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Synaesthesia and special abilities in people from the general population with differing degrees of autistic traits

Synestezja i zdolności specjalne u osób z populacji ogólnej o różnym poziomie nasilenia cech autystycznych

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Abstract

Introduction and objective: The study was carried out to explore the potential positive correlations between the degree of autistic traits and various types of special abilities or synaesthetic experiences. Autistic traits are a set of cognitive and social features that occur both in individuals with autism spectrum disorder and – less frequently and to a lesser degree – in individuals from the general population. Synaesthesia refers to phenomena whose common foundation is the principle of intersensuality. It occurs more frequently among individuals fulfilling the diagnostic criteria for autism spectrum disorder. It is also hypothesised that synaesthesia plays a key role in the manifestation of savant abilities, which occur in approximately 10% of individuals with autism spectrum disorder. **Materials and methods:** The study included 181 subjects from the general population, who completed three questionnaires: the Autism-Spectrum Quotient (AQ), the Special Abilities Scale (Skala Zdolności Specjalnych, SZS), and an original questionnaire inspired by the Synaesthesia Battery. **Results:** The results confirmed a positive relationship between synaesthesia and the presence of special abilities, and a negative relationship between musical and linguistic abilities and the degree of autistic traits. **Conclusions:** The insights gained from this study and the existing literature outline an interesting area for further exploration of the indicated relationships. In addition, the findings contribute to the change in the narrative surrounding the autism spectrum: from characterisation as a disorder to a resource-based approach with emphasis on diversity and positive traits associated with non-neurotypicality.

Keywords: autistic traits, synaesthesia, special abilities

Streszczenie

Wprowadzenie i cel: Celem pracy było sprawdzenie, czy istnieją dodatnie związki pomiędzy nasileniem cech autystycznych a specjalnymi zdolnościami o różnym charakterze i doznaniami synestetycznymi. Cechy autystyczne to zestaw charakterystyk poznawczych i społecznych, które występują zarówno u osób z zaburzeniami ze spektrum autyzmu, jak i – rzadziej i w mniejszym nasileniu – u osób z populacji ogólnej. Synestezja odnosi się do zjawisk, których wspólną podstawą jest zasada intersensualności. Występuje częściej u osób spełniających kryteria diagnostyczne zaburzeń ze spektrum autyzmu. Postawiono również hipotezę, że synestezja odgrywa kluczową rolę w manifestacji zdolności sawantycznych, które występują u około 10% osób z zaburzeniami ze spektrum autyzmu. **Materiał i metody:** W badaniu wzięło udział 181 osób z populacji ogólnej, które wypełniły trzy kwestionariusze: kwestionariusz AQ (Autism-Spectrum Quotient), Skalę Zdolności Specjalnych (SZS) oraz autorski kwestionariusz inspirowany Synesthesia Battery. **Wyniki:** Wyniki badania potwierdziły istnienie dodatniego związku pomiędzy synestezją a występowaniem zdolności specjalnych oraz ujemnego pomiędzy zdolnościami o charakterze muzycznym i lingwistycznym a nasileniem cech autystycznych. **Wnioski:** Diagnozowanie zasobów psychologicznych oraz analiza indywidualnych charakterystyk wydają się wartościowym kierunkiem badań w celu analizy szerokiego fenotypu autyzmu. Prezentowane w tym artykule badanie wpisuje się w ten pozytywny paradygmat, przyczyniając się do zmiany narracji dotyczącej spektrum autyzmu: od scharakteryzowania go jako zaburzenia do podejścia opartego na zasobach, z naciskiem na różnorodność i pozytywne cechy związane z nieneurotypowością.

