Distributors of Psytech International

Assessment Instrument and Software

Abstract Reasoning Test (ART)

South African User Guide and Research Reference

Psytech South Africa
Nanette Tredoux
Crystal Clack

Abstract Reasoning Test (ART)

Introduction

Table of contents: Introduction

This guide is for users and potential users of the Abstract Reasoning Test (ART).

It should be used in conjunction with the Abstract Reasoning Test Technical Manual published by Psytech International.

This guide does not replace the Technical Manual, but it is intended to provide the additional information on the ART that South African users need.

This user guide will be updated regularly as new research evidence becomes available.

Psytech manuals are distributed on CD or flashdrive at a nominal cost. Extracts as well as updates are published on the company's website from time to time. It is recommended that users print the manuals and update sections as new studies become available. Printed copies of the latest versions of the user guides can also be purchased from the company if users prefer not to download the document themselves.

Structure of this manual

The manual is divided into the following sections:

- **Introduction**
  - This section covers the background to the questionnaire, administration instructions and general advice on the use of the ART in South Africa.
- **Norms**
  - This section contains descriptions of the various norm groups available for the various subtests of the ART – the composition of the norm groups, basic statistics on ART subtests and stanine tables.
- **Reliability**
  - This section contains reports on the reliability studies done on the ART in South Africa – the composition of the groups, reliability coefficients and standard error of measurement where suitable data exists.
- **Validity**
  - This section contains reports on the validation studies done on the ART in South Africa.

Studies will be added to the various sections as they are completed. The date when it was last updated appears on every study.

Every section has its own table of contents and introductory section.

Classification status of the Abstract Reasoning Test

The ART has not yet been submitted for classification. The established psychometric properties are discussed in the body of this manual, and covers reliability, validity and bias.

Conditions of use and professional responsibilities

The ART must be used under the control of a registered Psychologist, Psychometrist (Independent Practice), or Registered Counsellor.

Purchasing Abstract Reasoning Test materials and scoring services

When purchasing test materials or scoring services relating to the ART, the signature and registration number of a Psychologist, Psychometrist (Independent Practice) or Registered Counsellor is required.

Constructing of test batteries

Only a Psychologist, Psychometrist (Independent Practice) or a Registered Counsellor may decide which tests or questionnaires to use for a particular purpose. Psychometrists registered for supervised practice or other role players such as HR Practitioners or line managers may not act independently of the psychology registered professional, and may not overrule their decisions in this regard.

Administration of the Abstract Reasoning Test

- The tests may be administered by a Psychologist, Psychometrist (Supervised Practice), Psychometrist (Independent Practice), Registered Counsellor or Psychotechnician.

- Psychometrists (Supervised Practice) have to be supervised by a Psychologist.

Scoring of the Abstract Reasoning Test

The ART may be scored by

- A Psychologist,
- A Psychometrist (Independent Practice),
- A Psychometrist (Supervised Practice),
- A Registered Counsellor, or
- A Psychotechnician.

The scoring of the ART is always done by computer. The act of scoring is pure data capture and no interpretation is involved.

Detailed instructions for scoring the ART by computer can be found on the GeneSys Online platform, under tutorials. There are videos and downloadable PDFs. Special training in the use of the software is available and we strongly recommend attending this.

Reporting on the Abstract Reasoning Test

The choice of which computerised report to use should be made by

- A Psychologist, Psychometrist (Independent Practice) or a Registered Counsellor.

Psychometrists (Supervised Practice) and Psychotechnicians should consult with a Psychologist about the most suitable report to use.

The choice of which norm group to use should be made by

- A Psychologist, Psychometrist (Independent Practice) or a Registered Counsellor.

Psychometrists (Supervised Practice) and Psychotechnicians should consult with a Psychologist or Psychometrist (Independent Practice) about the most suitable norm group to use.

Feedback on Abstract Reasoning Test reports

Feedback on the ART reports may be done by Psychologists, Psychometrists (Independent Practice) or Registered Counsellors. Psychometrists registered for supervised practice may give feedback on the ART within clearly circumscribed guidelines laid down by a Psychologist or Psychometrist (Independent Practice), and provided proper supervision, with regular consultation, is maintained.

What the Abstract Reasoning Test measures

The ART measures the ability to understand abstract logical problems and use new information outside the range of previous experience. This is the purest form of mental ability and is least affected by previous education and achievement.

For detailed information about the constructs measured by the ART, please consult the technical manual. The technical manual gives an overview of the theoretical basis for the constructs, as well as a more in-depth discussion regarding the development rationale and the relationship of the ART to other measures of ability.

Administration options for the Abstract Reasoning Test

The ART may be administered independently or may be combined with other measures, such as measures of personality, verbal or numerical ability of the appropriate level (i.e. CRTB2) or technical ability, to form a customised battery. The table below should help with the planning of a test battery:

Test	Time Limit	Pencil and Paper administration available	Computerised administration available
Abstract Reasoning	30 minutes	Yes	Yes

Respondents for whom the Abstract Reasoning Test is suitable

The ART is suitable for assessing individuals of various educational backgrounds and cultural groups.

Level of Education

The ART is intended for respondents with post-matric level qualifications, or respondents who are expected to function at a post-matric level. Since the ART measures abstract reasoning, it may be used on persons with lower levels of education, provided the purpose of the assessment justifies this.

Proficiency in English

The test user should bear in mind that even persons with post-matric qualifications can have widely varying levels of proficiency in English. Even though the items are largely of a non-verbal nature, the instructions are nonetheless delivered verbally and in English. The responsible psychology professional should ensure that respondents understand what is required of them in the test.

Standardised tests of English proficiency from other sources, such as the Elsa-plus from Kaleidoprax, or the HSRC's standardised tests of English proficiency, can also be considered.

A history of the Abstract Reasoning Test in South Africa

The Abstract Reasoning Test was introduced in South Africa in 2012. Initially it was used to assess managerial candidates, and undergraduate students. It took a long time to collect sufficient data for item bias studies, because initially the vast majority of the respondents were not white due to implemented Affirmative Action policies.

The effect of affirmative action recruitment and selection practices on test statistics

Many employers in South Africa are adopting affirmative action recruitment and selection practices. Because most of the data available to Psytech SA come from recruitment projects, this has an effect on the reported test statistics.

A very common strategy when recruiting candidates for affirmative action positions, is as follows:

- Seriously consider every applicant from a formerly disadvantaged background who may possibly meet the requirements of the position.
- Only consider applicants from formerly advantaged backgrounds once a quota of formerly disadvantaged individuals has been met, or when the supply of suitable disadvantaged applicants has been exhausted.

Assessing candidates with psychometric tests incurs a cost for the employer, and employers usually try to minimise costs. Thus testing occurs fairly late in the selection process. Frequently candidates are evaluated on application forms, CVs and interviews before they are tested. Often this means that the candidates from formerly advantaged backgrounds, who are tested, have been more rigorously pre-screened than the candidates from formerly disadvantaged backgrounds. This serves to aggravate the reported group differences on the tests, and can make a test appear more biased than it otherwise would be.

Users are advised to bear this in mind when evaluating the reported figures in this manual. Test users are also welcome to approach Psytech SA when large recruitment projects are being undertaken, so that the project can be planned in such a way as to render less distorted information about the tests. If necessary and justifiable in the interest of research, Psytech SA is willing to subsidise such projects.

Some cautionary notes

- ART should not be used on its own as a selection instrument. It should always form part of an assessment battery that includes other measures, and preferably some non-test information as well.

- It is strongly recommended that a validation/integration interview should follow any assessment by means of tests or questionnaires. The interviewer should use this opportunity to put the test results into perspective relative to the respondent's background and the purpose of the assessment.

- Users should pay attention to the reliability and validity data available relating to the population group on which they intend to use the questionnaire.

- Users should use norm groups that are appropriate for the test person being assessed, also bearing in mind the demands of the situation for which the person is being assessed.

- Bearing in mind that the ART is very short, users should consider that it is not an in-depth measure, and therefore the ART should not be interpreted in isolation.

Computer-assisted reports

Psytech tests and questionnaires are all supported by computer-assisted reports. Some of the tests have a range of computer-assisted reports, allowing instant interpretation of the test results from a variety of perspectives. For the ART, a Standard Report and a Feedback Report are available, in addition, a results summary spreadsheet is available to generate which is particularly useful as a summarised version of the individual candidates scores, or scores of a group of candidates that have completed the ART. Computerised reports can also be created for specific batteries of measures, integrating the results of ability tests with personality and perhaps interests.

How do the computer-generated reports work?

The reports represent an expert system, drawing on numerous built-in relationships between patterns of scores and human behaviour. It would normally take a user many years of experience to gain the knowledge and insight that are contained in this reporting system.

What are the advantages of computer-generated reports?

Computer-generated reports ensure that the complete pattern of scores is interpreted every time. No score or combination of scores is overlooked. Everyone is treated in exactly the same way, irrespective of whether the person interpreting the results is having an 'off day' or is pressed for time. This helps to ensure fairness and consistency. Moreover, computer-generated reports save a lot of time, freeing the professional up to add value in the interview, integration of results from other sources and feedback processes.

Are computer-assisted reports open to abuse?

Like any powerful tool, computer-assisted reports can be misused. They should not be used to substitute for professional expertise, but rather to supplement and support it.

One must remember that these reports are generic-the standard reports do not know anything about the requirements of the positions that the respondent may have applied for. They are also completely unaware of the respondent's background and personal circumstances. They can usually not stand on their own, but must be used as one source of information in the assessment process, and be integrated with other information. This integration and interpretation is highly skilled professional work, and it should not be left to persons who have not had the required training.

In some situations, handing out unaltered computer-generated reports to respondents or line managers without any counselling or explanation, could be considered abuse of these reports. We recommend that the technical appendix in a report, which gives a graphic summary of raw scores and profiles, not be given to untrained persons.

What about competency-based reports?

You need not be limited to the reports supplied with the GeneSys online platform. Special reports can be written for clients based on their own competency models, or based on the results of validation studies. Psytech SA undertakes to do these as consulting projects, and the cost is dependent on the length and complexity of the report that the client requires.

Administration instructions for the ART

The ART can be administered either on the computer, via the GeneSys online platform, or with paper and pencil.

For instructions on how to operate the platform for test administration, please refer to the GeneSys Online platform, under tutorials via https://eu.genesysonline.net/. There are videos and downloadable PDFs. Special training in the use of the software is available, which is strongly recommend. Do not attempt to use computer software for test administration if you are not completely comfortable with how the online platform works. Familiarise yourself with the process of setting up a testing session with the software, creating the data record and entering the respondent's biographical information into the system, or assisting the respondent in doing so themselves.

Comprehensive instructions for pencil and paper administration for the ART are included in the Technical Manual for the ART.

Abstract Reasoning Test (ART)

Norms Introduction

Table of contents

South African Norms available for the Abstract Reasoning Test (ART)

Different types of norms available

There are two kinds of norms available for Psytech tests. Many of the norm groups are based on means and standard deviations obtained through research. These means and standard deviations are used by the GeneSys online system to calculate standard scores. In the case of the ART, stanines are used.

Users of the test do not need to look up raw scores to find the corresponding standard scores, because the software does it for them. For this manual, however, stanine tables have been specially calculated from means and standard deviations to facilitate comparison between norm groups, so that users can more easily choose which norm group is most suitable for a given situation. This allows users to make a more informed choice rather than simply relying on automatic choices made by the online platform.

The second type of norm is the frequency norm. In this case, more information is stored internally, and it is possible to add additional cases to the norm group as more data are collected. The GeneSys online platform is able to create tables of standard scores for frequency norms. The tables of standard scores are provided for interest and information, which would assist when comparing one norm group with another. For the purpose of generating a report, the online system does the calculations internally, and does not refer to any tables.

Biographical data

The GeneSys online platform offers the facility to collect comprehensive biographical information on respondents. Unfortunately, test users very seldom collect these data. Having this information incomplete poses a serious concern for us as Psytech SA obtains most of its information from clients who use the assessments.

Users are advised to make an effort to capture full biographical information on the respondents. This will help to enable them to adhere to best practice and compliance with legal requirements.

SA Norms and international norms

The GeneSys online platform contains international norms on all Psytech tests, besides the South African norms that have been collected by Psytech South Africa.

Unless you have a very good reason to do otherwise, we recommend the use of South African norms rather than international norms. The South Africa norms are clearly marked with ‘SA’ in the heading. All other norms that do not include ‘South Africa’ or ‘SA’ in the heading are international norms. If you are assessing a person for placement overseas and you have a suitable international norm available, you could consider using the international norm in conjunction with a South African norm.

Outdated or unsuitable norms are subject to removal from the GeneSys online platform but would still be reflected in the South African User Guide as it serves as a repository of all research that has been done to date.

User-developed norms

The GeneSys online platform offers users the facility to generate their own norms on the data they have collected - these are frequency norms. Users must ensure that the data included in these in-house norms are “clean” – that they contain no dummy cases resulting from experimenting with the software, duplicates or other data that could interfere with the interpretation of the results. Psytech SA offers assistance in the creation of in-house norms for users who need it. If the norm group was generated on your own computer and not shared with Psytech SA, it will not appear in the documentation.

The norms we recommend and have calculated are based on standard deviations and means and are only added to the online system after they have done through an elaborate process of cleaning the data by removing duplicates, dummy and test cases and other data to make sure that users are using norms that were calculated on uncontaminated data (as far as is possible).

Choose the comparison group with care. Bear in mind factors such as race, language, level of education and level of proficiency in English.

List of South African norm groups for the Abstract Reasoning Test (ART)

Description	Study number
SA Aggregate Population 2017	N1
SA Afrikaans 2017	N2
SA English 2017	N3
SA Indigenous 2017	N4
SA isiZulu 2017	N5
SA Sepedi 2017	N6
SA Sesotho 2017	N7
SA Setswana 2017	N8

Abstract Reasoning Test (ART)

Norm Group: SA Aggregate Population, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 2191 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	999	999	45,59562	45,5956
M	1122	2121	51,20949	96,8051
U	66	2187	3,01232	99,8174
Missing	4	2191	0,18257	100,0000

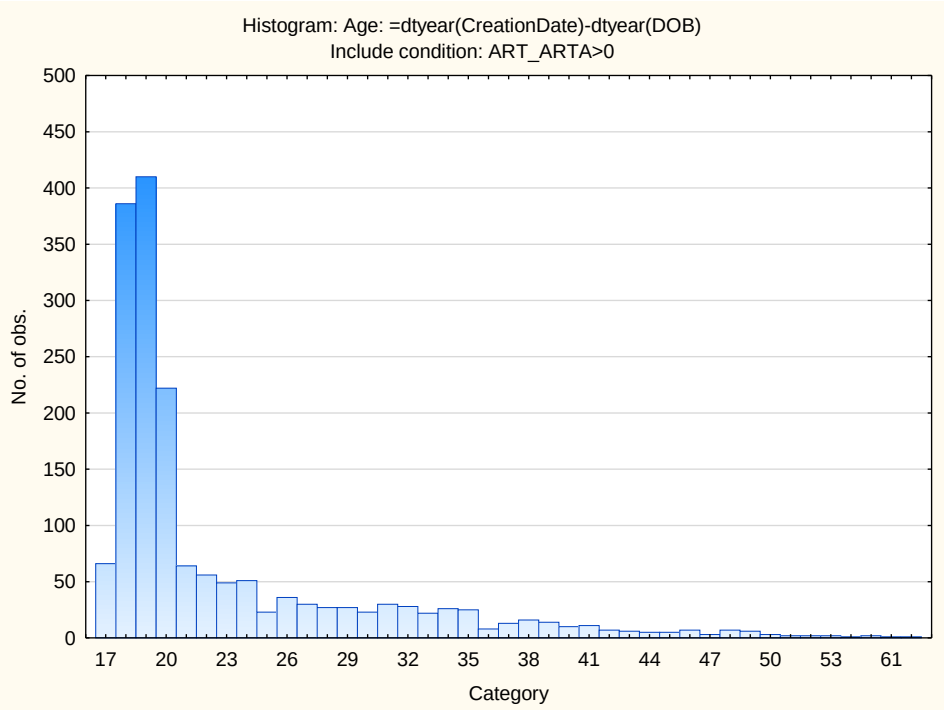
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	417	417	19,03241	19,0324
Grade 12	1272	1689	58,05568	77,0881
Post Graduate	303	1992	13,82930	90,9174
< Matric	39	2031	1,78001	92,6974
Missing	160	2191	7,30260	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	1130	1130	51,57462	51,5746
Coloured	86	1216	3,92515	55,4998
Indian	43	1259	1,96257	57,4623
European	509	1768	23,23140	80,6937
Asian	161	1929	7,34824	88,0420
Missing	262	2191	11,95801	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Sepedi	188	1049	8,58056	47,8777
siSwati	60	1109	2,73848	50,6162
Afrikaans	154	1263	7,02875	57,6449
Setswana	115	1378	5,24874	62,8937
Xitsonga	66	1444	3,01232	65,9060
isiZulu	248	1692	11,31903	77,2250
isiXhosa	89	1781	4,06207	81,2871
Sesotho	105	1886	4,79233	86,0794
Tshivenda	85	1971	3,87951	89,9589
isiNdebele	12	1983	0,54770	90,5066
Missing	208	2191	9,49338	100,0000

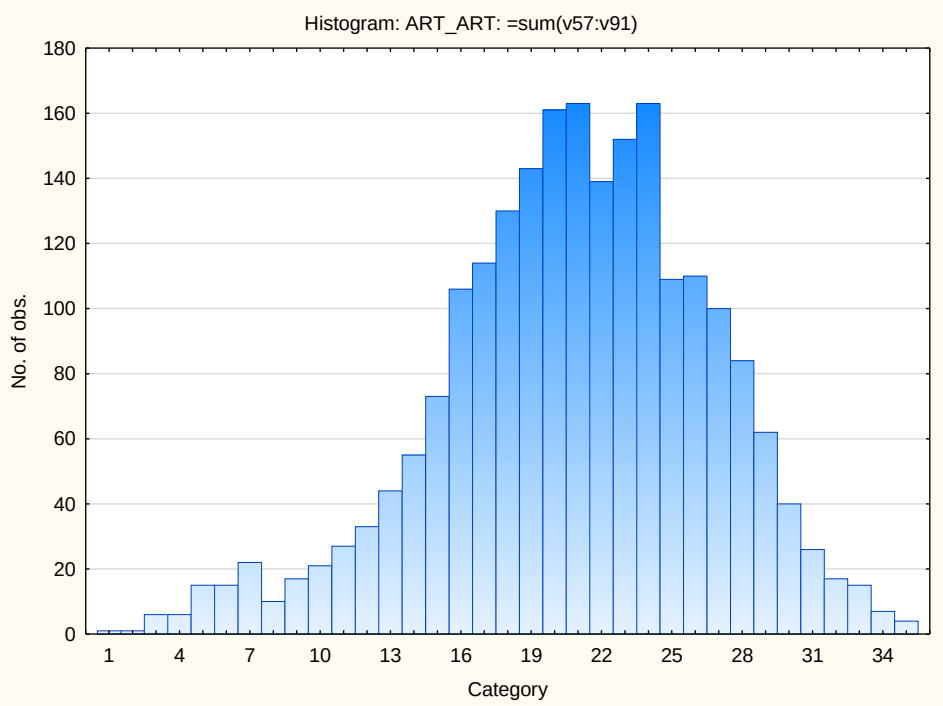
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Indigenous	968	1829	44,18074	83,4779
Afrikaans	154	1983	7,02875	90,5066
Missing	208	2191	9,49338	100,0000

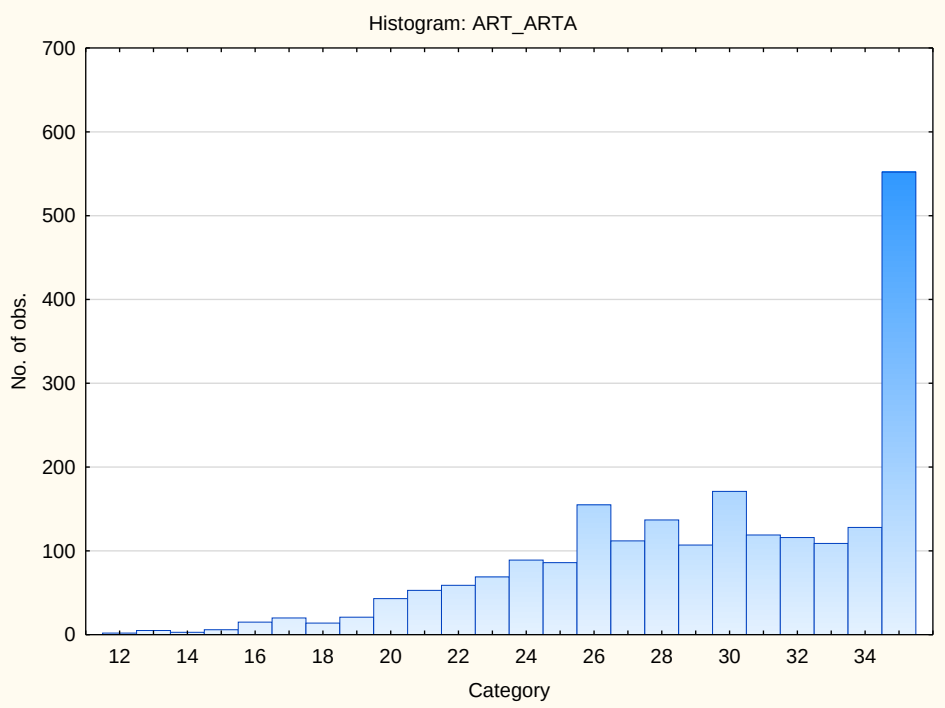
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	22,91056	7,292516	17,00000	63,00000	1733	458



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	20,81013	5,768400	1,00000	35,00000	2191	0
Abstract Reasoning Items Attempted	29,38795	5,098403	12,00000	35,00000	2191	0




Histogram: ART_ARTA
No. of obs.
700
600
500
400
300
200
100
0
12
14
16
18
20
22
24
26
28
30
32
34
Category

Stanine Table

Scales	Stanine Groups								
	S9_1	S9_2	S9_3	S9_4	S9_5	S9_6	S9_7	S9_8	S9_9
Abstract Reasoning	1-10	11-13	14-16	17-19	20-22	23-25	26-28	29-30	31-35
Abstract Reasoning Items Attempted	12-20	21-23	24-25	26-28	29-30	31-33	34-35		

Abstract Reasoning Test (ART)

Norm Group: SA Afrikaans Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 154 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	71	71	46,10390	46,1039
M	70	141	45,45455	91,5584
U	13	154	8,44156	100,0000
Missing	0	154	0,00000	100,0000

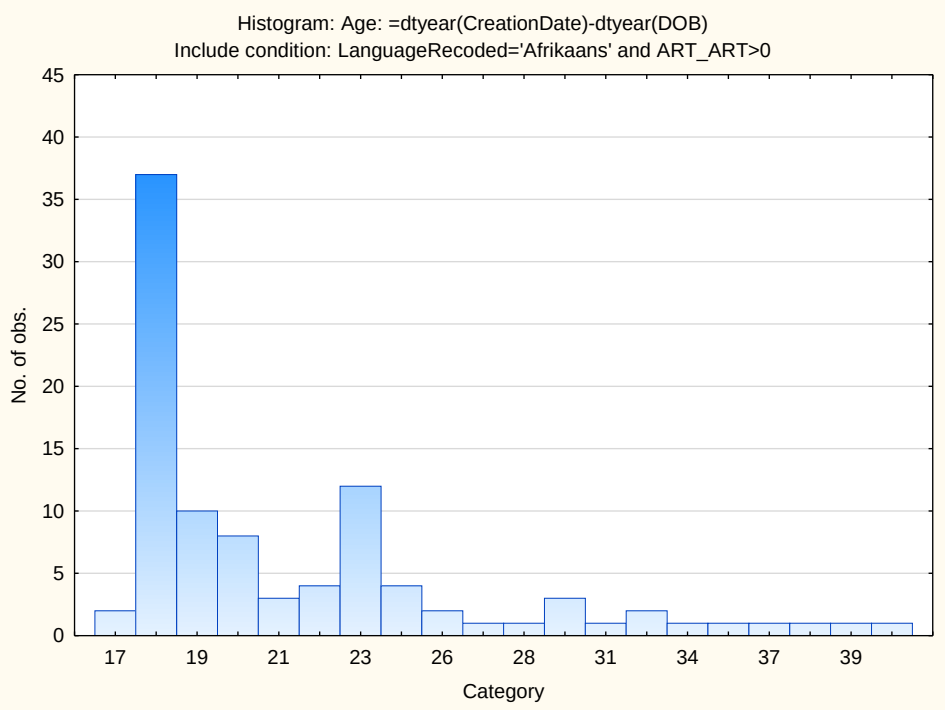
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	34	34	22,07792	22,0779
Grade 12	79	113	51,29870	73,3766
Post Graduate	31	144	20,12987	93,5065
< Matric	5	149	3,24675	96,7532
Missing	5	154	3,24675	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	1	1	0,64935	0,6494
Coloured	8	9	5,19481	5,8442
European	141	150	91,55844	97,4026
Missing	4	154	2,59740	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Afrikaans	154	154	100,0000	100,0000
Missing	0	154	0,0000	100,0000

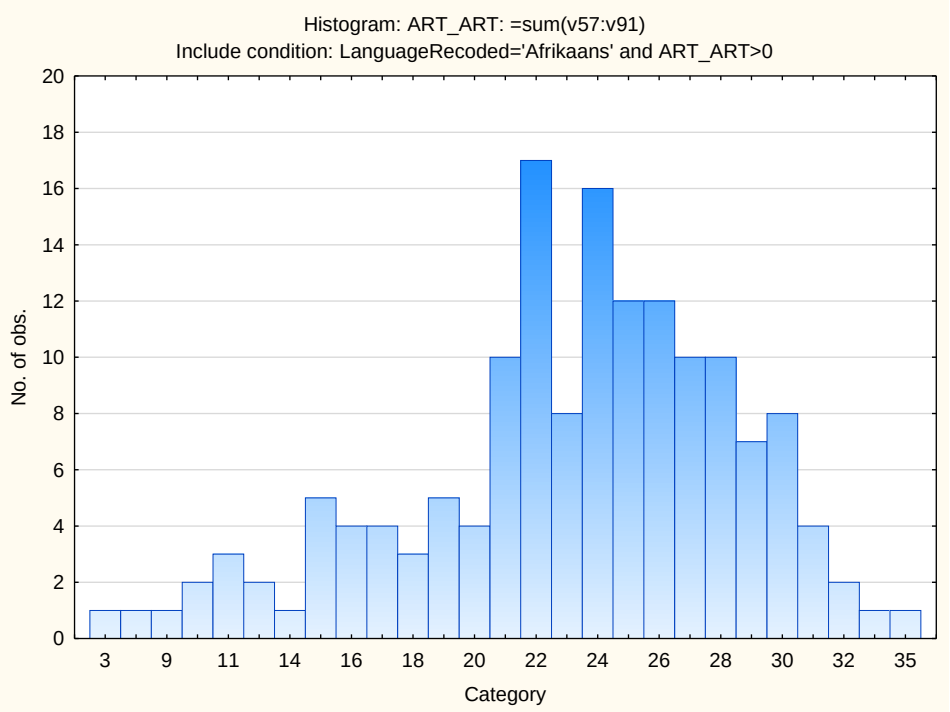
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Afrikaans	154	154	100,0000	100,0000
Missing	0	154	0,0000	100,0000

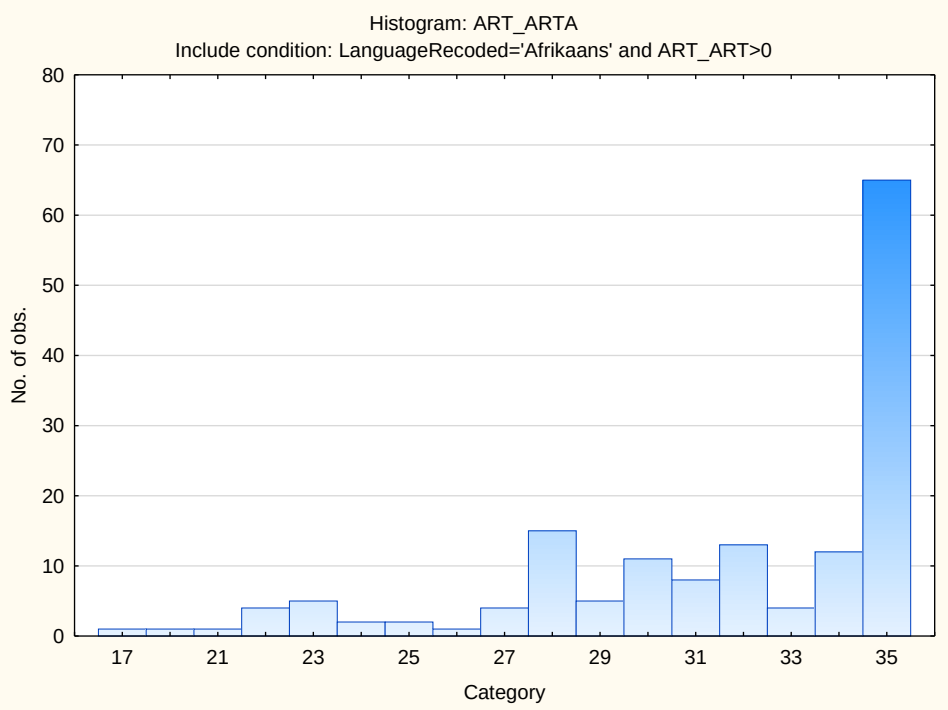
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	21,73958	5,421681	17,00000	42,00000	96	58



