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More than 15 years of human behaviour genetic research at the University of Warsaw

Human behaviour genetic research has been conducted at the University of Warsaw for more than 15 years. The main focus of this work have been the origins of individual differences in temperament and other personality traits. Other areas of interest include attitudes, risk factors for human health, and posttraumatic stress disorder (PTSD). The majority of the research is conducted using quantitative genetic methods although recently work using molecular techniques has also begun to develop. This article reviews the most important directions and findings of this research.

Keywords: *behaviour genetics, twins, molecular genetics*

For various reasons behaviour genetic research was absent in Poland until the early nineteen-nineties. The political breakthrough in 1989 which initiated social and economic transformation was also a gateway to the development of new research disciplines including behaviour genetics. It is generally accepted that this line of study began with the Bielefeld-Warsaw-Twin Project, a Polish-German initiative supervised by Jan Strelau (University of Warsaw, Poland) and Alois Angleitner (Bielefeld University, Germany). Several researchers from each participant country worked on this project. In the preparatory phase a data base containing the addresses of nearly 250 thousand pairs of twins living and residing in Poland was created on the basis of the Polish Electronic Population Records System. This address base was called the Polish Twin Register. The Register is still used to recruit twins for scientific research. Zygosity of the registered twin pairs is unknown and is determined by means of a special self-report instrument called the Twins Physical Resemblance Questionnaire (Oniszczenko, Angleitner, Strelau, & Angert, 1993; Oniszczenko & Rogucka, 1996). This questionnaire has 12 items concerning height, hair colour, eye colour, ear shape, blood group, and twin confusion. The questionnaire, whose validity is 94 percent of correctly classified twin pairs, has also been used in other research (cf. e.g. Oniszczenko & Jakubowska, 2005; Spinath et al., 2002; Stößel, Kämpfe, & Riemann, 2006). The present review presents the most important studies and outcomes of Polish behaviour geneticists within the last 15 years or so.

Twin studies. The Bielefeld-Warsaw-Twin Project, also mentioned by Plomin et al. (2001) in their handbook, was the first and so far largest research program in Central-Eastern Europe to try to identify the genetic and environmental determinants of individual differences in several dozen temperament traits. A total of 27 temperament traits were assessed in 1991 – 1994 using the following inventories: (1) The Formal Characteristics of Behaviour – Temperament Inventory FCB – TI by Zawadzki and Strelau which assesses briskness, perseveration, sensory sensitivity, emotional reactivity, endurance and activity; (2) the PTS Temperament Inventory by Strelau and Zawadzki which assesses strength of arousal, strength of inhibition and nervous process mobility, (3) the Revised Dimensions of Temperament Survey DOTS-R by Windle and Lerner which assesses activity level-general, activity level-sleep, approach-withdrawal, flexibility-rigidity, mood quality, rhythmicity-sleep, rhythmicity-eating, rhythmicity-daily habits, distractibility and persistence, (4) The EAS Temperament Survey (EAS-TS) for adults by Buss and Plomin which assesses dissatisfaction, fear, anger, activity, and sociability; and (5) the EPQ-R by Eysenck, Eysenck and Barrett which assesses extraversion, neuroticism and psychoticism.

In addition to the traditional self-report techniques we also used rating scales to assess traits. Each twin in a pair was rated by two independent observers by means of a

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questionnaire with items worded in third person singular. Thanks to these ratings it was possible to demonstrate the genetic bases of temperament by means of measures other than just self-report. The ratings were then averaged for each twin according to accepted aggregation rules. The Polish sample consisted of several hundred pairs of adult, same-sex twins reared together. All in all, ratings were obtained for over two thousand individuals. The results suggested that the mean heritability of temperament traits measured by means of the self-rating approach ranged from 0.28 for traits assessed with DOTS-R to 0.44 for traits assessed with the FCB-TI. The data obtained by means of the rating approach indicated heritability ranging from 0.18 for traits measured with the PTS (the basic Pavlovian nervous system properties) to 0.40 for the EPQ-R dimensions. The effect of specific environment accounted for the remaining variance of the majority of traits with the exception of several traits measured with the PTS and DOTS-R where a weak effect of the shared environment was found. We also found an effect of nonadditive genetic factors on the variance of several traits measured with the DOTS-R, EAS-TS and the FCB-TI (Strelau, 1998). A detailed report of the Polish-German twin study is given elsewhere (Oniszczenko et al., 2003).

