Polish Adult Reading Test – PART – construction of Polish test for estimating the level of premorbid intelligence in schizophrenia

Hanna Karakuła-Juchnowicz[1, 2], Mariola Stecka[1]

[1] I Department of Psychiatry, Psychotherapy and Early Intervention, Medical University of Lublin
[2] Department of Clinical Neuropsychiatry, Chair of Psychiatry, Medical University of Lublin

Summary

Aim. In view of unavailability in Poland of the standardized methods to measure PIQ, the aim of the work was to develop a Polish test to assess the premorbid level of intelligence – PART (Polish Adult Reading Test) and to measure its psychometric properties, such as validity, reliability as well as standardization in the group of schizophrenia patients.

Method. The principles of PART construction were based on the idea of popular worldwide National Adult Reading Test by Hazel Nelson. The research comprised a group of 122 subjects (65 schizophrenia patients and 57 healthy people), aged 18–60 years, matched for age and gender.

Results. PART appears to be a method with high internal consistency and reliability measured by test-retest, inter-rater reliability, and the method with acceptable diagnostic and prognostic validity. The standardized procedures of PART have been investigated and described.

Conclusions. Considering the psychometric values of PART and a short time of its performance, the test may be a useful diagnostic instrument in the assessment of premorbid level of intelligence in a group of schizophrenic patients.

Key words: schizophrenia, premorbid level of intelligence, Polish Adult Reading Test

Introduction

In research studies on psychiatric and neurological disorders, there is still a great interest in the premorbid intelligence quotient (PIQ) [1, 2, 3]. Estimation of the PIQ level is useful not only for research, but it is also reflected in designing individual programs

of rehabilitation and treatment in order to achieve possibly the best improvement in the cognitive, and indirectly social functioning [4]. The difficulty in measuring premorbid PIQ in Polish conditions results from a lack of available assessment methods. One of the most widely used methods of measuring PIQ in neurological [3, 5] and psychiatric [6, 7] patients is the National Adult Reading Test (NART) by Hazel E. Nelson [7, 8]. This test provides important information about the functioning and cognitive potential of the patient by comparing the current IQ (WAIS-R), with premorbid IQ (NART) [4]. The author [8] points out that there is a lack of reliable methods for evaluating global cognitive functioning simultaneously taking into account the occurrence of a specific disorder, e.g. in the early stages of dementia. In the course of routine tests, she showed that among patients with dementia reading ability remained at high level relatively long despite the progressive disorder. This observation gave rise to the hypothesis concerning the ability of reading irregular words, as a new index for evaluation of PIQ. Based on the results of her research, Nelson developed a NART, which is designed to estimate premorbid intelligence in people with cognitive deterioration resulting from psychiatric and neurological disorders [7, 9]. The test can be used in studies of patients with schizophrenia and depression because of the relative resistance of this method for this kind of disease factors [8].

NART is based on the assumption that knowledge of words is strongly correlated with cognitive abilities [10, 11, 12]. Other methods based on this assumption [2] are: Wechsler Test of Adult Reading (WTAR) [4], Spot-the-Word (STW) [13], Swedish Lexical Decision Test (SLDT) [9], Mehrfachwahl-Wortschatz-Intelligenztest (MWT) [14], the Wide Range Achievement Test (WRAT) [15] and Cambridge Contextual Reading Test (CCRT) [16]. The popularity of NART is evidenced by the fact that it has been translated and adapted to local conditions in many countries around the world, including USA – American Adult Reading Test (AMNART) [4, 17] and North American Adult Reading Test (NAART) [14], Denmark – Danish Adult Reading Test (DART) [10], Japan – the Japanese version of the National Adult Reading Test (JART) [18], Sweden – National Adult Reading Test Swedish (NART-SWE) [13], France – French National Adult Reading Test (fNART) [19], as well as in New Zealand – the New Zealand Adult Reading Test (NZART) [20].

