

Psychometric Assessment, Statistics and Report Writing

An introduction for psychologists, teachers and health professionals

Dr. Barry Johnson and Dr. Gareth Hagger-Johnson

SAMPLE

SAMPLE

Copyright © 2013 Pearson Education, Ltd. or its affiliate(s).

All rights reserved. This publication is protected by copyright and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise.

Published by
Pearson
Assessment
80 Strand
London WC2R 0RL

Pearson is a trademark, in the U.S. and/or other countries, of Pearson Education, Inc. or its affiliate(s).

Visit our website at www.pearsonclinical.co.uk

Printed in the United Kingdom

978 0 749163 77 8

13 14 15 16 17 A B C D E

Introduction		vii
About the Authors		ix
Acknowledgement		ix
Permissions		ix
SECTION 1	STATISTICAL TERMS AND EQUATIONS	1
Chapter 1	Basic Statistical Terms	3
Chapter 2	Types of Standard Scores	21
Chapter 3	Standard Error of Measurement of the Difference	41
Chapter 4	Statistical and Clinical Differences Between Test Scores	45
Chapter 5	Simple Regression to the Mean	55
Chapter 6	A Simple Regression Table	61
Chapter 7	Standard Error of the Estimate	65
Chapter 8	Regression and Confidence Ranges	73
Chapter 9	Test-Retest	77
Chapter 10	Growth Scale Values and Normal Curve Equivalents	79
Chapter 11	Coefficient of Determination	85
Chapter 12	Standard Error of the Mean	89
Chapter 13	Binomial Distribution Probability and Multiple-Choice Tests	95
Chapter 14	Multiple Regression	99
SECTION 2	REPORT WRITING	103
Chapter 15	Range Descriptors	105
Chapter 16	Data Merging and <i>Auto Text</i>	111
Chapter 17	Using Charts in Reports	125
SECTION 3	THE FUTURE	149
Chapter 18	The Future: Trends and Issues	151
Appendix A	Conversion Table for Standardised Scores	160
Appendix B	Z-P Conversion Table (Positive Z Scores)	162
Appendix C	Z-P Conversion Table (Negative Z Scores)	163
Appendix D	Percentile-Z Conversion Table	164
Appendix E	Ability-Achievement Look-Up Table	165
References		167
LIST OF TABLES		
Table 1.1	Tests and their Standard Errors of Measurements	13
Table 1.2	Tests and their Confidence Ranges	14
Table 1.3	The Null Hypothesis	17
Table 2.1	Types of Standardised Scores (i)	21
Table 2.2	Types of Standardised Scores (ii)	23
Table 2.3	Creating a Look-up Table	25
Table 2.4	Extract from a Z-P Table	27
Table 2.5	Extract from a Negative Z-P Table	28
Table 2.6	Converting Z Scores to Percentiles	29
Table 2.7	Types of Standardised Scores (iii)	29
Table 2.8	Stanines and Ranking	34
Table 2.9	Frequency of Raw Scores	36
Table 2.10	Converting Raw Scores to Percentile Ranks	37
Table 2.11	Z Scores and Levels of Confidence	40

Table 3.1	P and Z Scores for One- and Two-Tailed Tests of Significance	43
Table 4.1	Z Values and Levels of Confidence	46
Table 6.1	KBIT-2 Composite IQ and Reading Comprehension Scores	61
Table 6.2	Predicted Reading Comprehension Scores from KBIT-2 Composite IQ Scores	63
Table 10.1	Raw and Standard Scores over Time	79
Table 10.2	Growth Scale Values over Time	81
Table 10.3	Trends of Growth Scale Value and Standardised Scores	82
Table 11.1	Comparing IQ Scores on Two Tests	86
Table 11.2	Tests' Coefficients of Determination and Reliability Coefficients	86
Table 12.1	Standard Error of the Mean – Spelling Scores for Two Groups of Students	90
Table 15.1	Standard and Scaled Scores for Subtests	105
Table 15.2	Standard Scores for Subtests	106
Table 15.3	Range Descriptors for Subtest Scores	107
Table 15.4	Reference Table for Tests' Range Descriptors	108
Table 17.1	WMS-IV Subtest Scaled Scores	125
Table 17.2	CELF-4 ^{UK} Subtest Scaled Scores	132
Table 17.3	Raw Scores on Probe Sheet	140
Table 17.4	Raw Scores on Probe Sheet – Preparation for <i>Excel</i> Chart	141