Słowa kluczowe: cechy autystyczne, synestezja, zdolności specjalne

INTRODUCTION

Autistic traits are a set of cognitive and social characteristics that occur both in individuals with autism spectrum disorder (ASD) and – to a lesser degree – in individuals from the general population. For this reason, many studies (Rynkiewicz and Łucka, 2018) often refer to ASD as autism spectrum conditions (ASC). These traits may be considered a congenital neurobiological condition associated with atypical behavioural patterns (Constantino and Todd, 2003). The most common traits include mild deficits in social and communication skills, similar to those found in individuals on the autism spectrum, but exhibited to a lesser degree. They are called the "broad autism phenotype" and, since they are observed in the families of individuals with autism, they are believed to be genetically conditioned (Kunihira et al., 2006).

Over the last decades, an increasing amount of evidence has suggested that ASD exists on a continuum, ranging from low to high degrees of autistic traits, which are distributed across the population on a continuous scale (Baron-Cohen et al., 2001; de Groot and Van Strien, 2017). This means that everyone in society has varying degrees of autistic traits, and individuals with higher levels of autism may not stand out in any significant way, though they may experience difficulties functioning in certain areas. This applies in particular to adaptation to social situations, which can lead to anxiety and a sense of exclusion. Such incompatibility may make those individuals more prone to depression, chronic stress, and anxiety disorders (Stefańska-Klar, 2017). Studying these traits and their relationships with other psychological characteristics has the potential to broaden the scope of research and shift the focus toward autistic features themselves, not only in diagnosed individuals. The growing interest in autistic traits in the non-clinical population has led researchers to explore correlations between autistic features and factors such as subjective well-being, personality traits, or attitude toward life (Stefańska-Klar, 2017). The assessment of psychological resources and analysis of individual characteristics appears to be a valuable direction for research into the broad autism phenotype. The study presented here aligns with this positive paradigm, seeking to explore the relationships between the degree of autistic traits and special abilities or synaesthetic experiences.

Synaesthesia and autism spectrum

Synaesthesia refers to more or less related phenomena whose common foundation is the principle of intersensuality. It may be described metaphorically as a "dialogue of the senses" in which diverse sensual channels interpenetrate (Kozłowska, 2015). From a psychological point of view, synaesthesia is a hereditary condition in which everyday stimuli trigger unusual secondary experiences (Carmichael et al., 2015). For example, when synaesthetes listen to music, they see colours in addition to hearing sounds. One of the particularly well-studied variants is grapheme–colour synaesthesia, in which individuals experience colours while reading (Carmichael et al., 2019).

Strong synaesthesia is considered a neurodevelopmental condition (Burghoorn et al., 2020) with an atypical demographic profile. It is reported to occur in one in 2,000 people, with a six-fold higher prevalence in women compared to men (Martino and Marks, 2001). Strong indications of its co-occurrence within families have led some researchers to conclude that synaesthesia may be genetically based. There have been speculations about potential loci for the trait in the human genome; however, scientists also emphasise the polymorphic nature of synaesthesia and the complexity of its hereditary pattern (Martino and Marks, 2001). Both self-reported and clinically diagnosed synaesthesia occurs more frequently among individuals fulfilling the diagnostic criteria for ASD (van Leeuwen et al., 2021). While the general prevalence of synaesthesia only lies around ~4% (Simner et al., 2006), approximately 20% of individuals with ASD experience synaesthesia (Baron-Cohen et al., 2013; Neufeld et al., 2013). It is also suggested that synaesthesia plays a key role in relation to savant abilities, which occur in approximately 10% of individuals on the autism spectrum (van Leeuwen et al., 2020). The co-occurrence of synaesthesia and ASD appears to coincide with such abilities, and individual synaesthetic savants, such as S., in a case reported by Łuria, describe synaesthetic feelings as being key to memorising or distinguishing pieces of information (van Leeuwen et al., 2021).

