

The logo for King's College London, featuring the text "KING'S" in a large, white, serif font, "College" in a smaller, white, script font, and "LONDON" in a white, serif font, all on a red background.

KING'S
College
LONDON

The Wellcome logo, featuring a large, white, stylized "W" above the word "wellcome" in a white, lowercase, sans-serif font, all on a black background.

W
wellcome

The logo for Queen Mary University of London, featuring a white crown icon above the text "Queen Mary" in a white, serif font, and "University of London" in a smaller, white, sans-serif font, all on a dark blue background.

Queen Mary
University of London

The iTEDS logo, featuring a stylized figure with two dots for eyes above the text "iTEDS" in a blue, sans-serif font, all on a white background.

iTEDS

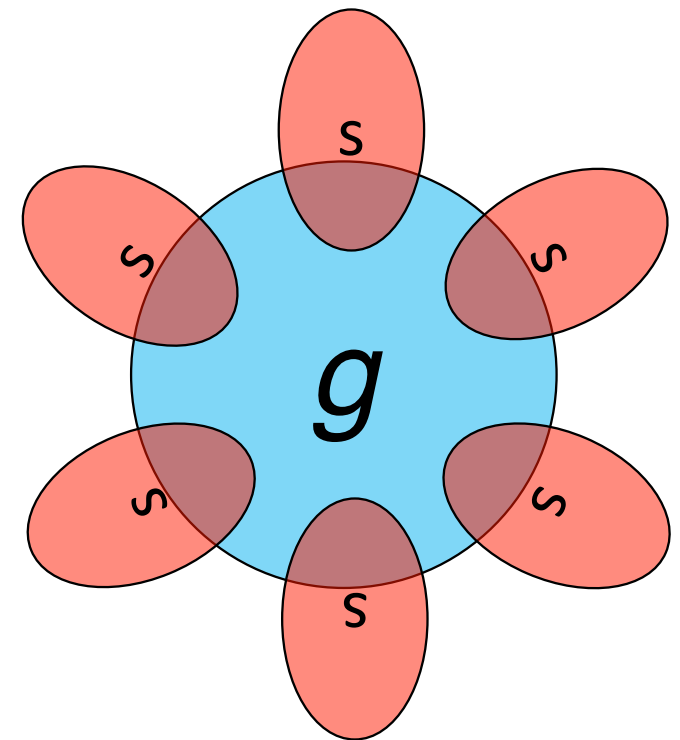
Novel online measures of cognition in the Twins Early Development Study

Dr Margherita Malanchini

Dr Kaili Rimfeld

General cognitive ability (g)

- Psychometric construct – indexing covariation between cognitive abilities
- Stable over development and associated with important life outcomes
- Difficult to collect reliable data on general cognitive ability in large cohorts