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	23,11688	5,560068	3,00000	35,00000	154	0
Abstract Reasoning Items Attempted	31,60390	4,127730	17,00000	35,00000	154	0




Histogram: ART_ARTA
Include condition: LanguageRecoded='Afrikaans' and ART_ART>0
No. of obs.
Category
0
10
20
30
40
50
60
70
80
17
21
23
25
27
29
31
33
35

Stanine Table

Scales	Stanine Groups								
	S9_1	S9_2	S9_3	S9_4	S9_5	S9_6	S9_7	S9_8	S9_9
Abstract Reasoning	3-13	14-16	17-18	19-21	22-24	25-27	28-30	31-32	33-35
Abstract Reasoning Items Attempted	17-24	25-26	27-28	29-30	31-32	33-34	35-35		

Abstract Reasoning Test (ART)

Norm Group: SA English Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 861 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	433	433	50,29036	50,2904
M	404	837	46,92218	97,2125
U	24	861	2,78746	100,0000
Missing	0	861	0,00000	100,0000

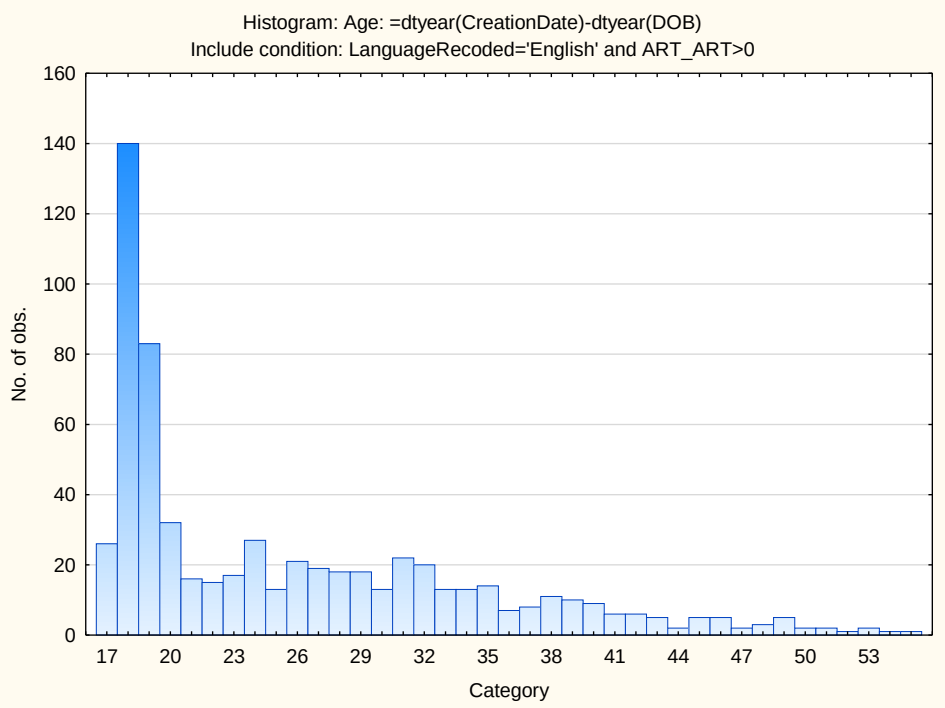
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	277	277	32,17189	32,1719
Grade 12	350	627	40,65041	72,8223
Post Graduate	194	821	22,53194	95,3542
< Matric	22	843	2,55517	97,9094
Missing	18	861	2,09059	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	125	125	14,51800	14,5180
Coloured	77	202	8,94309	23,4611
Indian	42	244	4,87805	28,3391
European	353	597	40,99884	69,3380
Asian	153	750	17,77003	87,1080
Missing	111	861	12,89199	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	100,0000	100,0000
Missing	0	861	0,0000	100,0000

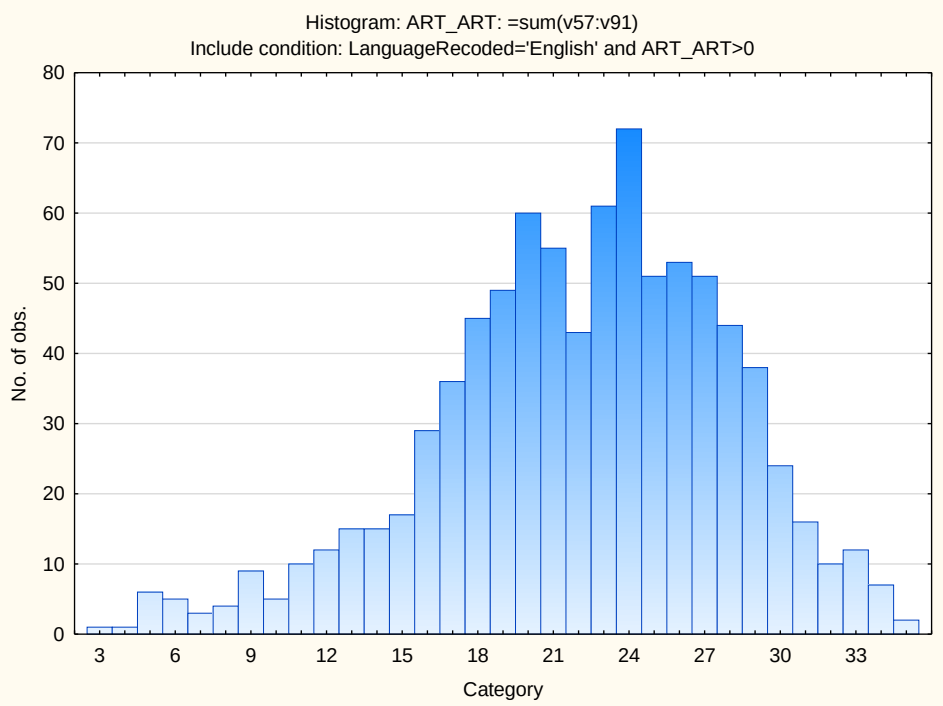
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	100,0000	100,0000
Missing	0	861	0,0000	100,0000

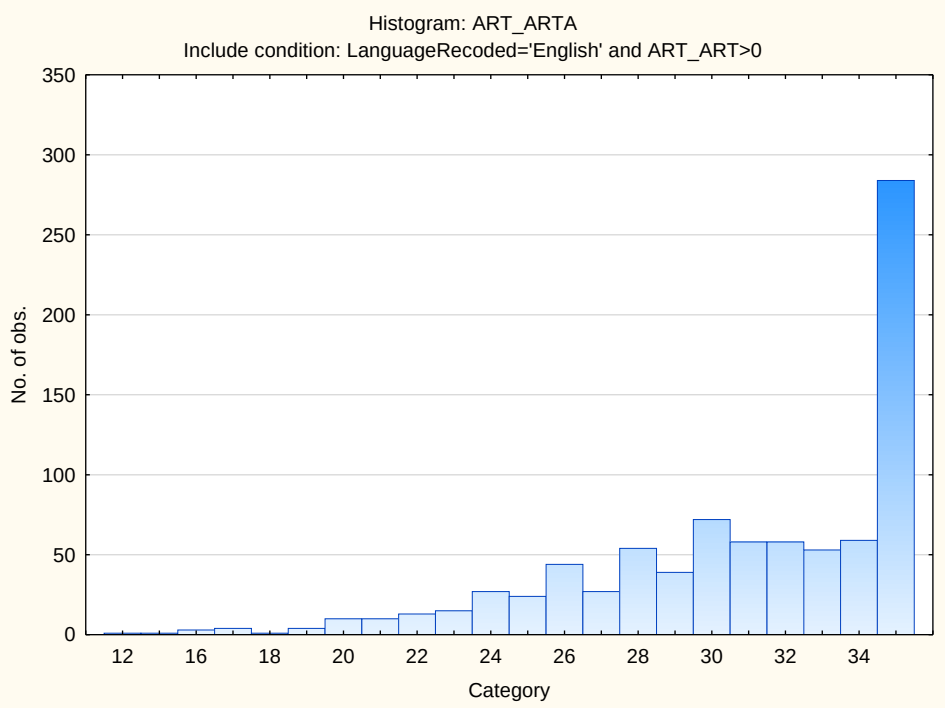
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	25,75197	8,784341	17,00000	63,00000	633	228



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	22,08827	5,828687	3,00000	35,00000	861	0
Abstract Reasoning Items Attempted	30,83508	4,428578	12,00000	35,00000	861	0




Histogram: ART_ARTA
Include condition: LanguageRecoded='English' and ART_ART>0
No. of obs.
Category
0
50
100
150
200
250
300
350
12
16
18
20
22
24
26
28
30
32
34

Stanine Table

Scales	Stanine Groups								
	S9_1	S9_2	S9_3	S9_4	S9_5	S9_6	S9_7	S9_8	S9_9
Abstract Reasoning	3-11	12-14	15-17	18-20	21-23	24-26	27-29	30-32	33-35
Abstract Reasoning Items Attempted	12-23	24-25	26-27	28-29	30-31	32-34	35-35		

Abstract Reasoning Test (ART)

Norm Group: SA Indigenous Language Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 968 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	422	422	43,59504	43,5950
M	527	949	54,44215	98,0372
U	19	968	1,96281	100,0000
Missing	0	968	0,00000	100,0000

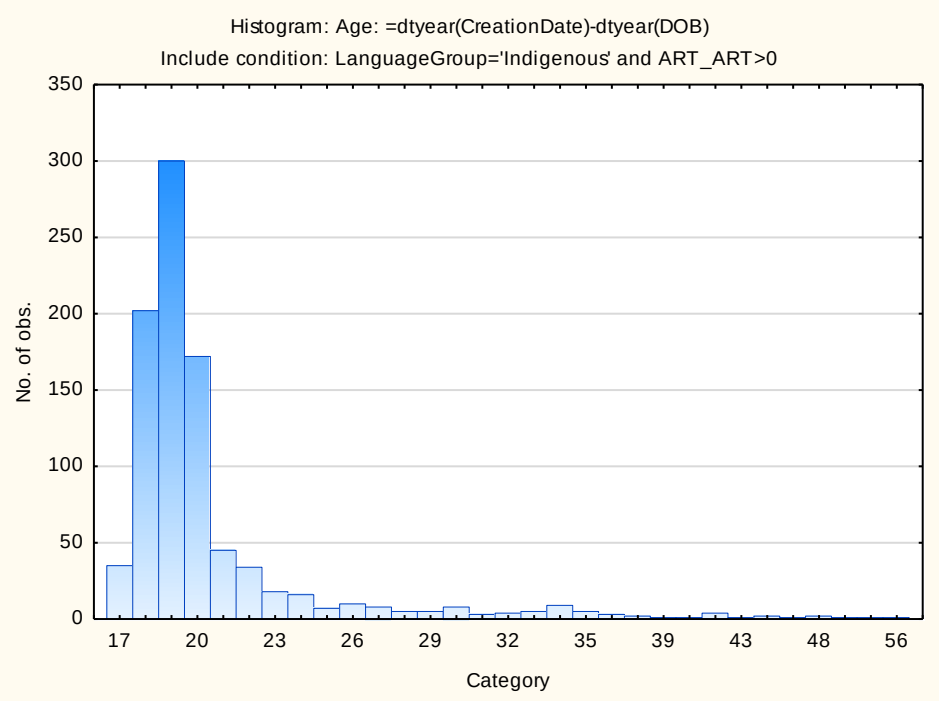
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	87	87	8,98760	8,9876
Grade 12	801	888	82,74793	91,7355
Post Graduate	57	945	5,88843	97,6240
< Matric	12	957	1,23967	98,8636
Missing	11	968	1,13636	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	953	953	98,45041	98,4504
European	2	955	0,20661	98,6570
Asian	5	960	0,51653	99,1736
Missing	8	968	0,82645	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Sepedi	188	188	19,42149	19,4215
siSwati	60	248	6,19835	25,6198
Setswana	115	363	11,88017	37,5000
Xitsonga	66	429	6,81818	44,3182
isiZulu	248	677	25,61983	69,9380
isiXhosa	89	766	9,19421	79,1322
Sesotho	105	871	10,84711	89,9793
Tshivenda	85	956	8,78099	98,7603
isiNdebele	12	968	1,23967	100,0000
Missing	0	968	0,00000	100,0000

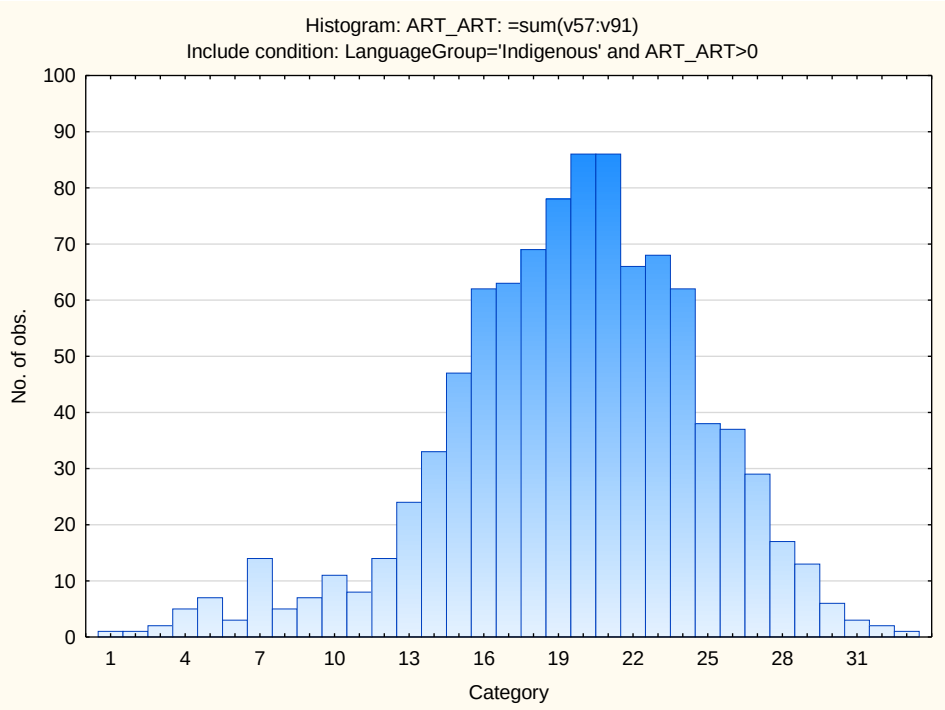
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	968	968	100,0000	100,0000
Missing	0	968	0,0000	100,0000

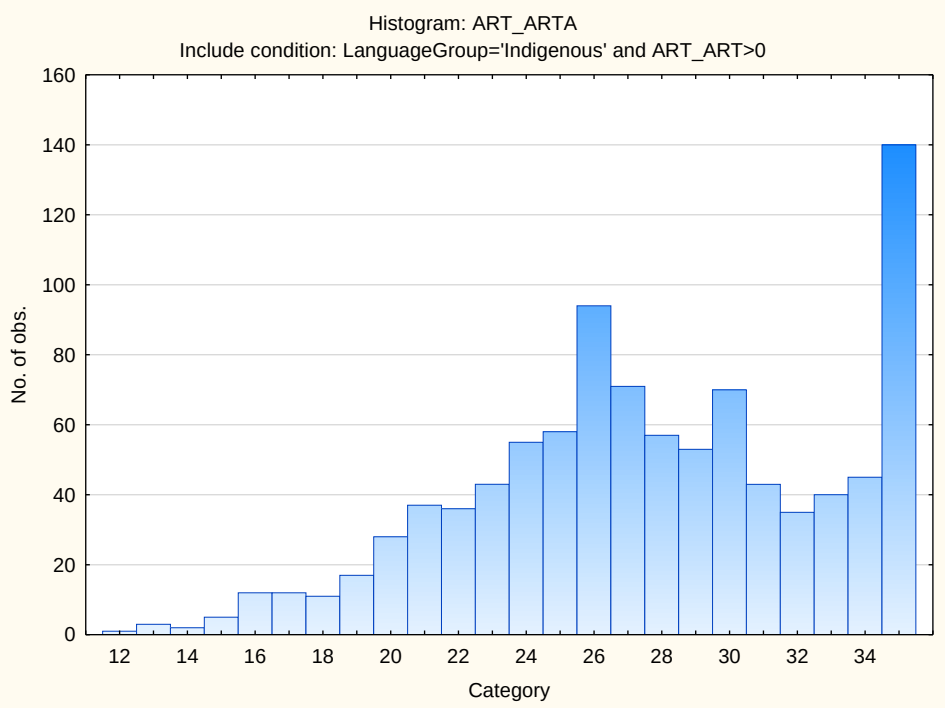
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,60373	4,717974	17,00000	56,00000	911	57



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	19,48657	5,155075	1,00000	33,00000	968	0
Abstract Reasoning Items Attempted	27,64050	5,213626	12,00000	35,00000	968	0




Histogram: ART_ARTA
Include condition: LanguageGroup='Indigenous' and ART_ART>0
No. of obs.
Category
0
20
40
60
80
100
120
140
160
12
14
16
18
20
22
24
26
28
30
32
34

Stanine Table

Scales	Stanine Groups								
	S9_1	S9_2	S9_3	S9_4	S9_5	S9_6	S9_7	S9_8	S9_9
Abstract Reasoning	1-10	11-13	14-15	16-18	19-20	21-23	24-25	26-28	29-33
Abstract Reasoning Items Attempted	12-18	19-21	22-23	24-26	27-28	29-31	32-34	35-35	

Abstract Reasoning Test (ART)

Norm Group: SA isiZulu Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 248 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	112	112	45,16129	45,1613
M	133	245	53,62903	98,7903
U	3	248	1,20968	100,0000
Missing	0	248	0,00000	100,0000

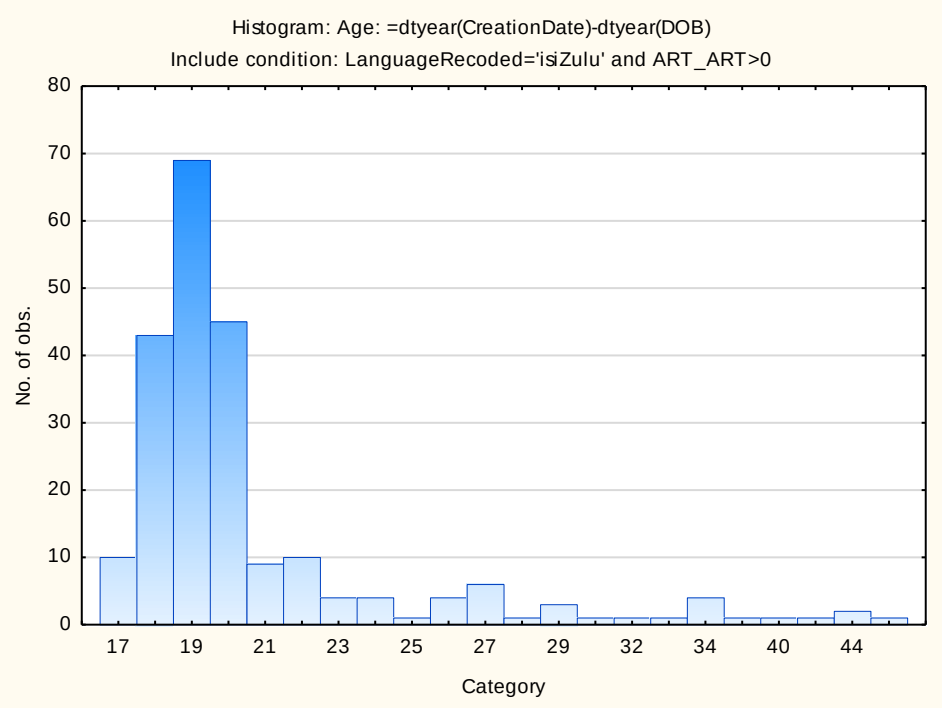
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	35	35	14,11290	14,1129
Grade 12	190	225	76,61290	90,7258
Post Graduate	16	241	6,45161	97,1774
< Matric	2	243	0,80645	97,9839
Missing	5	248	2,01613	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	240	240	96,77419	96,7742
European	2	242	0,80645	97,5806
Asian	3	245	1,20968	98,7903
Missing	3	248	1,20968	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
isiZulu	248	248	100,0000	100,0000
Missing	0	248	0,0000	100,0000

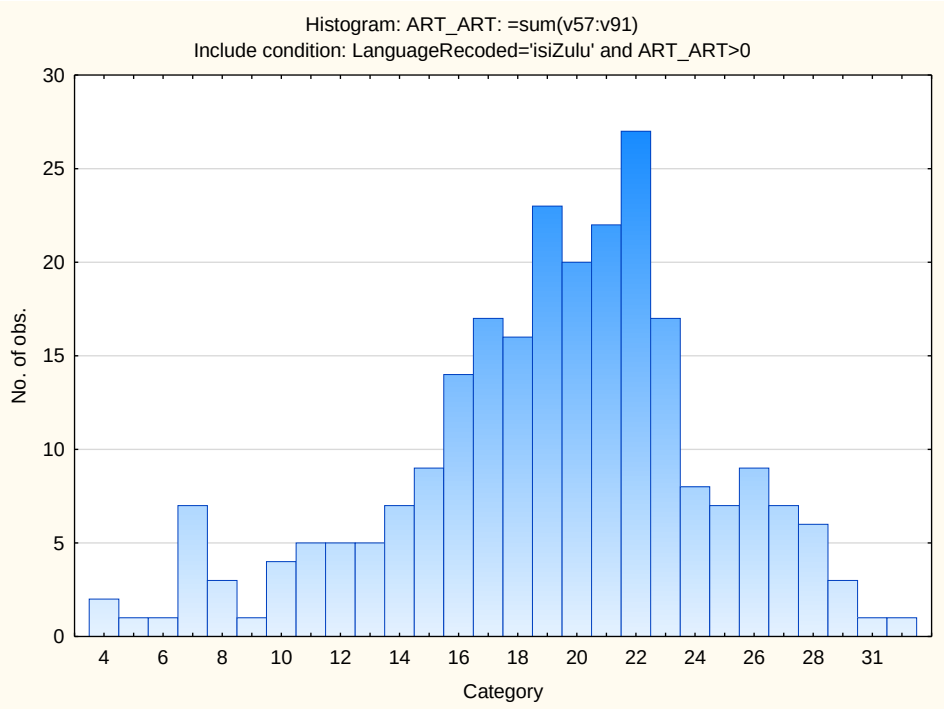
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	248	248	100,0000	100,0000
Missing	0	248	0,0000	100,0000

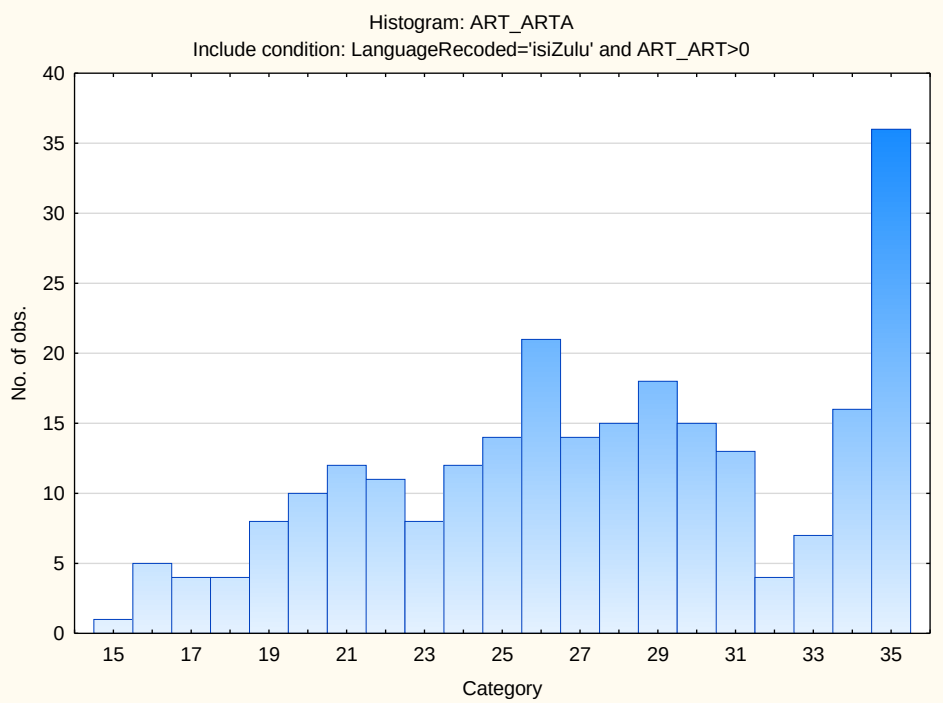
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,91892	4,918586	17,00000	48,00000	222	26



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	19,14113	5,301463	4,00000	32,00000	248	0
Abstract Reasoning Items Attempted	27,35887	5,448716	15,00000	35,00000	248	0




Histogram: ART_ARTA
Include condition: LanguageRecoded='isiZulu' and ART_ART>0
No. of obs.
Category
0
5
10
15
20
25
30
35
40
15
17
19
21
23
25
27
29
31
33
35

Stanine Table

Scales	Stanine Groups								
	S9_1	S9_2	S9_3	S9_4	S9_5	S9_6	S9_7	S9_8	S9_9
Abstract Reasoning	4-9	10-12	13-15	16-17	18-20	21-23	24-25	26-28	29-32
Abstract Reasoning Items Attempted	15-17	18-20	21-23	24-25	26-28	29-31	32-34	35-35	

Abstract Reasoning Test (ART)

Norm Group: SA Sepedi Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 188 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	75	75	39,89362	39,8936
M	110	185	58,51064	98,4043
U	3	188	1,59574	100,0000
Missing	0	188	0,00000	100,0000

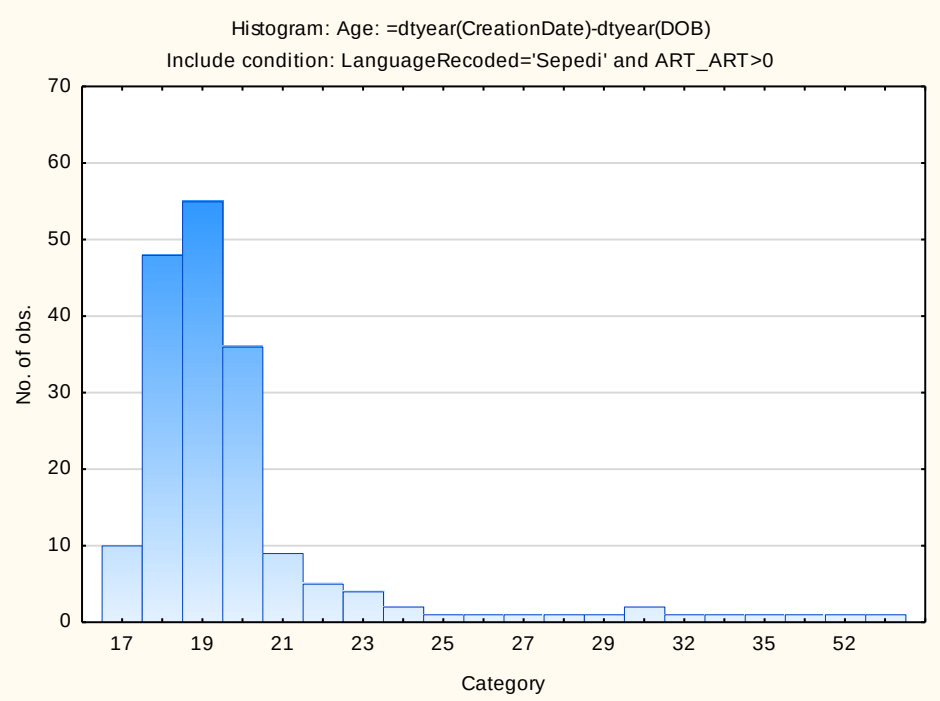
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	15	15	7,97872	7,9787
Grade 12	166	181	88,29787	96,2766
Post Graduate	4	185	2,12766	98,4043
< Matric	2	187	1,06383	99,4681
Missing	1	188	0,53191	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	187	187	99,46809	99,4681
Missing	1	188	0,53191	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Sepedi	188	188	100,0000	100,0000
Missing	0	188	0,0000	100,0000

