

# From Twins to Genetic Polymorphisms: Behavioral Genetic Research in Poland

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Behavioral genetic research has been conducted at the University of Warsaw for the past 20 years. The work done at the University focuses primarily on the origins of individual differences in temperament and other personality traits. In particular, research is directed toward the traits postulated in the Regulative Theory of Temperament. We also focused on the heritability of socio-political attitudes, risk factors for human health, and post-traumatic stress disorder. The majority of the research that has been carried out is grounded in twin and family studies, although recent work based on molecular techniques has also been developed. This article reviews the most important directions and findings of behavioral genetics research at the University of Warsaw.

■ **Keywords:** genetic behavior, twins, family studies, association studies

In this article, we summarize the results of research based on the twin studies, family studies, and molecular genetics studies that we have conducted in Poland over the past 20 years. We present the overall results, which have been published in different scientific journals in Poland and abroad, citing the appropriate sources.

## Twin Studies

### Studies on Temperament

Behavioral genetics studies in Poland are generally thought to have begun with the Bielefeld-Warsaw Twin Project (BWTP), a Polish–German initiative conducted from 1991 to 1994 and supervised by Jan Strelau of the University of Warsaw, Poland, and Alois Angleitner of Bielefeld University, Germany. The BWTP, also cited by Plomin et al. (2001) in their handbook, was the first and thus far the largest research program in Central-Eastern Europe which endeavored to identify the genetic and environmental determinants of individual differences in several dozen temperament traits. In the project, 27 temperament traits were assessed using the following questionnaires:

1. The Formal Characteristics of Behavior—Temperament Inventory (FCB-TI), developed by Strelau and Zawadzki (1995); this assesses briskness (speed, tempo, and mobility of behavior), perseveration (the tendency to maintain and repeat emotional states), sensory sensitivity (the capacity to respond to weak stimuli), emotional reactivity (the tendency to

intensively react to emotogenic stimuli), endurance (the capacity to adequately respond to highly stimulating situations), and activity (the tendency to engage in highly stimulating behavior or behavior that provides stimulating environmental input);

2. The Pavlovian Temperament Survey (PTS), developed by Strelau et al. (1999), which evaluates the strength of arousal and the strength of inhibition and nervous process mobility;
3. The Revised Dimensions of Temperament Survey (DOTS-R), created by Windle and Lerner (1986) to assess the following scales: activity level–general, activity level–sleep, approach–withdrawal, flexibility–rigidity, mood quality, rhythmicity–sleep, rhythmicity–eating, rhythmicity–daily habits, and distractibility and persistence;
4. The EAS Temperament Survey (EAS-TS), intended for adults and formulated by Buss and Plomin (1984) to assess distress, fear, anger, activity, and sociability; and
5. The EPQ-R by Eysenck and Eysenck (1991); this questionnaire assesses extraversion, neuroticism, and psychoticism.

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In the BWTP, we used rating scales in addition to traditional self-report techniques to assess traits. In twin studies, each twin in a pair was rated by two independent observers using a questionnaire with items worded in the third-person singular. These ratings enabled us to demonstrate the genetic bases of temperament by means of measures other than self-report approaches. The ratings were then averaged for each twin in accordance with accepted aggregation rules.

The starting point of this study was a database containing the postal addresses of 250,000 pairs of twins living in Poland; this database was created on the basis of the Polish Electronic Population Records System. The zygosity of the registered twin pairs was unknown and determined by a special self-report instrument called the Twins' Physical Resemblance Questionnaire (Polish and German versions), developed by Oniszczenko et al. (1993) and Oniszczenko and Rogucka (1996). This questionnaire has 12 items concerning height, hair color, eye color, ear shape, blood group, and the extent of twin confusion by parents, relatives, peers, and strangers. The questionnaire validity is 94% of correctly classified twin pairs.

The Polish sample consists of 546 pairs of adult twins aged 17 to 64 years living in Warsaw, with 317 MZ and 229 DZ same-sex pairs reared together (there were 322 female pairs and 224 male pairs). They were twin pairs who volunteered to participate in this project. Peer reports were collected from 2,014 persons aged from 20 to 71 years, including 1,282 women and 716 men (gender data on 16 individuals were not obtained). An important component is that the Polish sample consists of twins reared together and DZ same-sex twins only.