The existence of a relationship between synaesthesia and ASD is further supported by research showing that synaesthetes exhibit elevated autistic traits and, like those on the autism spectrum, display a modified style of sensory processing and increased attention to detail (van Leeuwen et al., 2021). This research used the Autism-Spectrum Quotient (AQ) (Baron-Cohen et al., 2001), which was originally designed to encompass five domains of autistic traits: communication, social abilities, imagination, attentional shift, and attention to detail. Ward et al. (2017) reported that all domains were significantly elevated in synaesthetes compared to the control group, but only the results in the "attention to detail" domain were similar to those seen in individuals on the autism spectrum. It was also found that synaesthetes achieve more accurate results than control participants on the Embedded Figures Test (EFT), which requires the suppression of global information processing for the purpose of detecting smaller details – an ability that is also enhanced in individuals on the autism spectrum (van Leeuwen et al., 2021).

Special abilities, savant syndrome and autism spectrum

Savant syndrome is a relatively rare phenomenon in which a person with an intellectual disability exhibits particular abilities to a degree that may cause them to be considered

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a genius. It is often associated with extraordinary memory. Both earlier and more current experimental research (Heaton and Wallace, 2004) indicates that savant abilities lie within a quite limited range. The most often reported and best-documented domains include mathematical skills (such as calendar calculations, arithmetic, and computation of prime numbers), musical and artistic skills, and the ability to remember dates, places and facts. Less commonly reported are language abilities (such as fluent use of foreign languages) and coordination and mechanical skills (Howlin et al., 2009).

Special abilities may be characterised similarly to those seen in savant syndrome. They include excellent mechanical memory, perceptive abilities, arithmetical aptitude, or artistic skills. These abilities may be found in individuals with different levels of general intellectual functioning, from significant disability to high intelligence (Pisula, 2015). This distinguishes the phenomenon from savant syndrome, which refers, by definition, to the co-occurrence of outstanding abilities in conjunction with a lowered level of intelligence.

One of the most fascinating and enigmatic features of the autism spectrum is that individuals with the disorder often exhibit extraordinary talents. In spite of their social deficits, many display unexpected abilities in various fields. Some of them have abilities that are classified as savant syndrome – this applies to approximately 10% of individuals on the autism spectrum (and at least half of all individuals with savant syndrome are diagnosed with autism). In addition, savant abilities are more often found in men than in women, with a reported ratio of 3:1 (Howlin et al., 2009). In a study by Kanner (1971), six of the 11 original cases were described as having special abilities, mainly relating to operative memory and music. Bölte and Poustka (2004) studied 254 individuals with autism, and in 33 (13%) of those cases they identified at least one special ability, as evaluated by the Autism Diagnostic Interview-Revised; of these individuals, 29 had savant abilities (of which exceptional memory was the one most often reported). Similarly, Rimland (1978), based on a survey of parents of children on the autism spectrum, found that 531 (9.8%) had savant abilities, the most common being musical abilities (53%), exceptional memory (40%), computational skills (25%), and artistic talent (19%). Notably, 53% had multiple special abilities.

The exceptional abilities found in individuals with autism can be explained by their distinctive mental functioning, particularly weak central coherence exhibited at various levels. Because the brains of people on the autism spectrum often perceive elements of reality more as parts than as an integrated whole, these individuals have access to details that are normally not taken into consideration. This specific cognitive style may predispose them to generate non-obvious connections between various parts of disparate systems (Howlin et al., 2009).

A differing cognitive functioning style in individuals with autistic traits is also indicated by Baron-Cohen (2002) in his "extreme male brain" theory of autism. He distinguishes between *empathising*, i.e. striving to identify the emotions and thoughts of another person and responding to them with appropriate emotions, and *systemising*, which means striving to analyse variables within a system with the aim of deriving the basic principles that govern its behaviour. According to the theory, women usually empathise spontaneously more than men do, while men systematise spontaneously more than women. The mental functioning of individuals on the autism spectrum is characterised by a number of typically male brain features existing to an extreme degree, including inferior empathising and superior systematising. In a study by Baron-Cohen et al. (2001), mathematicians, physicists, computer scientists, and engineers obtained higher AQ scores than scholars from the humanities, medicine, or biology. Similar results have been observed in different cultural contexts. Students of the pure sciences exhibit more autistic traits than those studying the humanities, arts, or social sciences, as confirmed in studies carried out in Poland (Pisula et al., 2013), the Netherlands (Hoekstra et al., 2008), and Japan (Kunihira et al., 2006).

