PROBLEM SOLVING AND INTELLIGENCE

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Problem Solving and Intelligence

Perceptual optimisation problems:

- Travelling Salesman Problems (TSP)
- Minimum Spanning Tree Problems (MSTP)
- Generalised Steiner Tree Problems (GSTP)

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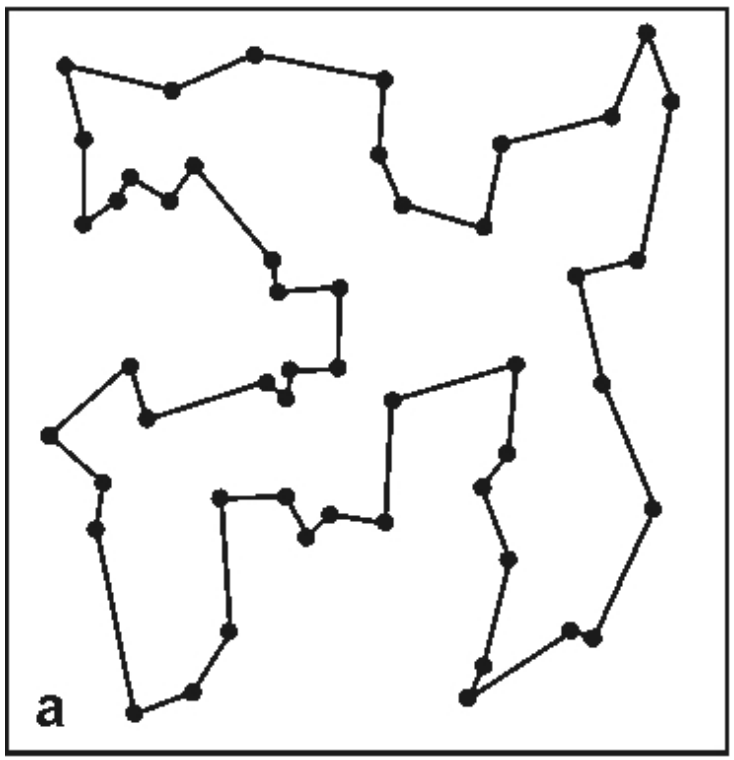
Travelling Salesman Problem:

- a series of *n* cities; devise a route whereby each is visited once and only once, concluding at the city where it began and with the overall distance as short as possible



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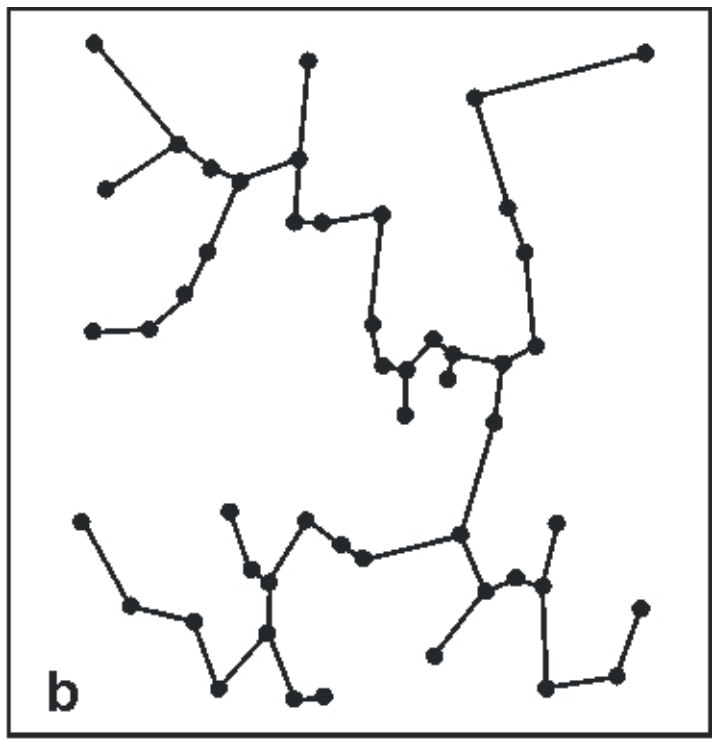
Minimum Spanning Tree Problem:

- find the shortest path that directly links all nodes in the array – does not have to be continuous and closed