In all twin studies, the data were analyzed using structural equation modeling. We used maximum likelihood model fitting to estimate the influence of genetic and environmental sources of variance on phenotypic traits using LISREL 8.03 (Jöreskog & Sörbom, 1993).

The results showed that the mean heritability of temperament traits in a Polish population measured by means of the self-rating approach ranged from 28% of variance explained by genetic factors for traits assessed with the DOTS-R to 44% for those evaluated using the FCB-TI. The data obtained by means of the rating approach indicated heritability that ranged from 18% for traits measured with the PTS (properties of the basic Pavlovian nervous system) to 40% for the EPQ-R dimensions. The effects of a specific environment accounted for the remaining variance in most of the traits, with the exception of several traits measured with the PTS and DOTS-R, in which a weak effect of shared environment was found. We also found an effect of non-additive genetic factors on the variance of several traits measured with the DOTS-R, EAS-TS, and FCB-TI (Oniszczenko et al., 2003). The results of the BWTP confirm previous findings in the domain of temperament and personality traits. The heritability estimates were higher

for self-report than for peer rating (44% to 32% in the Polish sample, 47% to 33% in the German sample). No statistically significant effect of culture on the heritability estimates was recorded. The study also showed that substantial heritability estimates may be obtained for adult temperamental traits based on data recorded by both the self- and peer-report methods. The results obtained during the BWTP study were also a starting point for more detailed analysis.

The results of one of the analyses carried out on the joint Polish and German data demonstrated substantial heritability estimates of Strelau's Regulatory Theory of Temperament (RTT; Strelau, 1998). Traits were obtained for both methods (self-report and peer rating), although the averaged peer rating tended to generate slightly lower heritability than did the self-report technique (for six traits 33% and 46% of total variance, on average, as determined by self-report and peer rating, respectively). A joint analysis based on both methods (which enabled the separation of error variance from the effect of non-shared environment) indicated a very strong effect of genetic factors (the average increased to 66% of total variance). No significant "sample effect" was found, leading us to conclude that temperament traits are determined to the same extent by genetic factors in both populations (Zawadzki et al., 2001).

Zawadzki et al. (2000) analyzed genetic influence on the "Big Five" dimensions measured by the self-report and peer-rating versions of Costa and McCrae's (1992) NEO-FFI in a Polish sample of 546 twin pairs (317 MZ and 229 DZ same-sex pairs aged 17–64 years). The results showed that the average of the estimates of genetic contributions to trait variance increased from 37% (self-report only) and 36% (averaged peer ratings only) to 58% (joint analysis via self-report and peer rating) and 70% (joint analysis via two peer ratings).

We also considered the heritability of temperament traits postulated by the RTT in two other studies conducted on younger samples. The first was carried out on 120 pairs of monozygotic same-sex twins and 76 pairs of dizygotic same-sex twins aged from 16 to 20 years. The traits were measured using the FCB-TI. An additive genetic factor explained 36% (briskness) to 59% (activity) of global trait variability. Non-shared environment accounted for 41–64% of trait variability (Oniszczenko, 1996a). In the second study, we investigated the relative influence of genetic and environmental factors on the phenotypic variations in the temperament traits postulated by the RTT in children. The traits were assessed by parent Temperament Inventory for Children ratings. A sample of 66 MZ and 100 DZ twin pairs of the same sex aged 6 to 11 participated in the study. For all six traits investigated, only a non-additive genetic factor accounted for trait variance, explaining 16% (endurance) to 83% (perseveration) of trait variability. Depending on trait, non-shared environment

explained 17–84% of global trait variability (Oniszczenko, 2001).

Similar results were obtained in our studies on 126 twins (57 MZ and 69 DZ same-sex pairs aged 3–10 years) diagnosed for EAS temperament traits (emotionality, activity, sociability, shyness) by the parent EAS Temperament Survey for Children (EAS-TSC). For all four EAS-TSC scales, the significant component of variance was non-additive genetic difference, which explained 24–68% of trait variance. About 32–76% of total variation was attributed to non-shared environment sources (Oniszczenko, 1998). An issue worth noting is that the two studies on twins in middle childhood revealed only the influence of non-additive genetic factors on trait variability, suggesting a significant error in measurement. The irrelevance of additive factors is a highly unlikely result.