So far, a method that would enable the estimation of premorbid IQ level has not been developed in Poland. Research results indicate the possibility of lowering the level of intellectual functioning in the course of schizophrenia [21], and the changes in the level of IQ may be present long before the development of the disease [22, 23]. Hence, an important part of neuropsychiatric and neuropsychological diagnosis of a patient is to assess premorbid intelligence level [24, 25]. So far, the assessment of the PIQ level has usually been made using a scale by D. Wechsler – WAIS-R-PL [22] and due to the lack of available verbal methods by analyzing the demographic variables, that is gender, age, education [2].

Aim

The aim of this study was to design Polish version of NART – Polish Adult Reading Test (PART) and to evaluate its psychometric values: diagnostic and predictive validity, reliability and standardization.

Material and Method

The study group consisted of 122 people, comprising 65 people with schizophrenia according to ICD-10 [26], hospitalized in the Department of Psychiatry, Medical University of Lublin and the Independent Public Psychiatric Department for Care and Treatment in Celejow and Nałeczow, being the clinical group, and 57 healthy controls matched for age and sex to the clinical group – the controls. They were recruited to the examination from the hospitals staff, their families and students which were taken part in the classes.

The inclusion criteria were as follows: 1. the expression of informed written consent to participate in the study; 2. age of 16–60 years; 3. no failure of hearing and vision organs, or in the event of a failure, the use of corrective glasses or a hearing aid, respectively; 4. balanced, stable somatic condition; 5. no symptoms indicating the occurrence of dementia, addiction to psychoactive substances (with the exception of nicotine), according to the psychiatric evaluation by one of the researchers (HKJ). In addition, with respect to the group of patients with schizophrenia – criterion 7. remaining in the remission of symptoms.

Description of study group

The study group consisted of 122 people: 65 (M = 37, F = 28) patients with schizophrenia – the clinical group and 57 (M = 24, F = 33) healthy people – the controls. The age range of the respondents was between 16 and 60 years. The mean age of clinical group was 35.5 (SD = 9.47) for women, and 39.5 (SD = 14.2) for men and of the control group 37.5 (SD = 15.6) for women and 37.1 (SD = 12.1) for men. Comparison of the two sub-groups, the clinical and control group in terms of sex (p = 0.15) and age (p = 0.87) showed no significant differences, indicating that both groups were well matched in this regard.

Most people (20F and 13M) included in the control group had a secondary education (60%), while in the clinical group: vocational education (6F and 11M; 28%) and secondary education (11F and 10M; 31%). The groups differed in terms of the level of education (p < 0.001), the results indicate that people with schizophrenia already in the premorbid phase showed a greater difficulty in learning, getting a lower level of education compared to people who did not become ill in later years. This observation is consistent with the findings presented by Meier [11], who claimed that the lower premorbid IQ maybe a predictor of later developing schizophrenia, and showed a decrease in the IQ level during the course of schizophrenia.

For the methodology purposes in accordance with the procedure used by Nelson [27] and Matsuoka et al. [18], a random distribution of the control group into validation (10M and 18F) and computational (14M and 15F) was made.

The purpose of this was to assess the Verbal IQ, Performance IQ and Full scale IQ based on the obtained number of errors in PART in computational group, and on these grounds estimating the predicted IQ in the validation group. Such a method allows the assessment of the accuracy of the method in the control group, in order to apply then the method in the clinical group.

The randomness of the distribution was checked by chi-square test and Wilcoxon test – these groups did not differ significantly by any feature. The gender distribution in the two separate groups was similar.

Differences between groups: computational group and validation group did not show any statistically significant differences in relation to age and gender of the subjects. The one-way ANOVA test revealed the existence of differences in the groups: clinical, computational, validation in terms of years of education ($p < 0.001$), which appears to be the result corresponding with observations concerning the lower IQ level in patients with schizophrenia [11].

The applied research methods

Polish Adult Reading Test

Polish Adult Reading Test is used to examine premorbid intelligence. The construction of this test is based on the idea of creating a NART by Nelson [27, 28].