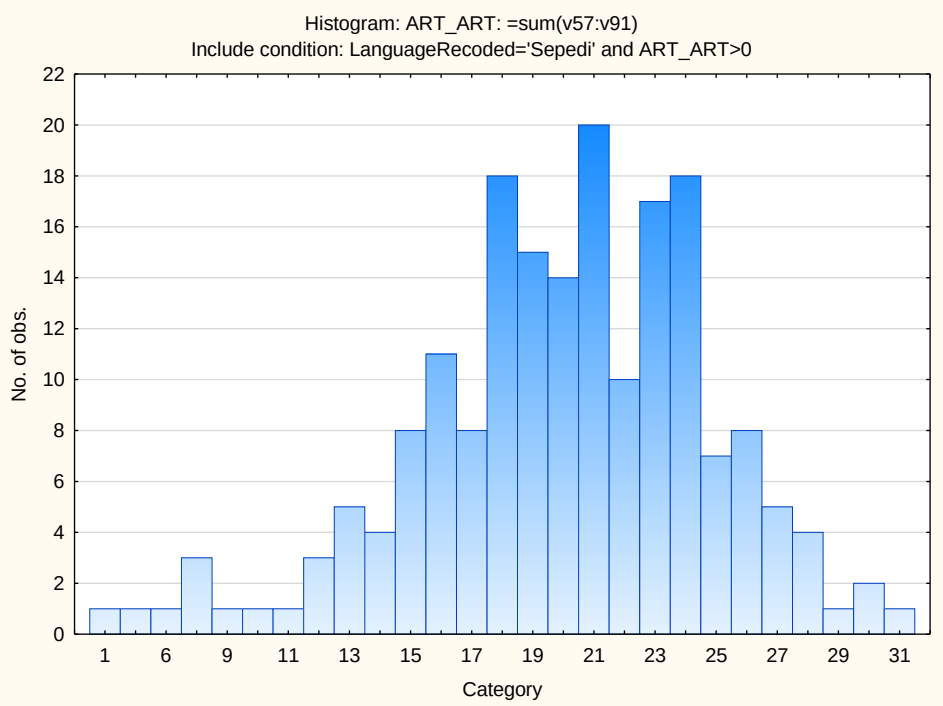
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	188	188	100,0000	100,0000
Missing	0	188	0,0000	100,0000

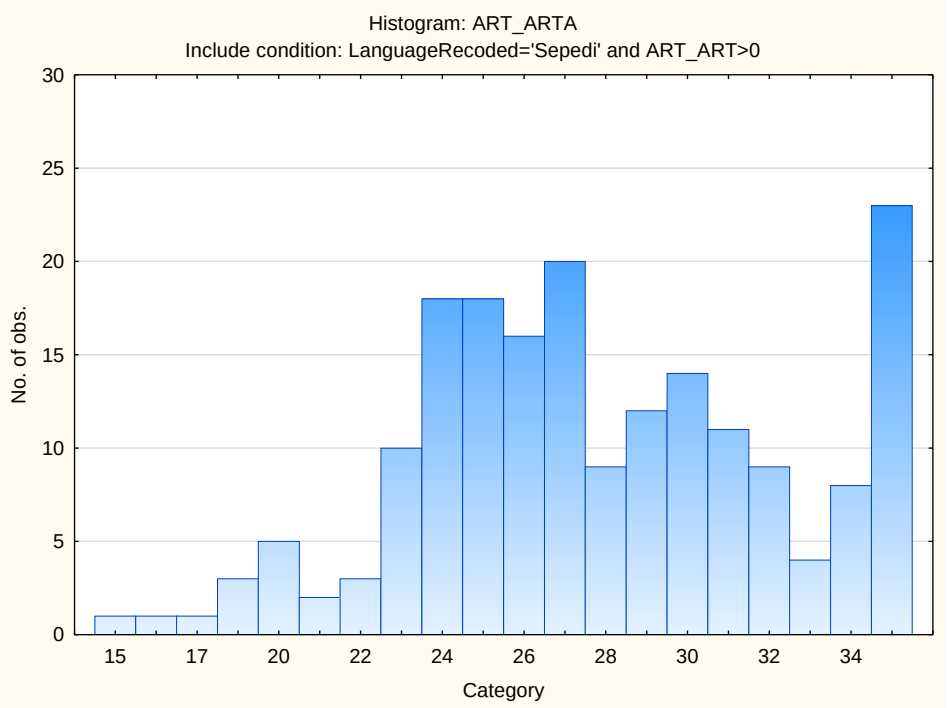
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,23077	4,804641	17,00000	56,00000	182	6



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	19,96809	4,945591	1,00000	31,00000	188	0
Abstract Reasoning Items Attempted	27,86702	4,513601	15,00000	35,00000	188	0




Histogram: ART_ARTA
Include condition: LanguageRecoded='Sepedi' and ART_ART>0
No. of obs.
Category
0
5
10
15
20
25
30
15
17
20
22
24
26
28
30
32
34

Stanine Table

Scales	Stanine Groups								
	S9_1	**S9_2**	**S9_3**	**S9_4**	**S9_5**	**S9_6**	**S9_7**	**S9_8**	**S9_9**
Abstract Reasoning	1-11	12-13	14-16	17-18	19-21	22-23	24-26	27-28	29-31
Abstract Reasoning Items Attempted	15-19	20-22	23-24	25-26	27-28	29-31	32-33	34-35	

Abstract Reasoning Test (ART)

Norm Group: SA Sesotho Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 105 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	45	45	42,85714	42,8571
M	56	101	53,33333	96,1905
U	4	105	3,80952	100,0000
Missing	0	105	0,00000	100,0000

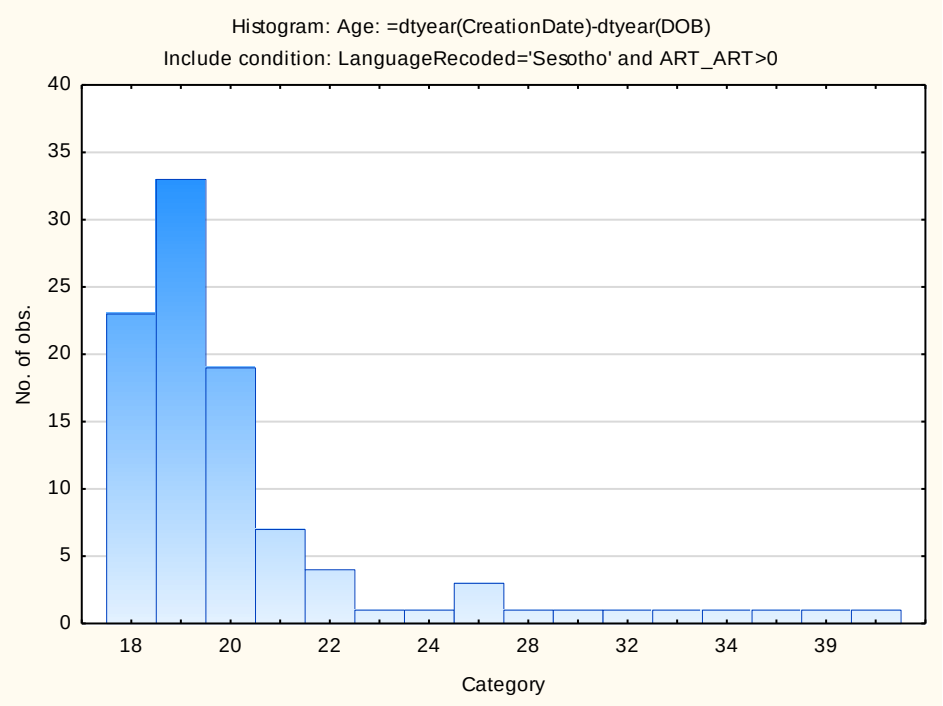
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	6	6	5,71429	5,7143
Grade 12	91	97	86,66667	92,3810
Post Graduate	5	102	4,76190	97,1429
< Matric	2	104	1,90476	99,0476
Missing	1	105	0,95238	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	105	105	100,0000	100,0000
Missing	0	105	0,0000	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Sesotho	105	105	100,0000	100,0000
Missing	0	105	0,0000	100,0000

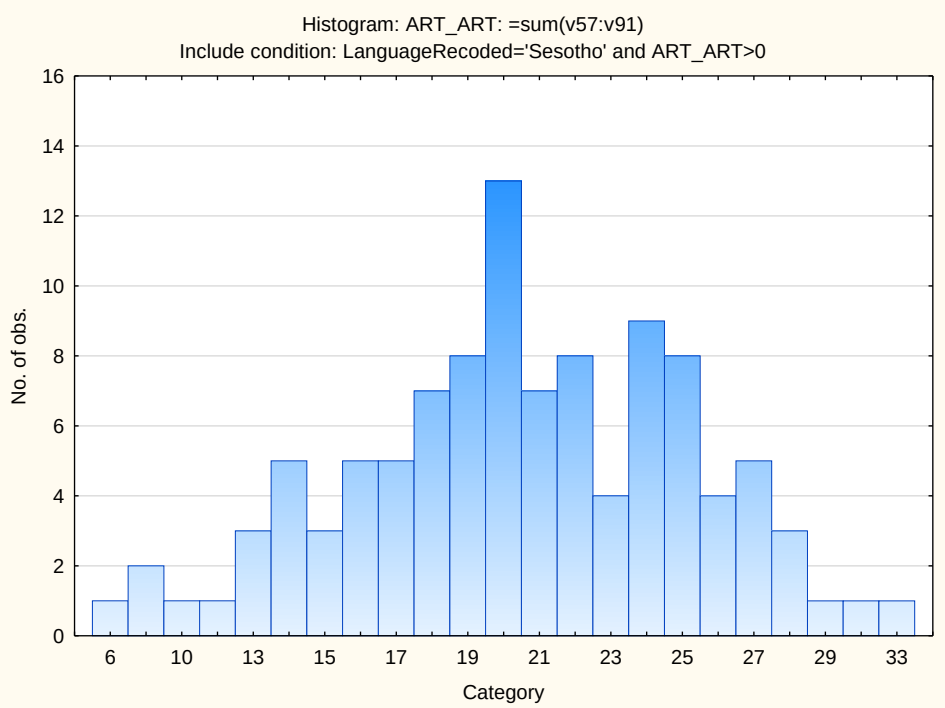
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	105	105	100,0000	100,0000
Missing	0	105	0,0000	100,0000

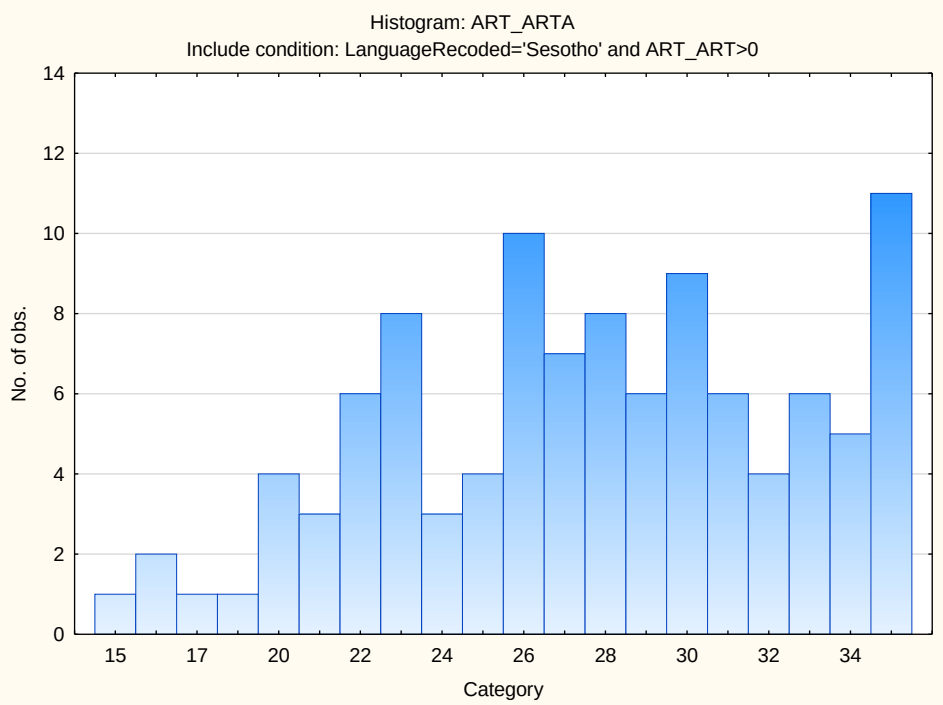
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,74747	4,456922	18,00000	41,00000	99	6



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	20,42857	4,992027	6,00000	33,00000	105	0
Abstract Reasoning Items Attempted	27,59048	5,037733	15,00000	35,00000	105	0




Histogram: ART_ARTA
Include condition: LanguageRecoded='Sesotho' and ART_ART>0
No. of obs.
Category
0
2
4
6
8
10
12
14
15
17
20
22
24
26
28
30
32
34

Stanine Table

Scales	Stanine Groups								
	S9_1	S9_2	S9_3	S9_4	S9_5	S9_6	S9_7	S9_8	S9_9
Abstract Reasoning	6-11	12-14	15-16	17-19	20-21	22-24	25-26	27-29	30-33
Abstract Reasoning Items Attempted	15-18	19-21	22-23	24-26	27-28	29-31	32-33	34-35	

Abstract Reasoning Test (ART)

Norm Group: SA Setswana Speakers, 2017

Norm Type:

Standard Deviation Norm

Composition of the Sample

Compiled from raw data on 115 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	59	59	51,30435	51,3043
M	56	115	48,69565	100,0000
Missing	0	115	0,00000	100,0000

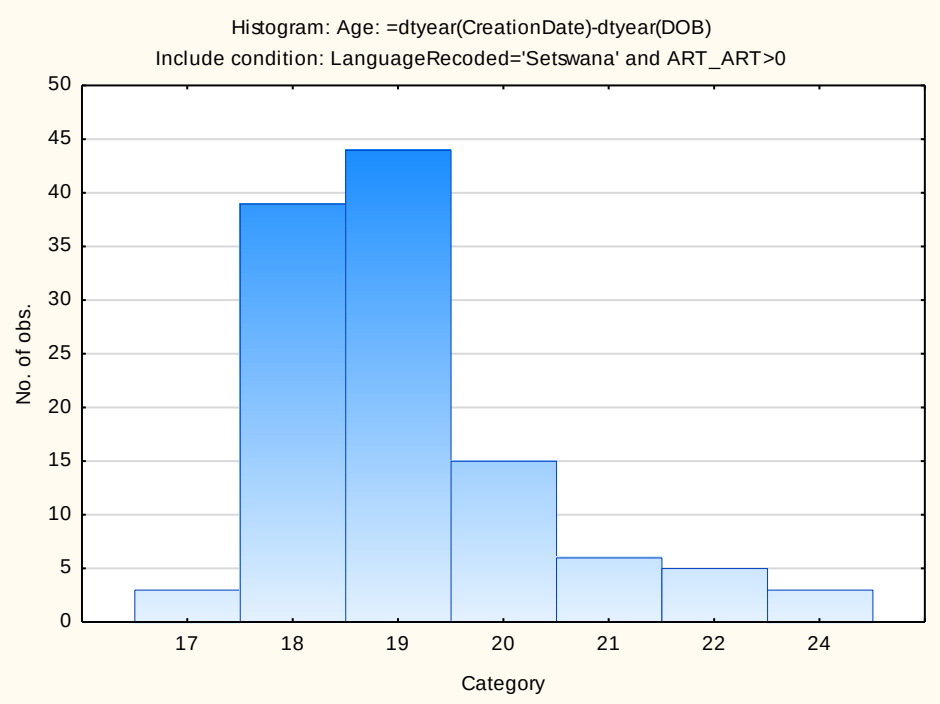
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	2	2	1,73913	1,7391
Grade 12	108	110	93,91304	95,6522
< Matric	3	113	2,60870	98,2609
Missing	2	115	1,73913	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	113	113	98,26087	98,2609
Asian	1	114	0,86957	99,1304
Missing	1	115	0,86957	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Setswana	115	115	100,0000	100,0000
Missing	0	115	0,0000	100,0000

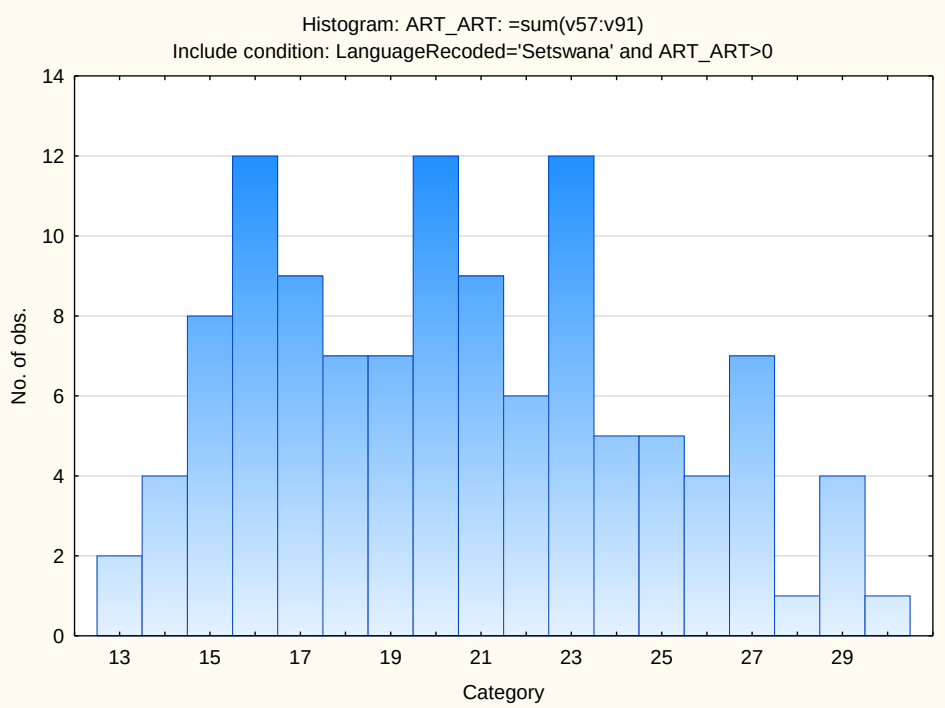
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	115	115	100,0000	100,0000
Missing	0	115	0,0000	100,0000

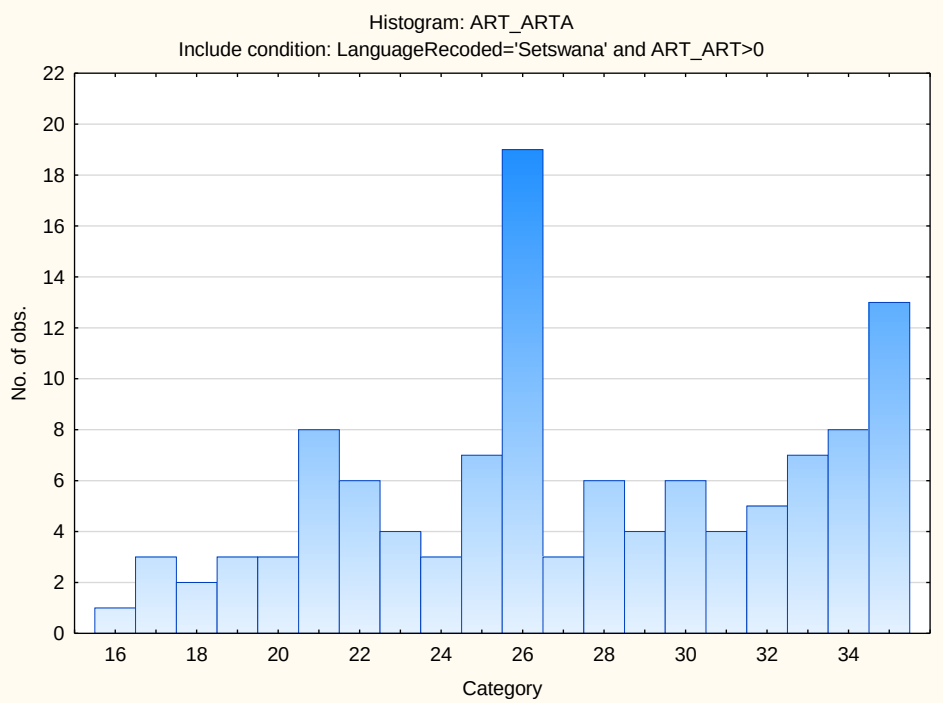
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	19,10435	1,353189	17,00000	24,00000	115	0



Descriptive Statistics on the Abstract Reasoning Test

Variable	Descriptive Statistics: Abstract Reasoning Test					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases
Abstract Reasoning Test	20,48696	4,255781	13,00000	31,00000	115	0
Abstract Reasoning Items Attempted	27,30435	5,321545	16,00000	35,00000	115	0




Histogram: ART_ARTA
Include condition: LanguageRecoded='Setswana' and ART_ART>0
No. of obs.
Category
0
2
4
6
8
10
12
14
16
18
20
22
16
18
20
22
24
26
28
30
32
34

Stanine Table

Scales	Stanine Groups								
	S9_1	**S9_2**	**S9_3**	**S9_4**	**S9_5**	**S9_6**	**S9_7**	**S9_8**	**S9_9**
Abstract Reasoning	13-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-31
Abstract Reasoning Items Attempted	16-17	18-20	21-23	24-25	26-28	29-31	32-33	34-35	

Abstract Reasoning Test (ART)

Reliability introduction

Reliability studies

Reliability studies are done whenever we receive a substantial body of data that contains item responses. Reliability calculation is one of the services offered by Psytech SA to its clients. In almost all cases, clients have been willing to share the results of these calculations with other users.

Availability of biographical information

Frequently full biographical information is not collected, which makes it very difficult to calculate separate reliabilities on different racial and language groups. In some cases, it has been necessary to do a post-hoc classification of respondents based on their names. In such situations it is usually not possible to distinguish between Whites and Coloureds, and they have had to be classified together in one group.

Relationship between reliability groups and norm groups

It is not possible to create a norm group for each reliability sample, because of sample size constraints. It is also not possible to report Coefficient Alpha for every norm sample, because item response data are not always available. For ease of reference, we have included as much information as possible about the composition of the samples, rather than refer the user to the description of a related norm group.

Standard error of measurement (SEM)

Where data are available, the standard error of measurement is reported for every group for which we have calculated reliabilities. This is usually done for samples that are also used as norm groups. In some cases, the standard error of measurement is reported for a group that has been screened for English comprehension, and for the total group as well.

Choosing an appropriate comparison group for reliability

If a larger, more diverse group is available that conforms to the demographic characteristics of the group you are interested in, use that table for comparison purposes.

The effect of reliability on validity

The reliability of a test places an upper limit on its validity. If a test is not reliable, it cannot be valid.

What does it mean if a test has low reliability?

On an ability measure, Reliability is considered low if it is below 0.75. In cases where the reliability is below 0.65, the results should be interpreted with extreme caution by using additional information for this purpose.
There are various reasons why the reliability of a test, or of a specific sample of the overall sample group, might be low:

- Respondents guessing the answers to items which they may not know. Results should therefore be interpreted with caution.
- Respondents may have rushed to complete the assessment or may have been lacking in motivation at the time of test completion. In this instance, a lower reliability could be attributed to guessing or hasty decision making.
- Respondents finding the test items too difficult.
- Shorter tests, although economic and quick to administer, tend to be less reliable.

It is best practice to always rely on multiple sources of information when making an informed decision utilising an assessment process. This is of particular importance when the reliability of an assessment is lower than usual.

Advice to users

- Collect full biographical information on the respondents.
- Verify whether the scales you are interested in for decision-making purposes, are reliable for the persons you want to test.
- Where available, bear the Standard Error of Measurement in mind when making decisions on test results.
- Do not use unreliable scales for decision making.
- Do not rely on a single test when reliability is doubtful.

List of South African reliability studies for the Abstract Reasoning Test

Description	Study number
SA Aggregate Population 2017	R1
SA Afrikaans 2017	R2
SA English 2017	R3
SA Indigenous 2017	R4
SA isiZulu 2017	R5
SA Sepedi 2017	R6
SA Sesotho 2017	R7
SA Setswana 2017	R8

Abstract Reasoning Test (ART)

Reliability: South Africans, Aggregate Population, 2017

Composition of the Sample

Compiled from raw data on 2191 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	999	999	45,59562	45,5956
M	1122	2121	51,20949	96,8051
U	66	2187	3,01232	99,8174
Missing	4	2191	0,18257	100,0000

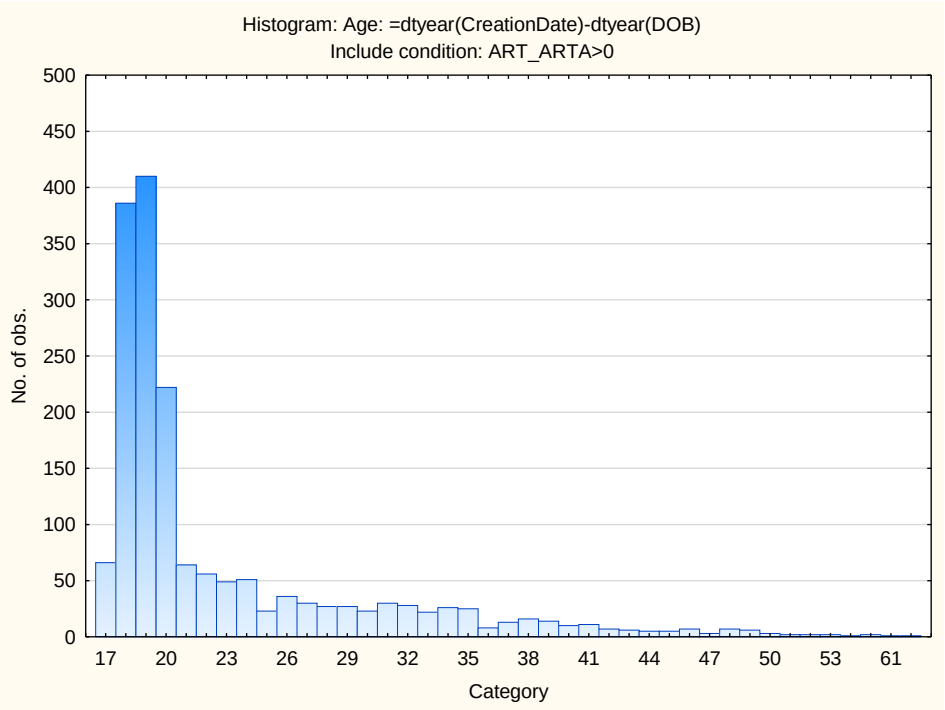
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	417	417	19,03241	19,0324
Grade 12	1272	1689	58,05568	77,0881
Post Graduate	303	1992	13,82930	90,9174
< Matric	39	2031	1,78001	92,6974
Missing	160	2191	7,30260	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	1130	1130	51,57462	51,5746
Coloured	86	1216	3,92515	55,4998
Indian	43	1259	1,96257	57,4623
European	509	1768	23,23140	80,6937
Asian	161	1929	7,34824	88,0420
Missing	262	2191	11,95801	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Sepedi	188	1049	8,58056	47,8777
siSwati	60	1109	2,73848	50,6162
Afrikaans	154	1263	7,02875	57,6449
Setswana	115	1378	5,24874	62,8937
Xitsonga	66	1444	3,01232	65,9060
isiZulu	248	1692	11,31903	77,2250
isiXhosa	89	1781	4,06207	81,2871
Sesotho	105	1886	4,79233	86,0794
Tshivenda	85	1971	3,87951	89,9589
isiNdebele	12	1983	0,54770	90,5066
Missing	208	2191	9,49338	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Indigenous	968	1829	44,18074	83,4779
Afrikaans	154	1983	7,02875	90,5066
Missing	208	2191	9,49338	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	22,91056	7,292516	17,00000	63,00000	1733	458



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,84	0,84

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,75	---

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,86	0,86

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,30736	5,768400	0,84

Abstract Reasoning Test (ART)

Reliability: South Africans, Afrikaans Speakers, 2017

Composition of the Sample

Compiled from raw data on 154 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	71	71	46,10390	46,1039
M	70	141	45,45455	91,5584
U	13	154	8,44156	100,0000
Missing	0	154	0,00000	100,0000