LIST OF FIGURES

Figure 1.1	Standard Deviation using <i>Excel</i> (i)	6
Figure 1.2	Standard Deviation using <i>Excel</i> (ii)	7
Figure 1.3	Standard Deviation using <i>Excel</i> (iii)	8
Figure 1.4	Standard Normal Distribution	8
Figure 1.5	Area Percentages within the Standard Deviations of a Standard Normal Distribution Curve	9
Figure 1.6	Pearson's Product Moment Correlation using <i>Excel</i>	11
Figure 1.7	Scatter Plot	11
Figure 1.8	Overlapping Confidence Ranges	15
Figure 1.9	Moderately Large Standard Deviation	18
Figure 1.10	Large Standard Deviation	18
Figure 1.11	Standard Deviation of a Standard Normal Distribution Curve	19
Figure 1.12	Normal Distribution Curve in <i>Excel</i> – SD 15	19
Figure 1.13	Normal Distribution Curve in <i>Excel</i> – SD 20	20
Figure 1.14	Normal Distribution Curve in <i>Excel</i> – SD 10	20
Figure 2.1	<i>Excel</i> Conversion Table for Standardised Scores	25
Figure 2.2	<i>Excel</i> Conversion Table for Scaled Scores	25
Figure 2.3	Z Score of 1.5 on the Standard Normal Distribution Curve	26
Figure 2.4	Filling Cells in <i>Excel</i>	31
Figure 2.5	Deriving Z Scores from Raw Scores via Percentiles	32
Figure 2.6	Deriving Standard Scores from Z Scores	32
Figure 2.7	Deriving the Standard Error of Measurement	33
Figure 2.8	Deriving Confidence Ranges	33
Figure 2.9	Stanines and Percentiles	34
Figure 2.10	Standard Normal Distribution Curve and Standardised Scores	35
Figure 2.11	Distribution of Raw Scores and their Frequencies	36
Figure 2.12	Score Frequencies and Percentile Ranks	37
Figure 2.13	Proportion of Unlikely Scores in the Normal Distribution Curve	38
Figure 2.14	Z Scores and Two-Tailed Test	39
Figure 2.15	Z Score and One-Tailed Test	39
Figure 4.1	Confidence Ranges – Levels of Confidence and Reliability Coefficients of Tests	46

