Heredity of Cognitive Functions and Personality in Twins

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Summary. *Background and Objective. The inheritance of cognitive functions and personality is still a problem under investigation. A classical method, investigation of twins, is often used to find relative contributions from genetics and the environment to quantitative traits. The aim of this study was to investigate a possible influence of heredity on cognitive functions (by applying the Raven test) and personality traits (according to the Eysenck's theory) in twins.*

Material and Methods. In total, 139 pairs of same-sex twins were investigated. The zygosity of the twin pairs was confirmed through genotyping with 15 molecular DNA markers. Constructive thinking was assessed using the Raven test. Personality assessment was conducted using the Eysenck Personality Questionnaire (EPQ) in Lithuanian.

Results. The difference in the total number of incorrect solutions between monozygotic (MZ) and dizygotic (DZ) twin pairs younger than 15 years was not significant; however, in the group older than 15 years, this difference was found to be significant. Based on the total number of incorrect solutions, the concordance in the MZ twins was greater than in the DZ twins. The same tendency was found with cumulative EPQ scores on the extraversion scale.

Conclusions. The results imply that the quality of cognitive functions and personality traits (extraversion) can be influenced by heredity. This confirms previous findings on the heritability of cognitive factors and personality traits.

Introduction

Quantitative genetic research has disclosed the importance of genetic factors in many complex behavior disorders and dimensions in the domains of psychopathology, cognitive abilities, and personality (1). The diminution in cognitive abilities that emerges with aging has been extensively investigated and has been associated with various determinants (2). This decline is a result of complex interactions between genetic and environmental factors, nature and mechanisms of which still remain largely unknown. The actual localization and identification of genes underlying the variation in general cognitive abilities has only recently begun. Most of the data converge on the conclusion that genetic factors play a crucial role in specific cognitive abilities (3–5), but the real environmental influence on these cognitive abilities has not been well quantified.

The evaluation of cognitive functions is frequently carried out by applying the Raven Progressive Matrices (RPM) (6). The RPM is a system of nonverbal tasks designed to examine the abilities of inductive thinking. The results of the studies where the cognitive functions of twins were investigated by applying by the Raven technique suggest that genetic factors have a greater influence (7–9).

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Personality traits also were explored in connection with heredity. Hans J. Eysenck, one of the famous theorists, based his concept of personality primarily on physiology and genetics. His theory considers personality differences as growing out of genetic heredity. He supposed that extraversion (E) was closely related to the degree of excitation and inhibition prevalent in the central nervous system; this balance is presumably largely inherited and may be mediated by the ascending reticular formation (10, 11). The strong influence of heredity on E and neuroticism (N) has been shown in these studies (12–14).

Research on twins is conducted by using the classical genetic method that helps determine how the differences of investigative features are affected by genetics and the environment. Monozygotic (MZ) twins develop from a single ovum when 1 fertilized ovule splits into 2 embryonic structures. Dizygotic (DZ) twins develop from 2 ova when 2 ovules matured at the same time are fertilized. If the differences of the investigated feature between MZ and DZ twins are detected, it is alleged that genetics has a greater influence. When there is no difference in the investigated feature, then the environment has a greater influence. The results of studies investigating twins have helped scientists evaluate the influence of genetic or behavior factors. As identical – or MZ – twins have all their genes in common, any difference between the members of a pair would arguably be due to environmental differences. As fra-

ternal – or DZ – twins share only half of their genes, the importance of genetic effects can be estimated by comparing the similarity of identical and fraternal twins. The extent to which MZ twins are different provides an estimate of the importance of nonshared environment, which represents those environmental factors that are specific to the individual and cause differences in the pairs of individuals (15).

The discussion on the relationship between inheritance and cognitive functions is still in progress. Current data need validation in different countries, and thus, our study conducted in Lithuania contributes to a better understanding of this topic.

The aim of this study was to investigate a possible influence of heredity on cognitive functions (by applying the Raven test) and personality (temperament) traits (according to the Eysenck's theory) in twins.