Based on the literature reviewed, the following research questions were formulated:

1. Is there a correlation between synaesthetic experience and autistic traits?
2. Is there a correlation between special abilities and autistic traits?
3. Is there a correlation between synaesthetic experience and special abilities?

MATERIALS AND METHODS

The present study was conducted in the form of an online questionnaire, which was available to respondents from the general population between 17 December 2023 and 3 January 2024. The questionnaire was distributed via social media platforms – Facebook, Instagram – in the form of a link. Before taking the survey, respondents were informed of the purpose of the survey, assured that it was completely voluntary and anonymous, that they could opt out at any time, and that the responses collected would be used solely for research purposes. Respondents were provided an email address for any questions. To proceed to the next part of the questionnaire, respondents had to indicate that they agreed to participate in the study and declare that they were over 18 years of age.

There were 181 respondents: 109 women, 70 men, and 2 persons stating their gender as "other". Participants ranged in age from 18 to 68 years (M_{age} = 36), and 51.4% were college graduates, 28.2% were currently studying, 16.6% had completed secondary school education, 3.3% had basic vocational education, and 0.6% had completed only primary education. They completed three questionnaires: the Autism-Spectrum Quotient (AQ) (Baron-Cohen et al., 2001), the Special Abilities Scale (Skala Zdolności Specjalnych, SZS) (Charzyńska and Wysocka, 2015), and a custom

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questionnaire inspired by the Synaesthesia Battery (Eagleman et al., 2007).

The AQ questionnaire was developed by Baron-Cohen and his team (2001) and adapted into Polish by Pisula et al. (2013). It serves to measure the degree to which an adult of average intelligence exhibits traits characteristic of the autism spectrum. The questionnaire consists of 50 items, and the Cronbach's alpha reliability coefficient for this tool is 0.789.

The SZS is designed to measure distinctive traits of a given person that are relevant to career path planning and the recognition of their resources and potentials. It was developed by Charzyńska and Wysocka (2015), and is based on Gardner's theory of multiple intelligences as well as the concepts of existential and spiritual intelligence. It consists of 68 statements and contains 10 subscales corresponding to various special abilities: musical, existential, natural, mathematical and logical, interpersonal, intrapersonal, spiritual, linguistic, visual and spatial, and kinaesthetic. In the present study, the most representative abilities were taken into consideration: musical, mathematical and logical, linguistic, and visual and spatial. The overall Cronbach's alpha reliability coefficient for this tool is 0.847, and its values for the individual studied abilities are as follows: musical – 0.884, mathematical and logical – 0.914, linguistic – 0.815, and visual and spatial – 0.726.

The Synaesthesia Battery is an online questionnaire developed by Eagleman et al. (2007), consisting of 80 questions. The questionnaire is interactive; depending on previous answers, further questions are matched to the subject's potential forms of synaesthesia. In view of the high cognitive load on respondents, a shortened, six-item version of the questionnaire was created for the purpose of this study, serving to investigate the presence of synaesthesia. The Cronbach's alpha reliability coefficient for this tool is 0.744.

RESULTS

To find answers to the research questions concerning the relationship between the intensity of autistic traits, various kinds of special abilities, and synaesthetic experiences, statistical analyses were carried out using IBM SPSS Statistics package, version 29. The software was used to calculate basic descriptive statistics and assess the normality of distribution. Next, a series of correlation analyses was carried out using the nonparametric correlation coefficient, Spearman's rho (ρ). The level of significance was set at a = 0.05. The basic descriptive statistics for the studied variables are given in Tab. 1.

The results for most of the variables were found to deviate significantly from a normal distribution. A distribution corresponding to a Gaussian curve was obtained only for linguistic abilities and overall special abilities). Moreover, in the studied group, with regard to the variable referring to synaesthesia, extreme outliers (exceeding three standard deviations) were observed following standardisation of the variable.

