

**DEVELOPMENTAL PROSOPAGNOSIA IN POLAND:
AN ANALYSIS OF ONLINE-CONDUCTED POPULATION
BASED STUDY**

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ABSTRACT

Background and aim of the study: Developmental prosopagnosia (DP) is defined as impaired face recognition in the absence of brain injury or intellectual deficit. Because of the complexity of validated face memory and perception tests, its online distribution greatly improves the effectiveness and convenience of conducting research. Assessment of DP occurrence in the Polish population concerning study sample collection and characteristics.

Material and methods: An online questionnaire consisting of the 20-item Prosopagnosia Index (PI20) was administered to assess self-reported problems with face recognition. Cambridge Face Memory Test (CFMT) and Glasgow Face Matching Test (GFMT) were applied to assess respondents' face memory and perception. Additional data on respondents' gender, age and handedness were also obtained. All of the components were arranged together using Google Forms tool. Respondents were recruited via social media announcements. The study was conducted from 1st January to 31st March 2019. Each of the respondents was provided with personalised results analysis, which was sent with an e-mail. They were also able to stay in contact with research authors, asking additional questions and giving remarks.

Results: During the study, a total of 1349 questionnaires were collected, out of which 1276 met inclusion criteria and were enrolled in the study. 66.1% of the respondent group were females and 33.9% males. The mean age was 28.3 ± 9.5 years (range: 14-75). The mean PI20 score was 49.6 ± 18 (range: 20-99). In 11.8% of respondents PI20 result indicated self-reported mild, in 8.3% moderate and in 3.9% severe DP. The mean CFMT total score was 58.1 (median: 59, range: 26-72) and mean GFMT score was 33.9 (median: 34, range: 18-40). According to the cutoff values from original papers, 81 (6.3%) of respondents scored below threshold in CFMT, 27 (2.4%) in GFMT. Out of 50 respondents who self-reported symptoms indicating severe DP, only 15 (30%) scored below the cutoff in CFMT and 6 (12%) in GFMT. On the contrary, 30 (3.1%) and 16 (1.4%) out of 970 respondents reporting no problems with face recognition had total scores below the cutoff in CFMT and GFMT, respectively.

Conclusions: The estimated prevalence of developmental prosopagnosia in Polish population is higher than in normative data. These discrepancies may result from specific demographics of participant group more than an online-character of the study. It is impor-

tant to focus on experiment design and methodology in order to maintain high quality of collected data. Development of country-specific norms and stimuli for face-recognition tests should also be considered .

Key words: developmental prosopagnosia, polish population, online tools.

INTRODUCTION

Developmental prosopagnosia (DP), sometimes also referred as congenital prosopagnosia, can be defined as impaired face recognition in the absence of coexisting intellectual deficit or brain injury (Behrmann, 2005). Despite growing interest in this condition, its etiology and pathomechanism is still not fully explained. It is believed to be present from early childhood and affects about 2.5% percent of the population (Kennerknecht, 2006). The severity of symptoms may vary greatly between individuals, influencing social life, employment opportunities and, in many cases, causing self-confidence loss and chronic anxiety (Yardley, 2008).

As there are no established diagnostic criteria for DP, clinical assessment is based mainly on self-reported difficulties in everyday life followed by various tests examining different processes within face recognition (Dalrymple, 2016), of which face memory and face perception are the most distinguishable.

Prosopagnosia Index (PI20) is one of the most popular self-assessment questionnaires for DP screening (Shah, 2015). It consists of 20 items regarding difficulties in face processing in daily situations. Cambridge Face Memory Test (CFMT) is the most widely known tool for detecting face memory impairment, characterised by its sensibility to a wide range of abilities (Duchaine, 2006). It has high internal and test-retest reliability (Bowles, 2009). Glasgow Face Matching Test (GFMT) is a useful in assessing face perception, which is measured by the ability to decide whether a face is of the same or different individuals (Burton, 2010).

Age, sex and ethnicity factors were described to influence performance on these available diagnostic tests (Bowles, 2009). A need for nationality-specific normative data and therefore different cut-off values was also suggested in the literature (Duchaine, 2006).

The aim of our study was to assess the prevalence and characteristics of DP in Polish population, as not enough data exists on this subject. We designed the research to be conducted online not only to improve the convenience, but also to recruit the most possibly representative group of respondents. Brian Nosek et al. (2002) indicates the accessibility of the study and the type of advertising as the most important factors that influence who would decide to participate. Social media communities are nowadays one of the most effective channels to access the entire cross-sections of society. *Google Form* is simple-designed, accessible from any electronic device tool, which allowed us to design and perform the research in an undisturbed way.