The data obtained for RTT temperament traits in three compared groups (adults, adolescents and children) suggest a decrease in trait heritability with age and a simultaneous increase in the input of a specific environment into the variability of the assessed traits in a lifespan (Oniszczenko, 2007).

Several subsequent studies on twins centered on important issues. The aim of one of these studies was to assess genetic and environmental contributions to the emotion-centered temperament traits measured by the FCB-TI (perseveration, emotional reactivity; Strelau & Zawadzki, 1995), Windle and Lerner's (1986) DOTS-R (approach-withdrawal, mood quality), and Buss and Plomin's (1984) EAS-TS (distress, fear, and anger). The analysis was performed using data from a joint Polish and German sample of 1,555 twins from both samples (1,049 MZ and 506 DZ same-sex pairs; 1,107 pairs were female and 448 were male) and 6,050 peers derived from German and Polish populations. The self-report data indicated that an additive genetic factor explained about 40% of the phenotypic variance in measured traits, and that non-shared environment accounted for about 60% of such variance. Peer-rating data enabled the separation of measurement error from the effect of non-shared environment. In this case, the additive genetic factor explained about 60% of the variance in emotion-centered traits.

The data based on cross-country comparisons suggest that the pattern of genetic and environmental contribution to the phenotypic variance in the traits being studied is universal (Strelau et al., 2002). In another study, we explored the relative influence of genetic and environmental factors on individual differences in nervous system properties (strength of excitation, strength of inhibition and mobility of nervous processes), as measured by the PTS inventory. The twin sample comprised 120 MZ and 76 DZ same-sex pairs, ranging in age from 16 to 20 years. For all three PTS scales, the largest component of variance was that registered by non-shared environment, which explained 48–62% of variance. About 38–52% of total variation was attributed

to additive and non-additive genetic sources (Oniszczenko, 1999).

### Studies on Attitudes

In addition to studies of temperament, we also estimated the heritability of socio-political attitudes in two more studies. The first, which included 242 twin pairs (119 MZ and 123 DZ same-sex twins reared together, aged 18–25), aimed to assess the heritability of socio-political attitudes in a Polish sample. The attitudes were examined on two separate dimensions—moral conservatism versus liberalism and free market economy versus state interventionism—using Jakubowska's Political Extremism Scale. Substantial input from additive genetic factors was exclusively shown in the variability of the conservatism-liberalism scale (28%). The results for both scales (37% and 53%, respectively) were explained to a large extent by the effect of shared environment, and to a lesser extent, by non-shared environment (Oniszczenko & Jakubowska, 2005).

The second study, which comprised only a small twin sample of 112 twins (19 MZ and 37 DZ same-sex twins reared together, aged 18–28 years), sought to identify the determinants of religious fundamentalism measured by Altemeyer and Hunsberger's (2004) revised 12-item Religious Fundamentalism Scale. The results showed that religious fundamentalism was determined mainly by environmental influences: In this study, 38% of variance was attributed to additive genetic factors, 46% to shared environment, and 16% to non-shared environment (Jakubowska & Oniszczenko, 2010).

### Studies on Health, Stress, and Coping

We also used the twin study method in a number of studies on the role of genetic and environmental determinants of human health, stress, and coping. In Oniszczenko et al.'s (2002) study on 74 pairs of adult twins (32 MZ and 42 DZ same-sex pairs, aged 23–66 years), the authors aimed to assess the relative contribution of genetic and environmental factors to the variability of indicators of acute stress induced by the drawing of blood. The indicators were state of anxiety, measured by Spielberger's STAI inventory, and blood plasma levels of epinephrine, norepinephrine, serotonin, dopamine, and cortisol. The obtained data showed the heritability of epinephrine (33%) and cortisol (30%) levels. The heritability coefficient of anxiety as a state was 14%. Non-shared environment explained 36% of epinephrine variation, 12% of cortisol variance, and 86% of anxiety variance. The heritability of other indicators of acute stress was not confirmed.