In the first stage, the construction of the test consisted in selecting irregular words, defined as those words, in case of which there are differences in the graphene-phoneme correspondences [18, 27]. The choice of such words by Nelson is used for checking intellectual ability, not ability to read phonetic symbols. In the Polish language, there are no words with irregular pronunciation, hence after the analysis of the NART construction in other languages, e.g. Danish [10], German [14], Swedish [9] and Japanese [18] and after consultation with a Polish linguist dr Anna Majewska-Wójcik at Polish Philology Institute of the Catholic University of Lublin, there were selected words from the Dictionary of Foreign Words [5] borrowed from foreign languages (among others, English, French, Italian) with a graphical notation different from the phonetic pronunciation, that are used today. From the Dictionary of Foreign Words there were selected originally 98 words differing by graphical notation from the phonetic pronunciation, which formed the experimental version of PART. On the example of NART [8, 27] and NART-SWE [9] there were taken into account words of the names of well-known people in different cultures, e.g. Richelieu and Einstein.

The second stage of construction of the test assumed individual conducting of the test in a group of 57 healthy persons as a control group and in 65 people with schizophrenia, who constituted a clinical group. The study was carried out in good audibility without external distractors. Before the start of the test, each participant was asked

about the efficiency of the eyesight, in the cases of deficits in this regard, the respondents were asked for putting on corrective glasses. The respondents received the list of 98 words included in the experimental version of PART on the A4 sheet, (computer printout, Times New Roman, font size 12) with the instruction "Please, read slowly aloud the following words". On the researcher's sheet next to the words, there was correct pronunciation and a place to enter the answer. For the correctly read word the respondent scored 1 point, for the erroneously read word: 0 points. Time of performing PART was minimally 2 minutes, maximum 10 minutes, and an average of 6 minutes.

The third stage of construction of the test was associated with extracting, like in NART construction, 50 words with the highest discriminatory power (meaning that these words have the greatest influence on the predicted IQ (PIQ), the creation of the final version and examining its psychometric values.

Wechsler Adult Intelligence Scale WAIS-R – PL

The most commonly used test for testing the intelligence in Poland is the Wechsler scale – WAIS-R-PL for adults, based on the basis of the Wechsler-Bellevue test from 1939 [4]. This test measures verbal and non-verbal ability and general ability; it differentiates the norm and mental retardation (mild, moderate, severe and profound) [22]. In a situation where a full examination with the Wechsler scale is not possible, selective treating of the test is recommended, and the use of a few selected scales. Wechsler [4] suggested the use of the Vocabulary, Information, and the Picture Completion. Subtest Vocabulary is a good diagnostic scale due to the measurement of verbal intelligence, relatively resistant to the time factor [22].

The testing procedure involved the administration of WAIS-R-PL and experimental version of PART on the same day.

Results

Comparison of IQ in study groups

The results obtained with the WAIS-R-PL scale indicate the existence of significant differences in the level of verbal ($p < 0.001$), performance ($p < 0.001$) and full scale intelligence ($p < 0.001$) between the clinical group and control group, while the patients diagnosed with schizophrenia had significantly lower IQ compared to the control subjects.

Selection of words in the final version of PART

After selecting 98 words from the Dictionary of Foreign Words, the test was conducted, with 122 respondents, consisting of 57 subjects in the clinical group and 65 subjects in the control group. The choice of vocabulary in the final version was made on the basis of the results obtained by the control group. The choice of vocabulary in the

final version of PART was guided by the principles of construction of NART [1, 7], too easy words that the majority of respondents read correctly (words with discriminatory power above 78% of correct answers), and the too difficult words that the majority of respondents read incorrectly (words with discriminatory power under 26% of correct answers), were rejected. The results were subject to analysis of variance, which showed that in the list of words presented in the study there were no words of a zero variance, i.e. words which received 100% of correct or incorrect answers. It has been shown that the most difficult word was the word foyer (14% of correct answers), which did not enter into the final list of words. In contrast, the easiest word was disco polo (87% of correct answers), which may indicate the socio-cultural changes with time passing by. Basing on construction of NART, abbreviations, for example CD, were rejected. Analyses were also carried out using the Spearman's r test, which aimed to assess the association between the result of PART, and the result of verbal, performance and full scale intelligence WAIS-R-PL, so that the selected words for the final version of PART could be the best IQ predictor.