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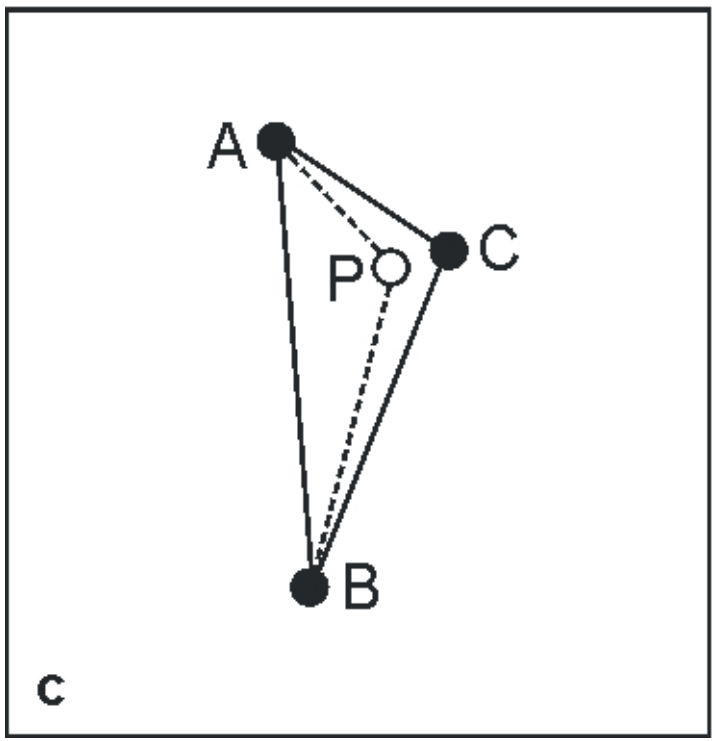
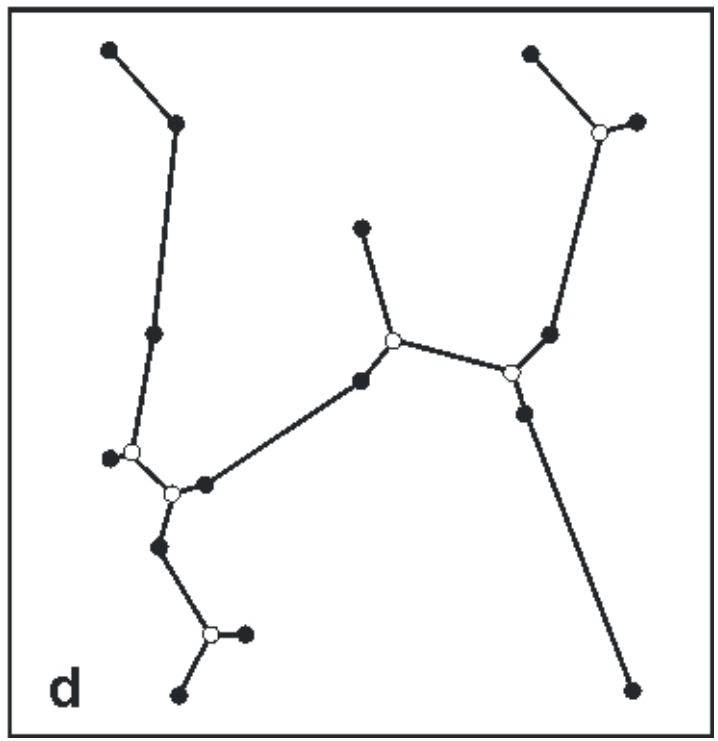
Generalised Steiner Tree Problem:

- Shortest path connecting three points in a plane - create links from Fermat point





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Vickers et al. (2004):

- TSP and Minimum Spanning Tree and Generalised Steiner Tree Problems
  - notionally differing degree of use of automatic perceptual vs cognitive processes

- Experiment 1
  - *N* = 69; 50-node TSP (x5); RAPM

- Experiment 2
  - *N* = 48; 50-node TSP, MSTP, 15 node GSTP (all x2); RAPM

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Vickers et al. (2004):

Performance quantified as proportion above benchmark

Expt 1: TSP and RAPM: r_m = -.37, CI_{95} = [-.56,-.15]

Expt 2: TSP and RAPM: r = -.46, CI_{95} = [-.66,-.20]
MSTP and RAPM: r = -.44, CI_{95} = [-.64,-.17]
GSTP and RAPM: r = -.46, CI_{95} = [-.66,-.20]

TSP, MSTP, GSTP: mean r = .67, CI_{95} = [.47,.80]
Mean test-retest reliability r = .7
Chronbach's α = .84 for five instances of TSP