MATERIALS AND METHODS

The study was conducted from 1st of January to 31st of March 2019. A questionnaire consisting of PI20, CFMT, GFMT was administered online using *Google Forms* tool. Additional data on respondents' gender, age and handedness were also obtained.

Approximate time of questionnaire completion was 30 minutes. Respondents were recruited via social media announcements and there were no restrictions in regard to qualification to the study. All respondents gave an informed consent. Every participant was provided with personalised results analysis, which was sent with an e-mail. It was also possible to stay in contact with research authors, asking additional questions and giving remarks.

Questionnaires with missing data were excluded from further statistical analysis. Results from participants, who had already completed the form once and of these, who reported neurological or psychiatric disorders, severe head traumas in the past and technical difficulties while taking test also were not taken into consideration.

Cambridge Face Memory Test consists of 4 stages (one for practice and three in actual test) in which participant has to memorise six faces of young Caucasian males. All faces are cropped to remove hair and facial blemishes and are of neutral expression. In each item one had to choose a target face among two similar distractor faces. The difficulty keeps increasing in consecutive stages, as models are presented from different viewpoints and in the last stage Gaussian noise is also added to all faces. The maximum amount of points possible to score in CFMT is 72. According to normative data the adopted cut-off score for impaired face memory was 42.

In short version of Glasgow Face Matching Test participants need to analyse 40 pairs of faces in order to choose whether each pair represents faces of the same or different people. It includes both male and female faces, all of them with neutral expression and frontal view. The maximum total score in short version of GFMT is 40. Cut-off value was established as the result below 2 standard deviations.

A univariate quantitative and qualitative analysis was performed using STATISTICA (StatSoft, version 13.0). Significance level was established as $\alpha = 0.05$. Categorical variables were presented as a number and percentage and continuous ones as the mean and standard deviation (SD) or as the median. Chi-squared test for independence, Mann-Whitney U test and Spearman's rank correlation were used to establish a significance of differences.

RESULTS

Out of 1349 questionnaires submitted, 1276 met inclusion criteria and qualified for the analysis. 840 (66.1%) of respondents were women, 430 (33.9%) were men. Mean age was 28.3 years (median 25, range: 14-75). 111 (8.73%) were left-handed. Mean 20-Item Prosopagnosia Index score was 49.6 ± 18 (median: 45, range: 20-99). In 11.8% of respondents PI20 result indicated mild, in 8.3% moderate and in 3.9% severe DP.

For the whole respondent group, mean CFMT total score was 58.1 (median: 59, range: 26-72) and mean GFMT score was 33.9 (median: 34, range: 18-40). Particular tests results with regard to participants gender and handedness are presented in Table 1.

Table 1.

Results of PI20, CFMT and GFMT in specific groups of participants.

	Women	Men	P-value	Right-handed	Left-handed	P-value
PI20	50.1 (median: 45)	48.6 (median: 45)	0.39	49.7 (median: 45)	49.2 (median: 46)	0.84
CFMT	58.3 (median: 59)	57.6 (median: 60)	0.32	58.2 (median: 60)	57.1 (median: 58)	0.29
GFMT	34.2 (median: 35)	33.4 (median: 34)	0.002*	33.9 (median: 35)	33.8 (median: 34)	0.71

Note: p-value <0.05 was considered significant.

Fifteen out of fifty respondents (30%) who reported symptoms indicating severe DP scored below cutoff in CFMT. On the contrary, 30 out of 970 respondents (3.1%) reporting no problems with face recognition had CFMT total scores below cutoff. According to the cutoff values from the original paper (Duchaine, 2006), 81 (6.3%) of respondents scored below threshold in CFMT. 27 (2.4%) of participants scored below 2 standard deviations in GFMT, and 50 (3.9%) self-reported symptoms indicating severe DP.

Positive correlations were found between age and total CFMT score (R 0.08, $p=0.003$) and CFMT and GFMT scores (R 0.52, $p<0.001$). Negative correlations were established between PI20 and CFMT (R -0.42, $p<0.001$) and GFMT (R -0.35, $p<0.001$) scores, respectively. There was also a positive correlation between age and PI20 score (R 0.16, $p<0.001$). Although when participants were divided into two subgroups according to age: below 50 years old and 50 or more, older group had significantly lower mean total CFMT score (54.3 vs 58.2, $p=0.011$).

