Individuals high on Reward Reactivity scales show tendency toward maintaining
223 one's safety (Threat Avoidance) and a greater capacity for developing tender, intimate,
224 supportive attachments with mates and offspring (Commitment). Reward Reactivity relates
225 to emotional reactions to the final attainment of a desired goal. It serves as “emotional fuel”
226 for the previous BAS processes (Corr & Cooper, 2016). Positive outcome followed by
227 positive emotional reaction serves as reinforcement of invested effort in attaining a desired
228 goal. According to our results, these processes have the importance in maintaining safety
229 and a relationship with others.

230 Compared to cooperation, competition as a resource acquisition strategy is a more
231 short-term strategy (Barclay, 2013; Stevens et al., 2005). RST-PQ Impulsivity relates with
232 motives such as achieving domination (Aggression), tendency of mocking others, being
233 sarcastic (Interpersonal Inquisitiveness), and searching for mates (Sex). In addition,

234 individuals high on SR are more willing to display intellectual and physical superiority
235 (Mental and Physical, respectively), material resources (Wealth), and to invest resources in
236 order to look well (Appearance). In general, a common feature of individuals that score
237 high on RST-PQ Impulsivity and the SR is a tendency to represent themselves as better
238 than others. However, it is important to emphasize the difference between SR and
239 Impulsivity (RST-PQ), which appeared in our results. While Impulsivity relates exclusively
240 to competitive motives, SR additionally correlates with integrity motives (Illness avoidance
241 and Threat avoidance) and negatively with Social Exchange. Furthermore, the Impulsivity
242 scale contains items that reflect tendencies of acting fast without thinking and not planning,
243 thus reflecting poor executive function (e.g. *“I think I should ‘stop and think’ more instead
244 of jumping into things too quickly”*). On the other hand, the SR contains items relating to
245 behavioural tendencies (e.g. *“When you are in a group, do you try to make your opinions
246 the most intelligent or the funniest?”*). The AIM-Q items are also designed to measure
247 motivational tendencies on a behavioural level (e.g. *“I show off my understanding of
248 abstract or complex ideas so people will respect me”*), which could result in common
249 method variance with the SR, and thus spuriously increases correlation coefficients. Hence,
250 we cannot discuss the relative importance of these two scales in competitiveness within this
251 study, since they obviously measure different aspects of impulsivity.

252 The rest of associations were not significant, although zero-order correlation matrix
253 in *Supplementary materials* might suggest the opposite. This discrepancy suggests that the
254 BAS scales correlate with some other motives as well, but these relations are confounded,
255 since the both – the BAS scales and the motives - are highly inter-correlated. Thus, the
256 discrepancy of the results represents the ability of SCA to detect confounding effects

257 between two sets of variables. This way, the SCA provides a unique relationship between
258 two variables, when many other variables are held under statistical control, and these
259 effects are very likely to replicate.

260 Most of the empirical work in the original version of the RST was based on animal
261 studies, particularly rodents. Upon these experiments, the idea of the unidimensional BAS
262 could seem very plausible. However, as we can see, different adaptive goals demand
263 different strategies of the BAS. We believe that the BAS complexity arises from highly
264 complex human environment in comparison to rodents' - which has not been taken into
265 account in the original version of RST.

266 The findings of this study hold significance in understanding the differences that are
267 commonly observed between the various BAS scales (e.g. Jackson & Smillie, 2004; Krupić
268 & Corr, 2014; Smillie, Jackson, & Dalgleish, 2006). Understanding the conceptual
269 differences between the BAS scales could lead toward setting more precise hypotheses in
270 RST studies. However, much work is needed in order to produce a complete picture of the
271 evolutionary origins of the BAS. Further studies should focus on sex dimorphism and
272 relationships between different aspects of the BAS functioning and variables such as
273 relationship instability, sociosexuality, parental effort, etc., which are important for
274 understanding its adaptive functions.

275 The major limitation of this study concerns the usage of only one psychometric
276 measure for competitive and cooperative motives, and the study design that does not allow
277 for causal interpretation. Furthermore, we did not include the BIS and FFFS scales in our
278 study, what might have influenced the results. Currently, the theory is not clear whether the
279 approach and avoidance system function separately, or they have mutually inhibitory

280 effects, which is beyond the scope of this paper (*however, reanalysed data can be found in*
281 *Supplementary materials*).

