

The relationship of Eysenck's Giant Three with fluid and crystallized intelligence and learning potential among adolescents

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Abstract

The aim of this study was to explore the relationship of Eysenck's Giant Three with Fluid and Crystallized Intelligence and Learning Potential among adolescents. A total of 205 students of the sixth grade (50,44% male) of five elementary schools participated in the research. The average age of the participants was $M = 12.56$ ($SD = 0.61$). Fluid intelligence was measured by Raven's Standard Progressive Matrices and Cattell's free-culture test, crystallized intelligence was measured by the Mill Hill Vocabulary Scale and Learning potential was measured by Learning Potential Assessment, (EPA-2). Personality traits were measured by the Eysenck Personality Questionnaire-Junior. The results are consistent with the findings of other studies in which moderate correlations between personality traits and intelligence have been established. Psychoticism, Extraversion and Lay scale are related to fluid and crystallized intelligence measurements. The correlation between personality traits and learning potential is lower in comparison with the correlations between personality traits and fluid and crystallized intelligence. The results gained in our research are partly in accordance with Chamorro-Premuzic and Furnham's (2005) two-level conceptual framework. Namely, we are prone to interpret Extraversion as personality trait that, except for being related to intelligence test performance, has a long-term effect on intelligence development, prior through sociability and activity. The results of our research point out to the assumption that dynamic intelligence testing method decreases the correlation between personality traits and intellectual skills, defined as learning potential. In addition, measurements obtained by dynamic intelligence testing are the additional explanatory constructs that can contribute to the explanation of the correlation between personality and intelligence. In general, the results obtained in our research are in line with Stimulation hypothesis (Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Strelau, Zawadzki, & Piotrowska, 2001). Sociability and activity, referred to as the components of Extraversion and the absence of Psychoticism, are positively related to new experience, greater stimulation, and higher levels of cognitive stimulation, which, in turn, may result in higher levels of cognitive aptitude. In general, pro-social behaviour pattern contributes to greater involvement in seeking for environmental resources which could foster cognitive development.

Keywords: Personality traits, Fluid intelligence, Crystallized intelligence, Learning potential.

A relação dos Três Gigantes de Eysenck com inteligência fluida e cristalizada e potencial de aprendizagem entre adolescentes

Resumo

O objetivo do estudo foi explorar a relação entre os Três Gigantes de Eysenck e inteligência fluida e cristalizada e potencial de aprendizagem entre adolescentes. Um total de 205 alunos da sexta série (50,44% do sexo masculino) de cinco escolas de ensino fundamental participou da pesquisa. A idade média dos participantes foi de 12,56 ($DP = 0,61$). A inteligência fluida foi medida pelo teste das Matrizes Progressivas de Raven e pelo *Cattell's free-culture test*, a inteligência cristalizada foi medida pela Escala de Vocabulário Mill Hill, e o potencial de aprendizagem foi medido pela Avaliação do

Potencial de Aprendizagem, (EPA-2). Os traços de personalidade foram medidos pelo *Junior Eysenck Personality Questionnaire*. Os resultados obtidos são consistentes com os resultados de outros estudos, nos quais correlações moderadas entre traços de personalidade e inteligência têm sido estabelecidas. Psicoticismo, Extroversão e escala Lay estão relacionados com medidas de inteligência fluida e cristalizada. A correlação entre traços de personalidade e potencial de aprendizagem é menor em comparação com as correlações entre traços de personalidade e inteligência fluida e cristalizada. Os resultados obtidos em nossa pesquisa estão parcialmente de acordo com o quadro de dois níveis conceituais de Chamorro-Premuzic e Furnham (2005). Ou seja, estamos propensos a interpretar Extroversão como traço de personalidade que, exceto se for relacionado com desempenho em teste de inteligência, tem um efeito a longo prazo no desenvolvimento da inteligência, previamente através da sociabilidade e da atividade. Os resultados de nossa pesquisa argumentam a favor da suposição de que o método de teste dinâmico de inteligência diminui a correlação entre traços de personalidade e habilidades intelectuais, definidos como potencial de aprendizagem. Além disso as medições obtidas pelo teste dinâmico de inteligência são os construtos de explicação adicional que podem contribuir para a explicação da correlação entre personalidade e inteligência. Em geral, os resultados obtidos na pesquisa são paralelos com a hipótese de Estimulação (Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Strelau, Zawadzki, & Piotrowska, 2001). Sociabilidade e atividade, referidos como os componentes de Extroversão e a ausência de Psicoticismo, estão relacionados positivamente com nova experiência, melhor estimulação, e níveis mais elevados de estímulo cognitivo, que, por sua vez, pode resultar em níveis mais elevados de aptidão cognitiva. Em geral, o padrão de comportamento pró-social contribui para um maior envolvimento na busca por recursos ambientais, os quais poderiam promover o desenvolvimento cognitivo.

Palavras-chave: Traços de personalidade, Inteligência fluida, Inteligência cristalizada, Potencial de aprendizagem.