In a more recent study of same-sex twins aged from 16 to 20 and reared together we used only the self-report method. The results were similar to the results of the adult sample except that the effect of nonadditive factors on the variance of the studied traits was more pronounced. In 2002 we constructed an instrument for children measuring the same traits which are measured in adults with the FCB-TI. This enabled us to study the youngest school-age twins. We conducted a study of same-sex twins aged from 6 to 11 reared together. In this sample only nonadditive factors had a significant effect and accounted for 53 percent of the variance of studied traits on the average. Specific environment accounted for the remaining variance.

We also used the twin study method in a number of studies of the role of genetic and environmental determinants of human health. All in all, we investigated several hundred pairs of adult twins reared together. In one study we estimated the heritability of three dimensions of the Mental Health Inventory (MHI) by V. T. Veit and E. Ware, Jr.: Psychological Distress (0.35), Well-Being (0.31) and Mental Health Index (0.35). We also demonstrated the heritability of coping styles measured with the CISS by Endler and Parker: task-oriented coping (0.34), emotion-oriented coping (0.36) and avoidance-oriented coping (0.44). Heritability of scores on vicarious activities and seeking company were 0.38 and 0.26. respectively. The remaining variance of the scales of the two questionnaires was accounted for by the effect of the specific environment. As far as R. H. Rahe's Recent Life Changes Questionnaire (RLCQ) is concerned, heritability was 0.14 for subjective life change intensity and 0.16 for intensity of change ratings. The effects of shared environment and specific environment accounted for the remaining variance (14 and 16 percent respectively). Sobolewski, Strelau and Zawadzki (2001) found that the risk of self-inflicted stressors, including stressors relating to lifestyle, is also genetically determined.

In another study using the twin study method we wanted to identify the heritability of biochemical and psychometric indicators of responses to stress caused by blood sampling in adults. Heritability of level of adrenalin was 0.33 and cortisol was 0.30. We also confirmed the heritability of a psychometric measure of stress, the difference in pre-blood-test and post-blood-test state anxiety measured with Spielberger's STAI. Heritability in this case was 0.14. Both shared and specific environment had a significant effect on the heritability of the variance of biochemical stress indicators (but only specific environment had a significant effect on the heritability of state anxiety). In this same study we applied the family study method and found positive (and significant) correlations between parental level of serotonin (mother's and father's) and that of their offspring, irrespective of sex. As far as level of cortisol is concerned, a positive and significant correlation was found between mothers and their children, both daughters and sons, and between fathers and sons but not daughters. A positive and significant correlation also emerged between mothers and their sons with respect to level of serotonin metabolite. A reversed pattern was found for fathers: here the level of serotonin metabolite correlated positively and significantly with their daughters' level of serotonin metabolite. Parent-child correlations for the remaining biochemical indicators were weak and statistically insignificant or completely absent.

Adult twins also participated in a study of heritability of blood serum lipid concentration and variability of arterial blood pressure. LDL and HDL heritability scores were 0.36 and 0.64 respectively. Specific environment accounted for the remaining variance of serum lipid concentration. No genetic contribution to the variance of triglycerides was found. The variance of this indicator was completely accounted for by environmental factors, both shared environment (0.36) and specific environment (0.64). The additive genetic factor accounted for from 37 percent (nocturnal diastolic blood pressure) to 79 percent (diurnal systolic blood pressure) of the variance of the studied parameters. The results of this study suggest that the functioning of the cardiovascular system and the level of risk factors for cardiovascular dysfunction are genetically determined to a certain extent but they are also determined to a considerable extent by such specific environmental factors as diet, exercise or alcohol consumption. Jedrusik et al. (2003) give a detailed account of these findings. Another line of research which we pursued was posttraumatic stress disorder (PTSD) in biological families which had

experienced a cataclysmic flood. Our findings suggests the coincidence of PTSD symptoms in relatives (parents – children) but also in spouses. The similarity of PTSD symptoms between these individuals increased with time – the more time had elapsed since the traumatic event, the greater the similarity. Similarity of PTSD symptoms was greater in father – offspring pairs than mother – offspring pairs. Presumably, the mechanism of biological transmission of PTSD symptoms in families may be based on dopamine secretion as suggested by the findings of another of our studies (Oniszczenko & Dragan, 2004) where we managed to demonstrate a significant relation between DRD4 polymorphism and differences in emotional reactivity. In the studied flood survivors this last factor had a significant effect on the presence of PTSD in families. Later molecular research revealed a relation between DRD4 7- and 8-repetition alleles and the intensity of PTSD symptoms in flood survivors.

