Seeing Reason: Visuospatial Ability, Sex Differences and the Raven's Progressive Matrices

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List of Abbreviations

2PL	Two-parameter logistic
3PL	Three-parameter logistic
AH	Alice Heim Test
APM	Raven's Advanced Progressive Matrices
AR	Abstract Reasoning (GRT2 subtest)
BIS	Berlin Structure of Intelligence
CAB-I	Comprehensive Ability Battery – Inductive Reasoning
CAB-Cf	Comprehensive Ability Battery – Flexibility of Closure
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CFIT	Cattell's Culture Fair Intelligence Test
CHC	Cattell-Horn-Carroll
CPM	Raven's Coloured Progressive Matrices
CTT	Classical Test Theory
DAS	Differential Aptitude Scales
DAT	Differential Aptitude Tests
DAT-AR	Differential Aptitude Tests – Abstract Reasoning
DAT-VR	Differential Aptitude Tests – Verbal Reasoning
DIF	Differential item functioning
DWLS	Diagonally weighted least squares
EA	Esoteric Analogies Test
EFA	Exploratory factor analysis
ESEM	Exploratory structural equation modeling
ETS	Educational Testing Service

g	General intelligence
Gc	Crystallised ability
Gf	Fluid ability
GRT2	General Reasoning Test 2
Gq	Quantitative ability
Gv	Visuospatial ability
I	Induction
ICC	Item characteristic curve
IQ	Intelligence Quotient
IRT	Item Response Theory
IST	Intelligence Structure Test
K-BIT	Kaufman Brief Intelligence Test
K-SNAP	Kaufman Short Neuropsychological Assessment Procedure
KAIT	Kaufman Adolescent and Adult Intelligence Test
MGCFA	Multiple-group confirmatory factor analysis
MIMIC	Multiple-indicator Multiple-causes
ML	Maximum likelihood
MRT	Mental Rotation Test
MTMM	Multitrait-multimethod
NR	Numerical Reasoning (GRT2 subtest)
PCA	Principal components analysis
PF	Paper Folding Test
PMA-R	Primary Mental Abilities – Reasoning
PSVT:R	Perdue Spatial Visualization Test of Rotations
RG	Sequential reasoning

RMSEA	Root Mean Square Error of Approximation
RPM	Raven's Progressive Matrices
RQ	Quantitative reasoning
SEM	Structural Equation Modeling
SRMR	Standardized Root Mean Square Residual
SPM	Standard Raven's Progressive Matrices
US	United States
UK	United Kingdom
VPR	Verbal-Perceptual-Image Rotation
VR	Verbal Reasoning (GRT2 subtest)
WAIS	Wechsler Adult Intelligence Scale
WLSMV	Weighted least squares mean and variance adjusted
WJ-III	Woodcock-Johnson Test of Cognitive Abilities – 3rd Edition

Abstract

This thesis sought to address the role of visuospatial ability in measures of inductive reasoning, with a particular focus on the Raven's Progressive Matrices (RPM). Given that males tend to perform better on certain measures of visuospatial ability, sex differences in performance on the RPM tests and in other measures of inductive reasoning were also examined.

The issue of the involvement of visuospatial ability in the RPM tests is important at both a practical and a theoretical level. At the practical level, these tests are often used as a sole measure of general intelligence, and conclusions regarding the relationship of general intelligence to other variables are made on the basis of results from this test. If the RPM tests require a substantive amount of visuospatial ability, this is problematic to the interpretation of results on this test as reflective of general intelligence. At a theoretical level, investigation of this question pertains to an understanding of the relationship between visuospatial abilities and fluid ability generally, but inductive reasoning more specifically. Many commonly used measures of inductive reasoning are presented in a visual format (e.g. abstract figures) and these tests are often shown to cross-load on both fluid and visuospatial factors.

This thesis addresses the issues of visuospatial ability and sex differences in the RPM by examining (1) the dimensionality of the Advanced RPM tests; (2) the role of Gv in performance on the RPM tests; and (3) sex differences in raw scores on the RPM and other measures of inductive reasoning. Additionally, the psychometric properties of the General Reasoning Test 2 (GRT2) in the Australian population were examined. This included an investigation of the relationship between figural, verbal and numeric reasoning items as well as sex differences.

Study 1 used confirmatory factor analysis and Rasch modeling to investigate the dimensionality of the Advanced RPM, measurement invariance and differential item functioning across sex. Study 2 used structural equation modeling to examine, in three separate samples, how well visuospatial abilities could account for the variance in a latent RPM factor not already accounted for by alternative fluid ability measures. This study additionally assessed invariance of the structural relationships between visuospatial ability, fluid ability and RPM across sex. Study 3 used meta-analytic techniques to synthesise research concerning sex differences on measures of inductive reasoning, considering the item stimulus and item type as potential moderators of this difference. Study 4 used exploratory and confirmatory structural equation modeling to examine the psychometric properties of the GRT2.

Results indicate that although the RPM tests are largely unidimensional, visuospatial ability is involved in performance. Furthermore, sex differences in raw scores and at the latent level were found, favouring males. Investigation of sex differences in inductive reasoning measures more broadly indicated that the figural format of these tests may contribute to the male advantage often identified; however, examination of the influence of the stimulus and type of question used in reasoning items in the GRT2 indicated that these do not meaningfully impact the latent construct measured.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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