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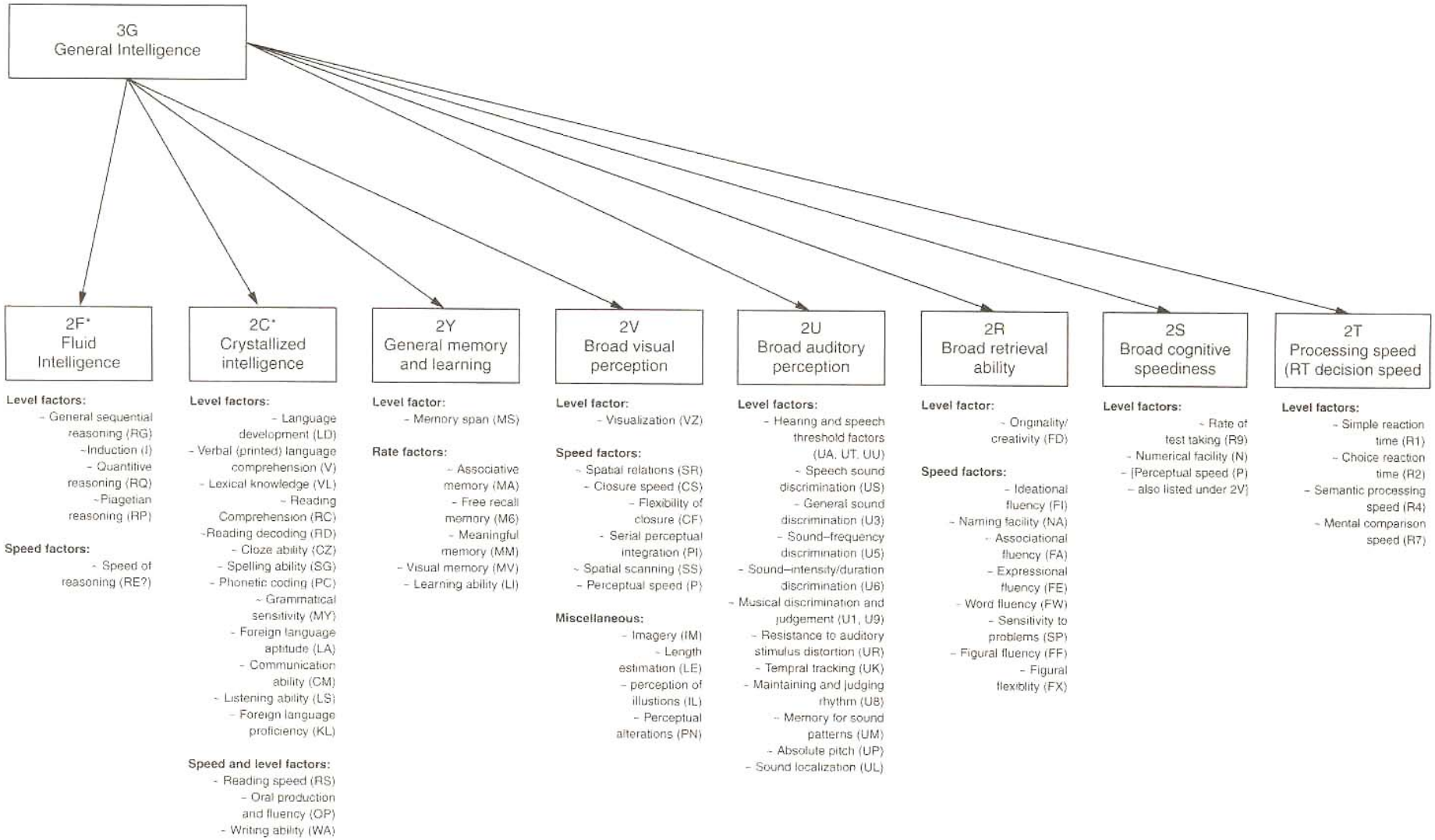

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Question is whether these correlations with Raven reflect shared perceptual processes, or shared cognitive processes, or both of them

Issue that Raven, while considered a pure measure of *g*, is a rather narrow measure of cognitive abilities

Perception is even more intelligent than has been generally assumed or cognition is more perceptually based?

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Cognitive optimisation problems:

- Secretary Problems (SecP)

- From a sequence of possible choices, accept or reject each in turn; choose the maximum value

- Distribution of numbers is known; number of values to be presented is known

- All incorrect decisions are equally wrong

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Secretary Problem:

- From a sequence of possible choices, accept or reject each in turn; choose the maximum value

79.69

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Secretary Problem:

- From a sequence of possible choices, accept or reject each in turn; choose the maximum value

34.40

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Secretary Problem:

- From a sequence of possible choices, accept or reject each in turn; choose the maximum value

82.55

[3/5]

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Secretary Problem:

- From a sequence of possible choices, accept or reject each in turn; choose the maximum value

95.77

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Secretary Problem:

- From a sequence of possible choices, accept or reject each in turn; choose the maximum value

24.26

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Method:

- *N* = 101; 58 males; mean age 25.3±7.6 yrs
- TSP (30-,60-,90-nodes, 1 of each)
- MSTP (30-,60-,90-nodes, 1 of each)
- GSTP (15-,20-,25-nodes, 1 of each)
- SecP (5-point and 10-point, 40 of each)