The relationship between synaesthesia and autistic traits was not found to be statistically significant ($\rho = 0.09$, $p = 0.238$), similarly as the relationship between overall special abilities and autistic traits ($\rho = -0.14$, $p = 0.069$). The lack of correlation may be attributable to the low intensity of autistic traits in the study group: $M = 19{,}71/M_{max} = 50$. A negative correlation with the degree of autistic traits was found only for musical abilities ($\rho = -0.16$, $p = 0.028$) and linguistic abilities ($\rho = -0.16$, $p = 0.029$). This suggests that the higher the level of autistic traits, the lower the level of musical and linguistic abilities. Finally, it was examined whether there exists a link between synaesthesia and special abilities.

The results indicate that synaesthesia was statistically significantly correlated with overall special abilities ($\rho = 0.29$, $p < 0.001$) and with musical abilities ($\rho = 0.24$, $p = 0.001$), linguistic abilities ($\rho = 0.26$, $p < 0.001$), and visual and spatial abilities ($\rho = 0.34$, $p < 0.001$). These correlations were positive, meaning that higher levels of synaesthesia were associated with higher levels of the aforementioned abilities. The strength of the correlations was moderate (for the relationship between synaesthesia and visual and spatial abilities) or weak (for the relationship between synaesthesia and overall special abilities, musical abilities, and linguistic abilities). No statistically significant relationship was identified between synaesthesia and mathematical and logical abilities. All results are presented in Tab. 2.

DISCUSSION

The aim of this study was to examine the relationship between autistic traits, special abilities, and synaesthetic experiences in individuals from the general population.

Variable	*M*	*Me*	*SD*	Sk.	Kurt.	Min.	Max.	*W*	*p*
Synaesthesia	0.66	0.00	1.19	1.84	2.54	0.00	5.00	0.62	<0.001
Musical abilities	23.46	24.00	7.45	0.02	–0.72	8.00	40.00	0.98	0.046
Mathematical and logical abilities	20.68	22.00	6.64	0.36	–0.88	6.00	30.00	0.95	<0.001
Linguistic abilities	22.77	23.00	5.81	–0.13	–0.51	8.00	35.00	0.99	0.103
Visual and spatial abilities	21.18	22.00	4.49	–0.33	–0.24	9.00	30.00	0.98	0.016
Special abilities – overall result	88.10	88.00	14.94	–0.18	–0.01	47.00	125.00	0.99	0.622
Autistic traits	19.71	19.00	6.98	0.42	–0.25	7.00	39.00	0.98	0.004
Sk. – skewness; **Kurt.** – kurtosis; ***W*** – result of Shapiro–Wilk test.									

*Tab. 1. Basic descriptive statistics and test of normality of distribution for the tested variables (*N = *181)*

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	Synaesthesia	Autistic traits	p_s	p_{at}
Special abilities – overall result	0.29	−0.14	<0.001	0.069
Musical abilities	0.24	−0.16	0.001	0.028
Mathematical and logical abilities	−0.05	0.04	0.467	0.611
Linguistic abilities	0.26	−0.16	<0.001	0.029
Visual and spatial abilities	0.34	−0.01	<0.001	0.983

*Tab. 2. Relationship between autistic traits, synaesthesia, and special abilities (*N = *181)*

A significant positive correlation was found between synaesthesia and the presence of special abilities, and a negative correlation between musical and linguistic abilities and the intensity of autistic traits. The absence of a correlation between autistic traits and synaesthesia may result from the relatively infrequent occurrence of the latter phenomenon in the population. Finding a larger number of individuals with this condition would require a much more complex procedure for selecting study subjects and the use of a more advanced and interactive tool.