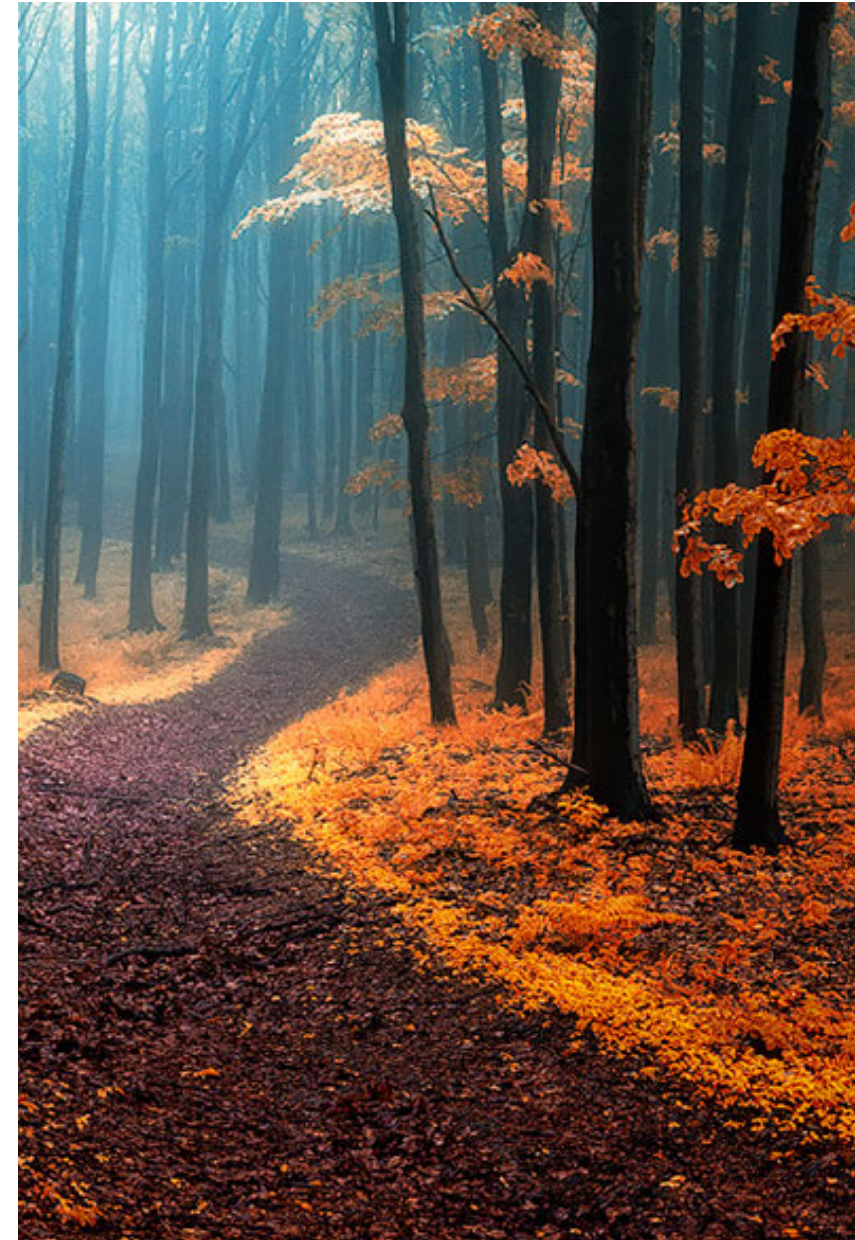


Spearman, 1904; Ceci, 1991;
Carroll, 1993; Deary, 2013

Pathfinder: A brief online measure to overcome these challenges

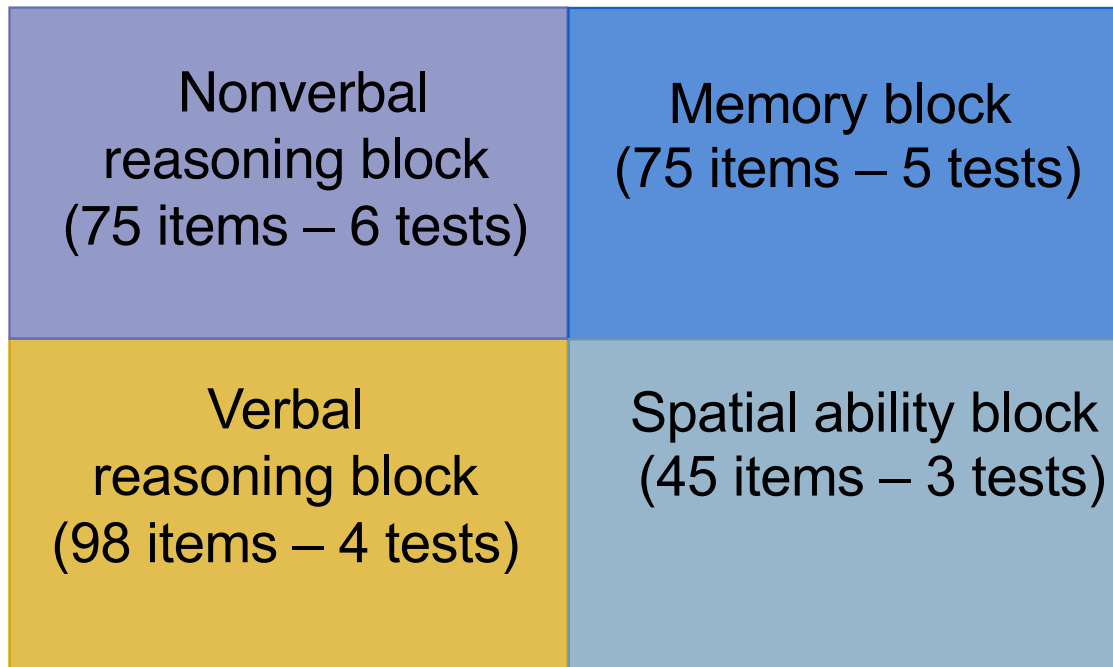
Over 4 studies, we developed a measure of g that is:

- Brief (15-minutes)
- Reliable (g total score + Verbal and Nonverbal composites)
- Administered online
- **Embedded in a gamified story line**