Material and Methods

Subjects. The study included 139 pairs of same-sex twins residing in Lithuania and registered in the Scientific Twin Centre, Lithuanian University of Health Sciences, during the study period from January 2011 to June 2012. Of these, 56 (40.3%) were male pairs, and 83 (59.7%) female pairs. Their mean age was 25.0 years (SD, 12.9; range, 8 to 62 years); the mean age of the men and women was 23.36 years (SD, 11.02) and 26.17 years (SD, 14.04), respectively (Table 1).

The zygosity of the twin pairs was confirmed through genotyping with 15 molecular DNA markers. In this process, DNA extraction from blood was performed using a reagent kit (Genomic DNA Extraction Module) and a chelating tar (Chelex-100). Then, the quality of the obtained DNA was assessed. Polymorphic DNA nucleotide sequences repeated in tandem were multiplied by using a polymerase chain reaction amplification kit (AmpFLSTR® Identifiler®, Applied Biosystems, USA). The AmpFLSTR® Identifiler® kit amplifies 15 short tandem repeat (STR) loci (D8S1179, D2S11, D7S820, CSF1PO, D3S1358, TH01, D13S317, D16, S539, D2S1338, D19S433, vWA, TPOX, D18S51, D5S818, and FGA) and the amelogenin (sex) gene fragment (Amel). The analysis of STR loci was carried out to identify the DNA identity, which enabled us to either confirm or rule out the twin monozygosity hypothesis. DNA extraction was carried out at the Laboratory of the Institute of Biological Systems and Genetics, Lithuanian University of Health Sciences. Zygosity was confirmed at the Laboratory of the SORPO Medical Research Centre.

The cognitive functions of the twins were investigated by applying the Raven test, which has been used since 1976 in the scientific research facilities of Kaunas Institute of Medicine. The Raven test consists of 60 progressive geometrical matrices (RPM) for adults and 36 colored progressive matrices (CPM) for children (younger than 15 years). Sorting the tasks from the easiest to the most difficult allows qualifying them as progressive. Task solutions correlate with the cognitive functions of participants, i.e., attention, memory, and thinking ability. When solving RPM tasks, the investigated person has to identify the missing piece of the matrix (picture), which is hidden among a few similar pieces. The individual has to determine the correlation between drawn symbols and to present a 3×3 matrix. The tasks are divided either into 5 parts (sections), each having 12 tasks for adults, or into 3 parts (sections), 12 tasks each for children. The RPM is the most well-known and best-studied of all culture-independent tests of the general mental ability. The quality of the solutions of cognitive tasks (S) is measured by the number of the mistakes made (6).

Personality (temperament) assessment was conducted by using the Eysenck Personality Questionnaire (EPQ) in Lithuanian for all investigated twin pairs. The EPQ, developed in 1986, was translated into Lithuanian in 1991 and has been successfully used in Lithuania since then (16). The EPQ is widely applied throughout the world and has received good reviews due to its reliability and validity. The EPQ comprises 101 questions that are assessed on the dimensions of extraversion (E), neuroticism (N), psychoticism (rigidity) (P), and lie (L). The questions can be answered by marking either a positive or a negative answer, depending on whether the respondent agrees with the statement or not. In this questionnaire, 11 questions are not used when processing the answers, while for others, the direction of the inquiry is re-coded, and the points are summed up with the higher values indicating more strongly expressed features. As provided by Eysenck, E is the degree to which a person is outgoing and interac-

Table 1. Data on Monozygotic and Dizygotic Twin Pairs

Zygosity	Males ⩽15 Years 13 Twin Pairs (n=26)	Females ⩽15 Years 13 Twin Pairs (n=26)	Males >15 Years 43 Twin Pairs (n=86)	Females >15 Years 70 Twin Pairs (n=140)	Total 139 Pairs (n=278)
MZ	5 (3.6)	6 (4.3)	23 (16.5)	41 (29.5)	75 (53.9)
DZ	8 (5.8)	7 (5.0)	20 (14.4)	29 (20.9)	64 (46.1)

Values are number (percentage). MZ, monozygotic, DZ, dizygotic.

tive with other people. Extroverts seek excitement and social activity in an effort to heighten their level of arousal. Eysenck designated E as one of 3 major traits in his P-E-N model of personality, which also includes P and N. E is closely related to the degree of excitation and inhibition prevalent in the central nervous system; this balance, too, is presumably largely inherited and maybe mediated by the ascending reticular formation. Neuroticism is characterized by anxiety, moodiness, worry, envy, and jealousy. Individuals who score high on N are described as anxious, worrying, moody, and frequently depressed. Psychoticism refers to a personality pattern typified by aggressiveness and interpersonal hostility. The L scale is a one-dimensional measure that completes the EPQ by presenting a set of items to provide an indication of the extent to which the respondent has answered truthfully in other parts of the test (10).