- RPM, CCFT (Fluid ability, Gf; Visuo-spatial ability, Gv)
- Picture Swaps (Gf)
- Spatial Relations, Space Relations (Gv)
- Digit Symbol, Visual Matching (Speed of processing, Gs)

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Correlations with RPM:

	r	CI_{95}	Vickers et al
TSP	-.35	[-.51,-.17]	-.41
MSTP	-.25	[-.43,-.06]	-.44
GSTP	-.46	[-.60,-.29]	-.46

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Correlations among problem solving tasks:

	TSP	MSTP
MSTP	.50	
GSTP	.71	.68

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Three initial models to generate observed covariance structure:

- Single general factor (cf Spearman)

- Separate problem solving ability correlated with Gf, Gv, Gs

- Perceptual problem solving tasks load Gv and SecProb loads Gf

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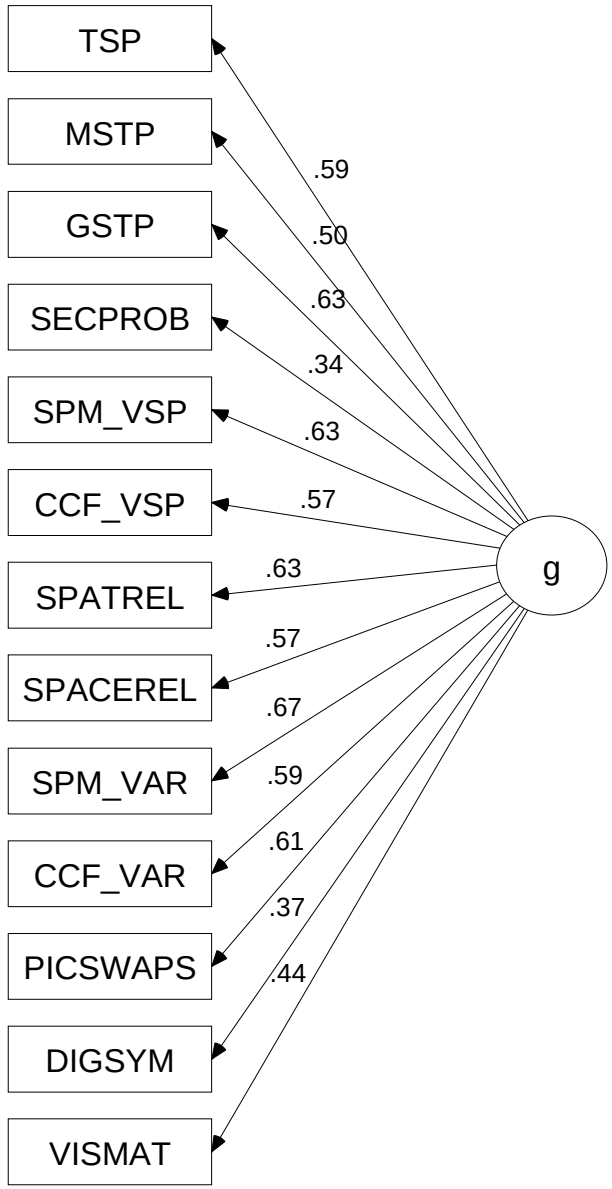

BIC = 356.5

RMSEA = .16, CI_{90}=[.14,.18]