Relación de los Tres Gigantes de Eysenck con la inteligencia cristalizada y fluida, y el potencial de aprendizaje entre adolescentes

Resumen

El objetivo del estudio fue explorar la relación de los Tres Gigantes de Eysenck con la inteligencia fluida y cristalizada y potencial de aprendizaje entre los adolescentes. Un total de 205 estudiantes del sexto grado (50,44% hombres), de cinco escuelas primarias participaron en la investigación. El promedio de edad de los participantes fue de $M = 12,56$ ($SD = 0,61$). La inteligencia fluida fue medida por las Matrices Progresivas Estándar de Raven y por el *Cattell's free-culture test*, la inteligencia cristalizada fue medida mediante la Escala de Vocabulario Mill Hill, y potencial de aprendizaje se midió por la Evaluación del Potencial de Aprendizaje, (EPA-2). Los rasgos de personalidad fueron medidos por el *Junior Eysenck Personality Questionnaire*. Los resultados obtenidos son consistentes con los hallazgos de otros estudios, en los cuales las correlaciones moderadas entre los rasgos de personalidad y la inteligencia han sido establecidas. Psicoticismo, extraversión y escala Lay están relacionados con el fluido y medidas de inteligencia cristalizada. La correlación entre los rasgos de la personalidad y el potencial de aprendizaje es menor en comparación con las correlaciones entre rasgos de personalidad y la inteligencia fluida y la cristalizada. Los resultados obtenidos en nuestra investigación están, en parte, de acuerdo con el marco de dos niveles conceptuales de Chamorro-Premuzic y Furnham (2005), marco conceptual de dos niveles. Es decir, somos propensos a interpretar la extroversión como rasgo de personalidad que, salvo si es relacionado con el desempeño en la prueba de inteligencia, tiene un efecto a largo plazo en el desarrollo de la inteligencia, previo, a través de la sociabilidad y la actividad. Los resultados de nuestra investigación abogan a favor de la suposición de que el método dinámico de las pruebas de inteligencia disminuye la correlación entre los rasgos de la personalidad y las habilidades intelectuales, definidos como potencial de aprendizaje. Además, las mediciones obtenidas por las pruebas dinámicas de inteligencia

son los constructos explicativos adicionales que pueden contribuir a la explicación de la correlación entre personalidad e inteligencia. En general, los resultados obtenidos en nuestra investigación son paralelos con la hipótesis de estimulación (Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Strelau, Zawadzki, & Piotrowska, 2001). La sociabilidad y la actividad, conocidos como componentes de la extraversión y la ausencia de Psicoticismo, se relacionan positivamente con una nueva experiencia, una mejor estimulación, y niveles mas elevados de estímulos intelectivos, que a su vez, puede dar como resultado niveles más altos de aptitud cognitiva. En general, el patrón de conducta pro-social contribuye a una mayor participación en la búsqueda de los recursos ambientales, los cuales podrían favorecer el desarrollo cognitivo.

Palabras clave: Rasgos de personalidad, Inteligencia fluida, Inteligencia cristalizada, Potencial de aprendizaje.

Introduction

Despite the relatively huge body of theoretical knowledge and results of empirical investigation, many leading differential psychologies assume that it is worthy to investigate the relationship between personality and intelligence. According to Stankov, Boyle and Cattell (1995) studies on personality and intelligence more significantly contribute to the explanation of social life than many other psychological research areas. Snow (1995) assumes that the correlation of personality and intelligence presents „a central problem of integration for psychology“. According to Saklofske and Zeidner (1995), the rationale for efforts to integrate personality and intelligence arises from the following premises: (1) cognitive ability and personality “are linked and have much in common by virtue of being key sources of individual and group differences in behavior” and (2) “the field of personality itself is frequently viewed as the combination and organization of all relatively enduring dimensions of individual differences” (p. xvii). Authors' demands for investigating the relationship between personality and intelligence studies is an understandable consequence of their practical application in many areas of human activities. Besides, it is impossible to elude the question of position and cognitive abilities role in models and theories of personality; without cognitive abilities the personality coherence and the continuity of its functioning cannot be understood.

Detailed review of research results and of the interpretation of relationship between personality and intelligence could be found at Saklofske and Zeidner (1995), Sternberg and Ruzgis (1994), Collis and Messick (2001) and Chamorro-Premuzic and Furnham (2005), and in meta-analytical studies of Ackerman and

Heggestad (1997) and Austin et al. (2002). In studies of the relationship between intelligence and personality trait the most frequent results are low to moderate coefficients of correlation between intelligence and the Big Five dimensions. The correlation between Openness to Experience and intelligence is moderate and positive (Ackerman & Heggestad, 1997; Austin et al., 2002; Chamorro-Premuzic, Moutafi, & Furnham, 2005). Furthermore, studies point to a low and negative correlation between Conscientiousness and intelligence (Ackerman & Heggestad, 1997; Austin et al., 2002; Moutafi, Furnham, & Crump, 2003) whereas the correlation between Neuroticism and intelligence is usually negative (Ackerman & Heggestad, 1997; Austin et al., 2002.) The results of research on the correlation between Extraversion and intelligence are inconsistent; in some studies the authors report a positive correlation (e.g. Ackerman & Heggestad, 1997), while other researchers report a zero correlation (e.g. Austin et al., 2002) and even a negative correlation (Austin et al., 2002). Among the Big Five personality traits, Agreeableness is the least correlated with intelligence. Ackerman and Heggestad (1997) determined positive, low and statistically insignificant coefficients of correlation between Agreeableness and intelligence. However, a meta-analytical study by Austin et al. (2002) found low, negative, statistically significant correlations.