In their study on 73 healthy pairs of twins (39 MZ and 37 DZ same-sex twins, aged 18–45 years), Jędrusik et al. (2003) focused on genetic and environmental contributions to blood pressure, heart rate, and serum lipids. The authors found a significant genetic effect on systolic (SBP) and

diastolic blood pressure (DBP), ranging from 37% of explained variance for night-time DBP to 79% for daytime SBP. The significant genetic effect on heart rate ranged from 59% for office measurements to 69% for 24-hour mean values. The authors also found a genetic effect on total cholesterol, LDL- and HDL-cholesterol (but not triglycerides), with estimates ranging from 36% to 64% of explained variation. Furthermore, shared environmental and non-shared environmental components for triglycerides were found, estimated at 36% and 64%, respectively.

Kozak et al. (2005) conducted genetic analyses of data obtained from 612 adult Polish twin pairs (324 MZ and 288 DZ same-sex twins, aged 17–64 years). The study demonstrated reasonable genetic contribution to the variations in scores of the Task-Oriented, Emotion-Oriented, Social Diversion, and Distraction scales of Ender and Parker's Coping Inventory for Stressful Situations. The scores ranged from 33% to 39% of explained variance. The environmental correlations between scales were generally low (maximum  $r = 0.24$  between Social Diversion and Task-Oriented coping), but some of the genetic correlations were considerably higher (maximum  $r = 0.52$  between Social Diversion and Distraction).

Sobolewski et al. (2001) used Rahe's Recent Life Changes Questionnaire in their study on 464 pairs of adult twins (245 MZ and 219 DZ same-sex pairs, aged 19–66 years). The authors used the instrument as a basis for classifying life changes, as stressors, into the following three categories: subject-independent life events, negative subject-dependent life events, and challenges. The authors showed that the variance in independent stressors could be explained by environment only (11% by shared environment and 89% by non-shared environment). Additive genetic factors explained 26% of the variation in negative subject-dependent stressors and 36% of the variance in subject-dependent stressors–challenges. The study suggested that exposure to stressors that are dependent on individuals, among other aspects associated with lifestyle, can also be genetically determined.

Domozych and Dragan (2014) have recently conducted the genetic analyses of data obtained from 148 pairs of adult twins (83 MZ and 65 DZ same-sex pairs, aged 18–66 years). Using Bernstein and Putnam's Dissociative Experiences Scale (Carlson & Putnam, 1993) and Cloninger's Temperament and Character Inventory (Cloninger et al., 1994), the authors investigated the genetic and environmental basis of the relationship between dissociation and temperament and character traits. Significant genetic correlations between dissociative experiences and all the traits, except for Harm Avoidance, were identified. The percentages of common genetic variance with dissociation were highest for Novelty Seeking, Self-directedness, and Self-transcendence. The heritability of dissociative experiences was estimated at 54%.

## Family Studies

Family studies are complementary to research on twins. In a previous study by Oniszczenko (1996b), the author showed that 3- to 7-year-old children, whose emotionality was measured by Buss and Plomin's EAS-TC, were more similar to their mothers in terms of the two components of emotionality (distress and fear; 0.38 and 0.26, respectively) than to their fathers (0.26 and 0.08, respectively). Conversely, the children were more similar to their fathers than to their mothers in terms of sociability (0.24 and 0.19, respectively). Furthermore, the children's shyness was more strongly negatively correlated with the sociability of their fathers than with that of their mothers ( $-0.17$  and  $-0.09$ , respectively).

In terms of RTT traits, the level of trait correlation in the child–father dyad ranged from 0.01 (emotional reactivity) to 0.16 (briskness and sensory sensitivity), whereas that in the child–mother dyad ranged from 0.09 (sensory sensitivity) to 0.27 (briskness). The correlation coefficients of the traits measured by the NEO-FFI for the father–child dyad ranged from 0.05 (conscientiousness) to 0.34 (agreeableness), and those for the child–mother dyad ranged from 0.09 (agreeableness) to 0.22 (extraversion and neuroticism). The correlation coefficients were generally low to moderate (Oniszczenko, 2005).