The assumed relationships may also be more complex. Research by van Leeuwen et al. (2020) suggests that only when synaesthesia and autism are experienced together, exceptional talents may emerge. In another study, van Leeuwen et al. (2019) showed that individuals with or without synaesthesia are characterised by completely different profiles in terms of the intensity of individual autistic features as measured by the AQ, which implies that certain autistic features may correlate more strongly with synaesthesia than others. In addition, some of them correlate positively, others negatively, while others do not correlate at all. In such cases, using the correlation coefficient as a measure of the relationship between autism and synaesthesia may either fail to detect an association or show a certain trend, but too weak to be considered statistically significant.

The possibility of links between synaesthesia and other mental health conditions should not be excluded either. There is already evidence of associations between synaesthesia and anxiety (Carmichael et al., 2019) and between synaesthesia and post-traumatic stress disorder (Hoffman et al., 2019). Whatever the mechanisms behind these associations, they are likely to require a reconceptualisation of synaesthesia not just in terms of sensory experiences, but as a broader neurocognitive phenotype (Ward and Filiz, 2020).

A surprising result is the negative correlation identified between musical and linguistic abilities and intensity of autistic traits. It would appear that the development of these abilities is supported by good communication with those around and a certain kind of social exchange, which is inconsistent with autistic withdrawal (Anderson et al., 2009). ASD is a continuum of traits that may negatively affect social and emotional competencies of individuals, including challenges in their engagement abilities, limitations in reciprocal interactions, and inflexibility in initiating and sustaining communication (Vaiouli and Andreou, 2022). Such difficulties may affect language development, speech acquisition, and the motivation to develop musical skills. However, this hypothesis would require further study and observation.

The results obtained may also have been influenced by the limitations of this study. These include the small sample size, the low number of male participants, the online nature of the survey, the fact that special and synaesthetic abilities were identified on a declarative rather than a behavioural basis, and the subclinical nature of the sample studied. If a study were to be conducted on a clinical group of individuals diagnosed with autism spectrum disorder, it is possible that the expected relationships would be more visible. Nevertheless, resource-oriented research remains valuable, as it helps avoid the stigmatisation of individuals with autistic traits and draws attention to their unique nature and cognitive potential.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organisations which might negatively affect the content of this publication and/or claim authorship rights to this publication.

Author contribution

Original concept of study, collection, recording and/or compilation of data: DW. Analysis and interpretation of data; writing of manuscript: MO.

References

Anderson DK, Oti RS, Lord C et al.: Patterns of growth in adaptive social abilities among children with autism spectrum disorders. J Abnorm Child Psychol 2009; 37: 1019–1034.

Baron-Cohen S: The extreme male brain theory of autism. Trends Cogn Sci 2002; 6: 248–254.

Baron-Cohen S, Johnson D, Asher J et al.: Is synaesthesia more common in autism? Mol Autism 2013; 4: 1–6.

Baron-Cohen S, Wheelwright S, Skinner R et al.: The Autism-Spectrum Quotient (AQ): evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. J Autism Dev Disord 2001; 31: 5–17.

Bölte S, Poustka F: Comparing the profiles of savant and non-savant individuals with autistic disorder: Intelligence 2004; 32: 121–131.

Burghoorn F, Dingemanse M, van Lier R et al.: The relation between autistic traits, the degree of synaesthesia, and local/global visual perception. J Autism Dev Disord 2020; 50: 12–29.

Carmichael DA, Down MP, Shillcock RC et al.: Validating a standardised test battery for synesthesia: does the Synesthesia Battery reliably detect synesthesia? Conscious Cogn 2015; 33: 375–385.

Carmichael DA, Smees R, Shillcock RC et al.: Is there a burden attached to synaesthesia? Health screening of synaesthetes in the general population. Br J Psychol 2019; 110: 530–548.

Charzyńska E, Wysocka E: Skala Zdolności Specjalnych (SZS). Podręcznik testu – książka użytkownika. Fundacja Pomocy Osobom Niepełnosprawnym, Katowice 2015.

Constantino JN, Todd RD: Autistic traits in the general population: a twin study. Arch Gen Psychiatry 2003; 60: 524–530.