One of the first explanations of the relationship between intelligence and personality was proposed by Spearman (1927), according to whom: “The most plausible explanation seems to be that advanced by Webb, namely, that they are all manifestations of mental vigor” (p. 354). Spearman reported that general intelligence was positively related

to a number of “character” traits, such as perseverance, conscientiousness, cheerfulness. Wechsler assumed intelligence as manifestation of personality in general, and that the particular affective and motivational factors are an integral part of intelligence (Wechsler, 1950). According to Eysenck (1982) personality is manifested in cognitive ability “through the intermediary of cortical arousal” (p. 21). Brody (1992) states the following explanations of correlation between personality and intelligence: personality traits can be moderators of relationship between intelligence and academic success (e.g. it has been shown that impulsiveness moderates the impact of individual differences in intelligence on success at school); personality traits could have impact on the development of intellectual skills (some personality traits could have negatively impact on intellectual functioning through long-time period); personality traits can affect performance on the intelligence test (e.g. test-based anxiety impacts negatively on performance on the intelligence test); there are conceptual analogies between intelligence and personality (e.g. consistency of intelligence and personality traits, cross-situational consistency, heredity).

Chamorro-Premuzic and Furnham (2004, 2005) proposed a two-level conceptual framework for understanding the results found in investigations of the relationship between the five broad personality traits and fluid and crystallized intelligence. The first level of the model refers to the relationship between ability as test performance output (measured directly) and Neuroticism and Extraversion, while the second level of model refers to relationship between ability as a latent variable (which refers immeasurable capacity) and Conscientiousness and Openness to new experiences. The negative effects (anxiety, worry, tension, depression, anger) interfere with the cognitive processes needed for an efficient solution of a problem (Chamorro-Premuzic & Furnham, 2005). On the other hand, the correlation between Extraversion and intelligence depends on the nature of the intelligence test (Chamorro-Premuzic & Furnham, 2005). Extraverted persons were more successful in time-limited tests, while the introverts were more successful in those tasks that were not time-limited and needed introspection. Conscientiousness and Openness have long-term effects on the development of

intellectual abilities and are referred as the “investment traits”. In two studies (Moutafi et al., 2003; Moutafi, Furnham, & Paltiel, 2004) a negative correlation between Conscientiousness and intelligence was determined. In order to explain such results the authors proposed a compensation hypothesis, according to which comparatively lower capability in competitive surroundings is compensated with higher levels of Conscientiousness. Besides, it is possible that intelligent individuals do not become more conscientious over time because they rely on abilities that are sufficient for the execution of every-day cognitive tasks. The positive correlation between Openness and crystallized intelligence is expected, considering the fact that Openness is associated with intellectual curiosity, lively imagination and flexibility in behavior (McCrae & Costa, 1997) which could lead to the higher intellectual involvement and knowledge acquisition. An important element of two level model is subjectively assessed intelligence (SAI), subjective indicators of ability. As Chamorro-Premuzic and Furnham (2005) proposed, SAI should be considered as a mediating variable between personality and intelligence. Personality traits may influence one’s estimations of his/her own abilities, which may affect performance on the test. Several studies have indicated significant relationship between SAI and IQ test performance (e.g. Furnham & Chamorro-Premuzic, 2004) and between SAI and personality traits (Furnham, Kidwai, & Thomas, 2001).

Overview of the current research

Despite the relatively huge body of empirical evidence of the relationship between personality and intelligence, few recent empirical studies have generally found little or no relationship between the two. For instance, in their review of empirical relationships between personality and intelligence, Brebner and Stough (1995) concluded that these two broad constructs are not related (with some exception, like speed-related factors and Eysenck’s measure of psychoticism and intelligence). Hofstee (2001) draws similar general conclusions. Their findings increase doubts rather than enlarging the number of clearcut findings (Strelau, Zawadzki, & Piotrowska, 2001). Nevertheless, most studies on this topic assume that more empirical

research is needed to enlarge our understanding of the nature of relationships between personality and ability.

Much of the extent research on personality and cognitive ability has been conducted on adults. There is an expectation of few investigations studying adolescents that have tended to focus on extraversion and neuroticism (Eysenck, 1982; Eysenck & Cookson, 1969; Saklofske, 1985). Considering the significance of adolescence as a developmental transition between childhood and adulthood, the demand for research of the relationship between personality and intelligence is especially significant. Adolescence is characterized by rapid and profound physical changes, reproductive maturity, searching for identity, and ability to think abstractly and to use scientific reasoning developments. There are different quantitative and qualitative differences in personality and intellectual functioning between adults and adolescents. For example, the personality in adulthood is more stable and less complex than in the childhood. Thus researchers found, instead of five, seven factors at children in the research carried out in U.S.A (John, Caspi, Robins, Moffitt, & Stouthamer-Loeber, 1994) and Netherlands (van Lieshout & Haselager, 1994). Instead of Extraversion, researchers have found two distinct factors of sociability and activity, and instead of the Neuroticism factor they have found two distinct factors from fearfulness and irritability. Originally distinct dimensions are joined to form a more general one, integrated personality dimension which we recognize in an adult person; this shows that the personality expression change during the development. Further, intelligence takes pluralistic forms across development, depending on the ability and the context in which that ability is examined. Intelligence functioning is also highly variable throughout development. Cognitive maturity in adolescents is characterized by attainment of formal operation (Piaget, 1952), capacity for abstract thinking which gives adolescents opportunity to deal with abstraction, test hypotheses and see infinite possibilities.