Comparisons related to symptoms of post-traumatic stress disorder (PTSD) in the families of flood victims were also performed. Zawadzki et al. (2002) analyzed the co-existence of symptoms of PTSD in a sample comprising the families of flood victims. The field research on the families (each family consists of a mother, a father and a child) was conducted for two groups of flood victims. The first group was examined 3 months after the flood (116 families) and the second was examined 3 years after the flood (72 families). The data analysis showed that the PTSD experienced by one family member was significantly correlated with the PTSD experienced by the other members. The PTSD of one family member, therefore, is an independent predictor of the PTSD of other family members. This finding indicates the occurrence of within-family contamination of PTSD symptoms. In addition, the results obtained for both groups suggest that fathers are a source of PTSD symptom contamination in the families of flood victims. The derived effects were independent of the time that elapsed since the flood and non-specific for the method of PTSD diagnosis. The comparison of the results for both groups suggests that the familial co-existence of symptoms increases with time. Siwy and Kozak (2004) used the family study method to estimate PTSD symptom heritability. The authors demonstrated that the variance in PTSD in a few weeks after a flood is minimally determined by genetics (14% of explained variation). This variance depends primarily on the non-specific environmental factor that explains 86% of the variation in PTSD symptoms after the flood.

## Molecular Studies

In 2002, we began association studies that continue to be a subject of interest for the University of Poland. The purpose of our first set of studies was to determine the relationship between two of the temperament traits postulated by the RTT (i.e., emotional reactivity and activity) and serotonin transporter (*5-HTT*, chromosome 17), dopamine receptor (*DRD4*, chromosome 11) and dopamine transporter (*DAT1*, chromosome 5) gene polymorphisms. These two traits were selected because they exhibit the highest heritability indices, and being temperament traits, are directly related to individual level of arousal; they should therefore be most strongly affected by the above-mentioned neurotransmitters.

We demonstrated that 5-HTTLPR (serotonin-transporter-linked polymorphic region) polymorphism is associated with activity in a sample of healthy men aged 18 to 27. Neither the relationship between regulatory region polymorphism and emotional reactivity nor the association between intron 2 VNTR polymorphism and the temperament traits being studied has been confirmed (Dragan & Oniszczenko, 2005). We also showed that *DRD4* exon III polymorphism plays a role in modulating emotional reactivity as a temperament trait in healthy men (Oniszczenko & Dragan, 2005). The aim of our next study was to determine whether 5-HTTLPR polymorphism is related to the temperament traits measured using the FCB-TI and the personality traits assessed by the NEO-FFI inventory in females aged 18 to 29. The differences in endurance and neuroticism between the S group (genotypes SS and SL) and the L group (genotype LL) were statistically significant. In addition, differences were found between the LL and SS groups and the SL and SS groups with regard to activity (Dragan & Oniszczenko, 2006). In this female sample, we also studied the association between *DRD4* exon III and 3'UTR *DAT1* polymorphisms and the personality traits measured by the NEO-FFI. The 7-repeat variant of the *DRD4* gene was associated with a lower level of conscientiousness. A statistically significant interaction between *DRD4* and *DAT1* polymorphisms was also found with respect to neuroticism (Dragan & Oniszczenko, 2007).

In a recent study, we looked into the association between *DRD4* exon III VNTR and *DAT1* 3'UTR polymorphisms and the temperament assessed with the FCB-TI in a sample of healthy men and women aged from 18 to 55. A significant main effect of *DAT1* variant, as well as a significant interaction of sex and *DRD4* variant, was found for sensory sensitivity. No main effects of *DRD4* or significant three-way interactions (*DAT1* × *DRD4* × gender) were found in any of the analyzed temperament traits (Oniszczenko & Dragan, 2012). Using a family-based method, we identified the relationship between several polymorphisms in dopamine genes (*DRD2*, *DRD3*, *DRD4*, *DAT1*, *ANKK1*, *SNAP-25* and *COMT*) and sensory sensitivity (SS) as a temperament trait.

The study was run on 149 biological families with one or two children aged from 3 to 12 years. We found a significant association between SS and rs463379, the single-nucleotide polymorphism (SNP) in intron 4 of the dopamine transporter gene (*DAT1*). In addition, we found a significant association between sensory sensitivity and haplotypes in *DAT1* and *SNAP-25* (the synaptosomal associated protein of 25 kDa) genes (Dragan et al., 2012). In our latest research, the same family sample and the same family-based method as the aforementioned study were employed. We found significant associations between two SNPs in the *SNAP-25* gene (rs363039 and rs363050) and the shyness measured by Buss and Plomin's EAS Temperament Survey for Children. We also identified significant relationships of this trait with haplotypes in *DAT1* and *SNAP-25* genes (Dragan et al., 2013).