$\chi^2(65) = 236.5$, $p < .001$

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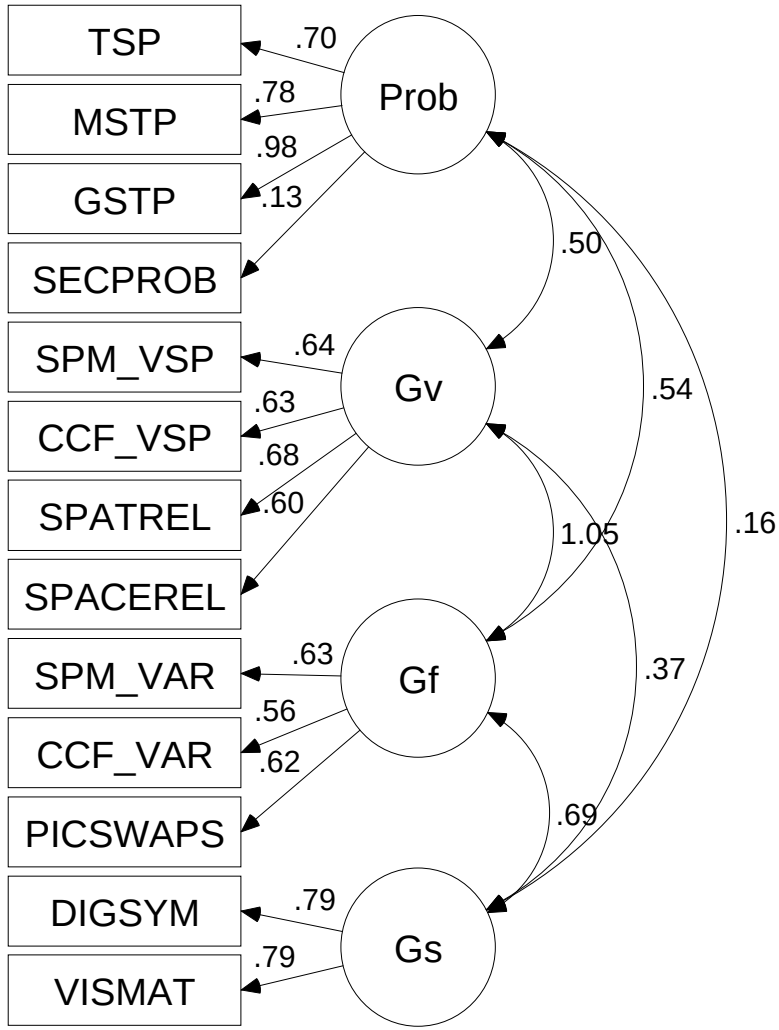

BIC = 239.5
RMSEA = .07, CI_{90}=[.04,.10]
$\chi^2(59) = 91.8$, $p = .004$

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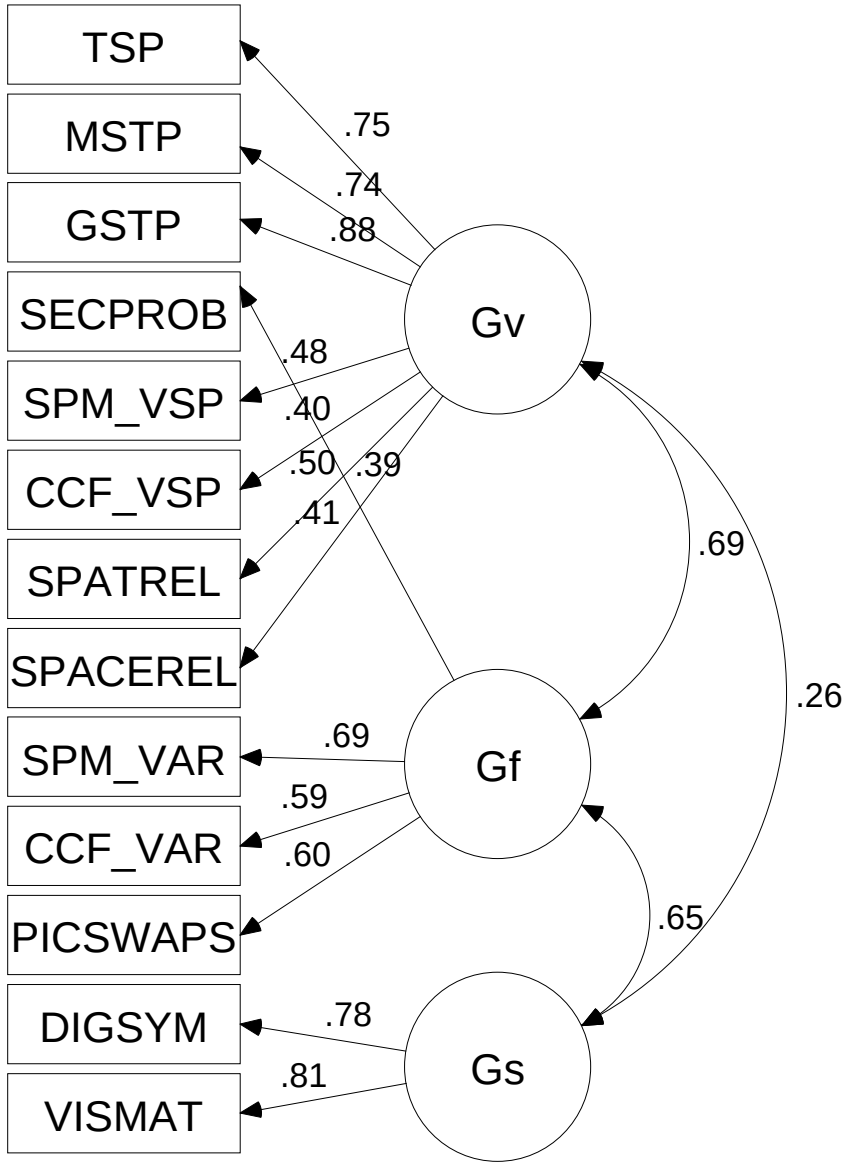