282 In conclusion, the results of this study show that impulsivity, as measured by RST-
283 PQ and SR from SPSRQ, relates to competitive, Goal-Drive Persistence and Reward
284 Reactivity relate to cooperative, while Reward Interest relates to both resource acquisition
285 strategies, which altogether represent a set of novel findings in RST research. Clearly, the
286 evolutionary perspective provides a coherent theoretical account of the multidimensionality
287 of approach motivation.

288

289

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440 *Table 1. Descriptive statistics and results of set correlations analysis between AIM-Q*
 441 *motives and approach dimensions of SPSRQ-20 and RST-PQ controlled for gender and*
 442 *age*

	Motives facilitating individual integrity			Motives facilitating cooperation				
	THA	ILA	EIQ	COM	KIN	SOC	LEG	MEA
Gender	.01	-.03	.24**	.09	-.07	.05	.12	.11
Age	.06	.05	.01	-.04	-.09	.06	.05	.05
Reward Interest	-.08	-.11	.44**	-.02	.22**	.15	.32**	.32**
Goal-Drive Persistence	.07	.02	.07	.02	-.04	.23**	-.03	-.08
Reward Reactivity	.26**	.14	-.00	.18**	.02	.14	.04	-.06
Impulsivity	-.04	.02	.07	.08	.12	-.07	.06	.03
Sensitivity to reward	-.19**	.17**	-.11	-.13	-.10	-.23**	-.09	-.00
M	15.49	12.29	17.96	18.11	16.03	20.25	12.36	11.98
SD	4.217	3.738	4.025	4.987	4.033	2.621	4.966	5.822
α	.73	.58	.87	.91	.75	.72	.87	.93
R	.29	.23	.56	.26	.28	.44	.38	.29
R ²	.086	.053	.318	.067	.079	.197	.143	.084
F (7, 386)	5.20**	3.09**	25.71**	3.98**	4.74**	13.51**	9.19**	5.05**

443 * $p < 0.05$; ** $p < 0.01$; α – Cronbach alpha; R – multiple correlation coefficient; R² – multiple
 444 determination coefficient; THA – Threat Avoidance; ILA – Illness Avoidance; EIQ -
 445 Environmental Inquisitiveness; COM – Commitment; KIN – Kin Altruism; SOC – Social;
 446 Exchange; LEG – Legacy; MEA – Meaning; positive correlation for Gender indicates
 447 higher score for males.

448 *Table 1. (continued) Descriptive statistics and results of set correlations analysis between*
 449 *AIM-Q motives and approach dimensions of SPSRQ-20 and RST-PQ controlled for*
 450 *gender and age*

	Motives facilitating competition for resources and mates						
	AGG	INI	SEX	APP	WEA	MEN	PHY
Gender	-.01	-.08	-.27**	.18**	-.11	.02	-.17**
Age	-.07	-.11	.06	.04	-.00	-.07	.02
Reward Interest	-.01	-.07	.00	.04	-.10	-.01	.25**
Goal Drive Persistence	-.05	-.08	-.14	-.03	.01	.10	.06
Reward Reactivity	-.11	.03	-.02	-.04	.05	.01	-.04
Impulsivity	.21**	.22**	.17**	.06	.12	.01	-.11
Sensitivity to reward	.32**	.24**	.19**	.37**	.41**	.49**	.36**
M	6.84	10.53	8.60	6.64	6.75	10.63	10.97
SD	3.357	5.161	4.218	3.446	3.554	4.552	5.257
α	.80	.91	.85	.80	.84	.83	.89
R	.43	.42	.43	.38	.49	.53	.51
R ²	.183	.176	.186	.148	.239	.283	.262
F (7, 386)	12.37**	11.74**	12.60**	9.57**	17.29**	21.75**	19.58**

451 *** p < 0.01; α – Cronbach alpha; R – multiple correlation coefficient; R² – multiple*
 452 *determination coefficient; AGG – Aggression; INI - Interpersonal Inquisitiveness; SEX*
 453 *– Sex; APP – Appearance; WEA – Wealth; MN – Mental; PH – Physical; positive*
 454 *correlation for Gender indicates higher score for males.*

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