The study was approved by Kaunas Regional Bioethics Committee. Each participant signed an informed consent form before entering the study.

Statistical Analysis. The data analysis was conducted by using the Statistical Package for Social Sciences (SPSS) 17.0 for Windows and MS Office Excel 2007. The data analysis was conducted separately for the MZ and DZ twins. The parametric statistical criteria were used for the normally distributed quantitative variables, and means with standard deviations (SD) were calculated, as well as the standard error of the mean (SEM). The χ^2 test was used to compare qualitative variables and to estimate possible correlations. Two independent samples were compared using the nonparametric Mann-Whitney *U* test. The Spearman correlation coefficient *r* was calculated to explore the correlation between the variables. When determining the level of significance, *P* values less than 0.05 were considered as statistically significant.

Results

Due to a small difference in the number of incorrect solutions within the twin pairs of children younger than 15 years, the respondents were divided into 2 groups: the group 1 consisted of the pairs that made no incorrect solutions, the pairs where the difference was 1 incorrect solution, and the pairs where the difference was 2 incorrect solutions. The group 2 included the pairs that differed by 3 or 4 incorrect solutions; on the other hand, there could be no difference between the pairs, but if they made 3 or more mistakes, they were still attributed to the group 2 (Fig. 1). In total, 18.8% of the MZ twin pairs older than 15 years completed the Raven test with the same results, compared with 16.3% of the DZ twin pairs. In 70.3% of the MZ pairs and in 38.8% of the DZ pairs, the difference in the number of incorrect solutions was up to 4; meanwhile, in 10.9% of the MZ pairs and in 34.7% of the DZ pairs, the difference was up to 10 (Fig. 2). After the classification of the total number of incorrect solutions by age, the difference between the MZ and DZ twin pairs younger than 15 years was not significant ($z=-0.054$, $P>0.05$). However, in the group of the subjects older than 15 years, this difference was found to be significant ($z=-2.674$, $P=0.008$). Based on the total number of incorrect solutions, the concordance between the MZ twins was greater than in the DZ twin pairs (Fig. 3).

When comparing the differences in the number of incorrect solutions between the male MZ and DZ twins, no significant differences were found ($z=-0.691$, $P>0.05$). However, a significant difference was found between the female MZ and DZ twins ($z=-2.034$, $P=0.042$) (Fig. 4).

The tasks of Raven are sorted into 5 levels of difficulty in the ascending order. Therefore, the difference in the mean number of incorrect solutions among the MZ and DZ twins was compared in sep-

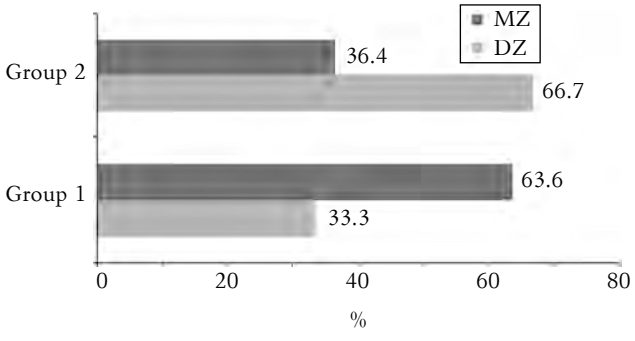

Fig. 1. The evaluation of constructive thinking among twins (⩽15 years old) based on the difference in the number of incorrect solutions

$P=0.126$.