DISCUSSION

The estimated prevalence of developmental prosopagnosia in our study group was high in relation to existing normative data (Kennerknecht, 2006; Duchaine, 2006). This trend was particularly noticeable in the results of PI20, where 24% of respondents indicated at least mild disturbances in facial perception. The average PI20 score in the study group was higher than in other centers, where it was reported to be within 40-42 points (Gray, 2017; Shah, 2015). Although the average CFMT result in our study was similar to the original data (Duchaine, 2006), as many as 6.3% of participants were below the cut-off point established at that time. Such discrepancy may indicate that either frequency of DP in the Polish population is underestimated or the population participating in this web-based study

has shown some selectivity, which could raise concerns about the representativeness of the group collected through the internet. Participants in our study were recruited through social media. Posts were publicly available and participation in the experiment was voluntary, with no eligibility criteria set. It is therefore likely that people who had previously suspected facial recognition abnormalities were more likely to participate in it. This hypothesis seems to be confirmed by the fact that we observed both very high and very low scores more often than in similar trials (Shah, 2015; Duchaine, 2006; Bowles, 2009). This divergence may also result from the hyper-recognition of various psychosomatic disorders in a fairly young age group (average age of 28.26 years). Among the study participants, only 30% who reported symptoms indicating severe DP scored below cutoff in CFMT.

The sample collected via online form was relatively high comparing to similar studies (Bowles, 2009; Albonico, 2017; Herzmann, 2008). Some of them were also conducted using the Internet (Verhallen, 2017), although in the abovementioned experiment all participants already visited the laboratory before. In our study the duration to complete the whole test was quite long. Online surveys should be designed to be short and concise to ensure satisfactory response rate (Kaye, 1999). However the frequency of receiving subsequent replies was, in our observation, above the expectations. We also got in feedback many questions and remarks. We believe that the possibility of quick, direct contact with the authors, as well as the fact that each of the participants received a personalised analysis of their results soon after the solution, greatly improved the general reception and involvement of the participants in the study.

The majority of the analysed group were women, accounting for over 66% of respondents. Similar observation was made by other authors (Germine, 2012) and is consistent with the fact, that women are more likely to take part in online-based surveys and tests in general (Smith, 2008). Females scored significantly higher than males in GFMT, however difference in mean CFMT scores between men and women was not statistically significant. Small, but not significant woman advantage in CFMT was already reported (Duchaine, 2006; Bowles, 2009). Another study showed that women perform better in recognition of female faces, whereas there are no differences in such tasks using males as models (Lewin, 2002).

The impact of the online method of conducting the experiment on the results obtained is questionable. Validity and reliability of data collected through internet has already been confirmed not only for surveys and questionnaires, but also for more complex experiments, also related to face perception. Despite concerns about the lower quality of data collected in poorly controlled conditions, it has been shown that the results of online tests did not differ significantly from those carried out in the laboratory (Germine, 2012). In our study, out of 1349 questionnaires, 73 (5.4%) were excluded from the analysis. The reasons for the exclusion were mainly missing data, repeated participation and technical problems reported. These observations are very similar to those reported by Laura Germine et al. 2012. Other exclusion criteria listed include cheating or using the inappropriate device. Due to the low average age of the study group, it is unlikely that the results of the experiment could be affected by problems associated with the use

of technology or cognitive impairment. Participants over the age of 50 accounted for only 3.45% of the study group and obtained a significantly lower CFMT result than people under the age of 50. This difference is due to a natural decline in facial recognition from a certain age (Bowles, 2009; Lamont, 2005) rather than a lack of computer skills.

Another possible factor which may disrupt the objectification of results is the ethnic mismatch between the studied population and the used face stimuli. Face memory is weaker for faces of people of a different ethnic origin, which is known as other-race effect (McKone, 2012). Although CFMT uses young Caucasian male faces, which seems to be appropriate for Polish population, some authors indicate the need to adapt different norms and diagnostic criteria for even more specific demographic groups (Duchaine, 2006; Albonico, 2017). Currently different versions of the test using other sets of faces were developed in order to ensure the reliability while testing various populations (Bowles, 2009; McKone, 2017).

CONCLUSIONS

The estimated prevalence of developmental prosopagnosia in Polish population is higher than in normative data. These discrepancies may result from specific demographics of participant group more than an online-character of the study. It is important to focus on experiment design and methodology in order to maintain high quality of collected data.

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