In another study, we examined the association between VNTR *DRD4* exon III polymorphism and the intensity of PTSD symptoms in 107 survivors (57 women and 50 men, aged 14–62 years) of a flood. The intensity of PTSD symptoms was measured using the PTSD-F questionnaire (Strelau, 2008). The data showed that the participants with at least one copy of the *DRD4* long allele (7 or 8 repetitions) suffered from more intense PTSD symptoms than did the participants who did not have these alleles in their genotype. These findings were determined by the Avoidance/Numbing scale and the Total Scale of the PTSD-F (Strelau, 2008). In addition, we showed the interaction between *DAT-1* (9/10 genotype) and a perceived threat of life with respect to the intensity of PTSD symptoms (Dragan & Oniszczenko, 2009).

We also sought an association between the structure of RTT temperament traits with the high processing of stimulation (i.e., effectively coping with distress; high levels of endurance and activity and low level of emotional reactivity) and *5-HTT*, *DAT1*, and *DRD4* polymorphisms in a sample of women aged from 18 to 29 years. We demonstrated that *5-HTT* polymorphism is associated with a harmonized structure of the temperament characterized by a high potential for stimulation processing. The difference in similarity to this temperament structure profile between the S group (genotypes SS and SL) and the L group (genotype LL) was statistically significant. The L group was more similar to the harmonized structure of the temperament than was the S group. No significant association was observed for *DAT1* and *DRD4* polymorphisms (Oniszczenko & Dragan, 2006).

## Concluding Remarks

The Interdisciplinary Centre for Behavior Genetic Research has been operating at the University of Warsaw since 1998. The Centre was established by Jan Strelau, who funded it with the resources that he was granted for the New Europe Prize for outstanding achievement in academic teaching

and scientific research. The Centre's mission is to conduct research and popularize knowledge on behavioral genetics. Our current research focuses on the molecular genetic basis of temperament and mental disorders in the general population.