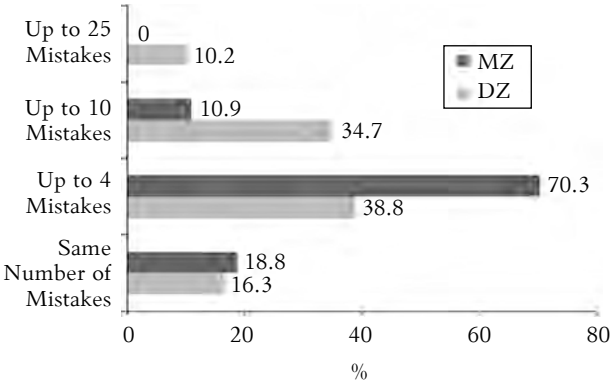

Fig. 2. The evaluation of constructive thinking among twins (>15 years old) based on the difference in the number of incorrect solutions

$P=0.001$.

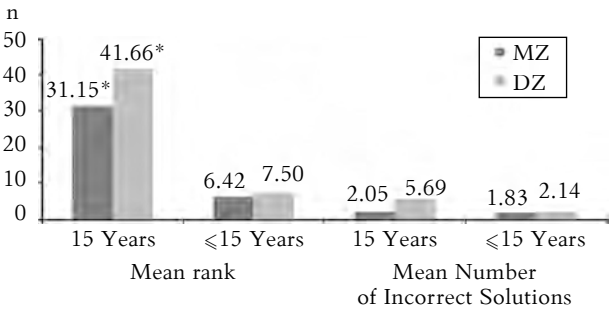

Fig. 3. The evaluation of constructive thinking among twins based on the difference in the number of incorrect solutions and age

*P=0.008.

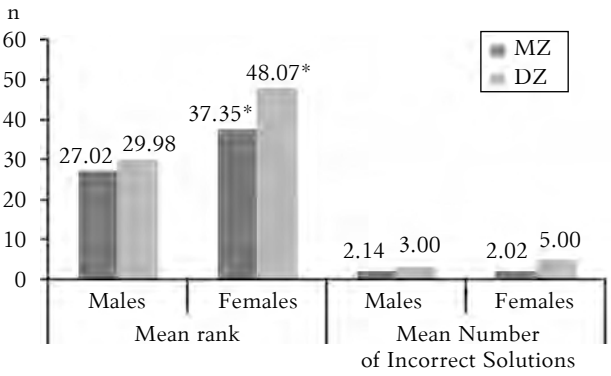

Fig. 4. The evaluation of constructive thinking among twins based on the difference in the number of incorrect solutions and sex

*P=0.042.

arate sections (Table 2). The results showed that the MZ twins (>15 years old) solved difficult tasks more similarly. However, with the increasing difficulty of the tasks, there were no significant results regarding zygosity and the significant difference in the number of incorrect solutions. There were no significant differences when comparing the twins (⩽15 years old) who did CPM regarding zygosity or the difference in mistakes made (Table 3).

The MZ twins (>15 and ⩽15 years old) solved complex tasks more similarly. However, with tasks getting increasingly complex, no significant differences were found concerning zygosity or the difference in the number of mistakes made.

To assess personalities (temperaments) of the twins, the EPQ was used. A higher average rank in the DZ group indicates that for the DZ twins, the values varied more considerably than they did for the MZ twins. The differences in E were significant (P<0.001), indicating the influence of heredity. The correlation coefficients for the E, N, and L dimensions showed a stronger correlation for the MZ twins, indicating that the MZ twins were more similar than the DZ twins. The correlation was stronger in the DZ twins for the P dimension (Table 4).

The comparison of the EPQ assessments by sex showed that among the women, no dimension differed significantly between the MZ and DZ twins (P>0.05). Among the men, the differences in E were significant (P=0.001), indicating that the difference among the DZ twins was greater (Table 5).

When sorting the results of the EPQ test by the respondents' age, the differences in the E dimension were significant for the MZ and DZ twins in the age groups of younger and older than 19 years. The ranks for the MZ twins were lower, indicating that they were more similar than the DZ twin pairs (individuals younger than 19 years usually live with their parents as a family) (Table 6). Sorting the results by age and sex showed that for the women younger than 19 years and older than 19 years, no significant differences were observed (P>0.05). For the men younger than 19 years, E was significantly different (P=0.03) as it was for the men older than 19 years (P=0.03).

Summing up all the twins' answers to the EPQ questions, the analysis showed that the differences were significant for the E dimension. The results for the separate questions where the differences were significant are shown in Table 7.