In line with previous, this research is carried out with the first aim of exploring the relationship of Eysenck's giant three with fluid and crystallized intelligence. As conceptual framework for understanding the relationships between personality traits and intelligence, the

two-level model of Chamorro-Premuzica and Furnhama (*two-level conceptual framework*) is used. Considering that psychoticism of Eysenck's model corresponds to low Conscientiousness and to low Openness for new experiences, it seems reasonable to substitute these two Big Five model traits with the psychoticism trait of Eysenck's model. Fluid intelligence refers to the processing of information and the ability to reason with the aim to understand relationships and abstract propositions (Stankov, 2000), whereas crystallized intelligence refers to the acquisition, storing, organization and conceptualization of pieces of information (Chamorro-Premuzic & Furnham, 2005).

The next aim of the study was to verify the hypothesis based on Eysenck and Eysenck (1985) arousal theory, which states that extraverts would be better than introverts on speed tests, whereas introverts can be expected to outperform extraverts on verbal tests and tasks that require insight and reflection. This hypothesis was not confirmed in some studies (Rawlings & Skok, 1993; Furnham, Forde, & Cotter, 1998). Inconsistencies in the relationship between psychometric intelligence and Extraversion are still far from clear understanding and remain an interesting topic of research for differential psychologists. Therefore, we decided to replicate previous researches and to investigate differences in relationships between extraversion and fluid intelligence measured by speed test and extraversion and fluid intelligence measured by strength test, and extraversion and crystallized intelligence measured by vocabulary test.

Finally, we were interested in the relationship between personality traits and learning potential. Learning potential measurement is the result of learning potential assessment, rapidly developing approach of interactive, test-intervention-retest model of psychological assessment, with important practical usage especially in the field of education. This approach is developed from the work of Vygotsky and Feuerstein, "who recognized that human beings are not static entities but are always in states of transition and transactional relationships with the world" (Haywood & Lidz, 2007, p. xiii) and that the traditional way of intelligence measurement does not appease to such a general view on a human. In literature, the traditional way of exploring intelligence is referred to as static

measurement. Learning potential assessment and dynamic test of intelligence are two terms that appear to be used interchangeably in literature. Sternberg and Grigorenko (2002) define dynamic testing of intelligence as test plus some instructional intervention. According to Guthke, Beckmann and Dobat (1997) dynamic testing is a common term that includes different assessment procedures, such as border testing, learning potential assessment, interactive dynamic assessment, learning test concept. According to Fernandez-Ballesteros, Calero, Camp-Illonch and Belchi (2000) the term «learning potential» expresses the capacity for modification of the level at which the person is able to enhance the product on the test tasks after the intervention.

Considering some of the major characteristics of dynamic testing of intelligence (e.g. during the assessment there is a two-way interaction between examinees and examiner, interaction is individualized for every examinee, etc.), the effect of some environmental, family and personality variables on test performance should be decreased (Budoff, 1987; Carlson & Wiedel; 1992). Carlson and Wiedel (1992) are among the first who introduced personality as variable in dynamic testing of intelligence. They assumed that the low ability test product is the result, among others, of personality variables set, such as test anxiety, personality traits and self-esteem. Results of the researches shown that dynamic intelligence testing decreases test anxiety and negative orientation to test situation (Bethge, Carlson, & Wiedel, 1982). Budoff (1987) in his research on children with low IQ showed that children with greater learning potential are more sociable, show greater motivation for accomplishment, and are less rigid and impulsive than the children with similar IQ but with lower learning potential.

In line with previous studies, two sets of hypotheses can be stated:

H1: In accordance with the two-level model and the results of previous research we expect that the correlation between PEN personality dimensions and fluid and crystallized intelligence will be statistically significant. In this sense, we also expect: negative correlation between psychoticism and fluid intelligence (H1a) and crystallized intelligence (H1b); positive correlation between extraversion and fluid intelligence operationalized as strength test (H1c), and

negative between extraversion and fluid intelligence operationalized as speed test (H1d); positive correlation between extraversion and crystallized intelligence (H1e); negative correlation between neuroticism and fluid intelligence (H1f); negative correlation between lay scale and intelligence (H1g). In addition, we expect that the personality traits will significantly contribute to the explanation of results of variability on intelligence measurements.

H2: In line with theoretical expectations according to which the dynamic testing of intelligence decreases the effects of personality on cognitive performance, we expect zero correlations between PEN personality dimensions and learning potential.

Method

Participants

The study was conducted on a group of 203 students of the sixth grade of five elementary schools in Sarajevo, Bosnia and Herzegovina. Of the 53 total participants, 7% were male. Average age of the participants was $M = 12.6$ ($SD = 0.60$).