## References

- Altemeyer, B., & Hunsberger, B. (2004). A revised religious fundamentalism scale: The short and sweet of it. *The International Journal for the Psychology of Religion*, 14, 47–57.
- Buss, A. H., & Plomin, R. (1984). *Temperament: Early developing personality traits*. Hillsdale, NJ: Erlbaum.
- Carlson, E. B., & Putnam, F. W. (1993). An update on the dissociative experiences scale. *Dissociation*, 6, 16–27.
- Cloninger, C. R., Przybeck, T. R., Svrakic, D. M., & Wetzel, R. D. (1994). *The temperament and character inventory (TCI): A guide to its development and use*. St. Louis, MO: Washington University, Center for Psychobiology of Personality.
- Costa, P. T., & McCrae, R. R. (1992). *Revised NEO personality inventory (NEO-PI-R) and NEO five-factor inventory (NEO-FFI) professional manual*. Odessa, FL: Psychological Assessment Resources.
- Domozych, W., & Dragan, W. Ł. (2014). *Genetic and environmental basis of the relationship between dissociative experiences and Cloninger's temperament and character dimensions*. Manuscript in preparation.
- Dragan, W. Ł., & Oniszczenko, W. (2005). Polymorphisms in the serotonin transporter gene and their relationship to temperamental traits measured by the formal characteristics of behavior—temperament inventory: activity and emotional reactivity. *Neuropsychobiology*, 51, 269–274.
- Dragan, W. Ł., & Oniszczenko, W. (2006). Association of a functional polymorphism in the serotonin transporter gene with personality traits in females in a Polish population. *Neuropsychobiology*, 54, 45–50.
- Dragan, W. Ł., & Oniszczenko, W. (2007). An association between dopamine D4 receptor and transporter gene polymorphisms and personality traits, assessed using NEO-FFI in a Polish female population. *Personality and Individual Differences*, 43, 531–540.
- Dragan, W. Ł., & Oniszczenko, W. (2008). Polimorfizm w genie transportera dopaminy (*DAT1*) i postrzegany stopień zagrożenia życia a zaburzenie po stresie traumatycznym w grupie powodziń [Association between polymorphism in the dopamine transporter gene (*DAT-1*) and perceived threat of life and PTSD in a group of flood victims]. *Studia Psychologiczne*, 46, 77–86.
- Dragan, W. Ł., & Oniszczenko, W. (2009). The association between dopamine D4 receptor exon III polymorphism and PTSD symptoms in Polish flood victims. *Anxiety, Stress, & Coping*, 22, 483–495.
- Dragan, W. Ł., Oniszczenko, W., Czerski, P. M., & Dmitrzak-Węglarz, M. (2012). Dopamine genes and sensory sensitivity as a temperamental trait. A family-based association study. *Journal of Individual Differences*, 33, 205–211.
- Dragan, W. Ł., Oniszczenko, W., Czerski, P. M., & Dmitrzak-Węglarz, M. (2013). Polimorfizmy w genach systemu dopaminergicznego a cechy temperamentu EAS—rodzinne badanie asocjacyjne [Family-based association study of dopaminergic gene polymorphisms and EAS temperamental traits]. *Psychiatria Polska*, 47, 185–195.
- Eysenck, H. J., & Eysenck, S. B. J. (1991). *EPQ-R manual (adult)*. London: Hodder & Stoughton.
- Jakubowska, U., & Oniszczenko, W. (2010). The role of personality, cognitive, environmental and genetic factors as determinants of religious fundamentalism: A twin study in a Polish sample. *Studia Psychologica*, 52, 253–263.
- Jędrusik, P., Januszewicz, A., Busjahn, A., Zawadzki, B., Wocial, B., Ignatowska-Świtalska, H., . . . Januszewicz, W. (2003). Genetic influence on blood pressure and lipid parameters in a sample of Polish twins. *Blood Pressure*, 12, 7–11.
- Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8: User's reference guide*. Chicago, IL: SPSS.
- Kozak, B., Strelau, J., & Miles, J. N. V. (2005). Genetic determinants of individual differences in coping styles. *Anxiety, Stress & Coping*, 18(1), 1–15.
- Oniszczenko, W. (1996a). Formal characteristics of behavior: An adolescent twin study. *Polish Psychological Bulletin*, 27(4), 373–387.
- Oniszczenko, W. (1996b). Rodzice-dzieci: Czy temperament jest odziedziczalny? Raport z badań [Parents-children: Is temperament heritable? Research report]. *Kwartalnik Polskiej Psychologii Rozwojowej*, 4, 19–32.
- Oniszczenko, W. (1998). Odziedziczalność temperamentu EAS u dzieci w wieku 3–10 lat [Heritability of the EAS temperaments in children aged 3 to 10 years]. *Psychologia Wychowawcza*, 41, 1–16.
- Oniszczenko, W. (1999). Odziedziczalność cech układu nerwowego [Heritability of nervous system properties]. *Przegląd Psychologiczny*, 42, 193–207.
- Oniszczenko, W. (2001). The regulative theory of temperament traits: The study of twins during middle childhood. *Polish Psychological Bulletin*, 32, 143–149.
- Oniszczenko, W. (2005). *Genetyczne podstawy ludzkich zachowań. Przegląd badań w populacji polskiej* [Genetic foundations of human behavior. A review of data obtained from the Polish population]. Gdańsk: Gdańskie Wydawnictwo Psychologiczne.
- Oniszczenko, W. (2007). Genetic and environmental influence on temperamental traits postulated in the Strelau's regulative theory of temperament in a Polish sample: Data from children, adolescents, and adults. In S. B. Malych & A. M. Torgersen (Eds.), *Gene, brain, behavior* (pp. 33–41). Oslo-Moscow: Russian Panorama Press.
- Oniszczenko, W., Angleitner, A., Strelau, J., & Angert, T. (1993). The questionnaire of twins' physical resemblance. Unpublished instrument. Available from the University of Warsaw, Warsaw, Poland and the University of Bielefeld, Bielefeld, Germany.
- Oniszczenko, W., & Dragan, W. (2005). Association between dopamine D4 receptor exon III polymorphism and emotional reactivity as a temperamental trait. *Twin Research and Human Genetics*, 8, 633–637.