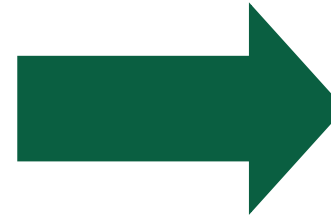
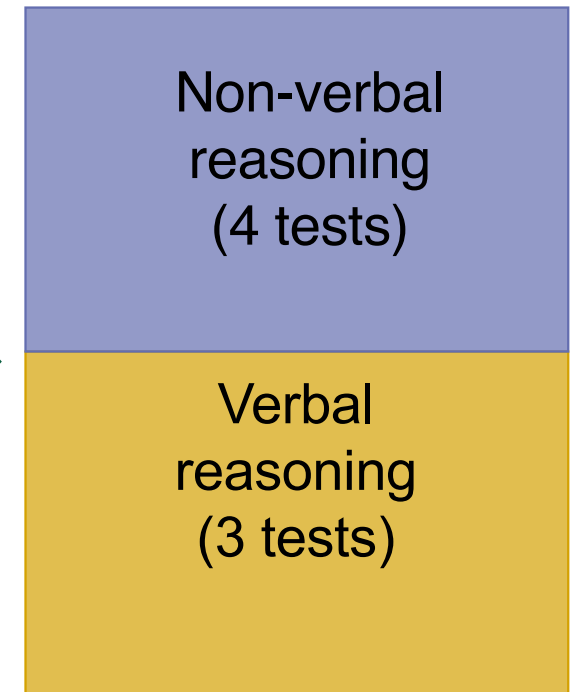


Study 1

18 cognitive tests (298 items)



7 tests (138 items)



$r(g\ 18\ \text{tests}, g\ 7\ \text{tests}) = .852, p < .001, N = 126$

Study 2

7 tests (138 items)

Nonverbal reasoning (4 tests)

NV reasoning – Sequences

NV analogies

NV reasoning – Groups

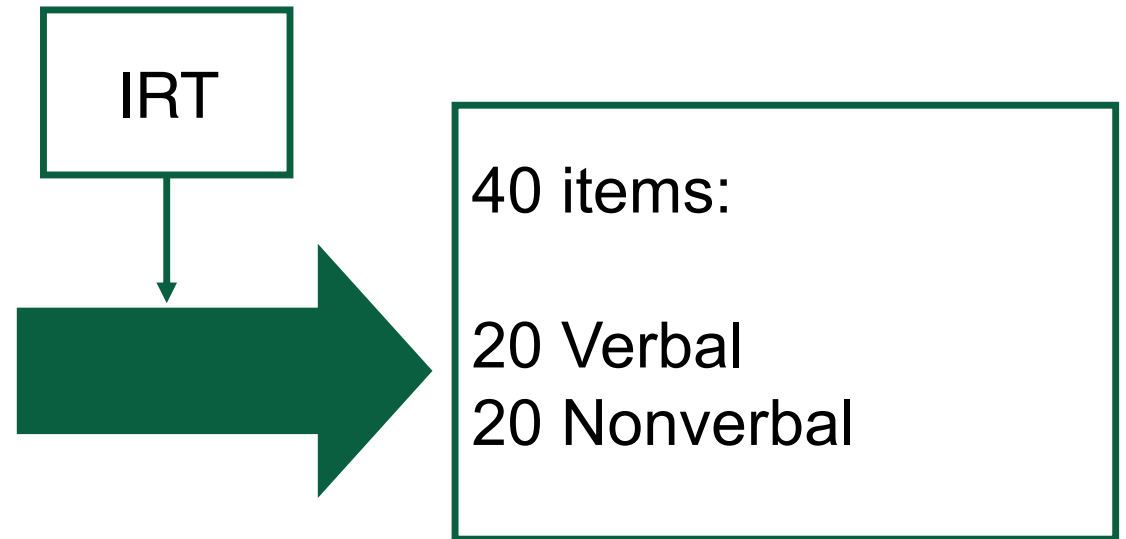
Matrix reasoning

Verbal reasoning (3 tests)