Measures

Raven's Standard Progressive Matrices (Raven, Court, & Raven, 1994) measure fluid intelligence. They represent a non-verbal test for the evaluation of the ability to understand complex situations, find meaning in events and of rational perception and thinking. According to Carpenter, Just and Shell (1990) Raven's Progressive Matrices measure analytical intelligence, that is the ability to reason and produce a solution for problems involving new pieces of information, without extensive use of an explicit store of declarative knowledge. Work time was not limited.

Mill Hill Vocabulary Scale (Raven et al., 1994) is a companion measure to the Standard Progressive Matrices and assesses reproductive ability, that is, being able to master, recall and reproduce verbal information. It consists of 68 items divided into two segments: Series A (gap filling) and Series B (selection of the correct answer from several offered). The Mill Hill Vocabulary Scale allows the assessment of the ability to store and recall information and knowledge that is accumulated over time by the

individual from experiences at home, school, or in the environment and therefore is based on the extensive use of declarative knowledge. With regard to definition of crystallized intelligence (Stankov, 2000), crystallized abilities are typically measured by vocabulary test. Original version of Mill Hill Vocabulary Scale is translated and adapted into Croatian language (Križan & Matešić, 2001). Series A (gap filling) was used in the present research.

Culture fair intelligence test, Scale II (Cattell & Cattell, 1973) is aimed to measure fluid intelligence for children aged 8 to 14. It consists of four subtests: Series, Classification, Matrices, and Topology. The number of items varies from 8, contained in the Topology subtest, to 14 contained in the Classification subtest. Cattell and Cattell (1973) reports research results conducted in France, according to which correlations of subtests with g-factor number between 0,78 and 0,83 and acceptably reliability typed test-retest (0,82 and 0,85) and split-half (0,70 do 0,92). Time for every subtest was limited. In this research, Cronbach's coefficient of inner reliability for the total test was $\alpha=0.748$.

EPQ Junior, Eysenck's personality questionnaire for children (Eysenck & Eysenck, 1993) measures three basic personality dimensions: extraversion-introversion, neuroticism-emotional stability and psychoticism and lay scale. It contains 81 items to which every examinee answers with «YES» or «NO». In this research the Chronbach's coefficients of reliability for extraversion scale was $\alpha=0.668$, neuroticism scale $\alpha=0.809$, psychoticism scale $\alpha=0.704$, and lay scale $\alpha=0.854$.

Learning potential assessment (Evaluación del Potencial de Aprendizaje, EPA-2), (Fernandez-Ballesteros et al., 2000) an instrument for measuring learning potential for children from 5-14 years of age, with or without mental retardation or problems in knowledge acquisition, or for older persons with or without cognitive dysfunctionality. Through training, directed to strategy learning, processes or using the skills needed to solve cognitive problems, cognitive modification is being determined. Training material consists of 132 patterns that represent 68 matrice problems (task and solution for every problem and few orientation patterns). Problems are grouped in two levels. Level I contains 39 problems and

are used for exercising series A, Ab and B Raven's Matrices in color. Level II consists of 29 problems, used for exercising series C, D and E of Raven's Standard Matrices. Problems such as those present in substitution of elements by rows and columns and require their mutual combination. Only the patterns that correspond to series A, B, C, D and E of Raven's Matrices are used in the present research.

Before and after training, Raven's progressive matrices are being used. On second occasion, parallel form of SPM was used. The increase of scores on Raven's test after the training, i.e. gain, is the indicator of cognitive modificability and also the indicator that the person should take some advantage of similar kinds of training.

Research results point to training effectiveness in increasing retest results in different groups. Training is effective in strategy learning which is in the core of solving matrices problems. Fernandez-Ballesteros et al. (2000) have determined significant predictive EPA validity in relation to Feuerstein's programme of instrumental enhancement on IQ increase on WISC. Especially interesting is the result that difference (gain) presents a significant predictor of verbal IQ increase on WISC after long-term cognitive intervention.

In the research conducted on a sample of students from general population in Bosnia and Herzegovina, statistically significant training effect on accomplishment in the second application of SPM is established (Đapo, 2007).

Traditional change measurement model implies gathering data in two time periods and calculating simple differences between the second and the first measurement points. However, this kind of procedure was subject to many critics and suggestions of new ways of operationalizing the change. Bereiter (1963) states that the simple difference cannot be simultaneously reliable and valid. Calculation of residual gain has been suggested by Cronbach and Furby (1970) as the measure of change because it is in the zero correlation with the initial status. In our study we used residual gain as a measure of cognitive modificability, not only simple difference score between results obtain on SPM after and before training. Namely, considering it is eligible to assess the difference independently on initial status, the retest result is divided in two parts: 1) the first part are results of retest predicted by the test

and 2) the second part presents residual difference (gain) i.e. differences between results obtain on the retest and results of retest predicted by the test.

Procedure

Data were collected during regular classes. The sequence of the application of instruments was equable for all subjects in the following order: Raven's standard matrices, Culture fair intelligence test, Mill Hill test and EPQ Junior. Groups of students were included in the training by EPA-2 materials. Training took two school hours and was executed in groups of 12-15 students. At the end, the parallel form of Raven's standard matrices was administrated. Time needed to solve the tasks of Raven's Standard Progressive Matrices and Mill Hill Vocabulary Scale was not limited. Time needed to solve the tasks of Culture fair intelligence subtest was limited.