- Oniszczenko, W., & Dragan, W. Ł. (2006). Struktura temperamentu w ujęciu *regulacyjnej teorii temperamentu* a polimorfizmy w genach *5-HTT*, *DAT1* i *DRD4* u młodych kobiet [The structure of the temperaments postulated in the regulative theory of temperament and polymorphisms in the *5-HTT*, *DAT1* and *DRD4* genes in young females]. *Neuropsychiatria i Neuropsychologia*, *1*, 24–30.
- Oniszczenko, W., & Dragan, W. Ł. (2012). Association between temperament in terms of the regulative theory of temperament and *DRD4* and *DAT1* gene polymorphisms. *Comprehensive Psychiatry*, *53*, 789–796.
- Oniszczenko, W., & Jakubowska, U. (2005). Genetic determinants and personality correlates of sociopolitical attitudes in a Polish sample. *Twin Research and Human Genetics*, *8*, 47–52.
- Oniszczenko, W., & Rogucka, E. (1996). Diagnoza zygocności bliźniąt na podstawie kwestionariusza fizycznego podobieństwa [The diagnosis of twin zygosity on the basis of the questionnaire of twins physical resemblance]. *Przegląd Psychologiczny*, *39*, 151–160.
- Oniszczenko, W., Strelau, J., Fogel, A., Zawadzki, B., & Siwy, A. (2002). Reakcja na ostry stres: udział czynników genetycznych i środowiskowych [Reaction to acute stress: the contribution of genetic and environmental factors]. *Psychologia—Etologia—Genetyka*, *5*, 35–50.
- Oniszczenko, W., Zawadzki, B., Strelau, J., Riemann, R., Angleitner, A., & Spinath, F. M. (2003). Genetic and environmental determinants of temperament: A comparative study based on Polish and German samples. *European Journal of Personality*, *17*, 207–220.
- Plomin, R., DeFries, J. C., McClearn, G. E., & McGuffin, P. (2001). *Behavioral genetics*. New York: Worth Publishers.
- Siwy, A., & Kozak, B. (2004). Zespół stresu pourazowego i style radzenia sobie ze stresem—uwarunkowania genetyczne i środowiskowe szacowane metodą studiów rodzinnych [Post-traumatic stress disorder and coping with stress—genetic and environmental factors estimated by the family studies method]. In J. Strelau (Ed.), *Osobowość a ekstremalny stres* (pp. 343–357). Gdańsk: Gdańskie Wydawnictwo Psychologiczne.
- Sobolewski, A., Strelau, J., & Zawadzki, B. (2001). The temperamental determinants of stressors as life changes: A genetic analysis. *European Psychologist*, *6*, 287–295.
- Strelau, J. (1998). *Temperament: A psychological perspective*. New York: Plenum Press.
- Strelau, J. (2008). *Temperament as a regulator of behavior. After fifty years of research*. New York: Eliot Werner Publications.
- Strelau, J., Angleitner, A., & Newberry, B. H. (1999). *The pavlovian temperament survey (PTS). An international handbook*. Goettingen: Hogrefe and Huber Publishers.
- Strelau, J., & Zawadzki, B. (1995). The formal characteristics of behaviour—temperament inventory (FCB-TI): Validity study. *European Journal of Personality*, *9*, 207–229.
- Strelau, J., Zawadzki, B., Oniszczenko, W., Angleitner, A., & Riemann, R. (2002). Genetic and environmental determinants of emotions: Data based on cross-country twin studies on temperament. *Polish Psychological Bulletin*, *1*, 5–13.
- Windle, M., & Lerner, R. M. (1986). Reassessing the dimensions of temperamental individuality across the life-span: The revised dimensions of temperament survey (DOTS-R). *Journal of Adolescent Research*, *1*, 213–230.
- Zawadzki, B., Oniszczenko, W., Strelau, J., & Angleitner, A. (2000). Evidence for genetic influence on the ‘Big Five’ personality dimensions: Self-report and peer-rating twin study. *Polish Psychological Bulletin*, *31*, 29–54.
- Zawadzki, B., Strelau, J., Kobyłka, E., Oniszczenko, W., Pawłowski, P., & Sobolewski, A. (2002). Współwystępowanie objawów zespołu stresu pourazowego (PTSD) w rodzinach powodzian: trauma, temperament i indukowanie rodzinne? [The co-existence of post-traumatic stress disorder (PTSD) symptoms in flood victims’ families: trauma, temperament and within family contamination]. *Psychologia—Etologia—Genetyka*, *6*, 7–34.
- Zawadzki, B., Strelau, J., Oniszczenko, W., Riemann, R., & Angleitner, A. (2001). Genetic and environmental influences on temperament: The Polish–German twin study, based on self-report and peer-rating. *European Psychologist*, *6*, 272–286.