The final version of the test included 50 selected words presented in Table1. These words had a significantly high rate of correlation, demonstrating the fact that the words selected to PART using statistical analyses are a good IQ indicator in the validation group and, therefore, maybe a good PIQ predictor in the clinical group. Analysis of words chosen for the final version of PART revealed that the chosen words are characterized by 26%–78% (min. *faux pas* – 26%, max. Whisky – 78%) correctness of reading. The words which, due to a very low correlation significance coefficient with IQ (r less than 0.46) were not included in the final version of the test, include, among other things: *de facto,* curry*, quo vadis* and *ad hoc.*

Table 1. **List of vocabulary selected to the final version of PART**

Word	Spearman's r	P	N	%	Word	Spearman's r	p	N	%
Fast food	0.64	0.001	77	63	Manicure	0.54	0.001	73	60
Jacuzzi	0.63	0.001	76	62	Weekend	0.53	0.001	90	74
Leasing	0.64	0.001	70	57	Ecru	0.53	0.001	59	49
Outsider	0.64	0.001	62	51	Fair play	0.53	0.001	74	61
Zombie	0.64	0.001	84	69	Thriller	0.52	0.001	77	63
Science fiction	0.63	0.001	71	58	Mademoiselle	0.52	0.001	38	31
Outlet	0.63	0.001	58	47	Sacrum	0.52	0.001	89	73
Paparazzi	0.62	0.001	79	65	Popcorn	0.51	0.001	91	75
Joystick	0.61	0.001	75	61	Blues	0.51	0.001	89	73
Einstein	0.60	0.001	71	58	Deja vu	0.52	0.001	48	39
Talk show	0.61	0.001	60	49	Whisky	0.50	0.001	95	78
Mail	0.59	0.001	75	62	Faux Pas	0.50	0.001	32	26
Peeling	0.59	0.001	71	58	Football	0.50	0.001	82	67

Make up	0.59	0.001	67	55	Mafioso	0.49	0.001	83	68
Walkman	0.59	0.001	59	48	Broadway	0.49	0.001	83	68
Dealer	0.58	0.001	81	66	Macho	0.49	0.001	72	59
Postscriptum	0.58	0.001	88	63	Mozzarella	0.48	0.001	73	62
Sitcom	0.58	0.001	74	61	Pizza	0.48	0.001	92	75
Boom	0.58	0.001	79	64	Rock	0.48	0.001	90	74
Pub	0.57	0.001	77	63	Lady	0.48	0.001	83	68
Wall street	0.56	0.001	73	60	Richelieu	0.47	0.001	49	40
Tabasco	0.55	0.001	86	75	Yeti	0.47	0.001	93	76
Sex Appeal	0.54	0.001	54	44	Vademecum	0.47	0.001	92	75
Va banque	0.54	0.001	82	67	Chili	0.46	0.001	83	68
Alzheimer	0.54	0.001	64	53	Sensu Stricto	0.46	0.001	71	58

Psychometric values of PART

Creating a new diagnostic method under existing psychometric procedures, evaluation of its validity, reliability and standardization is carried out [29, 30].

Validity

While assessing the test, the sum of incorrectly read answers in PART was taken into consideration, on the basis of which regression equations were created for the verbal, performance and full scale IQ in the computational group. Because of testing of the model within the control group, further analyses were related to the use of these equations to estimate the verbal, performance, and general IQ in the validation group using the slope of regression line method.

Regression model showed significance for the verbal (p = 0.001), performance (0.0069) and full scale IQ (0.0003) (Table 2). That means that there are statistically significant relationships between the results of PART and WAIS-R-PL. Whereby, verbal intelligence WAIS-R-PL correlated most with the number of errors in PART.

Table 2. **Beta coefficient of slope of the regression line for the verbal, performance, and the full scale IQ in the computational group**

IQ	PART				
	B	r^2	r^2 aligned	Snedecor's F	P
Verbal IQ	-0.80	0.42	0.40	19,73	0.0001
Performance IQ	-0.71	0.24	0.21	8.54	0.0069
Full scale IQ	-0.77	0.39	0.37	17.46	0.0003

These data confirm the value of PART, as a verbal method to measure PIQ.