Results

Table 1 displays the means, standard deviations and intercorrelations for the results

on PEN dimensions of personality (P, E, N, L), fluid (SPM1, SPM2 and Cattell cultural fair intelligence test-CCFIT) and crystallized intelligence (MH) and learning potential measures (GAIN). Psychoticism correlated significantly with SPM1 ($r=-.135$, $p<.05$) (H1a was confirmed), SPM2 ($r=-.201$, $p<.01$) and GAIN ($r=-.164$, $p<.05$) (H2 was not confirmed), but not with MH (H1b was confirmed). Extraversion correlated significantly with CCFIT ($r=.274$, $p<.01$) (H1d was not confirmed), SPM1 ($r=.218$, $p<.01$) (which confirmed H1c), SPM2 ($r=.152$, $p<.05$) and MH ($r=.135$, $p<.05$) (H1e was confirmed). Neuroticism correlated significantly with CCFIT ($r=-.171$, $p<.05$) (H1f was confirmed) and residual gain ($r=-.164$, $p<.05$) (H2 was not confirmed). Finally, Lay scale significantly correlated significantly with MH ($r=-.153$, $p<.05$) (H1g was confirmed).

With the aim to assess the joint effect of the PEN dimensions of personality on the MH, CCFIT and SPM and measure of learning potential, five standard multiple regression analyses were performed. The results are shown in Table 2.

Table 1 – Means, standard deviations, and intercorrelations of study variables

	P	E	N	L	MH	CCFIT	SPM1	SPM2	GAIN
P		,159*	,308**	-,451**	-,100	-,098	-,135*	-,201**	-,164*
E			-,048	-,081	,135*	,274**	,218**	,152*	-,003
N				-,235**	-,102	-,171*	-,052	-,104	-,164*
L					-,153*	-,040	-,121	-,084	,013
MH						,418**	,302**	,316**	,152*
CCFIT							,630**	,660**	,294**
SPM1								,809**	,000
SPM2									,588**
GAIN									
M	2,63	18,03	10,16	12,60	11,39	26,55	39,44	40,97	0,17
s	2,11	3,54	4,53	4,51	5,59	5,82	7,23	6,78	4,06

Note: *** $p<0.001$; ** $p<0.01$; * $p<.05$

Table 2 – Results of linear multiple regression to predict fluid and crystallized intelligence and potential for learning

	MH		CCFIT		SPM1		SPM2		GAIN	
	β	t	β	t	β	t	β	t	β	t
P	-0,211	-2,58**	-0,162	-1,911	-0,275	-3,309***	-0,316	-3,777***	-0,166	-1,856
E	0,144	2,008*	0,284	3,873***	0,244	3,359***	0,177	2,454*	0,009	0,111
N	-0,091	-1,216	-0,138	-1,812	-0,008	-0,103	-0,044	-0,584	-0,13	-1,609
L	-0,258	-3,263***	-0,124	-1,519	-0,225	-2,807**	-0,226	-2,808**	-0,093	-1,088
R=	0,299		0,35		0,344		0,338		0,218	
R ² =	0,089		0,123		0,118		0,114		0,047	
ΔR ² =	0,07		0,102		0,098		0,094		0,024	
F=	4,54***		5,90***		5,82***		5,64***		2,06	
df=	4;185		4;169		4;174		4;175		4;166	

Note: *** p<0.001; ** p<0.01; * p<,05

The model included PEN personality dimensions was significant for MH (F(4,185)=4,54, p<0,001), CCFIT (F(4,169)=5,90, p<0,001), SPM1 (F(4,174)=5,82, p<0,01) and SPM2 (F(1,175)=5,64, p<0,01) as dependent variables, accounting for 7,0%, 10,2%, 9,8% and 9,4% variance of dependent variables respectively. Model was not significant for GAIN as dependent variable. Psychoticism was a significant predictor of SPM1 (β =-.275, t=-3,309, p<0,001) and SPM2 (β =-.316, t=-3,777, p<0,001) as well as MH scores (β =-.211, t=-2,58, p<0,01), although bivariate correlation between these two variables was not significant. Extraversion was a significant predictor of MH (β =.144, t=2.008, p<0,05), CCFIT (β =.284, t=3,873, p<0,001), SPM1 (β =.2444, t=3,359, p<0,001) and SPM2 (β =.177, t=2.454, p<0,05). Neuroticism did not reach a level of statistical significance. Lay scale was a significant predictor of MH scores (β =-.258, t=-3,263 p<0,001), SPM1 (β =-.225, t=-2,807, p<0,01) and SPM2 (β =-.226, t=-2,808, p<0,01).

Discussion

This study investigates the relationship of Eysenck’s giant three with fluid and

crystallized intelligence and learning potential among adolescents. In general, the results obtained in our research are consistent with the findings of other studies that determined moderate correlations between personality traits and intelligence. Psychoticism, Extraversion and lay scale were related to measurements of fluid and crystallized intelligence. The correlation between personality traits and learning potential is lower in comparison with the correlation of personality traits and fluid and crystallized intelligence.