BIC = 314.1

RMSEA = .14, CI_{90}=[.11,.16]

$\chi^2(62) = 180.3$, $p < .001$

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Comparison of models:

Model	BIC	RMSEA	Chi-sq	df	*p*
1	356.5	.16	236.5	65	<.001
2	239.5	.07	91.8	59	.004
3	314.1	.14	180.3	62	<.001
Saturated	420.0	-	0	0	-
Null	596.6	.24	536.6	78	<.001

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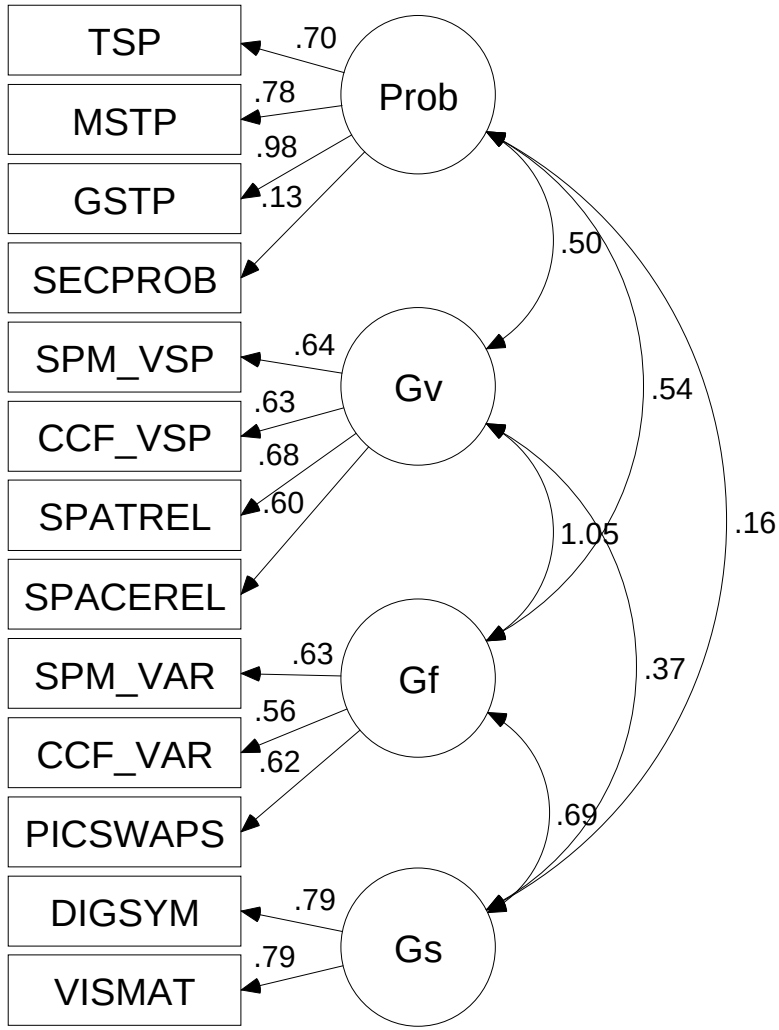