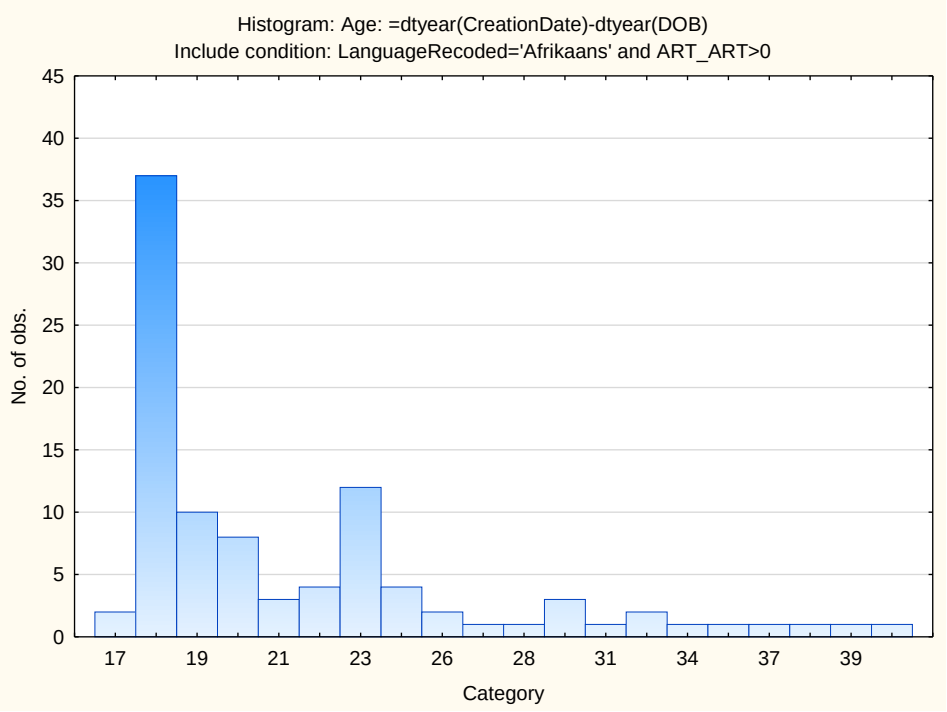
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	34	34	22,07792	22,0779
Grade 12	79	113	51,29870	73,3766
Post Graduate	31	144	20,12987	93,5065
< Matric	5	149	3,24675	96,7532
Missing	5	154	3,24675	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	1	1	0,64935	0,6494
Coloured	8	9	5,19481	5,8442
European	141	150	91,55844	97,4026
Missing	4	154	2,59740	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Afrikaans	154	154	100,0000	100,0000
Missing	0	154	0,0000	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Afrikaans	154	154	100,0000	100,0000
Missing	0	154	0,0000	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	21,73958	5,421681	17,00000	42,00000	96	58



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,84	0,85

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,71	0,98

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,83	0,83

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,2240272	5,560068	0,84

Abstract Reasoning Test (ART)

Reliability: South Africans, English Speakers, 2017

Composition of the Sample

Compiled from raw data on 861 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	433	433	50,29036	50,2904
M	404	837	46,92218	97,2125
U	24	861	2,78746	100,0000
Missing	0	861	0,00000	100,0000

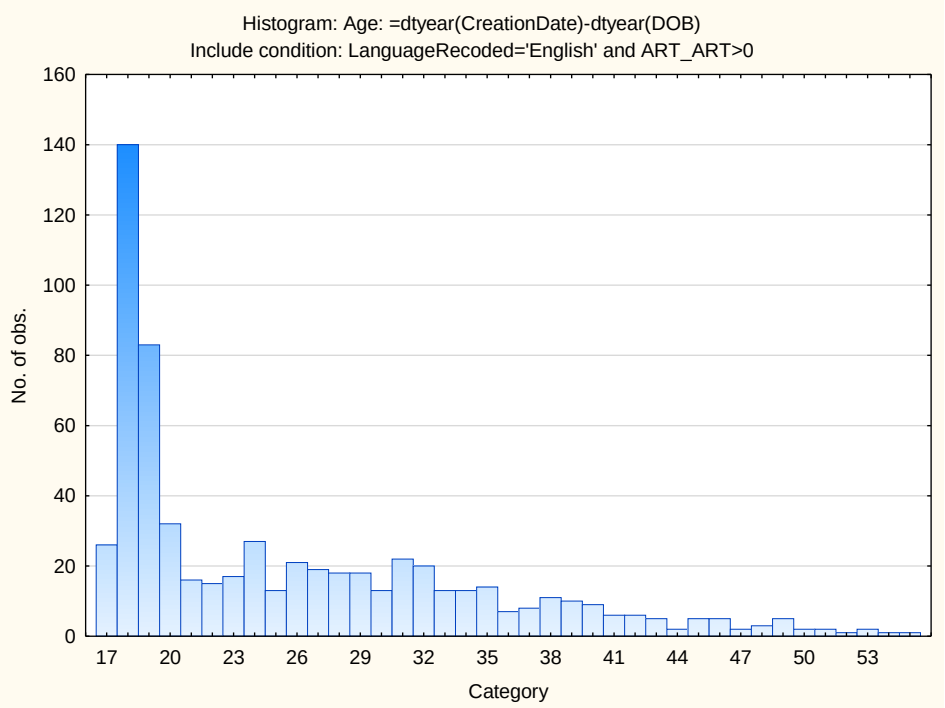
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	277	277	32,17189	32,1719
Grade 12	350	627	40,65041	72,8223
Post Graduate	194	821	22,53194	95,3542
< Matric	22	843	2,55517	97,9094
Missing	18	861	2,09059	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	125	125	14,51800	14,5180
Coloured	77	202	8,94309	23,4611
Indian	42	244	4,87805	28,3391
European	353	597	40,99884	69,3380
Asian	153	750	17,77003	87,1080
Missing	111	861	12,89199	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	100,0000	100,0000
Missing	0	861	0,0000	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	100,0000	100,0000
Missing	0	861	0,0000	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	25,75197	8,784341	17,00000	63,00000	633	228



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,85	0,85

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,77	---

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,87	0,87

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,25744077	5,828687	0,85

Abstract Reasoning Test (ART)

Reliability: South Africans, Indigenous Language Speakers, 2017

Composition of the Sample

Compiled from raw data on 968 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	422	422	43,59504	43,5950
M	527	949	54,44215	98,0372
U	19	968	1,96281	100,0000
Missing	0	968	0,00000	100,0000

Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	87	87	8,98760	8,9876
Grade 12	801	888	82,74793	91,7355
Post Graduate	57	945	5,88843	97,6240
< Matric	12	957	1,23967	98,8636
Missing	11	968	1,13636	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	953	953	98,45041	98,4504
European	2	955	0,20661	98,6570
Asian	5	960	0,51653	99,1736
Missing	8	968	0,82645	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Sepedi	188	188	19,42149	19,4215

Frequency table: Language

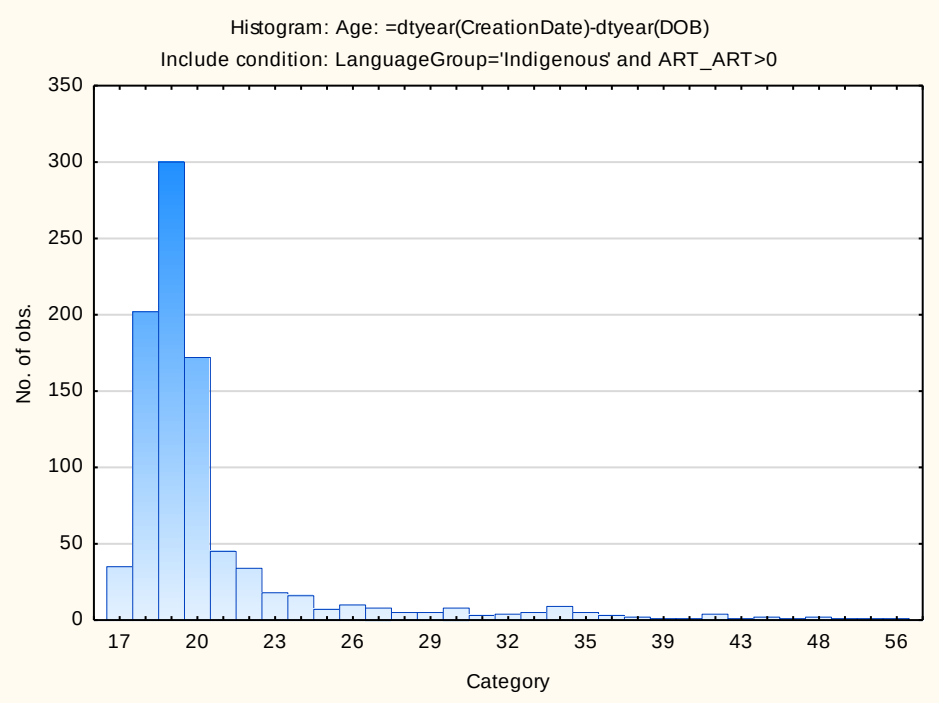
Category	Count	Cumulative Count	Percent	Cumulative Percent
siSwati	60	248	6,19835	25,6198
Setswana	115	363	11,88017	37,5000
Xitsonga	66	429	6,81818	44,3182
isiZulu	248	677	25,61983	69,9380
isiXhosa	89	766	9,19421	79,1322
Sesotho	105	871	10,84711	89,9793
Tshivenda	85	956	8,78099	98,7603
isiNdebele	12	968	1,23967	100,0000
Missing	0	968	0,00000	100,0000

Frequency table: Language Group

Category	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	968	968	100,0000	100,0000
Missing	0	968	0,0000	100,0000

Descriptive Statistics: Age

Variable	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,60373	4,717974	17,00000	56,00000	911	57



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,81	0,80

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,69	---

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,82	0,82

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,2470451	5,155075	0,81

Abstract Reasoning Test (ART)

Reliability: South Africans, isiZulu Speakers, 2017

Composition of the Sample

Compiled from raw data on 248 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	112	112	45,16129	45,1613
M	133	245	53,62903	98,7903
U	3	248	1,20968	100,0000
Missing	0	248	0,00000	100,0000

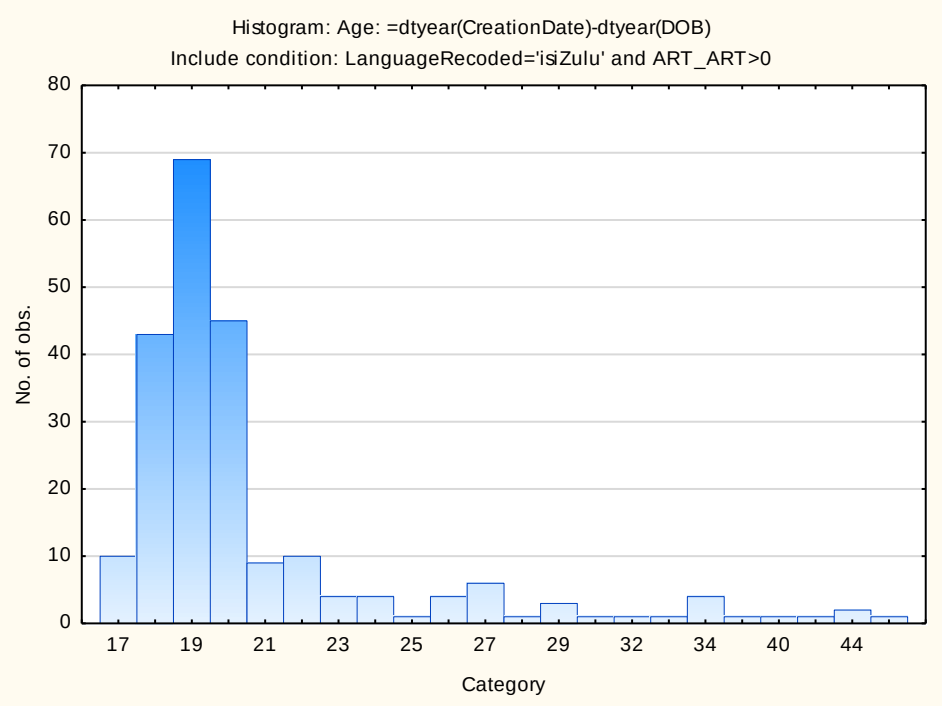
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	35	35	14,11290	14,1129
Grade 12	190	225	76,61290	90,7258
Post Graduate	16	241	6,45161	97,1774
< Matric	2	243	0,80645	97,9839
Missing	5	248	2,01613	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	240	240	96,77419	96,7742
European	2	242	0,80645	97,5806
Asian	3	245	1,20968	98,7903
Missing	3	248	1,20968	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
isiZulu	248	248	100,0000	100,0000
Missing	0	248	0,0000	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	248	248	100,0000	100,0000
Missing	0	248	0,0000	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,91892	4,918586	17,00000	48,00000	222	26



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,82	0,82

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,72	---

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,84	0,84

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,24922026	5,301463	0,82

Abstract Reasoning Test (ART)

Reliability: South Africans, Sepedi Speakers, 2017

Composition of the Sample

Compiled from raw data on 188 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	75	75	39,89362	39,8936
M	110	185	58,51064	98,4043
U	3	188	1,59574	100,0000
Missing	0	188	0,00000	100,0000

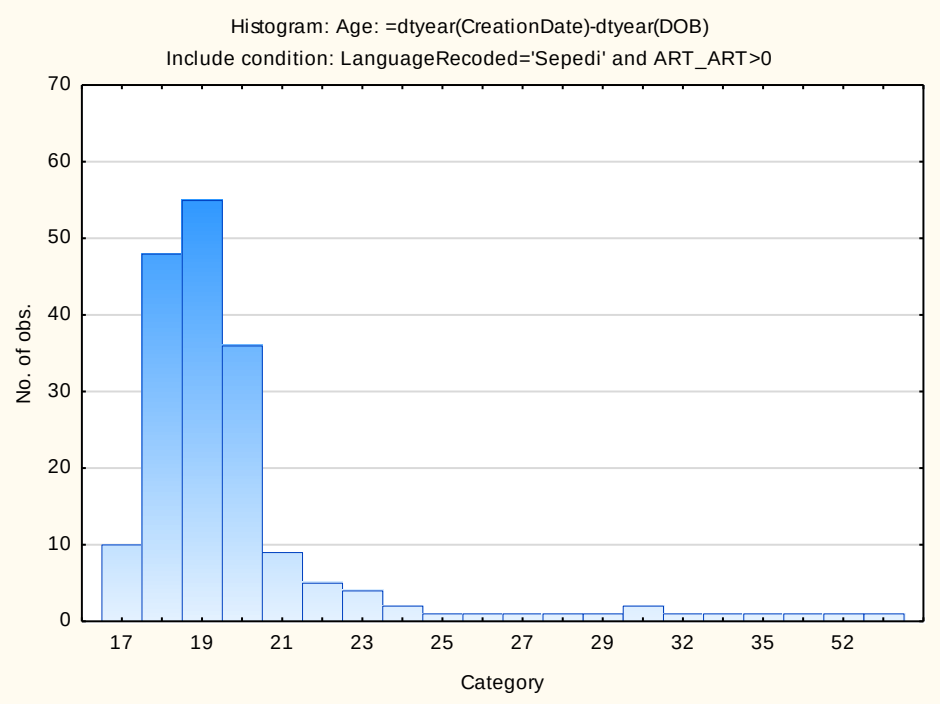
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	15	15	7,97872	7,9787
Grade 12	166	181	88,29787	96,2766
Post Graduate	4	185	2,12766	98,4043
< Matric	2	187	1,06383	99,4681
Missing	1	188	0,53191	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	187	187	99,46809	99,4681
Missing	1	188	0,53191	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Sepedi	188	188	100,0000	100,0000
Missing	0	188	0,0000	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	188	188	100,0000	100,0000
Missing	0	188	0,0000	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,23077	4,804641	17,00000	56,00000	182	6



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,80	0,80

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,63	0,93

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,77	0,77

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,21173553	4,945591	0,80

Abstract Reasoning Test (ART)

Reliability: South Africans, Sesotho Speakers, 2017

Composition of the Sample

Compiled from raw data on 105 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	45	45	42,85714	42,8571
M	56	101	53,33333	96,1905
U	4	105	3,80952	100,0000
Missing	0	105	0,00000	100,0000

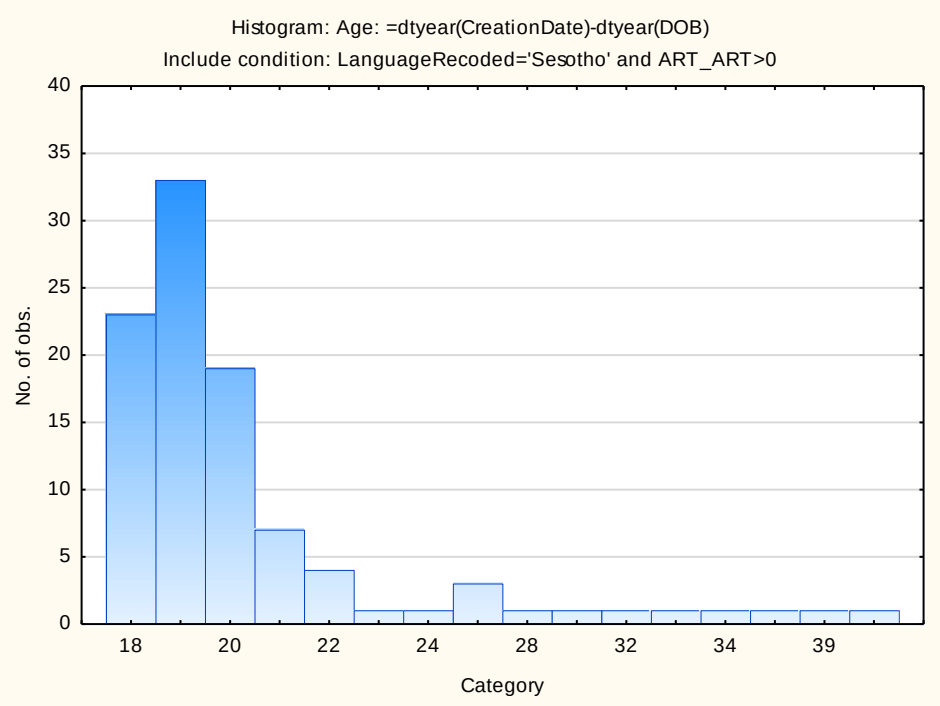
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	6	6	5,71429	5,7143
Grade 12	91	97	86,66667	92,3810
Post Graduate	5	102	4,76190	97,1429
< Matric	2	104	1,90476	99,0476
Missing	1	105	0,95238	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	105	105	100,0000	100,0000
Missing	0	105	0,0000	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Sesotho	105	105	100,0000	100,0000
Missing	0	105	0,0000	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	105	105	100,0000	100,0000
Missing	0	105	0,0000	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	20,74747	4,456922	18,00000	41,00000	99	6



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,80	0,80

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,74	---

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,85	0,85

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,23250234	4,992027	0,80

Abstract Reasoning Test (ART)

Reliability: South Africans, Setswana Speakers, 2017

Composition of the Sample

Compiled from raw data on 115 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	59	59	51,30435	51,3043
M	56	115	48,69565	100,0000
Missing	0	115	0,00000	100,0000

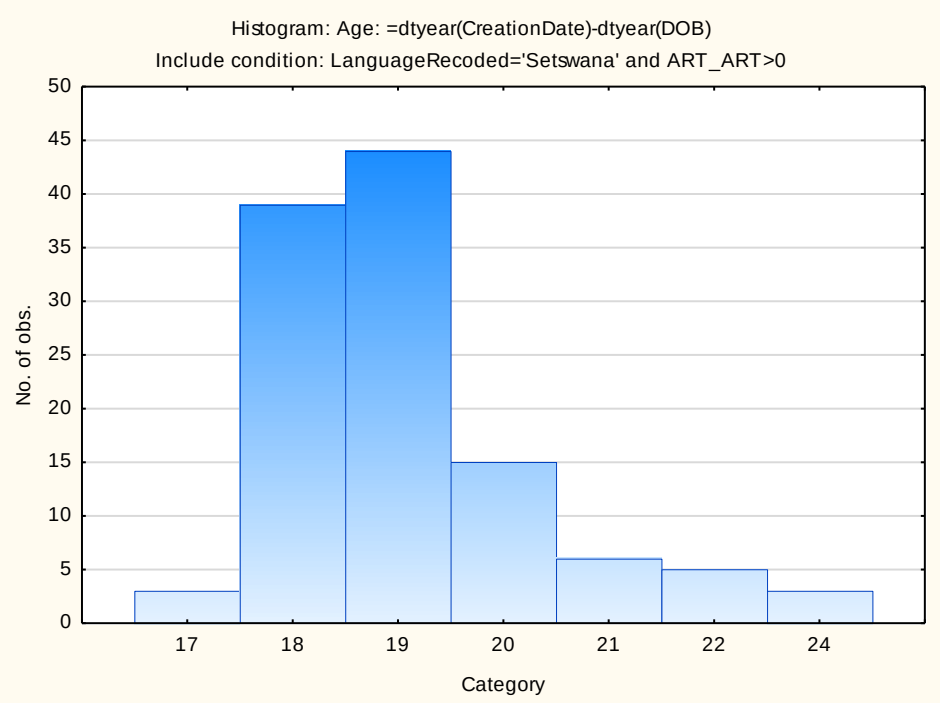
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	2	2	1,73913	1,7391
Grade 12	108	110	93,91304	95,6522
< Matric	3	113	2,60870	98,2609
Missing	2	115	1,73913	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	113	113	98,26087	98,2609
Asian	1	114	0,86957	99,1304
Missing	1	115	0,86957	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Setswana	115	115	100,0000	100,0000
Missing	0	115	0,0000	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Indigenous	115	115	100,0000	100,0000
Missing	0	115	0,0000	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	19,10435	1,353189	17,00000	24,00000	115	0



Cronbach Coefficient Alpha and Standardised Alpha for Abstract Reasoning Test

Subtest	Cronbach Coefficient Alpha	Standardised Alpha
Abstract Reasoning Test	0,72	0,70

Results of lower than 0.75 are possibly related to respondents guessing the answers to items which they may not know. Results should therefore be interpreted with caution. Do not rely on these tests in isolation, but to consider the results as part of a holistic assessment, which incorporates additional sources of information.

Split-half Reliability

Subtest	Corr. 1st & 2nd half	Attenuation corrected
Abstract Reasoning Test	0,61	---

Subtest	Split-half reliability	Guttman split-half
Abstract Reasoning Test	0,76	0,75

The items were split into odd and even numbers.

There are various ways of calculating reliability. We have reported on the calculations we did.

Standard Error of Measurement

Subtest	SEM	SD	Reliability
Abstract Reasoning Test	2,25194763	4,255781	0,72

Abstract Reasoning Test (ART)

Validity Introduction

Recommendations

Users are strongly encouraged to do validation studies on the instruments they use within their organisations or within their industry sectors, by co-operating with other organisations in the same industry. In some cases, this may mean sharing information with organisations that are potential competitors. In the interest of professionalism, users are encouraged to overcome their reservations in this regard, since co-operation is in their interest. Psytech South Africa provides extensive support for validation studies done on its instruments, and users are welcome to contact their representatives in this regard.

For construct validation studies, it is necessary to assess a particular ability with more than one instrument on the same respondents. This may seem like an unnecessary expense at first, but it is worthwhile to verify how ability measures relate to one another, particularly if one is still introducing a new measure.

Predictive validation studies can be done against competency ratings, or against 'hard' data like production or sales figures. It is preferable to use both types of criterion information, because that enables one to validate the competency ratings as well.

At the time of writing, there was still a shortage of validity information, particularly predictive validity, regarding the Abstract Reasoning Test in South Africa. More information is being sought, and this section will shortly be updated.

Index of validity studies done on the Abstract Reasoning Test in South Africa

Description	Study Number
ART Construct Validity with the GRT2	V1
ART Construct Validity with the CRTB2	V2

Abstract Reasoning Test (ART) Construct Validity: Correlations with General Reasoning Test (GRT2)

Sample Composition

The sample consists of respondents who have completed both the ART and a subtest of the GRT2. the number of respondents per subtest is as follows: 287 respondents completed the ART and the GRT2A, 165 respondents completed the ART and the GRT2N, and 159 respondents completed the ART and the GRT2V. Data were collected by Psytech SA and collaborators.

Biographical Composition: General Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
M	108	108	37,63066	37,6307
F	170	278	59,23345	96,8641
U	9	287	3,13589	100,0000
Missing	0	287	0,00000	100,0000

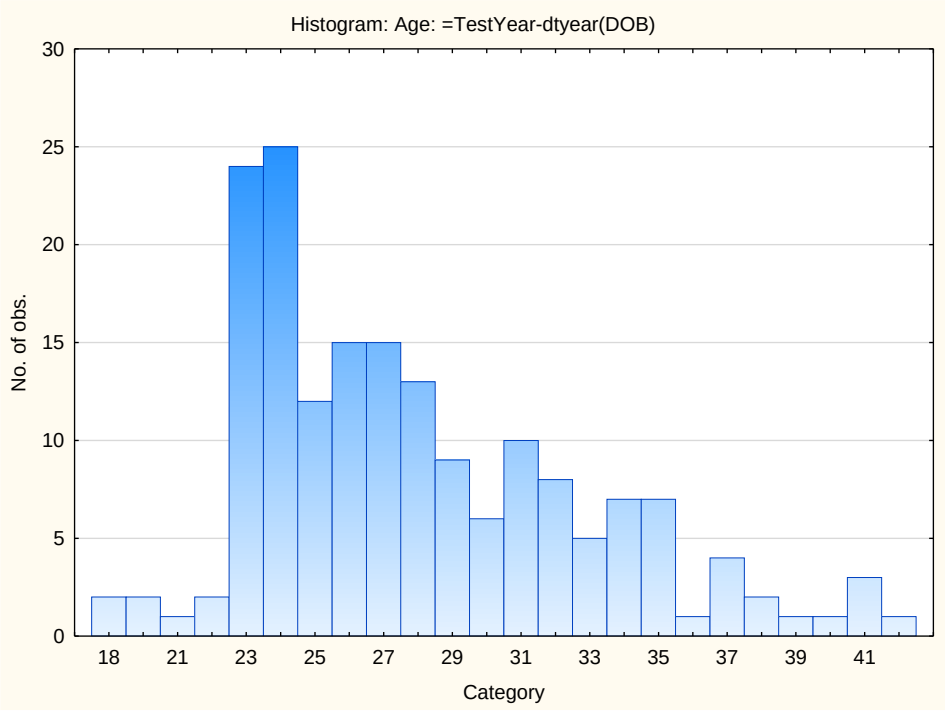
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Grade 12	18	18	6,27178	6,2718
Post Graduate	119	137	41,46341	47,7352
Tertiary	95	232	33,10105	80,8362
< Matric	3	235	1,04530	81,8815
Missing	52	287	18,11847	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
European	106	106	36,93380	36,9338
African	62	168	21,60279	58,5366
Coloured	22	190	7,66551	66,2021
Asian	6	196	2,09059	68,2927
Missing	91	287	31,70732	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	157	157	54,70383	54,7038
Afrikaans	23	180	8,01394	62,7178
Xitsonga	4	184	1,39373	64,1115
isiXhosa	7	191	2,43902	66,5505
Sesotho	5	196	1,74216	68,2927
Sepedi	7	203	2,43902	70,7317
Setswana	8	211	2,78746	73,5192
isiNdebele	1	212	0,34843	73,8676
isiZulu	7	219	2,43902	76,3066
Tshivenda	3	222	1,04530	77,3519
siSwati	3	225	1,04530	78,3972
Missing	62	287	21,60279	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	157	157	54,70383	54,7038
Afrikaans	23	180	8,01394	62,7178
Indigenous	45	225	15,67944	78,3972
Missing	62	287	21,60279	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	27,89205	4,893698	18,00000	42,00000	176	111



Biographical Composition: General Numerical Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
M	48	48	29,09091	29,0909
U	7	55	4,24242	33,3333
F	110	165	66,66667	100,0000
Missing	0	165	0,00000	100,0000