Table 2. Data of the Raven Test for Incorrect Solutions by Zygosity of Twin Pairs (>15 Years Old)

Total	MZ (n=128)	DZ (n=98)	z	P
Section A	0.75±0.11	0.55±0.09	−1.017	0.309
Section B	0.70±0.13	1.22±0.24	−1.708	0.088
Section C	1.11±0.13	1.45±0.16	−1.687	0.092
Section D	1.08±0.12	1.57±0.24	−1.069	0.285
Section E	1.33±0.15	2.04±0.31	−1.422	0.155

Values are mean ± standard error of the mean.
MZ, monozygotic, DZ, dizygotic.

Table 3. Data of the Raven Test for Incorrect Solutions in Progressive Colored Matrices by Zygosity of Twin Pairs (⩽15 Years Old)

Total	MZ (n=22)	DZ (n=30)	z	P
Section A	0.70±0.21	0.87±0.24	−0.715	0.507
Section B	0.89±0.27	0.80±0.31	−1.093	0.330
Section Ab	0.60±0.18	0.67±0.27	−1.410	0.305

Values are mean ± standard error of the mean.
MZ, monozygotic, DZ, dizygotic.

Table 4. Correlation Between Monozygotic and Dizygotic Twin Pairs and Personality Traits

Scale of Personality Traits	MZ	P	DZ	P
Psychoticism	0.293	0.011	0.303	0.015
Extraversion	0.524	0.001	0.269	0.032
Neuroticism	0.343	0.003	0.298	0.017
Lie	0.568	0.001	0.469	0.001

MZ, monozygotic, DZ, dizygotic.

Table 5. Data of the Eysenck Personality Questionnaire by Zygosity and Sex

Scale of Personality Traits	MZ Mean Difference	MZ Mean Rank	DZ Mean Difference	DZ Mean Rank	*z*	*P*
Psychoticism						
Women	1.85±0.22	43.62	1.47±0.19	38.79	–0.962	0.336
Men	2.14±0.42	28.73	1.93±0.33	28.27	–0.109	0.913
Total	1.96±0.21	71.74	1.67±0.18	66.91	–0.734	0.463
Extraversion						
Women	3.07±0.42	38.28	3.75±0.46	45.61	–1.399	0.162
Men	2.18±0.50	20.82	5.64±0.82	36.18	–3.55	0.001
Total	2.73±0.33	58.62	4.58±0.45	82.08	3.470	0.001
Neuroticism						
Women	4.28±0.58	38.74	5.14±0.64	45.03	–1.194	0.233
Men	4.61±0.75	31.95	2.96±0.61	25.05	–1.595	0.111
Total	4.41±0.46	70.23	4.19±0.46	68.66	–0.232	0.817
Lie scale						
Women	3.85±0.43	41.89	3.69±0.45	41.00	–0.170	0.865
Men	2.14±0.37	25.13	3.25±0.49	31.88	–0.170	0.117
Total	3.20±0.32	67.26	3.50±0.33	72.09	–0.715	0.475

Values are mean ± standard error of the mean. MZ, monozygotic, DZ, dizygotic.

Table 6. Data of the Eysenck Personality Questionnaire by Zygosity and Age

Scale of Personality Traits	MZ Mean Difference	MZ Mean Rank	DZ Mean Difference	DZ Mean Rank	*z*	*P*
Psychoticism						
⩽19 years old	2.50±0.45	40.45	1.76±0.35	25.98	–1.437	0.151
>19 years old	1.63±0.19	40.45	1.60±0.17	41.73	–0.253	0.800
Extraversion						
⩽19 years old	2.36±0.47	24.50	3.93±0.62	33.34	–2.035	0.042
>19 years old	2.96±0.44	34.35	5.11±0.64	49.74	–2.943	0.003
Neuroticism						
⩽19 years old	3.61±0.75	28.52	3.69±0.70	29.47	–0.218	0.828
>19 years old	4.89±0.57	41.64	4.60±0.62	40.16	–0.283	0.777
Lie						
⩽19 years old	3.11±0.45	28.13	3.48±0.49	29.84	–0.395	0.693
>19 years old	3.26±0.43	39.77	3.51±0.45	42.61	–0.544	0.587

Values are mean ± standard error of the mean. MZ, monozygotic, DZ, dizygotic.
Dizygotic twin pairs >19 years old (n=29) and ⩽19 years old (n=35).
Monozygotic twin pairs >19 years old (n=29) and ⩽19 years old (n=46).