Figure 4.2	Tests' Confidence Ranges	47
Figure 4.3	Comparison of Multiple Test Scores	49
Figure 4.4	Highlighting Significant Test Scores	50
Figure 4.5	Options for Highlighting Significant Test Scores	51
Figure 4.6	'Greater Than' Option in <i>Excel</i>	51
Figure 4.7	Reference Table for Significant Differences between Test Scores	52
Figure 4.8	Table of Correlation Coefficients for Tests	53
Figure 4.9	Table of Severe Discrepancy Values Between Tests	53
Figure 5.1	Table of Predicted Scores Using the Simple Regression Formula	58
Figure 5.2	Regression of Attainment Scores from Ability	59
Figure 6.1	Regressed Scores	62
Figure 6.2	Predicted Scores for a Range of Correlation Coefficients	62
Figure 6.3	An Example of Looking Up a Regressed Score	63
Figure 7.1	Storing Reliability and Validity Data in <i>Excel</i>	68
Figure 7.2	Working across Worksheets in <i>Excel</i>	69
Figure 7.3	<i>Excel</i> and using Standard Error of the Estimate for Ability-Attainment Comparison	70
Figure 7.4	A Source of Standard Errors of the Estimates in <i>Excel</i>	71
Figure 7.5	An Example – Comparing Billy's ART Accuracy Score with his SPM+ Score	72
Figure 8.1	Comparing Confidence Ranges Derived from the Standard Error of Measurement and the Standard Error of the Estimate	75
Figure 10.1	Charting Progress over Time Using Standard Scores	80
Figure 10.2	Charting Progress over Time Using Growth Scale Values	81
Figure 10.3	Normal Curve Equivalents and Percentiles on a Standard Distribution Curve	83
Figure 12.1	Scatter Plot of Scores	91
Figure 12.2	Standard Deviation Calculations for Groups A and B	91
Figure 12.3	Sampling Numbers and the Standard Error of the Mean	93
Figure 13.1	Multiple Choice Items – Obtaining Binomial Probability using <i>Stat Trek</i>	97
Figure 13.2	Multiple Choice Items – Obtaining Binomial Probability using <i>Excel</i> (i)	97
Figure 13.3	Multiple Choice Items – Obtaining Binomial Probability using <i>Excel</i> (ii)	98
Figure 13.4	Probability (p) of Chance Successes on a Multiple-Choice Test	98
Figure 14.1	Multiple Regression – Step 1	99
Figure 14.2	Multiple Regression – Step 2	100
Figure 14.3	Multiple Regression – Step 3	100
Figure 14.4	Multiple Regression – Step 4	101
Figure 16.1	Example 1 of Core Templates	111
Figure 16.2	Example 2 of Core Templates	112
Figure 16.3	Preparing a Template for Data Merging	112
Figure 16.4	Data File for Merging	113
Figure 16.5	Selecting the Mail Merge Wizard in <i>Excel</i>	113
Figure 16.6	Mail Merge Wizard – Step 1	114
Figure 16.7	Mail Merge Wizard – Step 2	114
Figure 16.8	Mail Merge Wizard – Selecting the Client	115
Figure 16.9	Mail Merge Wizard – Step 3	115
Figure 16.10	Mail Merge Wizard – Inserting Data Fields	115
Figure 16.11	Mail Merge Wizard – Template with Data Fields	116
Figure 16.12	Mail Merge Wizard – Step 4	116
Figure 16.13	Mail Merge Wizard – Step 5	117
Figure 16.14	Mail Merge Wizard – Step 6	117
Figure 16.15	Final Mail Merged Report	118
Figure 16.16	<i>Microsoft's</i> Quick Access Toolbar	119