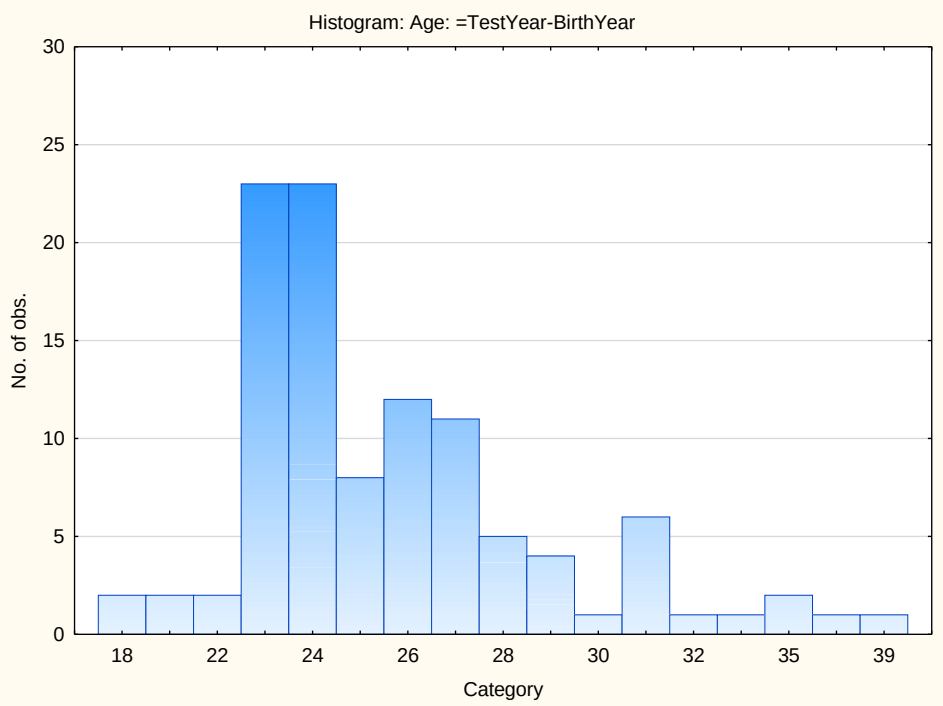
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Post graduate	95	95	57,57576	57,5758
Tertiary	41	136	24,84848	82,4242
< Matric	2	138	1,21212	83,6364
Grade 12	3	141	1,81818	85,4545
Missing	24	165	14,54545	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
European	20	20	12,12121	12,1212
Coloured	11	31	6,66667	18,7879
African	49	80	29,69697	48,4848
Asian	8	88	4,84848	53,3333
Missing	77	165	46,66667	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	84	84	50,90909	50,9091
Afrikaans	15	99	9,09091	60,0000
Xitsonga	4	103	2,42424	62,4242
isiXhosa	4	107	2,42424	64,8485
isiZulu	9	116	5,45455	70,3030
Sesotho	5	121	3,03030	73,3333
Sepedi	5	126	3,03030	76,3636
Setswana	7	133	4,24242	80,6061
Tshivenda	3	136	1,81818	82,4242
siSwati	3	139	1,81818	84,2424
Missing	26	165	15,75758	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	84	84	50,90909	50,9091
Afrikaans	15	99	9,09091	60,0000
Indigenous	40	139	24,24242	84,2424
Missing	26	165	15,75758	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	25,63810	3,595199	18,00000	39,00000	105	60



Biographical Composition: General Verbal Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
M	48	48	30,18868	30,1887
U	7	55	4,40252	34,5912
F	104	159	65,40881	100,0000
Missing	0	159	0,00000	100,0000

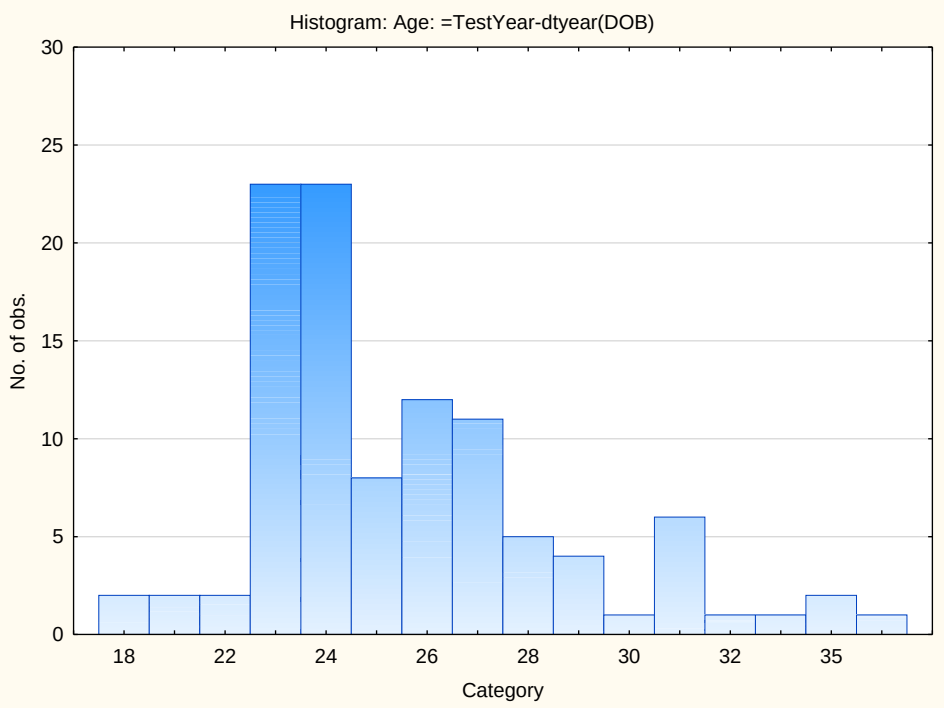
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Post Graduate	95	95	59,74843	59,7484
Tertiary	32	127	20,12579	79,8742
< Matric	3	130	1,88679	81,7610
Grade 12	3	133	1,88679	83,6478
Missing	26	159	16,35220	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
European	59	59	37,10692	37,1069
Coloured	11	70	6,91824	44,0252
African	45	115	28,30189	72,3270
Asian	6	121	3,77358	76,1006
Missing	38	159	23,89937	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	76	76	47,79874	47,7987
Afrikaans	15	91	9,43396	57,2327
Xitsonga	4	95	2,51572	59,7484
isiXhosa	5	100	3,14465	62,8931
isiZulu	8	108	5,03145	67,9245
Sesotho	5	113	3,14465	71,0692
Sepedi	5	118	3,14465	74,2138
Setswana	7	125	4,40252	78,6164
Tshivenda	3	128	1,88679	80,5031
siSwati	3	131	1,88679	82,3899
Missing	28	159	17,61006	100,0000

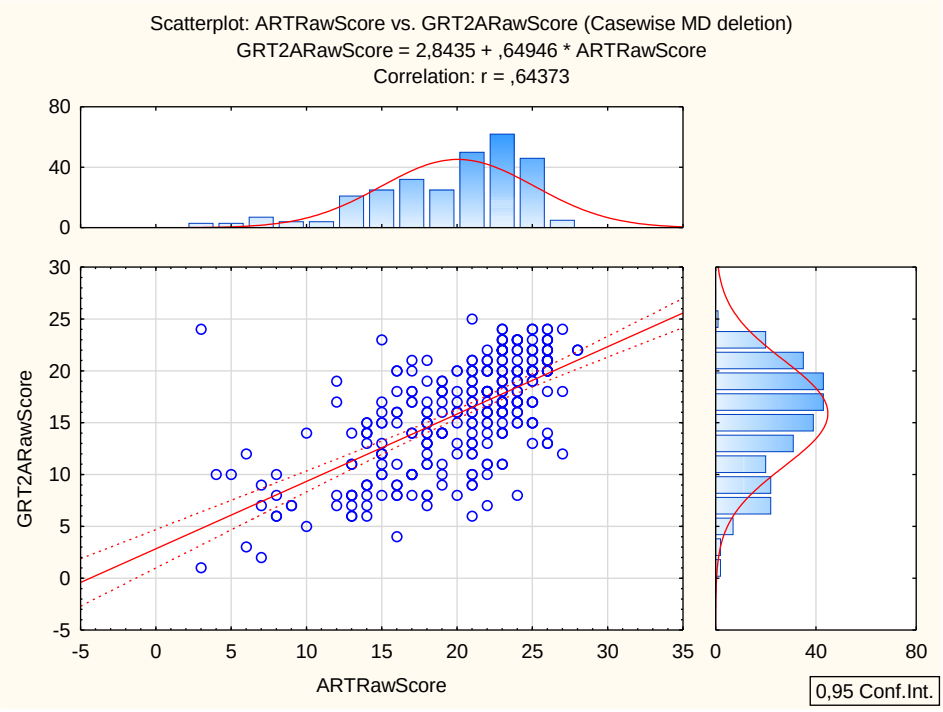
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	76	76	47,79874	47,7987
Indigenous	40	116	25,15723	72,9560
Afrikaans	15	131	9,43396	82,3899
Missing	28	159	17,61006	100,0000

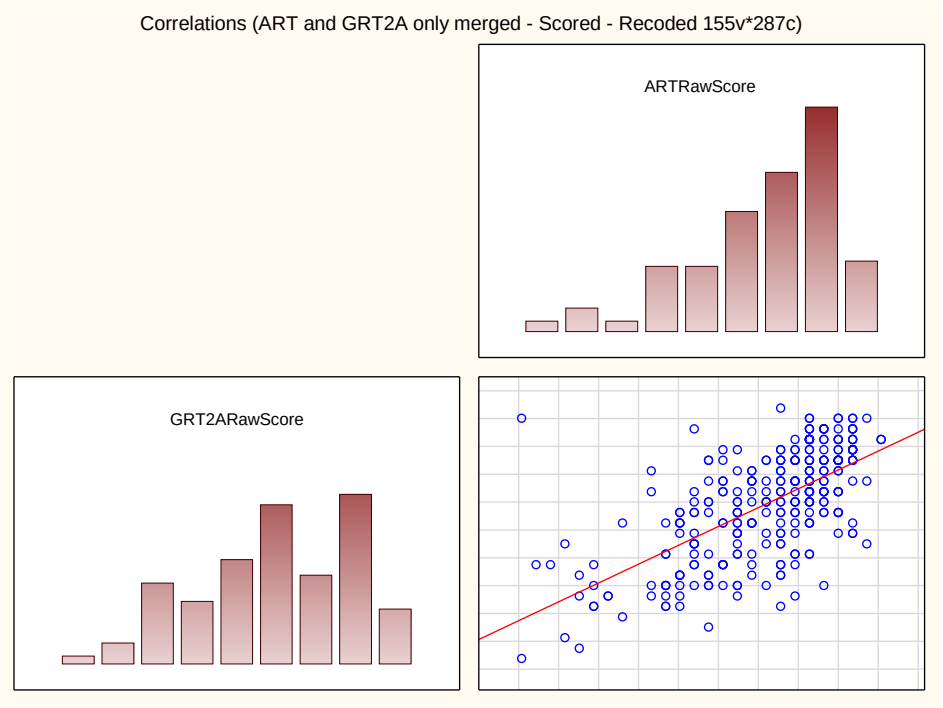
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	25,51923	3,398974	18,00000	39,00000	104	55



Correlations with the GRT2A

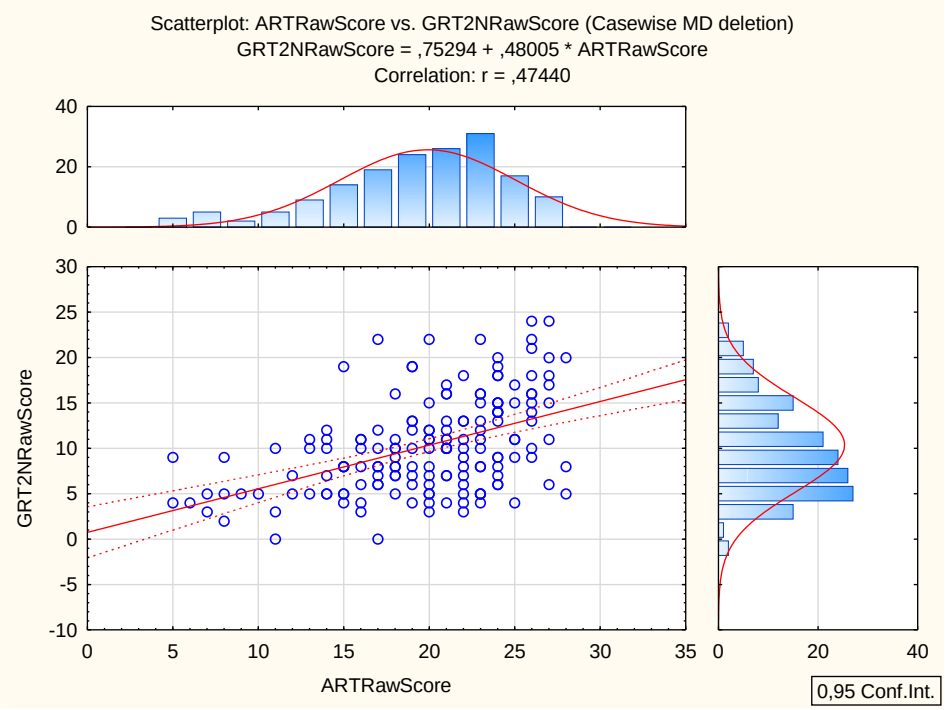
Variable	Correlations (ART and GRT2A only merged - Scored - Recoded) Marked correlations are significant at p < ,05000 N=287 (Casewise deletion of missing data)
	GRT2ARawScore
ARTRawScore	0,643727

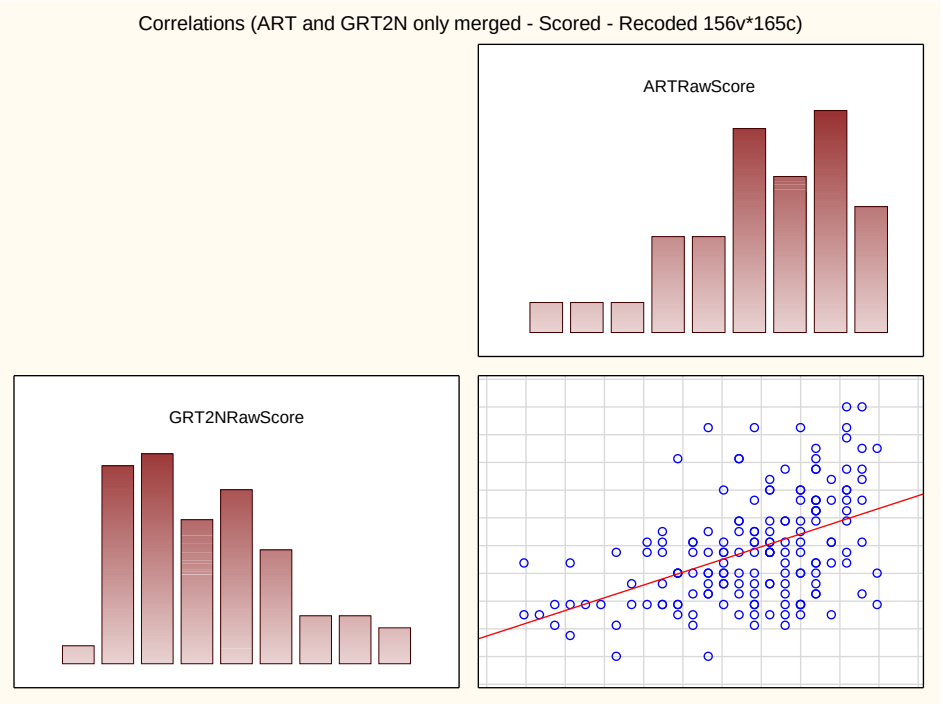




Correlations with the GRT2N

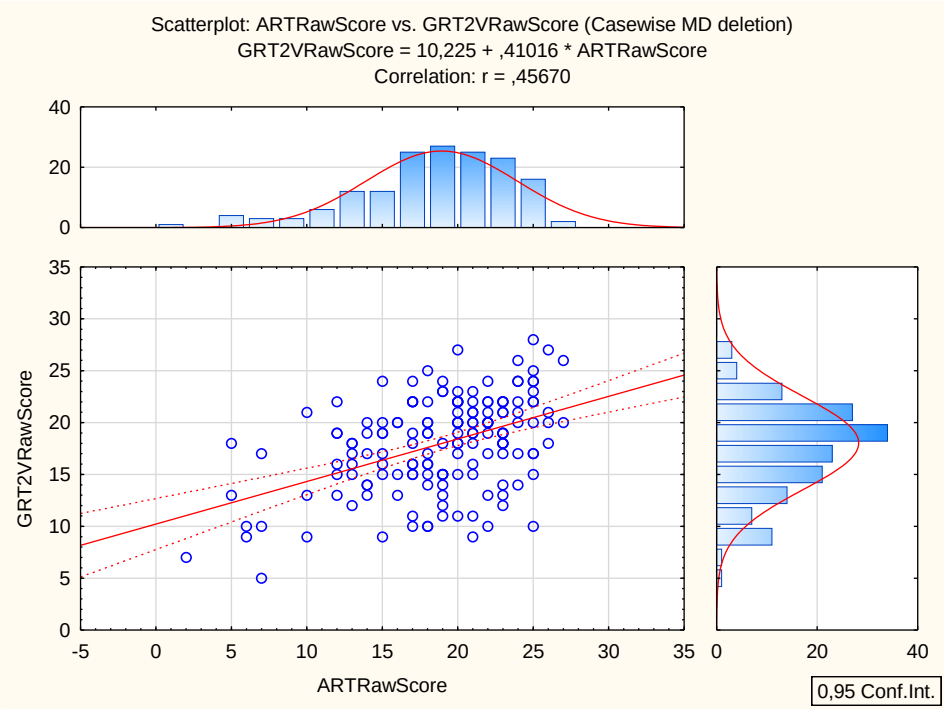
Variable	Correlations (ART and GRT2N only merged - Scored - Recoded) Marked correlations are significant at p < ,05000 N=165 (Casewise deletion of missing data)
	GRT2NRawScore
ARTRawScore	0,474395

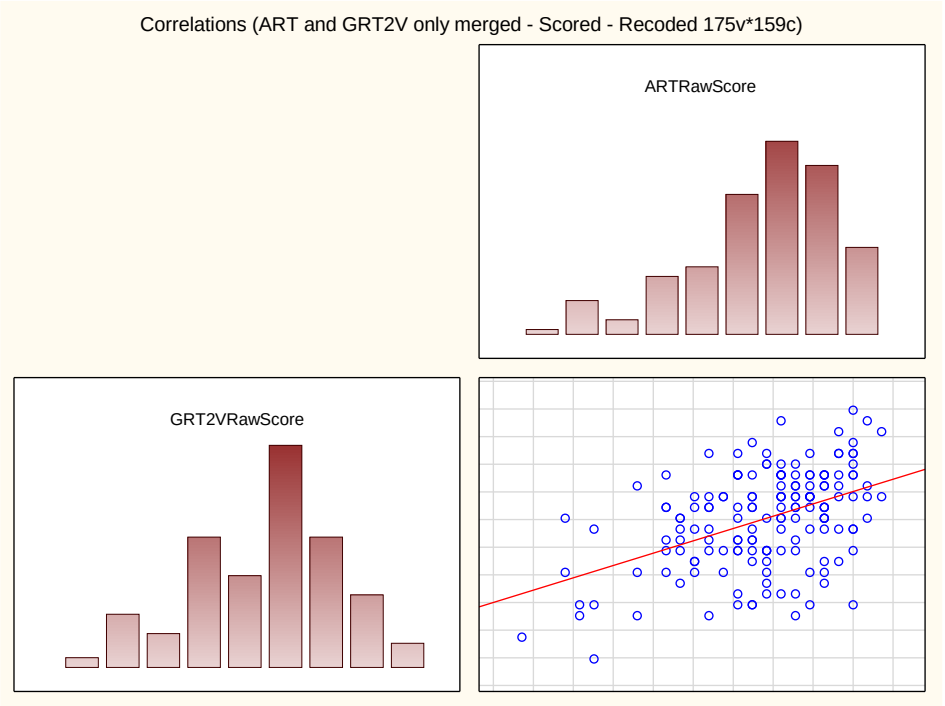




Correlations with the GRT2V

Variable	Correlations (ART and GRT2V only merged - Scored - Recoded) Marked correlations are significant at p < ,05000 N=159 (Casewise deletion of missing data)
	GRT2VRawScore
ARTRawScore	0,456697





Summary Table of Correlations with the GRT2

Test	GRT2A	GRT2N	GRT2V
ART	0,643727 p = 0.000	0,474395 p = 0.000	0,456697 p = 0.000

Correlations are marked significant at p < .05000. N differs per test and can be found in the sample composition. These correlations are uncorrected.

Comments:

The correlations of the General Reasoning Test Battery subtests and the Abstract Reasoning Test are significant, and support the construct validity of both tests. The GRT2A and Art correlated highly, but not so high as for them to be considered parallel forms. It should be borne in mind that the difficulty levels of these tests are not the same, with the ART being more difficult than the GRT2A. The correlations with the ART and the GRT2N and GRT2V are fair.

Abstract Reasoning Test (ART) Construct Validity: Correlations with Critical Reasoning Test Battery (CRTB2)

Sample Composition

The sample consists of respondents who have completed both the ART and a subtest of the CRTB2. The number of respondents per subtest is as follows: 807 respondents completed the ART and the CRTB2N, and 801 respondents completed the ART and the CRTB2V. Data were collected by Psytech SA and collaborators.

Biographical Composition: Critical Numerical Reasoning Test and Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	418	418	51,79678	51,7968
M	371	789	45,97274	97,7695
U	18	807	2,23048	100,0000
Missing	0	807	0,00000	100,0000

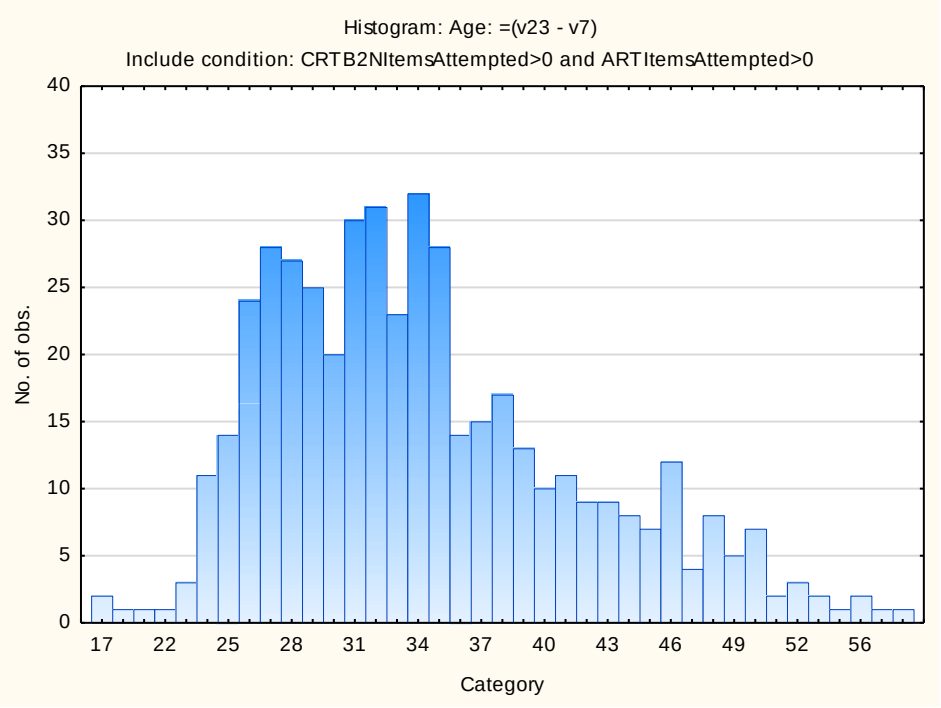
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary Cert / Trade	107	107	13,25898	13,2590
Post Graduate	247	354	30,60719	43,8662
Tertiary	250	604	30,97893	74,8451
Tertiary Cert / Trade	20	624	2,47831	77,3234
Grade 12	69	693	8,55019	85,8736
< Matric	6	699	0,74349	86,6171
Missing	108	807	13,38290	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	205	205	25,40273	25,4027
European	259	464	32,09418	57,4969
Coloured	52	516	6,44362	63,9405
Asian	34	550	4,21314	68,1537
Indian	57	607	7,06320	75,2169
Missing	200	807	24,78315	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
Afrikaans	56	56	6,93928	6,9393
English	497	553	61,58612	68,5254
isiZulu	44	597	5,45229	73,9777
isiXhosa	23	620	2,85006	76,8278
Sepedi	18	638	2,23048	79,0582
isiNdebele	2	640	0,24783	79,3061
Sesotho	8	648	0,99133	80,2974
Xitsonga	5	653	0,61958	80,9170
Setswana	10	663	1,23916	82,1561
siSwati	2	665	0,24783	82,4040
Tshivenda	9	674	1,11524	83,5192
Missing	133	807	16,48079	100,0000

Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	497	497	61,58612	61,5861
Afrikaans	56	553	6,93928	68,5254
Indigenous	121	674	14,99380	83,5192
Missing	133	807	16,48079	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age: =(v23 - v7)	34,32468	7,458242	17,00000	63,00000	462	345



Biographical Composition: Critical Verbal Reasoning Test and Abstract Reasoning Test

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	417	417	52,05993	52,0599
M	367	784	45,81773	97,8777
U	17	801	2,12235	100,0000
Missing	0	801	0,00000	100,0000

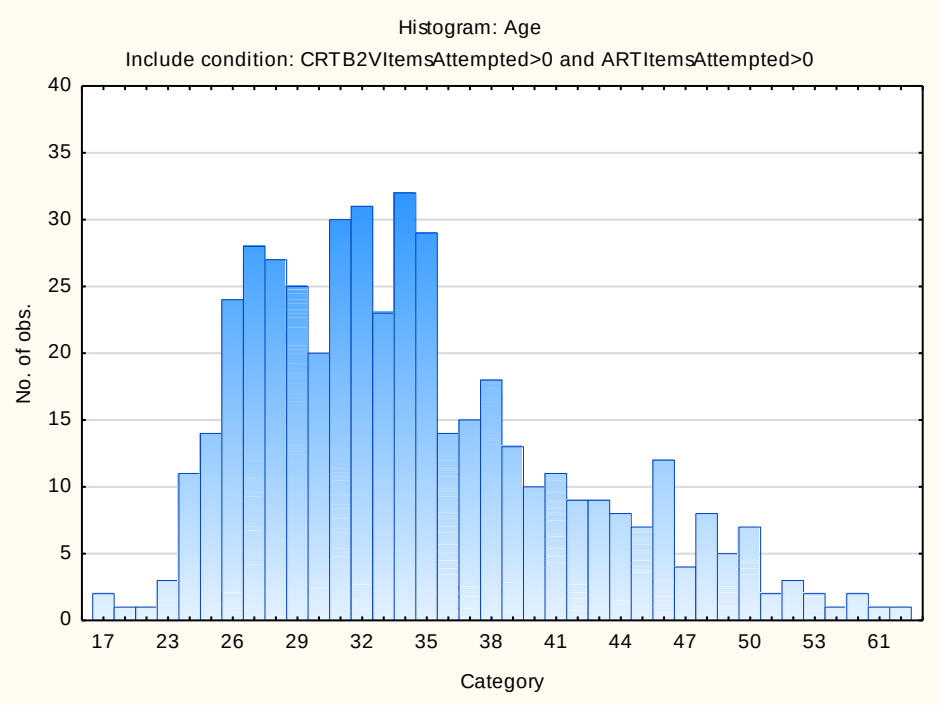
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertitary	250	250	31,21099	31,2110
Grade 12	66	316	8,23970	39,4507
Post Graduate	245	561	30,58677	70,0375
Tertitary Cert / Trade	109	670	13,60799	83,6454
Teritary Cert / Trade	20	690	2,49688	86,1423
< Matric	6	696	0,74906	86,8914
Missing	105	801	13,10861	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
Coloured	52	52	6,49189	6,4919
European	257	309	32,08489	38,5768
African	204	513	25,46816	64,0449
Asian	32	545	3,99501	68,0400
Indian	57	602	7,11610	75,1561
Missing	199	801	24,84395	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	496	496	61,92260	61,9226
Afrikaans	56	552	6,99126	68,9139
isiZulu	21	573	2,62172	71,5356
isiXhosa	23	596	2,87141	74,4070
Sesotho	8	604	0,99875	75,4057
Sepedi	18	622	2,24719	77,6529
Setswana	10	632	1,24844	78,9014
siSwati	2	634	0,24969	79,1511
Xitsonga	5	639	0,62422	79,7753
isiNdebele	2	641	0,24969	80,0250
Tshivenda	9	650	1,12360	81,1486
Missing	151	801	18,85144	100,0000

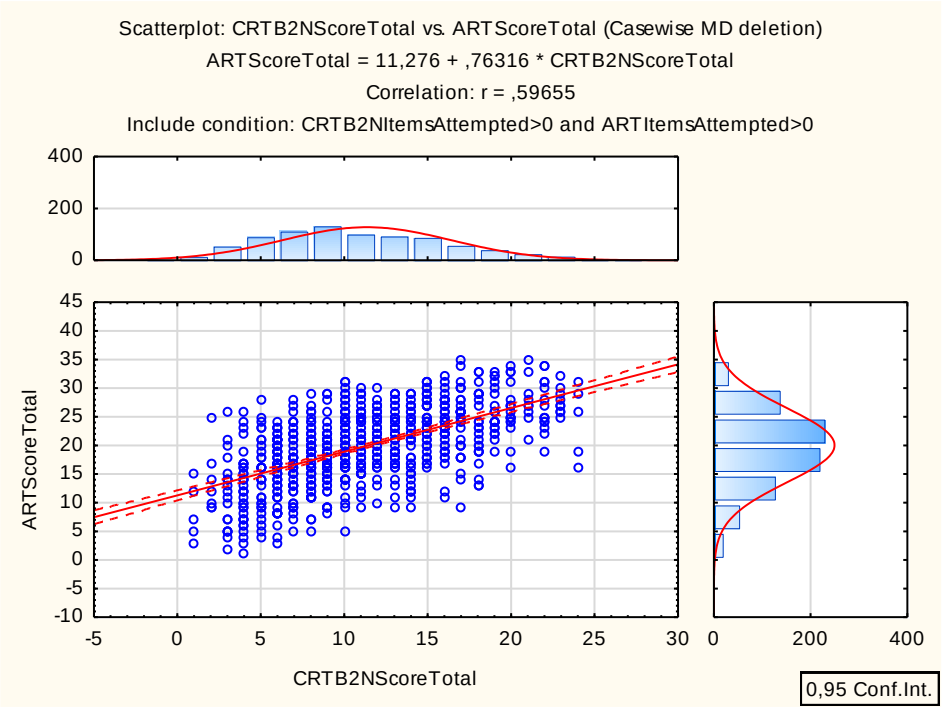
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	496	496	61,92260	61,9226
Afrikaans	56	552	6,99126	68,9139
Indigenous	98	650	12,23471	81,1486
Missing	151	801	18,85144	100,0000