Diagnostic and prognostic validity

Diagnostic validity understood as the degree of data fit to the model in the computational group evaluated using the coefficient of determination was: for the verbal IQ $r^2 = 42\%$, for the performance IQ $r^2 = 24\%$, for the full scale IQ $r^2 = 39\%$. This means that, for example premorbid IQ, which we predict on the basis of the results of PART, explains at 42% the current level of IQ WAIS-R-PL. PART predicts the best the verbal IQ, also relatively well it predicts the full scale IQ, however, it predicts performance IQ in a relatively low degree.

Predictive validity understood as the degree of data fit to the model in the validation group, between the current level of intelligence tested with WAIS-R-PL, and the expected result of PART intelligence based on the regression equation from the computational group was: for the verbal IQ – 61%, for performance IQ – 53%, for the full scale IQ – 71% (Figure 1). These results indicate that PART assesses the predicted premorbid level of verbal as well as full scale intelligence, relatively well. At the level of 53%, this test explains the level of the predicted performance IQ, which is a statistically significant result ($p < 0.001$), although low. It easily predicts premorbid level of full scale intelligence; at 71% it clarifies the predicted IQ, which is high and statistically significant result ($p < 0.001$).

Linear regression graph of verbal IQ WAIS-R-PL with IQ measured with PART confirms a relatively large scatter of results in IQ at average level, and with less scatter of IQ results at high level. This means that PART better estimates the verbal IQ, if it is at a high level, and full scale IQ.

For a more complete evaluation of the test, the correlation in the validation group, between the estimated IQ resulting from the number of generated errors in PART and the results of WAIS-R-PL, was analyzed, which illustrates the existence of a strong significant relationship between predicted IQ in PART, and the verbal IQ ($p = 0.001$), the full scale IQ ($p = 0.001$) and performance IQ ($p = 0.001$), confirming the accuracy of the method.
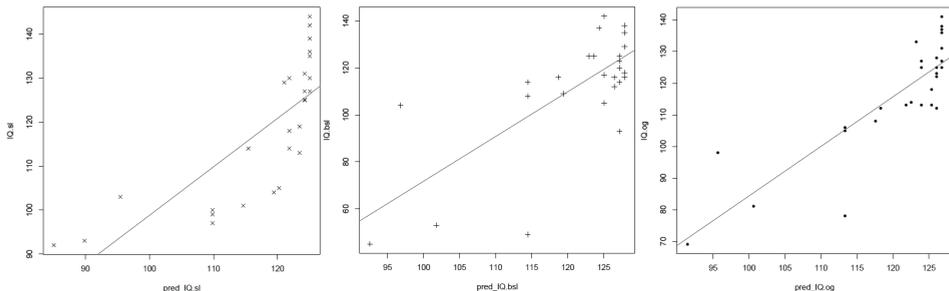

Figure 1. **Linear regression equations showing the correlation between the expected IQ in PART and verbal, performance and full scale IQ WAIS-R-PL**

Reliability

Reliability is a concept determining the accuracy of the measurement of the studied feature [31]. In PART, the reliability determined by standard errors of measurement (SE), in the computational group was: for the verbal IQ – SE = 12.53, for performance IQ – SE = 17.03, for the full scale IQ – SE = 12.93. These results are relatively high, which means that the confidence interval between the obtained result and the possibility of error is large, for the verbal IQ SE is 12.53, which means that the estimated result in PART was in the interval of error 12.53, and with the verbal IQ of 120, the interval of error is 108–132. The confidence interval is relatively wide, which means less risk of error in making an estimation of diagnosis of intelligence, but may also mean difficulty in precise determining of the IQ level. There is a possibility that such a wide interval of confidence may be due to the small sample size, so further analysis, which will include larger samples of respondents, should be carried out.

As part of the procedures for measuring the reliability of PART the following parameters were also rated:

- absolute stability of the test using the test-retest method, by performing the test after 1 week. The correlation coefficient between the two obtained results was r = 0.99, which means a very strong significant correlation, which indicates the stability of the test;
- the comparability of the assessments made by two independent researchers (inter-rater reliability), in this case the evaluators were HKJ and MS. Analysis of reliability showed a very high compliance of estimates of researchers (r = 0.98), indicating a very good psychometric properties of PART in this regard.

Based on test data, linear regression equations were created relating to the clinical group, to analyze the reliability of the method. These equations estimate how exactly the quotients of predicted verbal, performance and full scale intelligence of PART explain the observed level of verbal, performance and full scale intelligence in WAIS-R-PL.