Figure 16.17	Customising the Quick Access Toolbar for <i>Auto Text</i>	119
Figure 16.18	Creating a New <i>Auto Text</i>	120
Figure 16.19	Inserting an <i>Auto Text</i>	121
Figure 16.20	Inserting <i>Auto Text</i> as You Type – Step 1	121
Figure 16.21	Inserting <i>Auto Text</i> as You Type – Step 2	122
Figure 16.22	Inserting <i>Auto Text</i> as You Type – Step 3	122
Figure 17.1	Creating a Table of Subtest Z Scores in <i>Excel</i>	126
Figure 17.2	Creating a Chart – Step 1	126
Figure 17.3	Creating a Chart – Step 2	127
Figure 17.4	Creating a Chart – Step 3	127
Figure 17.5	Creating a Chart – Step 4	127
Figure 17.6	Creating a Chart – Step 5	128
Figure 17.7	Creating a Chart – Step 6	128
Figure 17.8	Creating a Chart – Step 7	129
Figure 17.9	Creating a Chart – Step 8	129
Figure 17.10	Creating a Chart – Step 9	130
Figure 17.11	Creating a Chart – Step 10	130
Figure 17.12	Creating a Chart – Step 11	130
Figure 17.13	Setting the Range of Scores in <i>Excel</i>	131
Figure 17.14	Example Chart of Scaled Scores	132
Figure 17.15	Creating a Stock Chart – Step 1	133
Figure 17.16	Creating a Stock Chart – Step 2	133
Figure 17.17	Creating a Stock Chart – Step 3	134
Figure 17.18	Creating a Stock Chart – Step 4	134
Figure 17.19	Creating a Stock Chart – Step 5	134
Figure 17.20	An Alternative Way of Creating a Chart – Step 1	135
Figure 17.21	An Alternative Way of Creating a Chart – Step 2	135
Figure 17.22	An Alternative Way of Creating a Chart – Step 3	136
Figure 17.23	An Alternative Way of Creating a Chart – Step 4	136
Figure 17.24	An Alternative Way of Creating a Chart – Step 5	137
Figure 17.25	An Alternative Way of Creating a Chart – Step 6	137
Figure 17.26	An Alternative Way of Creating a Chart – Step 7	137
Figure 17.27	An Alternative Way of Creating a Chart – Step 8	138
Figure 17.28	An Alternative Way of Creating a Chart – Step 9	138
Figure 17.29	Logarithmic Scale for a Chart	139
Figure 17.30	Charting Probe Scores – Step 1	142
Figure 17.31	Charting Probe Scores – Step 2	142
Figure 17.32	Charting Probe Scores – Step 3	143
Figure 17.33	Charting Probe Scores – Step 4	143
Figure 17.34	Charting Probe Scores – Step 5	143
Figure 17.35	Inserting a Trendline into a Chart – Step 1	144
Figure 17.36	Inserting a Trendline into a Chart – Step 2	144
Figure 17.37	Inserting a Trendline into a Chart – Step 3	145
Figure 17.38	Inserting a Trendline into a Chart – Step 4	145
Figure 17.39	Inserting a Trendline into a Chart – Step 5	146
Figure 17.40	Inserting a Trendline into a Chart – Step 6	147
Figure 17.41	Inserting a Trendline into a Chart – Step 7	147
Figure 18.1	WAIS-III ^{UK} Mean Raw Scores for Age Ranges	154

This book is designed primarily to support users of psychometric tests. It provides specialist teachers, psychologists and other health professionals with a practical reference book on basic statistical methods to aid them in their diagnostic interpretation of psychometric test scores when assessing children, young people and adults with special educational needs and specific learning difficulties. It offers a complementary resource to published test scoring and reporting software. It acknowledges that assessors often need to have available practical guidance and references on a number of statistical matters, particularly as the range of available tests is now extremely wide.

The level of statistical information provided is suitable for those UK teachers who are either training for their practising certificate in special education or seeking renewal of their certificate in order to be deemed as appropriately trained and safe to practice. It will also be helpful to experienced specialist teachers and psychologists who are practising as diagnosticians but who feel that they need additional help with their understanding and efficient application of a range of statistical concepts and approaches. Trainee and newly qualified educational and clinical psychologists in the UK will also find the book useful as an aid to their induction to fieldwork assessment practices and their CPD requirements for maintaining their HCPC professional registration. The book will be particularly relevant for those professionals involved in providing reports for clients who require assessments for consideration of eligibility for access arrangements for formal examinations such as GCSE/GCE and Disabled Students' Allowance (DSA).

The book includes references to a range of contemporary psychometric tests. The examples are selected predominantly from tests published or distributed by Pearson Assessment. The book draws on the tests' standardisation data and encourages users to adopt a critical stance when selecting tests for diagnostic purposes. It focuses on common mistakes and misunderstandings made by assessors when they attempt to interpret psychometric information for the purposes of providing diagnostic reports for their clients. In doing so, it is likely to be of significant help by ensuring that these professionals can be confident that their conclusions reflect sound principles of statistical interpretation and hypothesis-testing. Case examples and scenarios are given which are of the type commonly experienced by professionals, thereby making it relatively easy for them to be applied within their own contexts of need. Relatively simple *Excel* formulae and table creations are introduced to encourage professionals to establish incrementally a repertoire of reference sources, statistical tools and personal overview data relating to their assessment inputs. Tips are given on how to merge statistical data into reports and how to insert charts directly from data sources, thus making more efficient the report writing process and the gathering of overview data across assessments.