Table 7. Percentage Distribution of Twin Pairs by Answers According to the Eysenck Personality Questionnaire

Item	Both Answers Positive		Both Answers Negative		Different Answers		χ^2	*P*
	MZ	DZ	MZ	DZ	MZ	DZ		
Are you a talkative person? E	54.7	37.5	18.7	15.6	26.7	46.9	6.282	0.043
Do you enjoy a lot going out? E	44.0	45.3	34.7	15.6	21.3	39.1	8.528	0.014
Are you successful in breaking the ice in a boring company? E	41.3	18.8	37.3	32.8	21.3	48.4	13.396	0.001
Are you often concerned about what you did or said that you think you had better not done/said? N	66.7	62.5	2.7	14.1	30.7	23.4	6.420	0.040
Do you often start more tasks than you have the time available for? N	26.7	26.6	49.3	28.1	24.0	45.3	8.564	0.014
Have you ever been late to work or a scheduled meeting? L	73.3	53.1	16.0	6.3	10.7	40.6	17.725	0.001

Values are percentage. MZ, monozygotic, DZ, dizygotic.

The twins who solved 60 geometric tasks of progressively increasing difficulty (age >15 years) in the Raven test differed by 3.35 incorrect answers on average. The investigated twin pairs were divided into 2 groups: in one group, there were differences of up to 3.35 incorrect answers, and in another group, there were more than 3.35 incorrect answers. The children younger than 15 years were not included

Table 8. Coherence Between Cognitive Functions and Extraversion

Scale of Personality Traits	MZ ⩽Average		MZ >Average		DZ ⩽Average		DZ >Average	
	Mean Difference	Mean Rank	Mean Difference	Mean Rank	Mean Difference	Mean Rank	Mean Difference	Mean Rank
Psychoticism	1.89 (1.51)	37.49	1.81 (1.47)	20.66	1.23 SD 0.61	29.68	2.07 SD 1.41	22.8
Extraversion	2.94 (2.99)	30.62*	2.5 SD 2.1	16.91†	4.91 SD 3.52	44.36*	4.7 SD 3.71	25.0†
Neuroticism	4.09 (3.28)	34.74	6.81 SD 4.94	26.31	4.5 SD 4.1	35.55	3.96 SD 3.48	19.44
Lie	2.91 (2.54)	33.57	3.94 SD 3.38	22.25	3.5 SD 2.79	38.05	3.63 SD 3.38	21.85

Values are mean (standard deviation).
*P =0.007; †P=0.039.

into the calculations due to the small difference between the numbers of incorrect answers. The P, E, N, and L dimensions of the EPQ were analyzed in these groups. E was found to be significantly different (P<0.05) (Table 8). When comparing the EPQ dimensions for the MZ and DZ twins, the results showed that for the DZ twins who had more than 3.35 incorrect answers according to the Raven test, the value of the mean rank of the P dimension was higher (z=2.330, P=0.02). Among the MZ twins, no significant differences were found.

Discussion

Monozygosity is known to be associated with a greater inherited influence on somatic traits. There are ongoing studies on psychological traits and heredity of cognitive functions and personality. The analysis of the results of our study showed that the parameters of constructive thinking were more in concordance when applying the Raven test where based on the difference in the total number of incorrect solutions between the MZ and DZ twins (aged >15 years), the data were statistically significant. This means that genetic factors do affect constructive thinking, which suggests that heredity influences cognitive functions. Similar results were also discovered in the Netherlands in a study of twins, conducted by Risjdijk et al., using the Raven test (7). Earlier specific studies on the cognitive function of teenage and adult twins also showed that genetic factors were more influential in almost all study cases (8). In our study, no significant conclusive data were obtained based on the total difference in incorrect solutions among the twins aged 15 years or younger. The results should be interpreted cautiously due to the small number of the subjects. To put it in other words, based on the results obtained from the small group, we cannot draw reliable conclusions about the whole population.

