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2 The Evolution of the Behavioural Approach System (BAS):

3 Cooperative and Competitive Resource Acquisition Strategies

4

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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

3

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.

4

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, & Maestripieri, 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

6

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

13

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

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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; R^2 – 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.

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; R^2 – 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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