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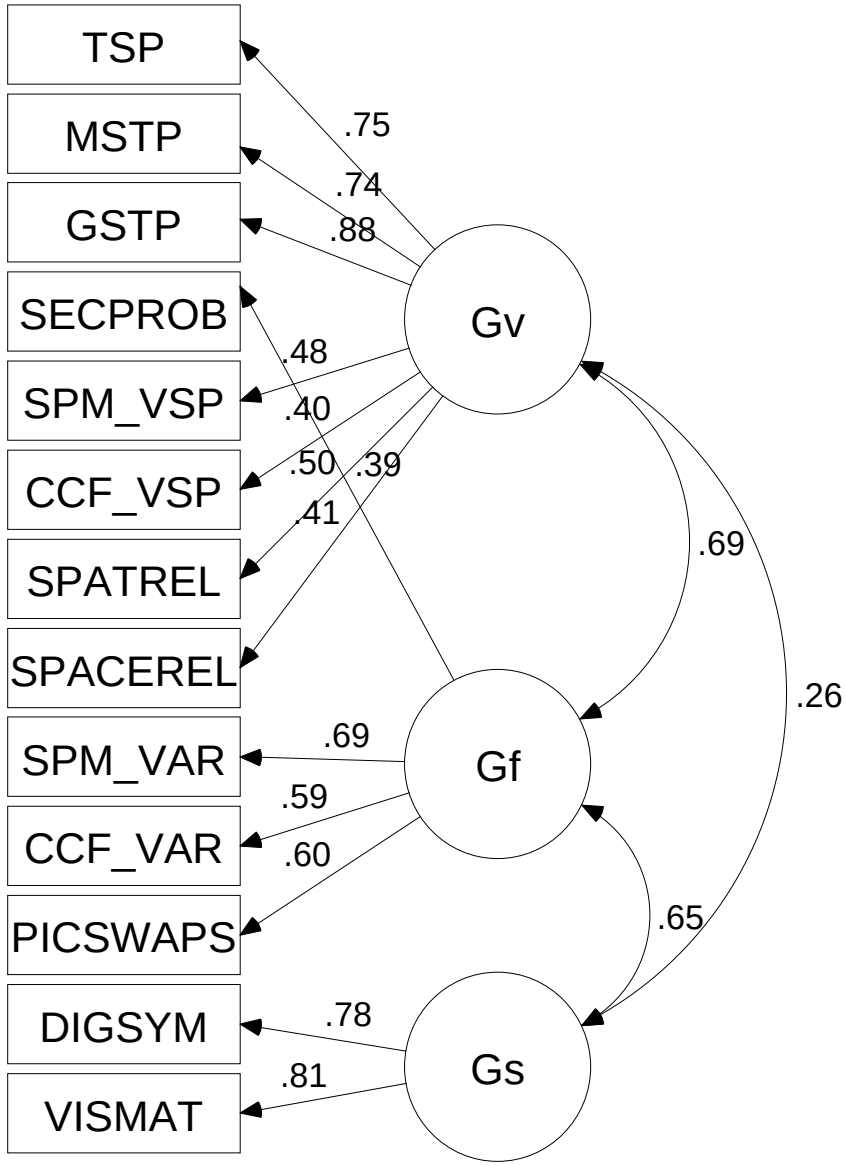
Problem Solving and Intelligence



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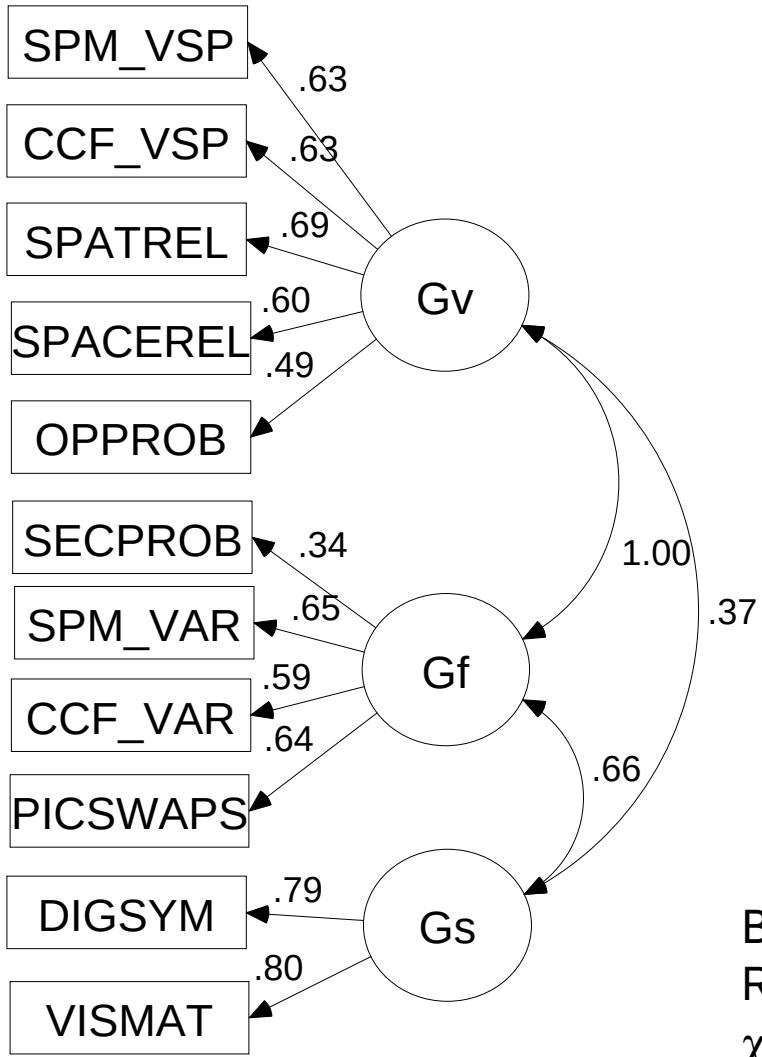