The book's early chapters are arranged to give case examples with related summaries of the statistical issues relevant to the cases being investigated. As the case examples continue, the statistical issues are expanded and gradually covered in more depth, enabling the reader to evolve their understanding and learning in a controlled way, yet still anchoring their acquired knowledge to the practical examples given. Later chapters give information on more complex means of interrogating psychometric information and are suitable for the more advanced and knowledgeable diagnostician.

Above all, it is hoped that the book encourages those involved in the diagnostic process of assessing clients' needs to adopt an inductive stance to their assessment framework. Assessment is not testing and testing is not assessment. The assessor needs to be continuously introducing and refining hypotheses, carefully selecting from a wide range of suitable tests. Each assessment needs to be fit for purpose, individualistic in style, and not pre-determined in such a way that the assessor goes into automatic pilot by administering the same core tests to all clients. Hence having the knowledge and confidence to compare and interpret scores across tests is an essential requirement for today's diagnostic assessor.

It is important to note that as new editions appear of the tests used for illustrative purposes, it is likely that the quoted reference tables and page numbers will not remain accurate. However, it is anticipated that similar tables/formulae will be found in different editions to aid one's understanding of each concept introduced. Where references to older tests occur, this is to illustrate particular concepts with tests that are currently accepted by professional organisations. Similarly, Microsoft Office *Excel* 2010 is used in this book, which is

likely to be updated. Examples may differ from the procedures needed in other versions. Current legislation will also change, for example, the statement of special educational needs will be replaced by an Education, Health and Care plan in 2014 (Petersen, 2012).

It should be noted that throughout the book the following convention has been adopted: the feminine personal pronoun is used to denote the assessor and the masculine personal pronoun is used to denote the person being assessed.

SAMPLE

Dr. Barry Johnson is Principal Educational Psychologist and Head of Assessment Services for Dyslexia Action, formerly known as The Dyslexia Institute. He is a member of the UK's Specific Learning Difficulties Assessment Standards Committee (SASC) and its sub-committee, the Specific Learning Difficulties Test Evaluation Committee (STEC). Barry has worked as an educational psychologist for 39 years in many settings in the UK and is an approved assessor for the British Psychological Society's qualification 'Test User: Educational Ability/Attainment (CCET)'. He has significant experience in the teaching of psychometrics to teachers and other professionals as well as advising on quality assurance parameters for psychologists' and teachers' diagnostic assessment and report writing needs across a wide area of educational and clinical settings. Barry provides assessment reports for the legal arena, including UK SENDIST hearings, and gives second opinions on borderline and complex cases involving the psychometric assessment of clients with special educational needs.

Dr. Gareth Hagger-Johnson is a psychologist and Senior Research Associate in the Department of Epidemiology and Public Health, University College London. He teaches methodology and statistics to both undergraduate and postgraduate students. His research and specialist areas are cognitive epidemiology, health behaviours, health literacy and personality traits. He is co-author of *Introduction to Research Methods and Data Analysis in Psychology* (Langdrige & Hagger-Johnson, 2009), and has published his research in peer-reviewed journals including *Health Psychology*, *Journal of Epidemiology and Community Health*, *Psychosomatic Medicine*, the *Journal of Psychosomatic Research* and *Quality of Life Research*.

Acknowledgement

The authors would like to thank Rick Portsmouth, educational psychologist and Director of Dyslexia North, for his comments and advice on draft sections of this book.

Permissions

Microsoft product screenshot(s) reprinted with permission from Microsoft Corporation.

SAMPLE