As far as other work based on the twin study method is concerned, it is worth mentioning one which strove to determine the heritability of socio-political attitudes in the Polish population. Two attitude dimensions were investigated: conservatism – liberalism and market economy – state interventionism. We only found a significant effect of the additive genetic factor on the variance of conservatism – liberalism (0.28). The scores on both attitude scales were largely accounted for by shared environment and, to a lesser extent, by specific environment. This study has been reported in detail by Oniszczenko and Jakubowska (2005).

Molecular studies. In 2002 we launched our first molecular study. The purpose of this study was to determine the relations between two of the temperament traits postulated by J. Strelau (1998) in his Regulative Theory of Temperament (RTT), emotional reactivity and activity, both of which are directly connected with individual level of activity, and serotonin transporter (5-HTT, chromosome 17), dopamine receptor (DRD4, chromosome 11) and dopamine transporter (DAT1, chromosome 5) gene polymorphism. The reason why we selected these two traits is that they have the highest heritability indices and, being temperament traits, they are directly related to individual level of activation and hence should be most affected by the abovementioned neurotransmitters. Several hundred healthy men aged from 18 to 27 participated in this study. We were unable to find any connection between dopamine transporter gene polymorphism and the studied temperament traits. However, when we analysed the gene polymorphisms for the serotonin transporter (5-HTT) we found significant relations between variants of this gene and differences in activity. High activity as a temperament trait is related to presence of the14-repeat allele (allele S) whereas presence of the 16-repeat allele (allele L) is related to low activity. The hypothesised relation between gene 5-HTT polymorphisms and differences in emotional reactivity was not supported. On the other hand, however, differences in emotional reactivity were significantly related to dopamine receptor gene polymorphism. Low emotional reactivity was related to the presence of a 7-repeat allele. A more detailed account of this work can be found elsewhere (Dragan & Oniszczenko, 2005; Oniszczenko & Dragan, 2005). Our next study was run on two hundred women aged from 18 to 29. We found a relation between serotonin transporter gene polymorphism and several of the traits measured with the FCB-TI and Costa and McCrae's NEO-FFI. Women whose genotype contained short gene 5-HTT alleles were significantly less enduring (FCB-TI) and significantly more neurotic (NEO-FFI) than women whose genotype contained only long 5-HTT alleles. We also found that women with two short 5-HTT alleles had significantly lower activity (FCB-TI) than women whose genotype contained the variant with two or only one long serotonin transporter gene allele (Dragan & Oniszczenko, 2006). Further analysis of this sample of women revealed a relation between dopamine receptor gene polymorphism and conscientiousness (NEO-FFI). Presence of the 7-repeat allele was related to low conscientiousness. We also found a relation between polymorphism interaction of the dopamine receptor DRD4 and the dopamine transporter with neuroticism (NEO-FFI). Results of subjects with 7-repeat allele of the DRD4 and with 9-repeat allele of the DAT1, as well as subjects without 7-repeat allele of the DRD4 and without 9-repeat allele of the DAT1 were higher on this dimension, while results of subjects without 7-repeat allele of the DRD4 and 9-repeat allele of the DAT1, as well as subjects with 7-repeat allele of the DRD4 and without 9-repeat allele of the DAT1, were lower (Dragan & Oniszczenko, 2007).

In a different analysis we found that, compared with women whose genotype contained two or just one short 5-HTT allele, women with two long alleles of the serotonin transporter had a temperament profile (FCB-TI) approaching the ideal, i.e., a harmonised structure with considerable stimulus processing potential: high endurance, high activity, high briskness, high sensory sensitivity, low emotional reactivity and low perseveration. We found no significant relations with dopamine receptor or dopamine transporter gene polymorphisms (Oniszczenko & Dragan, 2006).

To conclude this brief review of Polish behaviour genetic research let me add that the Interdisciplinary Centre for Behaviour Genetic Research (ICBGR) has been operating at the University of Warsaw since 1998. This Centre was established by Jan Strelau who funded it with The New Europe Prize for outstanding achievement in academic teaching and scientific research which he was awarded. The Centre's mission is to conduct research and popularise knowledge on behaviour genetics.

The ICBGR has been publishing a half-yearly journal *Psychology – Ethology – Genetics* since 1999. The journal is in Polish and publishes article from the intersection of psychology and biology. It is addressed to everybody who is interested in the following areas of research: behaviour mechanisms, individual and evolutionary development of behaviour, individual differences, the role of genetic and environmental factors in behaviour development, comparative analysis of behaviour in different animal species (including humans), applied psychology, ethology, and behaviour genetics.

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