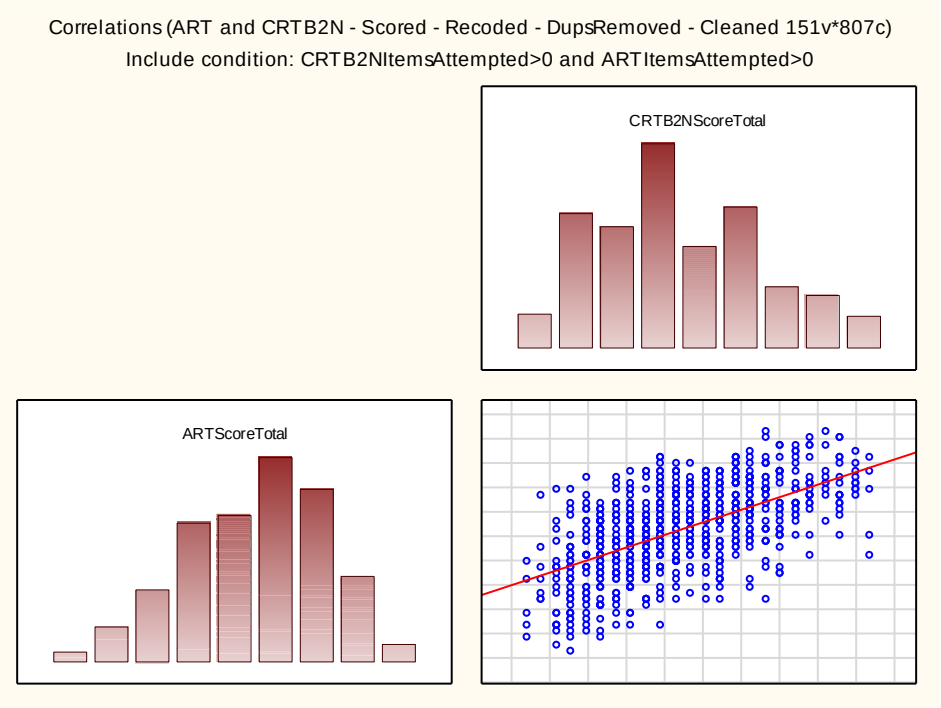
Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	34,36501	7,422225	17,00000	63,00000	463	338


Histogram: Age
Include condition: CRTB2VItemsAttempted>0 and ARTItemsAttempted>0
No. of obs.
0
5
10
15
20
25
30
35
40
17
23
26
29
32
35
38
41
44
47
50
53
61
Category

Correlations with the CRTB2N

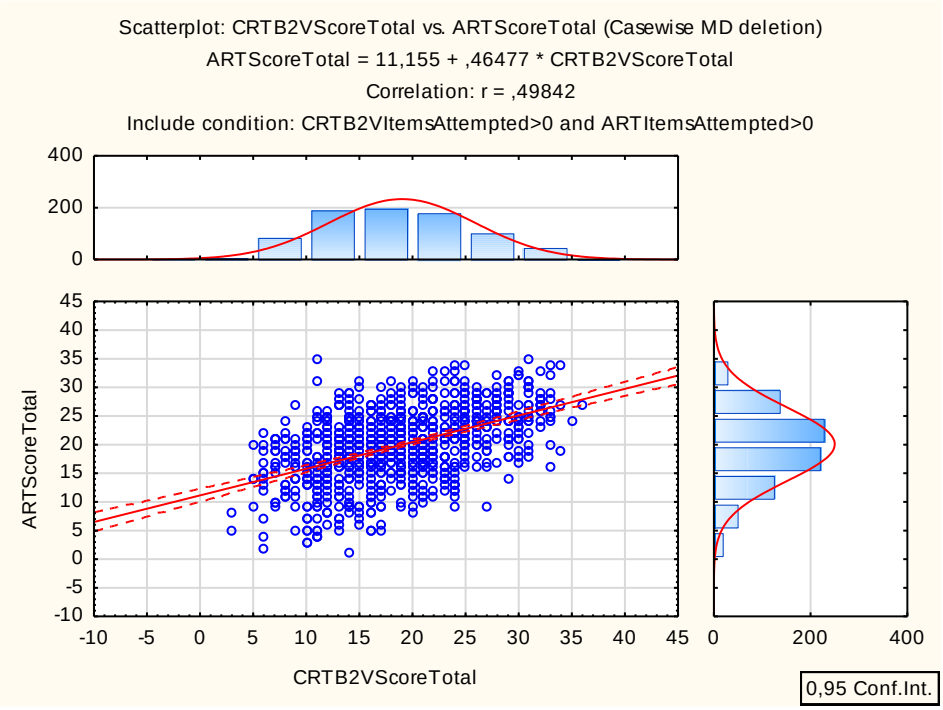
Variable	Correlations ART and CRTB2N Marked correlations are significant at p < ,05000 N=807 (Casewise deletion of missing data) Include condition: CRTB2NItemsAttempted>0 and ARTItemsAttempted>0
	CRTB2NRawScore
ARTRawScore	0,596549

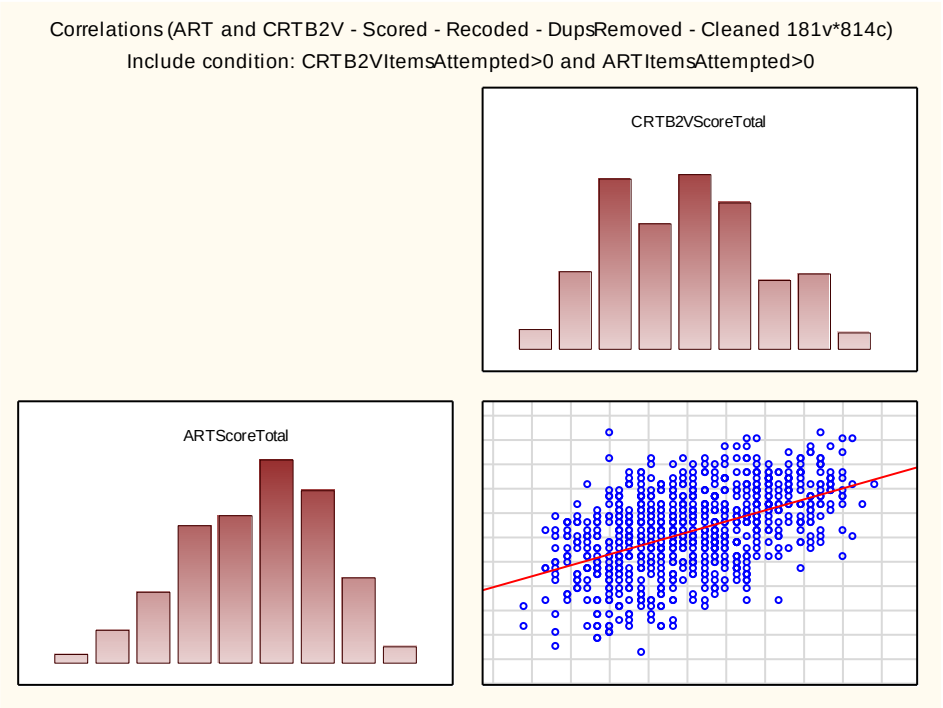




Correlations with the CRTB2V

Variable	Correlations ART and CRTB2V Marked correlations are significant at p < ,05000 N=801 (Casewise deletion of missing data) Include condition: CRTB2VItemsAttempted>0 and ARTItemsAttempted>0
	CRTB2VRawScore
ARTRawScore	0,498421


Scatterplot: CRTB2VScoreTotal vs. ARTScoreTotal (Casewise MD deletion)
ARTScoreTotal = 11,155 + ,46477 * CRTB2VScoreTotal
Correlation: r = ,49842
Include condition: CRTB2VItemsAttempted>0 and ARTItemsAttempted>0
ARTScoreTotal
CRTB2VScoreTotal
0,95 Conf.Int.


Correlations (ART and CRTB2V - Scored - Recoded - DupsRemoved - Cleaned 181v*814c)
Include condition: CRTB2VItemsAttempted>0 and ARTItemsAttempted>0
CRTB2VScoreTotal
ARTScoreTotal

Summary Table of Correlations with the CRTB2

Subtest	CRTB2N	CRTB2V
ART	0,596549 p=0.00	0,498421 p=0.00

Correlations are marked significant at p < .05000. N differs per test and can be found in the sample composition. These correlations are uncorrected.

Comments:

The correlations of the Critical Reasoning Test Battery subtests and the Abstract Reasoning Test are significant and support the construct validity of both tests. The ART has been designed to compliment the CTRB2 as part of a battery.

Abstract Reasoning Test Battery

Differential Item Functioning

Introduction

What is Differential Item Functioning?

Differential item functioning is found when a test item behaves differently for different population groups. Normally this means that the item shows a different relationship to the construct in question for different population groups. Normally one groups the respondents in terms of their level of score achieved on the construct, and then compares the likelihood of getting an item correct for the different population groups and the different score levels.

There are two different forms of Differential Item Functioning that are of interest to us:
Uniform bias means that one population group consistently has a better chance of answering an item correctly, irrespective of their total score.
Non-uniform bias means that the relative chance of answering the item correctly is not the same across all score levels, for different groups. This can be seen clearly on a graph, when the lines plotting the mean item score for a group are not parallel and may cross in places.

Ways of calculating Differential Item Functioning

There are many different ways of investigating Differential Item Functioning.

For the purpose of this manual, **Factorial Analysis of Variance** was used. This technique allows us to investigate the effect of combinations of continuous and categorical variables on predictor variables. It produces a particularly informative graph which is useful for visualising the effect of non-uniform bias.
The Factorial Analysis of Variance can also indicate uniform bias when a significant effect for the race group variable is found. Non-uniform bias is indicated by a significant interaction effect for the race group variable and score level.

Dividing the samples into score levels

The samples were divided into score levels in such a way that there would be sufficient persons of each group in every score category. To do this, stanine scores were calculated and the frequency tables for every race group examined for the stanine scores. To avoid creating cells with very few cases, resulting in meaningless output, the groups could not always be divided up evenly. It should also be pointed out that the low end and high end of the distributions could not be examined in great detail, because there are few persons in any group that score at the extremes of the scale. Only if one has an extremely large sample can the high end and low end of a scale be fully studied for bias. The score level variable used in the study can only be considered ordinal data (the intervals are not of uniform size). This should be borne in mind when interpreting the graphs.

Grouping respondents

Ideally, one would want to examine all race groups in detail, but in practice this is not always possible. The grouping of respondents according to race group had to be determined by the availability of data. Grouping is usually done with all Black candidates on one group, and all the other groups in the other.

Direction and magnitude of differences

If DIF is found, the bias is not necessarily in favour of the Non-Black or Advantaged group. The size of the differences in item means scores must also be considered. In some cases, the differences are very small. For every study, a summary of the findings is given, as well as a detailed report of the findings for every item. The differences between race groups, where bias is found, is graphically depicted.

List of Differential item functioning studies reported for the Abstract Reasoning Test Battery:

Tests	Grouping	Sample	Study number
Abstract Reasoning Test	Language Group	Aggregate Population	D1
Abstract Reasoning Test	Black-Non-Black	Aggregate Population	D2

ART Differential Item Functioning. Grouping Variable – Language Group

Composition of the Sample

Compiled from raw data on 2191 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Sample

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	999	999	45,59562	45,5956
M	1122	2121	51,20949	96,8051
U	66	2187	3,01232	99,8174
Missing	4	2191	0,18257	100,0000

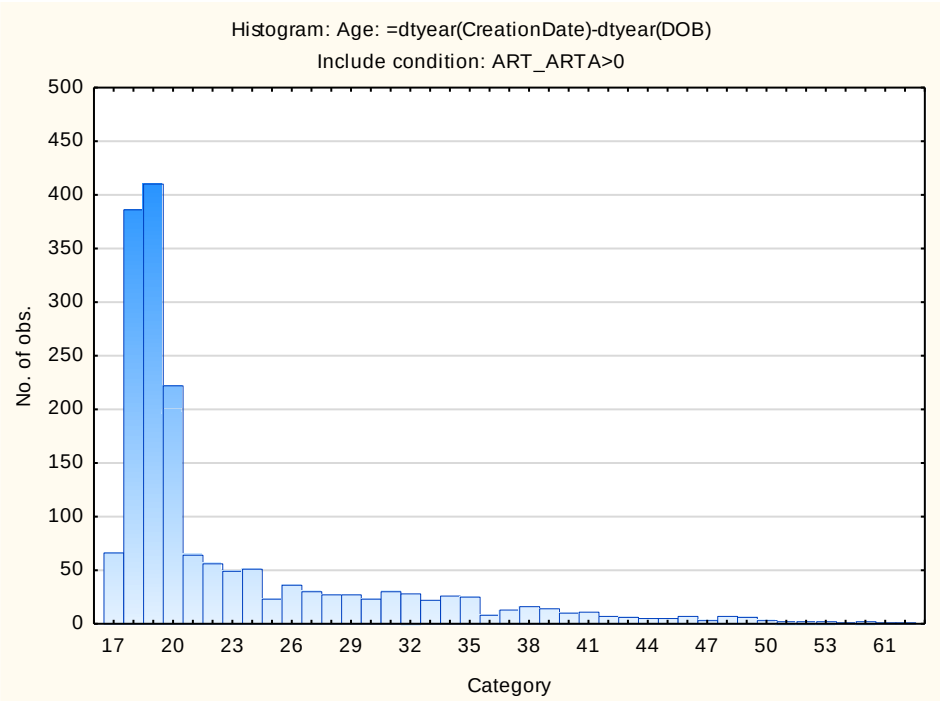
Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	417	417	19,03241	19,0324
Grade 12	1272	1689	58,05568	77,0881
Post Graduate	303	1992	13,82930	90,9174
< Matric	39	2031	1,78001	92,6974
Missing	160	2191	7,30260	100,0000

Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	1130	1130	51,57462	51,5746
Coloured	86	1216	3,92515	55,4998
Indian	43	1259	1,96257	57,4623
European	509	1768	23,23140	80,6937
Asian	161	1929	7,34824	88,0420
Missing	262	2191	11,95801	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Sepedi	188	1049	8,58056	47,8777
siSwati	60	1109	2,73848	50,6162
Afrikaans	154	1263	7,02875	57,6449
Setswana	115	1378	5,24874	62,8937
Xitsonga	66	1444	3,01232	65,9060
isiZulu	248	1692	11,31903	77,2250
isiXhosa	89	1781	4,06207	81,2871
Sesotho	105	1886	4,79233	86,0794
Tshivenda	85	1971	3,87951	89,9589
isiNdebele	12	1983	0,54770	90,5066
Missing	208	2191	9,49338	100,0000

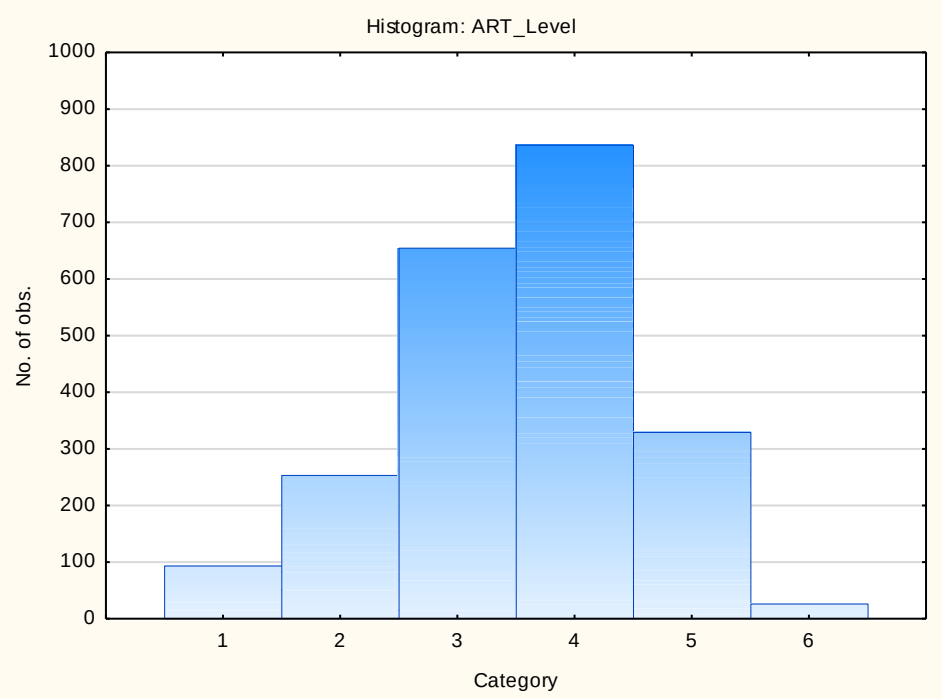
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Indigenous	968	1829	44,18074	83,4779
Afrikaans	154	1983	7,02875	90,5066
Missing	208	2191	9,49338	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	22,91056	7,292516	17,00000	63,00000	1733	458



Frequency Distribution of Score Levels

Category	Frequency table: ART Level			
	Count	Cumulative Count	Percent	Cumulative Percent
Level 1	93	93	4,24464	4,2446
Level 2	253	346	11,54724	15,7919
Level 3	654	1000	29,84938	45,6413
Level 4	836	1836	38,15609	83,7974
Level 5	329	2165	15,01597	98,8133
Level 6	26	2191	1,18667	100,0000
Missing	0	2191	0,00000	100,0000



Method

Applicants were classified into Language groups for the purpose of the analysis. These were Afrikaans (N= 154), English (N= 861) and Indigenous language speakers. (N= 968).

Applicants were classified into score levels for the test being evaluated. The cut-offs for the levels were determined by standardizing the raw scores from the ART for the language groups. The grouping intervals were half a standard deviation, resulting in six groups.

The statistical technique used in this study was factorial analysis of variance. For every item a factorial analysis of variance was done, using the scored item response as dependent variable, and the language group and score level (on the overall test score for the subtest being investigated) as predictor variables. If a significant effect was found for language, that was taken as an indication of uniform item bias, and the least-square difference in the means for that item was plotted graphically to illustrate which language group had a lower probability of getting the item right. If a significant interaction effect was found for language group and score level that was taken as an indication of non-uniform item bias, and the

means at all levels for all three language groups were plotted to illustrate the severity of the non-uniform bias that was found.

Results by item: Abstract Reasoning Test

Summary table

Item number	Uniform bias	In favour of group	Non-uniform bias
1	No		No
2	No		No
3	No		No
4	No		Yes
5	No		No
6	No		No
7	No		No
8	No		No
9	No		No
10	No		No
11	No		No
12	No		Yes
13	No		No
14	No		Yes
15	No		No
16	No		Yes
17	No		No
18	No		No
19	No		No
20	No		No
21	No		No
22	No		No
23	No		No
24	No		No
25	No		No
26	No		No
27	No		No
28	No		No
29	No		No
30	No		No
31	No		No
32	No		No
33	No		No
34	No		No
35	Yes	English and Afrikaans Speakers	No

Uniform bias was found in one out of 35 items, and it was found in favour of the English and Afrikaans Speakers. It should be borne in mind that this is the final item in a time-limited test, one which is intended to be the most difficult. Approximately 25% of respondents did not

answer this item. It is very likely that a number of the respondents who did answer this item may have been guessing.

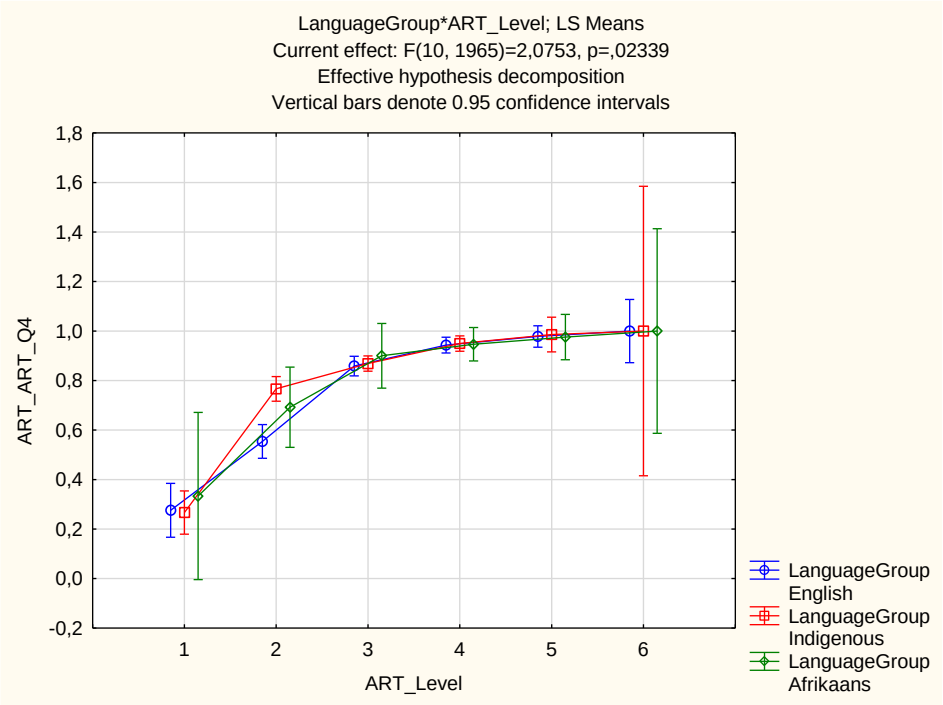
Non-uniform bias was found in four out of 35 items. The impact of that bias is best evaluated by inspecting the graphs in the detailed results that follow.
It should be noted that the Afrikaans group is substantially smaller than the other two groups. Therefore, there is less information available when determining item bias for that particular group. If more data are added to the sample, it is possible that changes in the bias findings may occur.

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q1 (SS)	ART_ART_Q1 (MS)	ART_ART_Q1 (F)	ART_ART_Q1 (p)
Intercept	1	97,8880	97,88800	988,1304	0,000000
LanguageGroup	2	0,0331	0,01654	0,1670	0,846221
ART_Level	5	12,5637	2,51274	25,3649	0,000000
LanguageGroup*ART_Level	10	1,1073	0,11073	1,1178	0,344534
Error	1965	194,6605	0,09906		
Total	1982	221,4655			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q2 (SS)	ART_ART_Q2 (MS)	ART_ART_Q2 (F)	ART_ART_Q2 (p)
Intercept	1	42,8300	42,83000	211,1840	0,000000
LanguageGroup	2	0,9520	0,47602	2,3472	0,095909
ART_Level	5	32,9997	6,59995	32,5427	0,000000
LanguageGroup *ART_Level	10	2,0900	0,20900	1,0305	0,414638
Error	1965	398,5196	0,20281		
Total	1982	479,8618			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q3 (SS)	ART_ART_Q3 (MS)	ART_ART_Q3 (F)	ART_ART_Q3 (p)
Intercept	1	71,3872	71,38724	508,0670	0,000000
LanguageGroup	2	0,0835	0,04174	0,2970	0,743052
ART_Level	5	34,5821	6,91641	49,2245	0,000000
LanguageGroup *ART_Level	10	2,1873	0,21873	1,5567	0,113657
Error	1965	276,0973	0,14051		
Total	1982	346,7877			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q4 (SS)	ART_ART_Q4 (MS)	ART_ART_Q4 (F)	ART_ART_Q4 (p)
Intercept	1	94,7775	94,77749	1065,707	0,000000
LanguageGroup	2	0,0875	0,04374	0,492	0,611552
ART_Level	5	15,8312	3,16624	35,602	0,000000
LanguageGroup *ART_Level	10	1,8456	0,18456	2,075	0,023395
Error	1965	174,7552	0,08893		
Total	1982	219,9758			



Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q5 (SS)	ART_ART_Q5 (MS)	ART_ART_Q5 (F)	ART_ART_Q5 (p)
Intercept	1	87,0784	87,07844	852,0639	0,000000
LanguageGroup	2	0,2065	0,10323	1,0101	0,364385
ART_Level	5	18,4947	3,69894	36,1942	0,000000
LanguageGroup *ART_Level	10	1,8161	0,18161	1,7771	0,059751
Error	1965	200,8172	0,10220		
Total	1982	242,6122			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization, Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q6 (SS)	ART_ART_Q6 (MS)	ART_ART_Q6 (F)	ART_ART_Q6 (p)
Intercept	1	92,7660	92,76600	762,0627	0,000000
LanguageGroup	2	0,0049	0,00245	0,0201	0,980057
ART_Level	5	10,7890	2,15780	17,7261	0,000000
LanguageGroup *ART_Level	10	1,1003	0,11003	0,9039	0,528620
Error	1965	239,1997	0,12173		
Total	1982	267,0045			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q7 (SS)	ART_ART_Q7 (MS)	ART_ART_Q7 (F)	ART_ART_Q7 (p)
Intercept	1	97,0909	97,09091	1026,742	0,000000
LanguageGroup	2	0,1340	0,06701	0,709	0,492429
ART_Level	5	11,4993	2,29986	24,321	0,000000
LanguageGroup *ART_Level	10	1,5617	0,15617	1,651	0,086716
Error	1965	185,8145	0,09456		
Total	1982	213,9768			

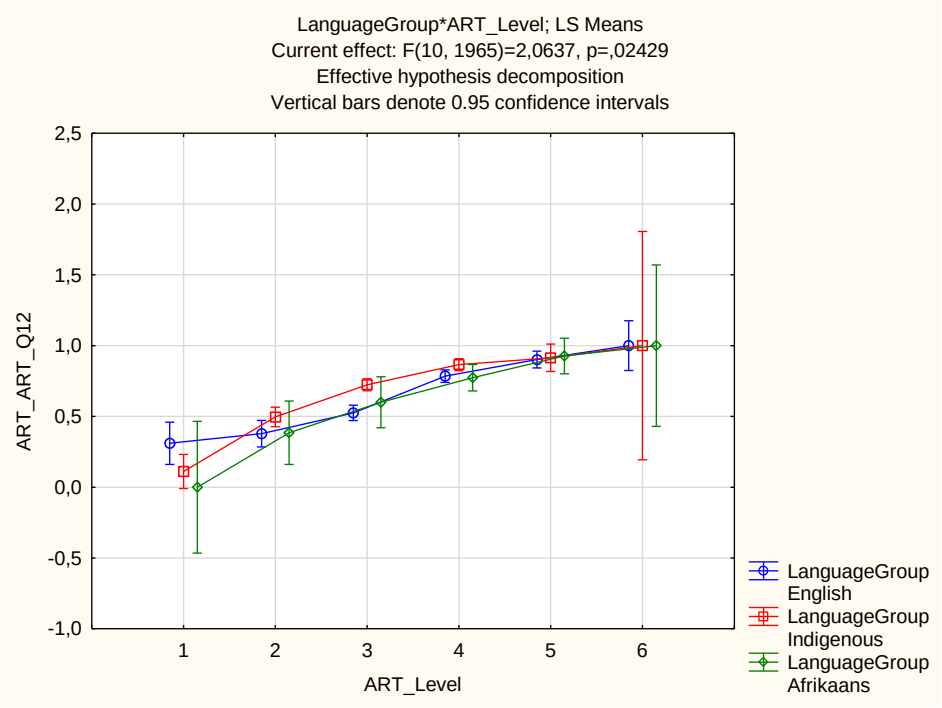
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q8 (SS)	ART_ART_Q8 (MS)	ART_ART_Q8 (F)	ART_ART_Q8 (p)
Intercept	1	100,2025	100,2025	1142,503	0,000000
LanguageGroup	2	0,1047	0,0523	0,597	0,550621
ART_Level	5	10,5820	2,1164	24,131	0,000000
LanguageGroup *ART_Level	10	0,9938	0,0994	1,133	0,333001
Error	1965	172,3391	0,0877		
Total	1982	204,8573			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q9 (SS)	ART_ART_Q9 (MS)	ART_ART_Q9 (F)	ART_ART_Q9 (p)
Intercept	1	85,1450	85,14501	719,5618	0,000000
LanguageGroup	2	0,0293	0,01467	0,1240	0,883372
ART_Level	5	20,3755	4,07509	34,4387	0,000000
LanguageGroup *ART_Level	10	0,6129	0,06129	0,5180	0,878598
Error	1965	232,5165	0,11833		
Total	1982	281,7045			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q10 (SS)	ART_ART_Q10 (MS)	ART_ART_Q10 (F)	ART_ART_Q10 (p)
Intercept	1	92,4286	92,42864	913,5293	0,000000
LanguageGroup	2	0,1739	0,08694	0,8593	0,423639
ART_Level	5	13,2910	2,65820	26,2726	0,000000
LanguageGroup *ART_Level	10	1,5236	0,15236	1,5058	0,130922
Error	1965	198,8139	0,10118		
Total	1982	230,3187			