Other studies showed that the influence of not only genetic factors was also important, especially in nonverbal tests for children (17). This suggests that the investigation of a greater number of twin pairs younger than 15 years might allow for drawing clearer conclusions on whether genetic factors or the external environment are more influential. Fischbein et al. in Sweden (Stockholm) and Israel (Jerusalem city and rural kibbutz) applied Raven tests to compare MZ and DZ twins with the control group (8). Their main working hypothesis stated that the influence of genetic factors on cognitive functions directly correlated with an increasing level of the subjects' education. Our findings confirmed this hypothesis, i.e., the educational level of the adult subjects was undoubtedly higher than that of the children. Studies on constructive thinking did not clearly state the influence of genetic factors, but it decreased from Jerusalem toward the kibbutz and Stockholm. This study is especially valuable as the same authors applied the same techniques to investigate 3 geographically and demographically different regions and obtained virtually identical results in all of them (8). When comparing by sex, a significant difference was found in the group of women; meanwhile, in men, the trend remained the same, yet the difference was not significant.

When re-standardizing Raven methods in various countries, researchers noticed an improvement in nonverbal abilities in the population. However, there has been no unanimous explanation concerning the causes of this phenomenon. According to Raven, an improvement in RPM scores during the recent decades might be related to the same factors that encourage an increase in human height and neonatal weight and a decrease in neonatal mortality, i.e., better diet, increased welfare, and better hygiene. He also emphasized the role of such factors as education and teaching techniques in the development of children's mental and social abilities (6).

Thus, some authors state that genetic factors have a greater influence on cognitive functions. There are also researchers who think that genetic and external environmental factors have an equal effect (50% each) (9, 18). Our study showed rather significant differences between the groups of children (younger than 15 years) and adults (older than 15 years). Children grow in their parent's homes under equal conditions, which mask the heredity component in cognitive functions, while adults (the oldest of them was 62 years old) live under increasingly different conditions, which allows purifying the effect of the

genetic component. The results of this study should be evaluated with caution due to a possible effect of secondary variables.

Research on extraversion and genetics was started early and confirms the results obtained in our study. Eysenck and Prell in 1951 stated that E was affected by inherited factors. More recent literature sources state that E is also affected by genetic factors. The results of our study showed that the difference in E between the MZ and DZ twins was significant, and the correlation coefficients among the MZ and DZ twins were similar to those reported by other researchers (11, 19–21).

Modern studies of twins have proven the influence of genetic factors on E (12, 22–25). Our study of the twins using the EPQ did not show that N and P were more influenced by genetic factors, yet our study was small in size, and the result may also depend on other groups. Loehlin and Martin in 2001 investigated more twin pairs (in total 5400 subjects) (13). Heath and Martin evaluated P by applying the EPQ, but failed to reach a clear conclusion whether P was influenced by external environmental or genetic factors (26).

No significant differences in P, E, or N were found between different age groups. The comparison of E by sex revealed a significant difference among the men, while among the women, even though the trend remained the same, the difference was not significant. Our results showed that E heredity links did not depend on age because in both groups, E differed significantly in the subjects younger than 19 years as well as among those older than 19 years.

The analysis of separate questions of the EPQ in our study helps better understand the total evaluations of the scales. The twin pairs were of the same age but could have been of different education as the education was not analyzed thoroughly. It is correct to say that the notion "dependence" has to be used with caution. It is not clear what level of influence the different number of women and men pairs had on the results. The differences in E for the men and the women could depend on social circumstances. The total score of the EPQ showed that E differed significantly. In our study, the subjects' answers to some significant questions were of relevance. Significantly more differences were found in the questions on the E scale (Are you a talkative person? Do you enjoy a lot going out? Are you successful in breaking the ice in a boring company?), the N scale (Are you often concerned about what you did or said that you think you had better not done/said? Do you often start more tasks than you have the time available for?), and the L scale (Have you ever been late to work or a scheduled meeting?). Those questions were mostly associated with the influence of heredity.

The comparison of the correlations between cognitive functions (constructive thinking) and personality traits (E) revealed no difference between them and showed that the influence of heredity was similar.

Conclusions

The results imply that the quality of cognitive functions and personality traits (extraversion) can be influenced by heredity. This confirms previous findings on the hereditability of cognitive factors and personality traits.

Statement of Conflict of Interest

The authors state no conflict of interest.

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