1. Verbal IQ = 124.9432 – 0.7980 x Number of errors in PART (p = 0.0001);
2. Performance IQ = 127.9096 – 0.7137 x Number of errors in PART (p = 0.0069);
3. Full Scale IQ = 126.7215 – 0.7748 x Number of errors in PART (p = 0.0003).

These equations are characterized by a high level of significance, which means that PART predicts well the premorbid verbal, performance and full scale IQ according to the principle that the fewer mistakes in PART, the higher the level of premorbid intelligence. In analyzes of reliability of the test, its consistency was also investigated using Cronbach's alpha coefficient. The obtained result of the coefficient = 0.99 is greater than widely considered to be a satisfactory level of 0.9, which indicates a very high consistency of the items constituting PART.

Standardization

Standardization means the uniform method of using the test by different people, regardless of where the study is conducted [30]. The aim of precise description of the test is to minimize the impact of external factors on the part of the researcher and the harmonization of conditions for carrying out research [31]. Based on research, the principles of using PART were created, taking into account the following procedures: collecting history about vision-hearing deficits and their possible correction, familiarizing the respondent with the instruction of test performance, reading the list of 50 words by a subject, listing the number of wrongly read words during the study, counting wrong answers and comparing them to the key. The number of wrong answers in PART corresponds to the predicted premorbid IQ, according to the key contained in Table3.

Table3. **The level of PIQ assessed in relation to the number of errors obtained in PART –Key**

Number of errors	Verbal IQ	Performance IQ	Full scale IQ	Number of errors	Verbal IQ	Performance IQ	Full scale IQ	Number of errors	Verbal IQ	Performance IQ	Full scale IQ	Number of errors	Verbal IQ	Performance IQ	Full scale IQ	Number of errors	Verbal IQ	Performance IQ	Full scale IQ
1	125	128	127	11	116	120	118	21	108	113	111	31	101	106	103	41	93	100	96
2	124	127	126	12	115	119	118	22	108	113	110	32	100	106	103	42	92	99	95
3	123	126	125	13	115	119	117	23	107	112	109	33	99	105	102	43	91	98	94
4	122	126	124	14	114	118	116	24	106	111	109	34	98	104	101	44	91	98	94
5	122	125	124	15	113	117	115	25	105	111	108	35	98	104	100	45	90	97	93
6	121	124	123	16	112	117	115	26	105	110	107	36	97	103	100	46	89	96	92
7	120	124	122	17	112	116	114	27	104	109	106	37	96	102	99	47	88	95	91
8	119	123	121	18	111	115	113	28	103	108	106	38	95	102	98	48	87	95	91
9	119	122	121	19	110	115	112	29	102	108	105	39	94	101	97	49	87	94	90
10	118	121	120	20	109	114	112	30	101	107	104	40	94	100	97	50	86	93	89

Conclusions

Polish Adult Reading Test (PART) is the only so far available in Poland method that allows examination of premorbid intelligence level in patients with schizophrenia [3]. A definite advantage of PART is the clear instruction, a short time of the test performance, as well as the transparency of the method, which seems to be particularly important in the case of testing psychiatric patients. In addition, the test has a good psychometric properties: 1). high reliability in terms of procedures: test-

retest (r = 0.99), inter-rater reliability (r = 0.98), internal consistency (Cronbach's alpha = 0.99); 2). moderate validity: a. diagnostic validity (coefficient r^2 for verbal IQ – r^2 = 42%, for performance IQ – r^2 = 24%, for the full scale IQ – r^2 = 39%; b. predictive validity: for the verbal IQ – 61%, for the performance IQ – 53%, for the full scale IQ – 71%. Based on the research, PART can be considered a useful method in the evaluation of the level of premorbid intellectual functioning; however, further studies which will include larger groups of subjects with a wide variety in terms of the variables related to the course of the disease and the age of patients seem to be necessary.

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Address: Mariola Stecka
I Department of Psychiatry
Psychotherapy and Early Intervention
Medical University of Lublin
20-439 Lublin, Głuska Street 1
mk.stecka@gmail.com