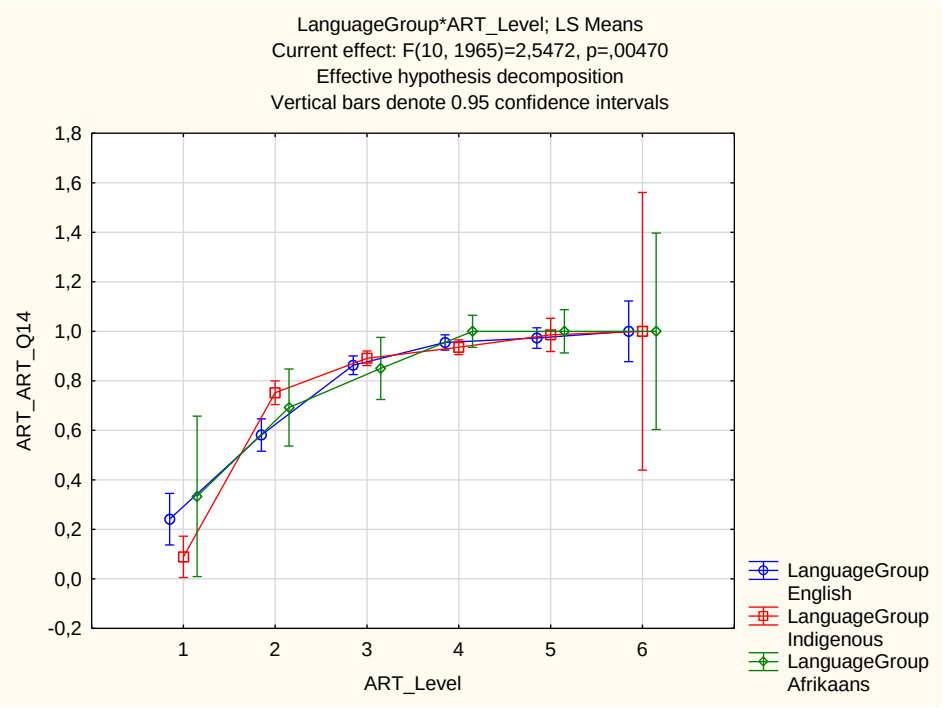
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q11 (SS)	ART_ART_Q11 (MS)	ART_ART_Q11 (F)	ART_ART_Q11 (p)
Intercept	1	94,1856	94,18563	1276,216	0,000000
LanguageGroup	2	0,3015	0,15073	2,042	0,129990
ART_Level	5	16,2711	3,25421	44,095	0,000000
LanguageGroup *ART_Level	10	0,7327	0,07327	0,993	0,447299
Error	1965	145,0184	0,07380		
Total	1982	181,4231			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q12 (SS)	ART_ART_Q12 (MS)	ART_ART_Q12 (F)	ART_ART_Q12 (p)
Intercept	1	63,4497	63,44974	375,3907	0,000000
LanguageGroup	2	0,0887	0,04437	0,2625	0,769156
ART_Level	5	28,8590	5,77181	34,1480	0,000000
LanguageGroup *ART_Level	10	3,4882	0,34882	2,0637	0,024288
Error	1965	332,1306	0,16902		
Total	1982	402,2905			



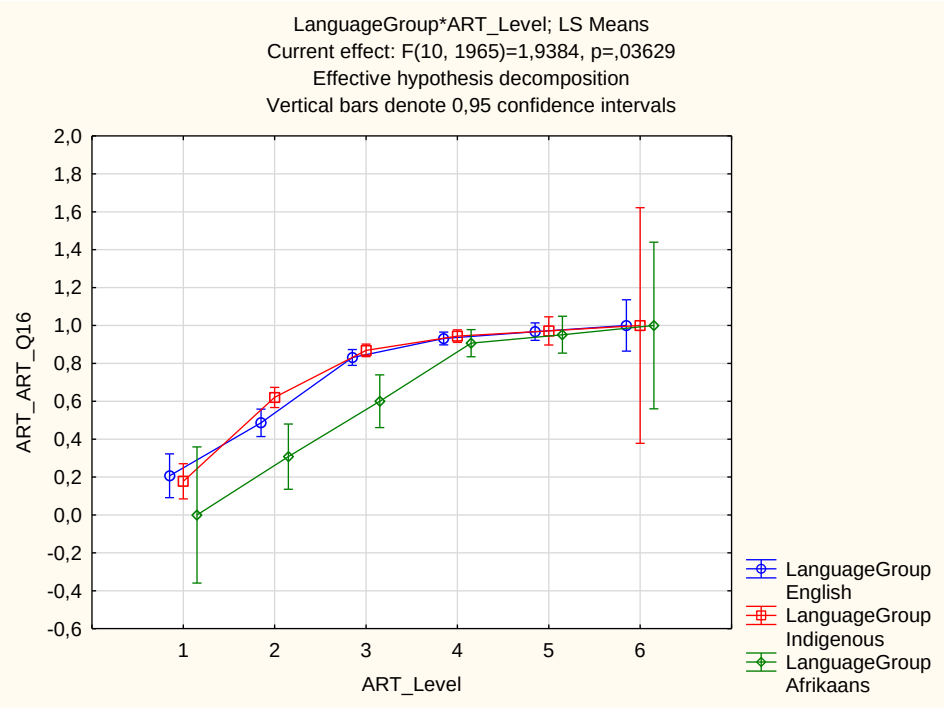
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q13 (SS)	ART_ART_Q13 (MS)	ART_ART_Q13 (F)	ART_ART_Q13 (p)
Intercept	1	78,3293	78,32932	417,9180	0,000000
LanguageGroup	2	0,3043	0,15213	0,8117	0,444265
ART_Level	5	16,6062	3,32124	17,7202	0,000000
LanguageGroup *ART_Level	10	3,3920	0,33920	1,8098	0,054100
Error	1965	368,2950	0,18743		
Total	1982	419,6369			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q14 (SS)	ART_ART_Q14 (MS)	ART_ART_Q14 (F)	ART_ART_Q14 (p)
Intercept	1	92,7631	92,76311	1133,200	0,000000
LanguageGroup	2	0,0623	0,03116	0,381	0,683440
ART_Level	5	18,8791	3,77583	46,126	0,000000
LanguageGroup *ART_Level	10	2,0852	0,20852	2,547	0,004703
Error	1965	160,8537	0,08186		
Total	1982	218,4821			



Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q15 (SS)	ART_ART_Q15 (MS)	ART_ART_Q15 (F)	ART_ART_Q15 (p)
Intercept	1	56,1134	56,11343	280,6214	0,000000
LanguageGroup	2	0,0428	0,02138	0,1069	0,898619
ART_Level	5	33,4151	6,68302	33,4216	0,000000
LanguageGroup *ART_Level	10	0,5941	0,05941	0,2971	0,982012
Error	1965	392,9240	0,19996		
Total	1982	467,3051			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q16 (SS)	ART_ART_Q16 (MS)	ART_ART_Q16 (F)	ART_ART_Q16 (p)
Intercept	1	75,6471	75,64706	752,5297	0,000000
LanguageGroup	2	0,4342	0,21712	2,1599	0,115613
ART_Level	5	31,8460	6,36919	63,3601	0,000000
LanguageGroup *ART_Level	10	1,9486	0,19486	1,9384	0,036286
Error	1965	197,5290	0,10052		
Total	1982	264,2794			



Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q17 (SS)	ART_ART_Q17 (MS)	ART_ART_Q17 (F)	ART_ART_Q17 (p)
Intercept	1	76,2086	76,20863	533,5080	0,000000
LanguageGroup	2	0,0372	0,01860	0,1302	0,877902
ART_Level	5	27,5402	5,50805	38,5598	0,000000
LanguageGroup *ART_Level	10	0,7773	0,07773	0,5442	0,859530
Error	1965	280,6893	0,14284		
Total	1982	350,0585			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q18 (SS)	ART_ART_Q18 (MS)	ART_ART_Q18 (F)	ART_ART_Q18 (p)
Intercept	1	67,8110	67,81096	376,0634	0,000000
LanguageGroup	2	0,3050	0,15251	0,8458	0,429370
ART_Level	5	22,9846	4,59692	25,4934	0,000000
LanguageGroup *ART_Level	10	2,1828	0,21828	1,2105	0,278890
Error	1965	354,3247	0,18032		
Total	1982	426,5265			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q19 (SS)	ART_ART_Q19 (MS)	ART_ART_Q19 (F)	ART_ART_Q19 (p)
Intercept	1	70,5525	70,55245	538,4243	0,000000
LanguageGroup	2	0,0043	0,00217	0,0165	0,983608
ART_Level	5	34,8453	6,96906	53,1847	0,000000
LanguageGroup *ART_Level	10	0,9574	0,09574	0,7307	0,696097
Error	1965	257,4839	0,13104		
Total	1982	350,0585			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q20 (SS)	ART_ART_Q20 (MS)	ART_ART_Q20 (F)	ART_ART_Q20 (p)
Intercept	1	52,7537	52,75370	290,4780	0,000000
LanguageGroup	2	0,0615	0,03077	0,1694	0,844165
ART_Level	5	45,1793	9,03587	49,7542	0,000000
LanguageGroup *ART_Level	10	0,9604	0,09604	0,5288	0,870838
Error	1965	356,8635	0,18161		
Total	1982	465,1084			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q21 (SS)	ART_ART_Q21 (MS)	ART_ART_Q21 (F)	ART_ART_Q21 (p)
Intercept	1	46,8109	46,81093	234,4392	0,000000
LanguageGroup	2	0,0992	0,04960	0,2484	0,780070
ART_Level	5	39,2956	7,85912	39,3602	0,000000
LanguageGroup *ART_Level	10	0,8030	0,08030	0,4022	0,946174
Error	1965	392,3553	0,19967		
Total	1982	481,4322			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q22 (SS)	ART_ART_Q22 (MS)	ART_ART_Q22 (F)	ART_ART_Q22 (p)
Intercept	1	48,5921	48,59211	272,3936	0,000000
LanguageGroup	2	0,0369	0,01843	0,1033	0,901862
ART_Level	5	49,7319	9,94638	55,7566	0,000000
LanguageGroup *ART_Level	10	0,6126	0,06126	0,3434	0,969155
Error	1965	350,5350	0,17839		
Total	1982	468,7242			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q23 (SS)	ART_ART_Q23 (MS)	ART_ART_Q23 (F)	ART_ART_Q23 (p)
Intercept	1	73,1657	73,16569	495,0625	0,000000
LanguageGroup	2	0,5564	0,27822	1,8826	0,152475
ART_Level	5	39,2224	7,84448	53,0783	0,000000
LanguageGroup *ART_Level	10	1,5982	0,15982	1,0814	0,372796
Error	1965	290,4090	0,14779		
Total	1982	402,2905			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q24 (SS)	ART_ART_Q24 (MS)	ART_ART_Q24 (F)	ART_ART_Q24 (p)
Intercept	1	47,7689	47,76886	227,3044	0,000000
LanguageGroup	2	0,0339	0,01693	0,0805	0,922617
ART_Level	5	28,5231	5,70463	27,1450	0,000000
LanguageGroup *ART_Level	10	2,6194	0,26194	1,2464	0,256067
Error	1965	412,9521	0,21015		
Total	1982	484,3278			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q25 (SS)	ART_ART_Q25 (MS)	ART_ART_Q25 (F)	ART_ART_Q25 (p)
Intercept	1	28,9017	28,90167	147,0201	0,000000
LanguageGroup	2	0,0125	0,00625	0,0318	0,968711
ART_Level	5	38,7739	7,75478	39,4478	0,000000
LanguageGroup *ART_Level	10	1,3952	0,13952	0,7097	0,716098
Error	1965	386,2858	0,19658		
Total	1982	475,6793			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q26 (SS)	ART_ART_Q26 (MS)	ART_ART_Q26 (F)	ART_ART_Q26 (p)
Intercept	1	34,0309	34,03091	157,8098	0,000000
LanguageGroup	2	0,0418	0,02090	0,0969	0,907617
ART_Level	5	23,8722	4,77445	22,1403	0,000000
LanguageGroup *ART_Level	10	1,7117	0,17117	0,7938	0,634908
Error	1965	423,7428	0,21565		
Total	1982	492,7211			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q27 (SS)	ART_ART_Q27 (MS)	ART_ART_Q27 (F)	ART_ART_Q27 (p)
Intercept	1	27,2979	27,29789	163,4500	0,000000
LanguageGroup	2	0,1673	0,08365	0,5009	0,606069
ART_Level	5	54,4418	10,88836	65,1956	0,000000
LanguageGroup *ART_Level	10	1,5963	0,15963	0,9558	0,480412
Error	1965	328,1759	0,16701		
Total	1982	449,6046			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q28 (SS)	ART_ART_Q28 (MS)	ART_ART_Q28 (F)	ART_ART_Q28 (p)
Intercept	1	26,8125	26,81246	163,8020	0,000000
LanguageGroup	2	0,0471	0,02354	0,1438	0,866051
ART_Level	5	59,5466	11,90931	72,7561	0,000000
LanguageGroup *ART_Level	10	1,9624	0,19624	1,1989	0,286625
Error	1965	321,6475	0,16369		
Total	1982	454,0676			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q29 (SS)	ART_ART_Q29 (MS)	ART_ART_Q29 (F)	ART_ART_Q29 (p)
Intercept	1	19,2456	19,24562	132,0185	0,000000
LanguageGroup	2	0,1312	0,06562	0,4501	0,637604
ART_Level	5	39,9926	7,99851	54,8671	0,000000
LanguageGroup *ART_Level	10	0,6227	0,06227	0,4271	0,934063
Error	1965	286,4572	0,14578		
Total	1982	377,3737			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q30 (SS)	ART_ART_Q30 (MS)	ART_ART_Q30 (F)	ART_ART_Q30 (p)
Intercept	1	17,0153	17,01526	128,1254	0,000000
LanguageGroup	2	0,1305	0,06523	0,4912	0,611955
ART_Level	5	38,7971	7,75941	58,4286	0,000000
LanguageGroup *ART_Level	10	0,5787	0,05787	0,4357	0,929576
Error	1965	260,9551	0,13280		
Total	1982	348,9723			

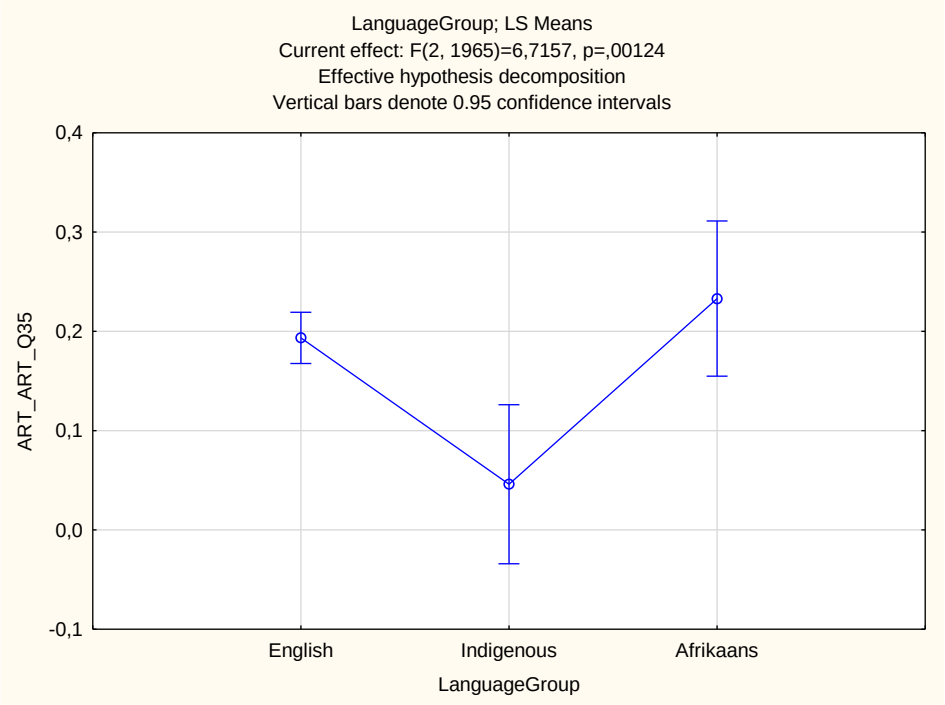
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q31 (SS)	ART_ART_Q31 (MS)	ART_ART_Q31 (F)	ART_ART_Q31 (p)
Intercept	1	7,4543	7,454304	125,2636	0,000000
LanguageGroup	2	0,0047	0,002364	0,0397	0,961062
ART_Level	5	12,7532	2,550649	42,8616	0,000000
LanguageGroup *ART_Level	10	0,8580	0,085802	1,4418	0,155727
Error	1965	116,9350	0,059509		
Total	1982	152,1039			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q32 (SS)	ART_ART_Q32 (MS)	ART_ART_Q32 (F)	ART_ART_Q32 (p)
Intercept	1	15,7879	15,78792	128,8308	0,000000
LanguageGroup	2	0,3057	0,15283	1,2471	0,287571
ART_Level	5	14,9083	2,98165	24,3305	0,000000
LanguageGroup *ART_Level	10	0,7156	0,07156	0,5839	0,828312
Error	1965	240,8062	0,12255		
Total	1982	283,6712			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q33 (SS)	ART_ART_Q33 (MS)	ART_ART_Q33 (F)	ART_ART_Q33 (p)
Intercept	1	11,0635	11,06352	121,9811	0,000000
LanguageGroup	2	0,0074	0,00370	0,0407	0,960077
ART_Level	5	9,6955	1,93911	21,3797	0,000000
LanguageGroup *ART_Level	10	0,8803	0,08803	0,9706	0,467034
Error	1965	178,2228	0,09070		
Total	1982	209,4352			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q34 (SS)	ART_ART_Q34 (MS)	ART_ART_Q34 (F)	ART_ART_Q34 (p)
Intercept	1	9,0597	9,059736	77,76782	0,000000
LanguageGroup	2	0,1371	0,068558	0,58850	0,555258
ART_Level	5	8,5709	1,714177	14,71431	0,000000
LanguageGroup *ART_Level	10	1,3067	0,130667	1,12163	0,341605
Error	1965	228,9171	0,116497		
Total	1982	250,4115			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q35 (SS)	ART_ART_Q35 (MS)	ART_ART_Q35 (F)	ART_ART_Q35 (p)
Intercept	1	3,7293	3,729289	65,10955	0,000000
LanguageGroup	2	0,7693	0,384654	6,71567	0,001240
ART_Level	5	5,9993	1,199863	20,94837	0,000000
LanguageGroup *ART_Level	10	0,9670	0,096697	1,68823	0,077879
Error	1965	112,5496	0,057277		
Total	1982	133,5431			



ART Differential Item Functioning. Grouping Variable – Race Group

Composition of the Sample

Compiled from raw data on 2191 respondents collected by Psytech SA and collaborators, via GeneSys for Windows and GeneSys Online, in the period between March 2012 and May 2017.

Biographical Composition of the Sample

Category	Frequency table: Sex			
	Count	Cumulative Count	Percent	Cumulative Percent
F	999	999	45,59562	45,5956
M	1122	2121	51,20949	96,8051
U	66	2187	3,01232	99,8174
Missing	4	2191	0,18257	100,0000

Category	Frequency table: Education			
	Count	Cumulative Count	Percent	Cumulative Percent
Tertiary	417	417	19,03241	19,0324
Grade 12	1272	1689	58,05568	77,0881
Post Graduate	303	1992	13,82930	90,9174
< Matric	39	2031	1,78001	92,6974
Missing	160	2191	7,30260	100,0000

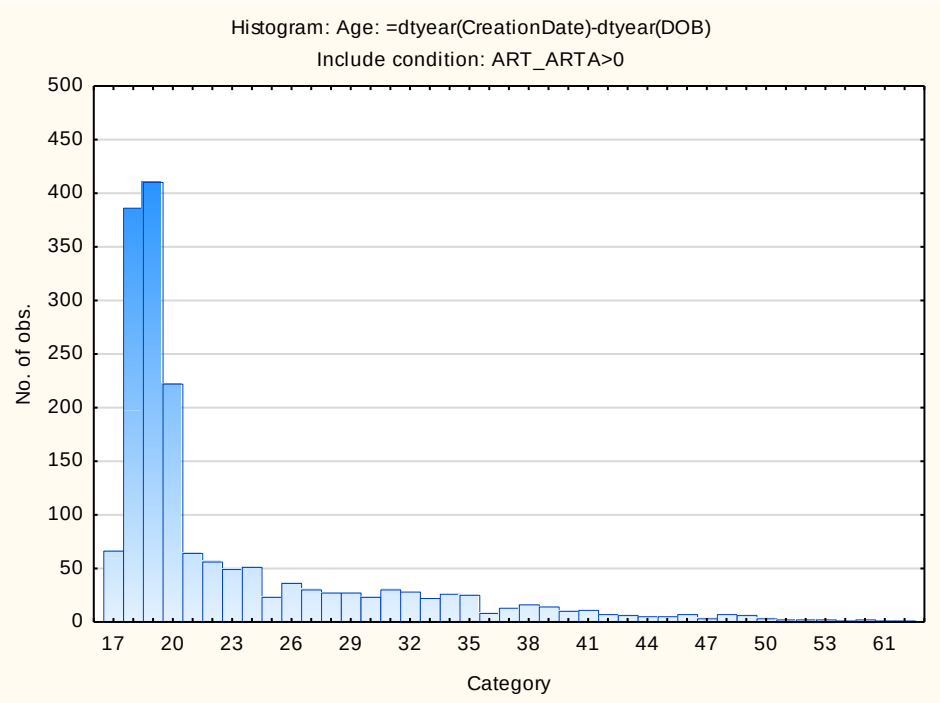
Category	Frequency table: Race			
	Count	Cumulative Count	Percent	Cumulative Percent
African	1130	1130	51,57462	51,5746
Coloured	86	1216	3,92515	55,4998
Indian	43	1259	1,96257	57,4623
European	509	1768	23,23140	80,6937
Asian	161	1929	7,34824	88,0420
Missing	262	2191	11,95801	100,0000

Category	Frequency table: Race Group			
	Count	Cumulative Count	Percent	Cumulative Percent
Black	1420	1420	64,81059	64,8106
Non-Black	509	1929	23,23140	88,0420
Missing	262	2191	11,95801	100,0000

Category	Frequency table: Language			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Sepedi	188	1049	8,58056	47,8777
siSwati	60	1109	2,73848	50,6162
Afrikaans	154	1263	7,02875	57,6449
Setswana	115	1378	5,24874	62,8937
Xitsonga	66	1444	3,01232	65,9060
isiZulu	248	1692	11,31903	77,2250
isiXhosa	89	1781	4,06207	81,2871
Sesotho	105	1886	4,79233	86,0794
Tshivenda	85	1971	3,87951	89,9589
isiNdebele	12	1983	0,54770	90,5066
Missing	208	2191	9,49338	100,0000

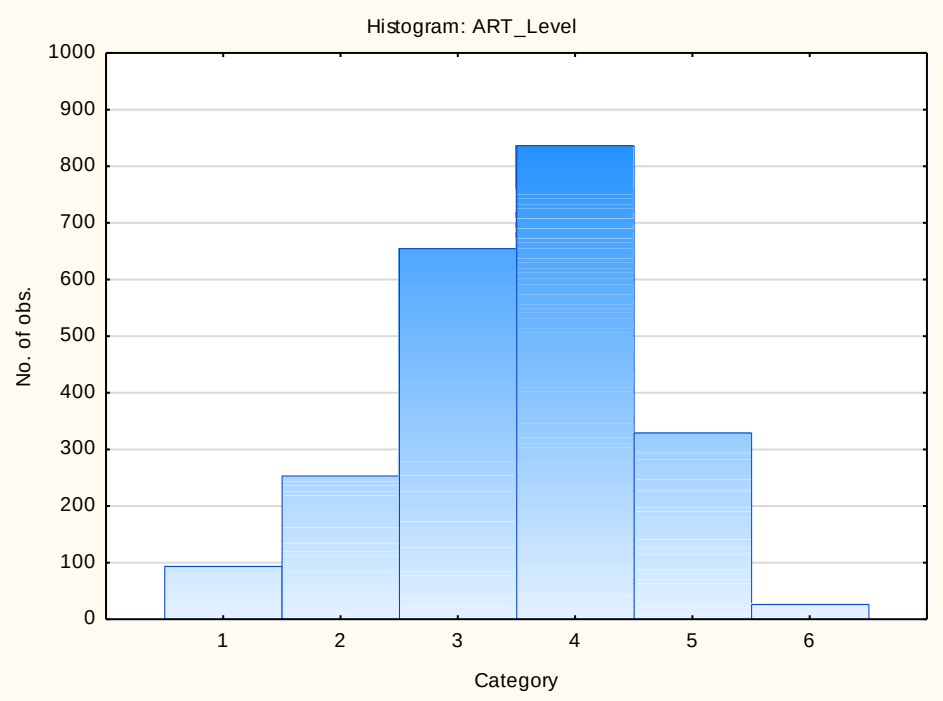
Category	Frequency table: Language Group			
	Count	Cumulative Count	Percent	Cumulative Percent
English	861	861	39,29712	39,2971
Indigenous	968	1829	44,18074	83,4779
Afrikaans	154	1983	7,02875	90,5066
Missing	208	2191	9,49338	100,0000

Variable	Descriptive Statistics: Age					
	Mean	Std.Dev	Minimum	Maximum	N	No.cases Missing
Age	22,91056	7,292516	17,00000	63,00000	1733	458



Frequency Distribution of Score Levels

Category	Frequency table: ART Level			
	Count	Cumulative Count	Percent	Cumulative Percent
Level 1	93	93	4,24464	4,2446
Level 2	253	346	11,54724	15,7919
Level 3	654	1000	29,84938	45,6413
Level 4	836	1836	38,15609	83,7974
Level 5	329	2165	15,01597	98,8133
Level 6	26	2191	1,18667	100,0000
Missing	0	2191	0,00000	100,0000



Method

Applicants were classified into Race groups for the purpose of the analysis. These were Black (N=1420) and Non-Black (N=509).

Applicants were classified into score levels for the test being evaluated. The cut-offs for the levels were determined by standardizing the raw scores from the ART for the race groups. The grouping intervals were half a standard deviation, resulting in six groups.

The statistical technique used in this study was factorial analysis of variance. For every item a factorial analysis of variance was done, using the scored item response as dependent variable, and the race group and score level (on the overall test score for the subtest being investigated) as predictor variables. If a significant effect was found for race, that was taken as an indication of uniform item bias, and the least-square difference in the means for that item was plotted graphically to illustrate which race group had a lower probability of getting the item right. If a significant interaction effect was found for race group and score level that

was taken as an indication of non-uniform item bias, and the means at all levels for both race groups were plotted to illustrate the severity of the non-uniform bias that was found.

Results by item: Abstract Reasoning Test

Summary table

Item number	Uniform bias	In favour of group	Non-uniform bias
1			
2			
3			
4			
5	Yes	Black	Yes
6			
7	Yes	Black	
8			
9			
10			
11			
12			
13			
14			
15			
16	Yes	Black	Yes
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			Yes
29			
30			
31			
32			
33			
34			
35	Yes	Non-Black	

Uniform bias was found in four out of 35 items, three out of those four were found to be found in favour of Black race group. It should be borne in mind that this is the final item in a time-limited test, one which is intended to be the most difficult. Approximately 25% of

respondents did not answer this item. It is very likely that a number of the respondents who did answer this item may have been guessing.

Non-uniform bias was found in three out of 35 items. The impact of that bias is best evaluated by inspecting the graphs in the detailed results that follow.