BIC = 168.0
RMSEA = .05, CI_{90}=[.00,.09]
$\chi^2(41) = 52.6$, p .11

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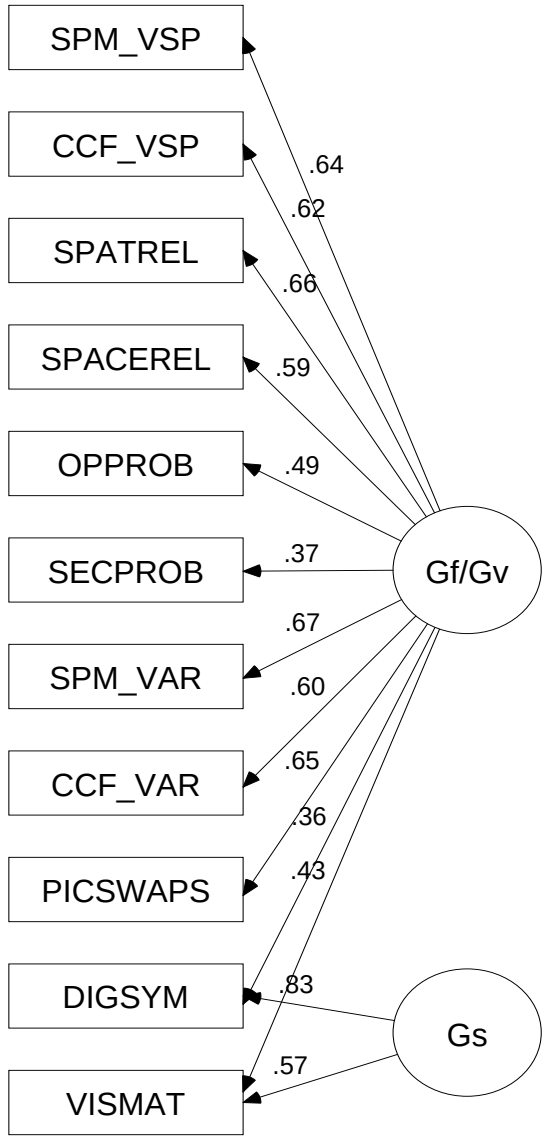

BIC = 167.7
RMSEA = .07, CI_{90}=[.02,.10]
$\chi^2(43) = 61.6$, $p = .03$

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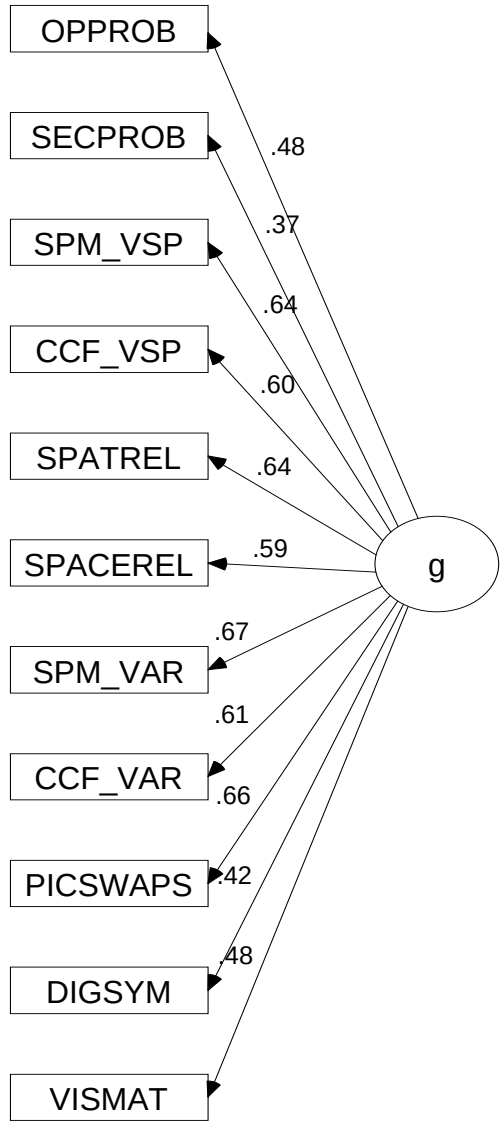

BIC = 199.6
RMSEA = .11, CI_{90}=[.08,.14]
$\chi^2(44) = 98.1$, $p < .001$

Problem Solving and Intelligence

Definitions of intelligence invariably make reference to problem solving

Perceptual optimisation problems can be represented by a single measure

Both perceptual and cognitive optimisation problems load a general ability factor (.5 and .4, respectively)

Potential to use optimisation problems as part of assessment batteries

Inform cognitive models of problem solving

Problem Solving and Intelligence

Intelligence:

- ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience

Difficult optimisation problems:

- can often be stated simply and readily understood
- related to real world problem solving

The End ...