In line with expectations, Psychoticism is related with fluid intelligence, as also as with the learning potential, whereas in the combination with extraversion and lay scale it is also related with crystallized intelligence. Results of regressive analysis point out that high values on Psychoticism in combination with expressed tendency towards giving socially eligible answers and introversion contribute to lower results on measurements of fluid and crystallized intelligence. Considering that Psychoticism includes increased tendency for expressing aggressive behavior generally as a reaction to frustrations, and persons who are high on this dimension are lonely, insensible, do not worry about others and do not accept social customs, results obtained in our research are expected. Eysenck assumed that “uncaring

and hostile nature'' person with high Psychoticism results with low academic outcomes (Eysenck & Eysenck, 1985, p. 322), what is confirmed in many studies (Furnham & Medhurst, 1995; Heaven, Ciarrochi, & Vialle, 2007; Aluja-Fabregat, Balleste-Almacellas, & Torrubia-Beltri, 1999). Furnham and Medhurst (1995) have determined that the high Psychoticism is related with weaker working habits, lower motivation and seminar engagement. Considering its nature, it seems reasonable to assume Psychoticism as trait of "(non)investment". Namely, students who do not accept the rules, are lonely, aggressive, and show asocial behavior features and do not engage in activities which provide knowledge acquisition. It is interesting that correlation between psychoticism and fluid intelligence is higher than correlation between psychoticism and crystallized intelligence. Namely, in accordance with Catell's investment theory, according to which fluid intelligence invests in crystallized, the reverse relation of these correlations was expected.

Furthermore, the result obtained by examination of the relationship between psychoticism and learning potential were also interesting. Learning potential is a composite, among others, and of cognitive effort i.e. current investment in learning new strategy (solving the problem such as matrice). If cognitive engagement fails, the training effect will also fail. This might be the possible scenario by which the relationship between psychoticism and learning potential can be explained, and which is reasonable to generalized on other, non-test situations. Therefore, psychoticism is related to long-term as well as with the current (non)investment in activities that can contribute to intelligence development as well as to performance in actual cognitive task.

Extraversion is the most consistent predictor of all intelligence measures. With the interpretation of the results obtained in our research we are inclined to the explanation of extraversion suggested by John et al. (1994), according to whom extraversion in an early adolescence can partly be manifested through social contact and partly through physical and social vividness. But in an adult period extraversion can notably be expressed through social activities, permeability and sociability. Thus separate factors of sociability and activities in childhood outshine the extraversion

factor. These two factors occur early and are mostly inherited temper traits (Buss & Plomin, 1984). The role of sociability and activity in intelligence development is of great importance. Namely, the child who is more sociable and more active is expected to be more active in searching for environment resources which encourage cognitive development, unlike the children who are not sociable nor active. Greater exposure to environmental resources arises intelligence development. On the other side, students who are more sociable, could be more accepted by their teachers, and their activity in school context leads them in more favorable position for cognitive development than introverts. They are more engaged in education, they take more effort, they are more active in non-educational activities; all this can be especially evaluated by the teacher, who notices such children much more and give them greater attention. Results of our study suggest that the Extraversion is the investment trait, and that is related to intelligence per se, at least among younger adolescents.

According to Eysenck's arousal theory, the relationship between psychometric intelligence and Extraversion should differ in arousing and nonarousing situations. An introvert has higher level of cortical arousal, which causes tendency of avoiding arousing stimuli; on the other hand, an extravert has a lower level of cortical arousal and a tendency to seek them. Further, extraverts show greater trade of speed for accuracy when taking an ability test than introverts (because of greater vigilance decrement), which causes extraverts to have an advantage when tests are short and time limited, whereas introverts would have an advantage when tests are long and unlimited. Therefore, it is to expect extroverts to be better than introverts in tests of speed, while introverts would be better in test of strength. Results gained in our research are not in accordance with these expectations. Namely, positive and significant correlations between Extraversion and results on tests of speed and strength are determined. Rawlings and Skok (1993) and Furnham et al. (1998), also in their studies, have not confirmed arousal hypothesis. Besides, Furnham et al. (1998) determined that introverts can be even better than extraverts in test of speed.

Results of our study point that Neuroticism is related to fluid intelligence measured by Cattell's Culture fair intelligence test, that is in accordance with the results of some studies

which have established significant correlations between Neuroticism and ability tests. It was shown that in the conditions of high arousability, triggered by e.g. test situation, anxiety has a negative effect on test performance. In the study of Kalmanchev and Kozeki (1983) conducted on children, low but statistically significant correlation between Neuroticism (measured by EPQ) and intelligence has been determined. Furthermore, Furnham et al. (1998) have established moderate but significant correlation between Neuroticism (again measured by EPQ) and intelligence. However, Sarason (1975) states that anxiety can influence ability test product only in competitive environment, while in neutral conditions anxiety has no effect, and differences in performance between anxious and non-anxious become marginal. This assumption is confirmed in the study of Markham and Darke (1991), who have established that high anxiety inhibits verbal reasoning, but only in conditions of high demand. Similarly, Dobson (2000) showed that only in stressful situations (e.g. time pressure or when the result has significant consequences on the person) Neuroticism is related to low test product of numeric reasoning. It is plausible that the students who participated in our research have not estimated the SPM tasks as demanding as the tasks of Culture fair intelligence test, and it led to the result by which Neuroticism is not related to fluid intelligence measured by SPM. It is interesting that Neuroticism is negatively related to learning potential. A result such as this can be explained with the effect of evaluation of students and training leader. Namely, training is conducted in small groups and could have included the fear from the external evaluation because students were required to actively participate in solving the problem and seeking the right answers. The exposure to evaluation and cognitive effort to which students were required by training might influence processing efficiency and thus reduce the effect of training. At this point it is useful to specify the distinction between performance effectiveness and processing efficiency given by Eysenck and Calvo (1992). Effectiveness refers to an objectively measurable level of performance, while Efficiency refers to the ratio between effectiveness and the amount of effort needed to attain the criterion level of performance. Anxiety impairs processing efficiency more