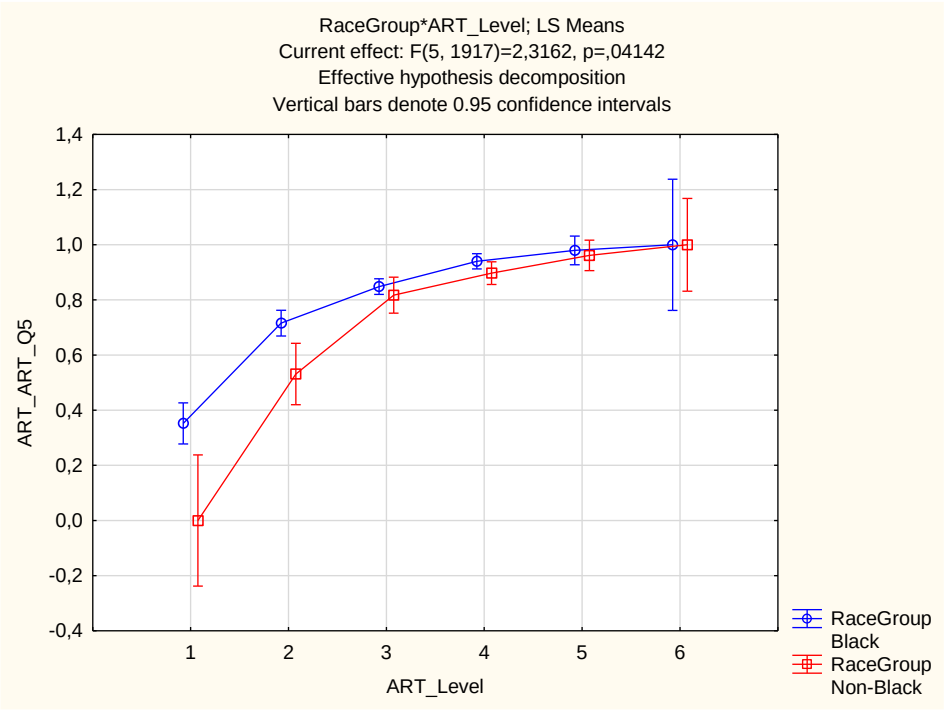
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q1 (SS)	ART_ART_Q1 (MS)	ART_ART_Q1 (F)	ART_ART_Q1 (p)
Intercept	1	212,7483	212,7483	2125,660	0,000000
RaceGroup	1	0,0873	0,0873	0,872	0,350424
ART_Level	5	14,2999	2,8600	28,575	0,000000
RaceGroup*ART_Level	5	0,7940	0,1588	1,587	0,160533
Error	1917	191,8645	0,1001		
Total	1928	216,8585			

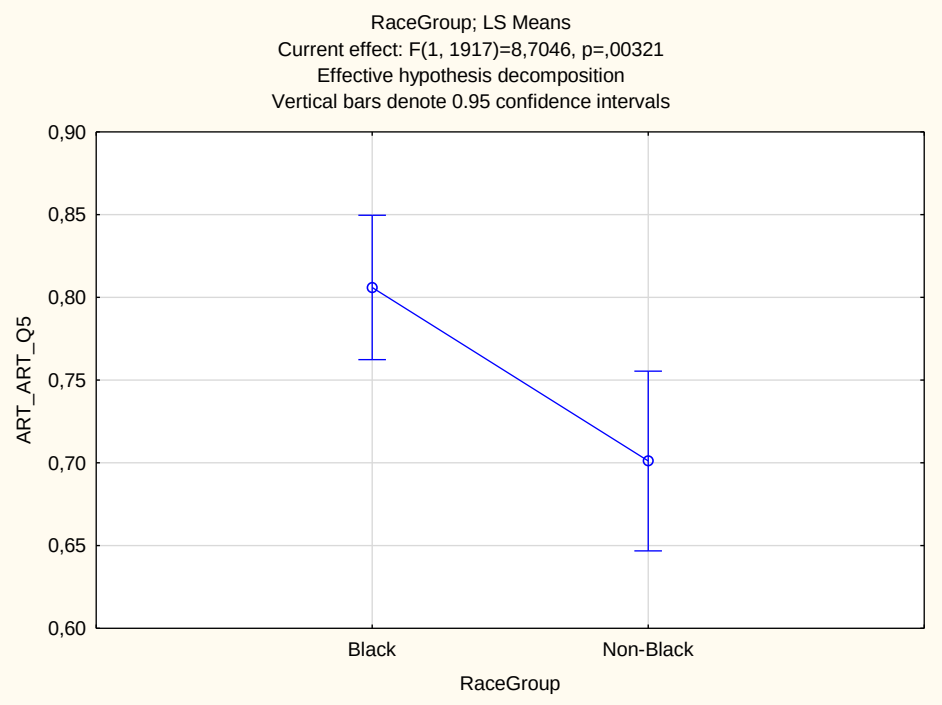
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q2 (SS)	ART_ART_Q2 (MS)	ART_ART_Q2 (F)	ART_ART_Q2 (p)
Intercept	1	99,3303	99,33025	484,4641	0,000000
RaceGroup	1	0,0158	0,01579	0,0770	0,781384
ART_Level	5	49,3694	9,87388	48,1579	0,000000
RaceGroup*ART_Level	5	0,8574	0,17148	0,8363	0,523740
Error	1917	393,0448	0,20503		
Total	1928	468,3919			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q3 (SS)	ART_ART_Q3 (MS)	ART_ART_Q3 (F)	ART_ART_Q3 (p)
Intercept	1	160,4851	160,4851	1141,042	0,000000
RaceGroup	1	0,0845	0,0845	0,601	0,438287
ART_Level	5	37,3402	7,4680	53,097	0,000000
RaceGroup*ART_Level	5	0,5858	0,1172	0,833	0,526072
Error	1917	269,6219	0,1406		
Total	1928	332,4800			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q4 (SS)	ART_ART_Q4 (MS)	ART_ART_Q4 (F)	ART_ART_Q4 (p)
Intercept	1	202,4277	202,4277	2290,227	0,000000
RaceGroup	1	0,0640	0,0640	0,724	0,394822
ART_Level	5	20,8949	4,1790	47,280	0,000000
RaceGroup*ART_Level	5	0,7602	0,1520	1,720	0,126651
Error	1917	169,4391	0,0884		
Total	1928	211,6402			

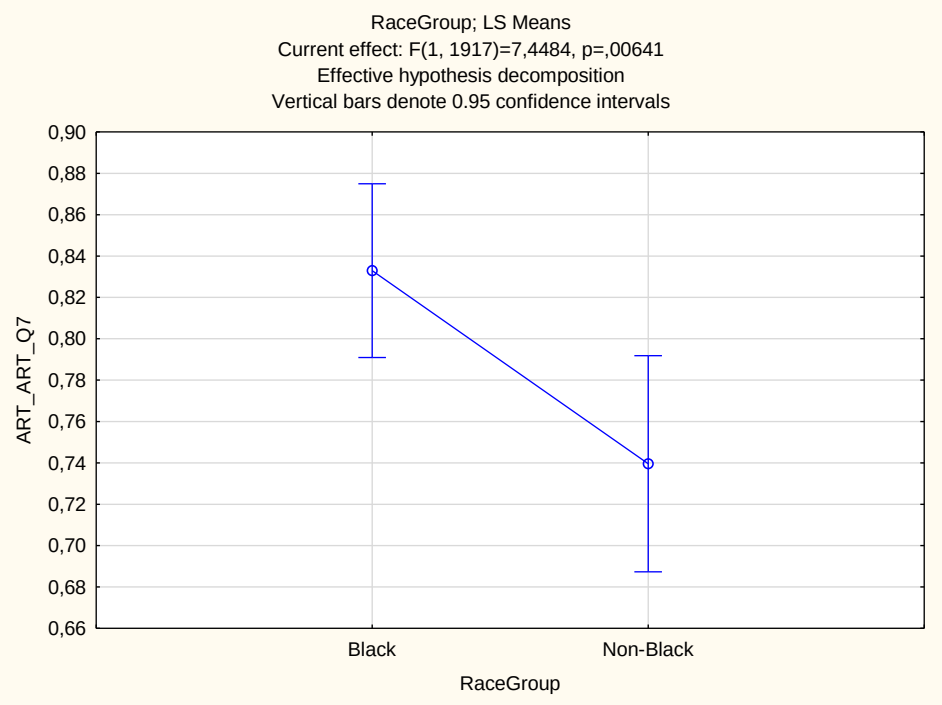
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q5 (SS)	ART_ART_Q5 (MS)	ART_ART_Q5 (F)	ART_ART_Q5 (p)
Intercept	1	185,2443	185,2443	1799,728	0,000000
RaceGroup	1	0,8960	0,8960	8,705	0,003212
ART_Level	5	23,9304	4,7861	46,499	0,000000
RaceGroup*ART_Level	5	1,1920	0,2384	2,316	0,041419
Error	1917	197,3150	0,1029		
Total	1928	235,7957			





Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q6 (SS)	ART_ART_Q6 (MS)	ART_ART_Q6 (F)	ART_ART_Q6 (p)
Intercept	1	196,3728	196,3728	1566,775	0,000000
RaceGroup	1	0,0776	0,0776	0,619	0,431516
ART_Level	5	12,8851	2,5770	20,561	0,000000
RaceGroup*ART_Level	5	0,2841	0,0568	0,453	0,811057
Error	1917	240,2686	0,1253		
Total	1928	266,9155			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q7 (SS)	ART_ART_Q7 (MS)	ART_ART_Q7 (F)	ART_ART_Q7 (p)
Intercept	1	201,6555	201,6555	2114,376	0,000000
RaceGroup	1	0,7104	0,7104	7,448	0,006407
ART_Level	5	16,6126	3,3225	34,837	0,000000
RaceGroup*ART_Level	5	0,9779	0,1956	2,051	0,068865
Error	1917	182,8311	0,0954		
Total	1928	210,1400			



Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q8 (SS)	ART_ART_Q8 (MS)	ART_ART_Q8 (F)	ART_ART_Q8 (p)
Intercept	1	215,6425	215,6425	2503,764	0,000000
RaceGroup	1	0,0097	0,0097	0,113	0,737102
ART_Level	5	13,5023	2,7005	31,354	0,000000
RaceGroup*ART_Level	5	0,3075	0,0615	0,714	0,612810
Error	1917	165,1061	0,0861		
Total	1928	197,2203			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q9 (SS)	ART_ART_Q9 (MS)	ART_ART_Q9 (F)	ART_ART_Q9 (p)
Intercept	1	180,9465	180,9465	1506,871	0,000000
RaceGroup	1	0,2345	0,2345	1,953	0,162405
ART_Level	5	26,0919	5,2184	43,457	0,000000
RaceGroup*ART_Level	5	0,7777	0,1555	1,295	0,263078
Error	1917	230,1952	0,1201		
Total	1928	277,4743			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q10 (SS)	ART_ART_Q10 (MS)	ART_ART_Q10 (F)	ART_ART_Q10 (p)
Intercept	1	211,7426	211,7426	2114,755	0,000000
RaceGroup	1	0,0219	0,0219	0,218	0,640239
ART_Level	5	12,6325	2,5265	25,233	0,000000
RaceGroup*ART_Level	5	1,0119	0,2024	2,021	0,072803
Error	1917	191,9422	0,1001		

Total	1928	224,2250			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q11 (SS)	ART_ART_Q11 (MS)	ART_ART_Q11 (F)	ART_ART_Q11 (p)
Intercept	1	209,1997	209,1997	2724,131	0,000000
RaceGroup	1	0,2334	0,2334	3,040	0,081403
ART_Level	5	17,1795	3,4359	44,741	0,000000
RaceGroup*ART_Level	5	0,3837	0,0767	0,999	0,416640
Error	1917	147,2161	0,0768		
Total	1928	181,6371			

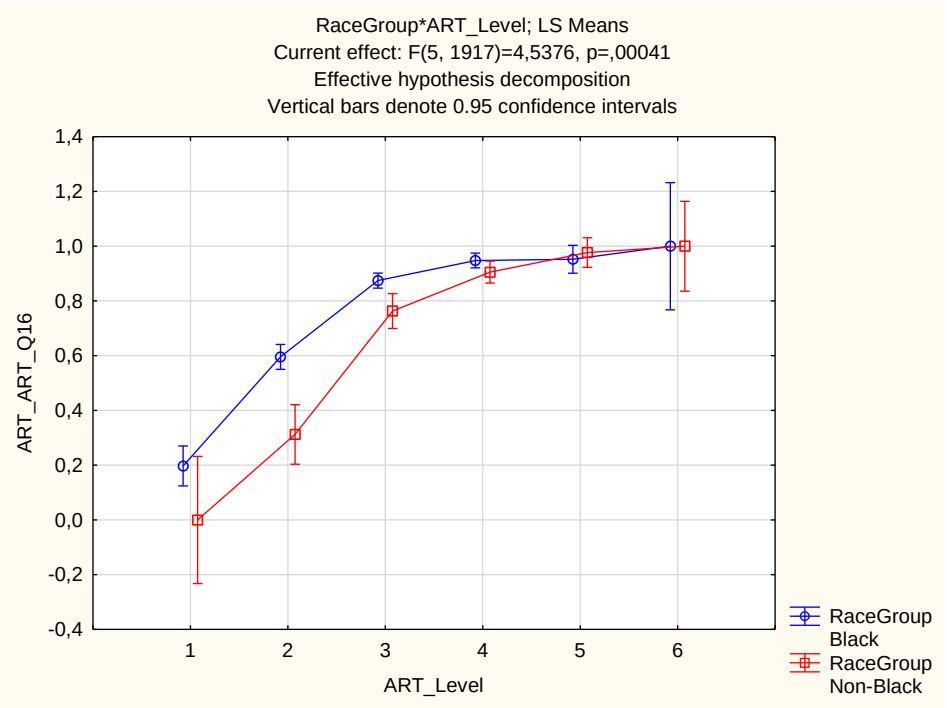
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q12 (SS)	ART_ART_Q12 (MS)	ART_ART_Q12 (F)	ART_ART_Q12 (p)
Intercept	1	142,0033	142,0033	846,7091	0,000000
RaceGroup	1	0,1406	0,1406	0,8381	0,360047
ART_Level	5	34,2905	6,8581	40,8922	0,000000
RaceGroup*ART_Level	5	0,1038	0,0208	0,1238	0,987091
Error	1917	321,5040	0,1677		
Total	1928	383,4774			

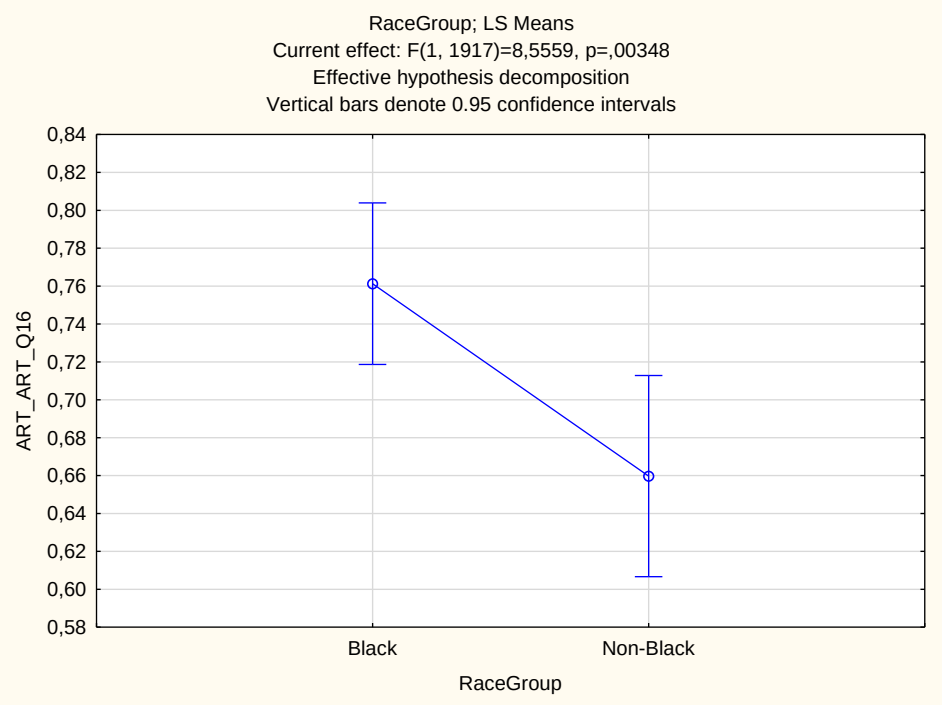
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q13 (SS)	ART_ART_Q13 (MS)	ART_ART_Q13 (F)	ART_ART_Q13 (p)
Intercept	1	167,3125	167,3125	877,4787	0,000000
RaceGroup	1	0,4240	0,4240	2,2236	0,136076
ART_Level	5	25,0570	5,0114	26,2825	0,000000
RaceGroup*ART_Level	5	1,2882	0,2576	1,3512	0,239950
Error	1917	365,5222	0,1907		
Total	1928	411,4723			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q14 (SS)	ART_ART_Q14 (MS)	ART_ART_Q14 (F)	ART_ART_Q14 (p)
Intercept	1	203,4742	203,4742	2526,107	0,000000
RaceGroup	1	0,0621	0,0621	0,771	0,379957
ART_Level	5	20,5263	4,1053	50,966	0,000000
RaceGroup*ART_Level	5	0,1800	0,0360	0,447	0,815678
Error	1917	154,4115	0,0805		
Total	1928	208,6356			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q15 (SS)	ART_ART_Q15 (MS)	ART_ART_Q15 (F)	ART_ART_Q15 (p)
Intercept	1	127,9717	127,9717	640,9604	0,000000
RaceGroup	1	0,1421	0,1421	0,7115	0,399036
ART_Level	5	44,5733	8,9147	44,6501	0,000000
RaceGroup*ART_Level	5	0,6870	0,1374	0,6881	0,632437
Error	1917	382,7409	0,1997		
Total	1928	456,5858			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization, Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q16 (SS)	ART_ART_Q16 (MS)	ART_ART_Q16 (F)	ART_ART_Q16 (p)
Intercept	1	164,6734	164,6734	1676,306	0,000000
RaceGroup	1	0,8405	0,8405	8,556	0,003484
ART_Level	5	39,5035	7,9007	80,426	0,000000
RaceGroup*ART_Level	5	2,2288	0,4458	4,538	0,000407
Error	1917	188,3181	0,0982		
Total	1928	255,4059			





Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q17 (SS)	ART_ART_Q17 (MS)	ART_ART_Q17 (F)	ART_ART_Q17 (p)
Intercept	1	165,8506	165,8506	1150,682	0,000000
RaceGroup	1	0,2112	0,2112	1,465	0,226236
ART_Level	5	34,9401	6,9880	48,483	0,000000
RaceGroup*ART_Level	5	0,5287	0,1057	0,734	0,598211
Error	1917	276,3018	0,1441		
Total	1928	349,2576			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q18 (SS)	ART_ART_Q18 (MS)	ART_ART_Q18 (F)	ART_ART_Q18 (p)
Intercept	1	135,1090	135,1090	750,9238	0,000000
RaceGroup	1	0,0630	0,0630	0,3504	0,553951
ART_Level	5	42,4594	8,4919	47,1972	0,000000
RaceGroup*ART_Level	5	0,2065	0,0413	0,2295	0,949761
Error	1917	344,9137	0,1799		
Total	1928	417,4692			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q19 (SS)	ART_ART_Q19 (MS)	ART_ART_Q19 (F)	ART_ART_Q19 (p)
Intercept	1	158,5541	158,5541	1198,443	0,000000
RaceGroup	1	0,1423	0,1423	1,076	0,299745
ART_Level	5	37,0364	7,4073	55,988	0,000000
RaceGroup*ART_Level	5	1,1021	0,2204	1,666	0,139535
Error	1917	253,6193	0,1323		
Total	1928	342,8813			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q20 (SS)	ART_ART_Q20 (MS)	ART_ART_Q20 (F)	ART_ART_Q20 (p)
Intercept	1	116,9003	116,9003	649,9528	0,000000
RaceGroup	1	0,1806	0,1806	1,0042	0,316414
ART_Level	5	59,5926	11,9185	66,2657	0,000000
RaceGroup*ART_Level	5	0,6809	0,1362	0,7571	0,580805
Error	1917	344,7909	0,1799		
Total	1928	452,5143			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q21 (SS)	ART_ART_Q21 (MS)	ART_ART_Q21 (F)	ART_ART_Q21 (p)
Intercept	1	105,9852	105,9852	533,8955	0,000000
RaceGroup	1	0,0039	0,0039	0,0197	0,888375
ART_Level	5	54,7856	10,9571	55,1959	0,000000
RaceGroup*ART_Level	5	0,2112	0,0422	0,2127	0,957218
Error	1917	380,5494	0,1985		
Total	1928	468,2219			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q22 (SS)	ART_ART_Q22 (MS)	ART_ART_Q22 (F)	ART_ART_Q22 (p)
Intercept	1	113,1485	113,1485	634,0844	0,000000
RaceGroup	1	0,0702	0,0702	0,3932	0,530712
ART_Level	5	64,8610	12,9722	72,6962	0,000000
RaceGroup*ART_Level	5	1,3059	0,2612	1,4636	0,198601
Error	1917	342,0770	0,1784		
Total	1928	454,7071			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q23 (SS)	ART_ART_Q23 (MS)	ART_ART_Q23 (F)	ART_ART_Q23 (p)
Intercept	1	149,8450	149,8450	1007,421	0,000000
RaceGroup	1	0,3405	0,3405	2,289	0,130420
ART_Level	5	51,2618	10,2524	68,928	0,000000
RaceGroup*ART_Level	5	0,6097	0,1219	0,820	0,535373
Error	1917	285,1368	0,1487		
Total	1928	391,4557			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q24 (SS)	ART_ART_Q24 (MS)	ART_ART_Q24 (F)	ART_ART_Q24 (p)
Intercept	1	109,0739	109,0739	518,8397	0,000000
RaceGroup	1	0,0414	0,0414	0,1971	0,657099
ART_Level	5	35,5150	7,1030	33,7873	0,000000
RaceGroup*ART_Level	5	1,7527	0,3505	1,6675	0,139174
Error	1917	403,0044	0,2102		
Total	1928	469,8756			

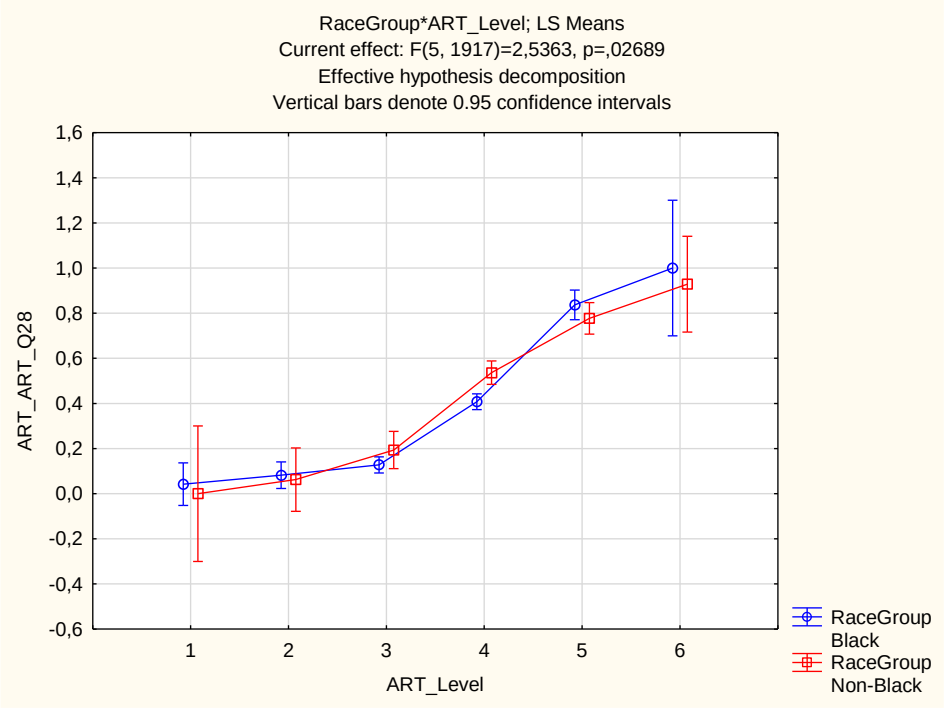
Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q25 (SS)	ART_ART_Q25 (MS)	ART_ART_Q25 (F)	ART_ART_Q25 (p)
Intercept	1	56,9575	56,95750	290,4007	0,000000
RaceGroup	1	0,1362	0,13619	0,6944	0,404791
ART_Level	5	55,3762	11,07525	56,4677	0,000000
RaceGroup*ART_Level	5	0,9143	0,18286	0,9323	0,458818
Error	1917	375,9892	0,19613		
Total	1928	461,2017			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q26 (SS)	ART_ART_Q26 (MS)	ART_ART_Q26 (F)	ART_ART_Q26 (p)
Intercept	1	79,5728	79,57275	371,9209	0,000000
RaceGroup	1	0,1930	0,19296	0,9019	0,342398
ART_Level	5	32,5852	6,51704	30,4605	0,000000
RaceGroup*ART_Level	5	1,5766	0,31533	1,4738	0,195163
Error	1917	410,1436	0,21395		
Total	1928	479,4495			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q27 (SS)	ART_ART_Q27 (MS)	ART_ART_Q27 (F)	ART_ART_Q27 (p)
Intercept	1	60,0065	60,00653	367,8164	0,000000
RaceGroup	1	0,2509	0,25092	1,5380	0,215062
ART_Level	5	80,5299	16,10598	98,7233	0,000000
RaceGroup*ART_Level	5	0,7094	0,14187	0,8696	0,500659

Error	1917	312,7444	0,16314		
Total	1928	430,3204			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q28 (SS)	ART_ART_Q28 (MS)	ART_ART_Q28 (F)	ART_ART_Q28 (p)
Intercept	1	56,4940	56,49399	344,3162	0,000000
RaceGroup	1	0,0000	0,00000	0,0000	1,000000
ART_Level	5	86,5438	17,30876	105,4924	0,000000
RaceGroup*ART_Level	5	2,0807	0,41614	2,5363	0,026894
Error	1917	314,5335	0,16408		
Total	1928	440,5848			



Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q29 (SS)	ART_ART_Q29 (MS)	ART_ART_Q29 (F)	ART_ART_Q29 (p)
Intercept	1	50,5801	50,58008	354,1001	0,000000
RaceGroup	1	0,4814	0,48141	3,3702	0,066540
ART_Level	5	66,8976	13,37952	93,6671	0,000000
RaceGroup*ART_Level	5	1,1031	0,22061	1,5444	0,172793
Error	1917	273,8266	0,14284		
Total	1928	361,5625			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q30 (SS)	ART_ART_Q30 (MS)	ART_ART_Q30 (F)	ART_ART_Q30 (p)
Intercept	1	36,1543	36,15427	281,0383	0,000000
RaceGroup	1	0,4368	0,43685	3,3958	0,065519
ART_Level	5	59,4060	11,88119	92,3562	0,000000
RaceGroup*ART_Level	5	0,2637	0,05273	0,4099	0,842172
Error	1917	246,6131	0,12865		
Total	1928	329,1177			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q31 (SS)	ART_ART_Q31 (MS)	ART_ART_Q31 (F)	ART_ART_Q31 (p)
Intercept	1	14,7154	14,71539	251,5825	0,000000
RaceGroup	1	0,0429	0,04294	0,7342	0,391635
ART_Level	5	23,9606	4,79212	81,9287	0,000000
RaceGroup*ART_Level	5	0,0755	0,01511	0,2583	0,935747
Error	1917	112,1278	0,05849		
Total	1928	140,8647			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q32 (SS)	ART_ART_Q32 (MS)	ART_ART_Q32 (F)	ART_ART_Q32 (p)
Intercept	1	37,4155	37,41549	310,5746	0,000000
RaceGroup	1	0,3347	0,33466	2,7780	0,095734
ART_Level	5	27,2795	5,45590	45,2878	0,000000
RaceGroup*ART_Level	5	0,1805	0,03610	0,2996	0,913211
Error	1917	230,9445	0,12047		
Total	1928	268,9155			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q33 (SS)	ART_ART_Q33 (MS)	ART_ART_Q33 (F)	ART_ART_Q33 (p)
Intercept	1	24,3497	24,34970	270,7334	0,000000
RaceGroup	1	0,2626	0,26261	2,9198	0,087659
ART_Level	5	20,4121	4,08242	45,3906	0,000000
RaceGroup*ART_Level	5	0,5809	0,11618	1,2917	0,264626
Error	1917	172,4145	0,08994		
Total	1928	199,5220			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q34 (SS)	ART_ART_Q34 (MS)	ART_ART_Q34 (F)	ART_ART_Q34 (p)
Intercept	1	17,0496	17,04962	151,9534	0,000000
RaceGroup	1	0,0101	0,01005	0,0896	0,764701
ART_Level	5	14,6288	2,92576	26,0756	0,000000
RaceGroup*ART_Level	5	0,2143	0,04287	0,3821	0,861344
Error	1917	215,0930	0,11220		
Total	1928	233,6464			

Effect	Univariate Results for Each DV (ART - Gen3 and Online - merged - dups removed - cleaned) Sigma-restricted parameterization. Effective hypothesis decomposition				
	Degr. of (Freedom)	ART_ART_Q35 (SS)	ART_ART_Q35 (MS)	ART_ART_Q35 (F)	ART_ART_Q35 (p)
Intercept	1	9,7063	9,706307	174,6936	0,000000
RaceGroup	1	0,3051	0,305097	5,4911	0,019215
ART_Level	5	11,9089	2,381779	42,8671	0,000000
RaceGroup*ART_Level	5	0,4245	0,084904	1,5281	0,177762
Error	1917	106,5122	0,055562		
Total	1928	122,9673