Eagleman DM, Kagan AD, Nelson SS et al.: A standardized test battery for the study of synesthesia. J Neurosci Methods 2007; 159: 139–245.
de Groot K, Van Strien JW: Evidence for a broad autism phenotype. Adv Neurodev Disord 2017; 1: 129–140.
Heaton P, Wallace GL: Annotation: the savant syndrome. J Child Psychol Psychiatry 2004; 45: 899–911.
Hoekstra RA, Bartels M, Cath DC et al.: Factor structure, reliability and criterion validity of the Autism-Spectrum Quotient (AQ): a study in Dutch population and patient groups. J Autism Dev Disord 2008; 38: 1555–1566.
Hoffman SN, Urosevich TG, Kirchner HL et al.: Grapheme-color synesthesia is associated with PTSD among deployed veterans: confirmation of previous findings and need for additional research. Int J Emerg Ment Health 2019; 21: 1–6.
Howlin P, Goode S, Hutton J et al.: Savant skills in autism: psychometric approaches and parental reports. Philos Trans R Soc Lond B Biol Sci 2009; 364: 1359–1367.
Kanner L: Follow-up study of eleven autistic children originally reported in 1943. J Autism Child Schizophr 1971; 1: 119–145.
Kozłowska Z: Synestezja. Forum Poetyki 2015; 1: 110–119.
Kunihira Y, Senju A, Dairoku H et al.: "Autistic" traits in non-autistic Japanese populations: relationships with personality traits and cognitive ability. J Autism Dev Disord 2006; 36: 553–566.
van Leeuwen TM, Neufeld J, Hughes J et al.: Synaesthesia and autism: different developmental outcomes from overlapping mechanisms? Cognit Neuropsychol 2020; 37: 433–449.
van Leeuwen TM, Petersen EV, Burghoorn F et al.: Autistic traits in synaesthesia: atypical sensory sensitivity and enhanced perception of details. Philos Trans R Soc Lond B Biol Sci 2019; 374: 20190024.
van Leeuwen TM, Wilsson L, Norrman, HN et al.: Perceptual processing links autism and synesthesia: a co-twin control study. Cortex 2021; 145: 236–249.
Martino G, Marks LE: Synesthesia: strong and weak. Curr Dir Psychol Sci 2001; 10: 61–65.
Neufeld J, Roy M, Zapf A et al.: Is synesthesia more common in patients with Asperger syndrome? Front Hum Neurosci 2013; 7: 847.
Pisula E: Autyzm. Od badań mózgu do praktyki psychologicznej. Gdańskie Wydawnictwo Psychologiczne, Gdańsk 2015.
Pisula E, Kawa R, Szostakiewicz Ł et al.: Autistic traits in male and female students and individuals with high functioning autism spectrum disorders measured by the Polish version of the Autism-Spectrum Quotient. PLoS One 2013; 8: e75236.
Rimland B: Savant capabilities of autistic children and their cognitive implications. In: Serban G (ed.): Cognitive Defects in the Development of Mental Illness. Brunner/Mazel, New York 1978: 43–65.
Rynkiewicz A, Łucka I: Autism spectrum disorder (ASD) in girls. Co-occurring psychopathology. Sex differences in clinical manifestation. Psychiatr Pol 2018; 52: 629–639.
Simner J, Mulvenna C, Sagiv N et al.: Synaesthesia: the prevalence of atypical cross-modal experiences. Perception 2006; 35: 1024–1033.
Stefańska-Klar R: Obecność autystycznego wzorca funkcjonowania w typowej populacji. Czy istnieją związki z płcią, wiekiem oraz szczęściem i satysfakcją z życia? Scope of Pedagogy and Psychology 2017; 2917: 289–299.
Vaiouli P, Andreou G: Promoting communication for young children with autism spectrum disorders: a family-centered music therapy intervention. Electron J Res Educ 2022; 20: 533–560.
Ward J, Filiz G: Synaesthesia is linked to a distinctive and heritable cognitive profile. Cortex 2020; 126: 134–140.

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