than it impairs performance effectiveness. Highly anxious individuals are hypothesized to be less efficient but can compensate by expanding additional effort on the task, which could be a possible explanation for the result gained in our study by which correlation between Neuroticism and SPM product is zero. Students had enough time in solving SPM tasks, but not to solve Cattell's test tasks, where the execution time was limited. Time-limited situation (such as it was during administration of Cattell's test), or situation when external evaluation occurred (such as it was during cognitive training), could produce higher anxiety, which, on the other side, affects processing efficiency and lower test performance.

Results obtained in our research show that the lay scale is related to crystallized intelligence, while in the combination with Psychoticism, it is related to fluid intelligence as well. Such result is in accordance with results gained in previous studies (e.g. Furnham et al., 1998). Considering that in our research the high correlation between neuroticism and lay scale has not been determined ($r=-0,235$, $p<.01$), it is justifiable to assume that examinees had not been motivated for dissimulation. Thus we can consider Lay scale as a measure of social ingenuousness and stable personality dimension. Social ingenuousness can be seen in no comprehension of the consequences of particular action or activities, misunderstanding of social relations or dynamic within peer's group, or perhaps in credulity. The acquisition of social mature behavior forms coincides with the cognitive development. Therefore, we can assume that the social ingenuousness and crystallized intelligence are mutually correlated through cognitive development.

Results gained in our research could partly be explained with two-level model. Namely, Extraversion could be interpreted as a personality trait that besides being related with intelligence test performance, could have long-term effect on intelligence development. According to investment hypothesis derived from Cattell's investment theory and elaborated in detail by Snow (1995) and Ackerman (1996, 1999), personality traits can have long-term effects on intellectual abilities development, especially on crystallized intelligence. Ackerman assumes that intelligence is partly the result of investment in intellectual

activities, whereby personality, interests and motivation determine the acquisition of knowledge (see Ackerman's theory of Intelligence as Process, Personality, Interests and Knowledge, PPIK). We assume that Extraversion is positively and Psychoticism negatively correlated with investment in intellectual activities, and thereby also with the intelligence development.

The correlational nature of the study does not allow causal conclusions to be drawn on the relations between the variables. However, in the study of individual differences the directional paths between personality and psychometric intelligence can only be determined conceptually or theoretically. Chamorro-Premuzic and Furnham's (2005) model of intellectual competence and Stimulation hypothesis provide a clear rationale to account for one of the possible paths between personality traits and intelligence measures.

Despite this limitation, the present findings could have important theoretical implications. Strelau et al. (2001) theorizes that "individuals who are prone to new experience and sensations open to the external world, tolerant for intensive stimulation, and are active, especially in the cognitive domain, have more possibilities and opportunities to get in contact with the surrounding world ... This results, as a consequence, in higher cognitive stimulation..." (p. 64). In general, results gained in our study can be interpreted as a confirmation of Stimulation hypothesis. Based on the results gained in our study, and in line with the quotation of Strelau et al., the personality traits set being non-stimulative for intelligence development could be recognized. It is to expect that extraversion, considering that it includes pro-social behavior forms, contributes to greater sociability and activity in searching for environmental resources which encourage cognitive development, to better social status within the group, but also to the more positive evaluation by the teachers. Better evaluation and greater expectations by teacher contribute to greater cognitive stimulation quality, which again leads to greater accomplishment at school and crystallized intelligence tests alike. "The Pygmalion effect" is thoroughly described in literature which refers to situations in which some students perform better than others simply because they are expected to do so, and "Golem effect" which refers to situations in

which teacher might harm low-achieving students through their negative expectations (Babad, 1993). Sociability and activity, as components of extraversion, and the absence of Psychoticism, are positively related to new experience, greater stimulation, and higher levels of cognitive stimulation, which, in turn, may result in higher levels of cognitive aptitude.

Results of our research are in line with the assumption that dynamic intelligence testing decreases the relationship between personality traits and intellectual abilities, defined as learning potential. Measures that are established by dynamic intelligence testing are additional explanatory constructs that can contribute to the explanation of the relation between personality and intelligence.

Studies on relationship between personality and intelligence supervene from the necessity of integration of conative, affective and cognitive domain with the aim of more spacious explanation and more accurate prediction of human behavior in different social situations. Therefore, it is not surprising that there are many empirical studies that attempt to shed a light on a relation between these two established psychological constructs. Although much knowledge about the relation between these two constructs has been accumulated until today, new studies are necessary, especially on children and adolescents. In following studies the attention should be directed towards examining effects of different mediating and moderating variables, what would contribute to understanding the nature of relation between personality and intelligence.

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