V reasoning – Missing letter

V analogies

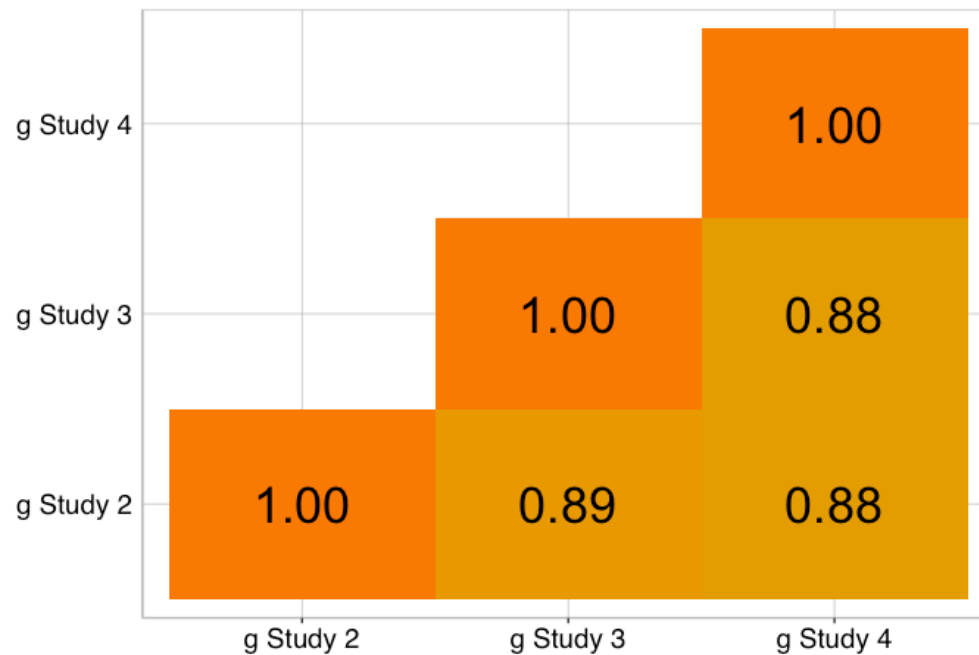
Vocabulary



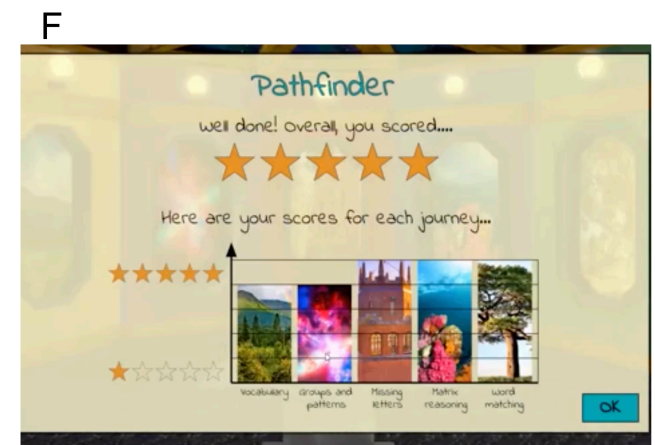
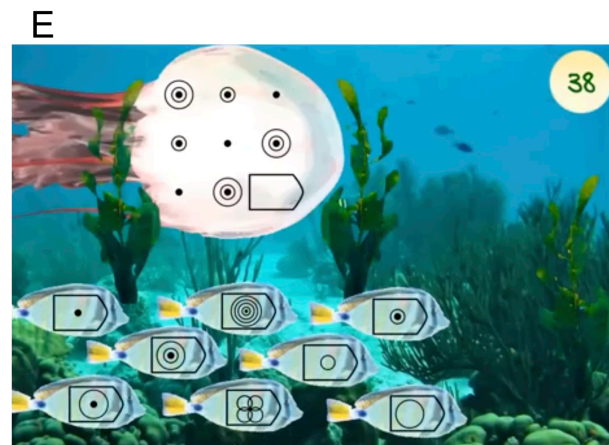
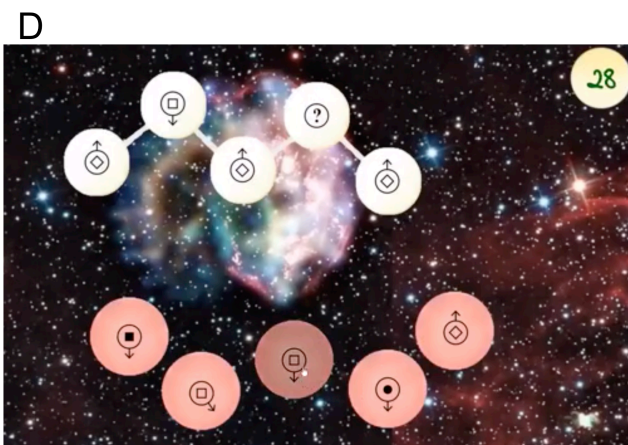
Study 3 & 4

Study 3: test-retest reliability (40 items), $N = 132$

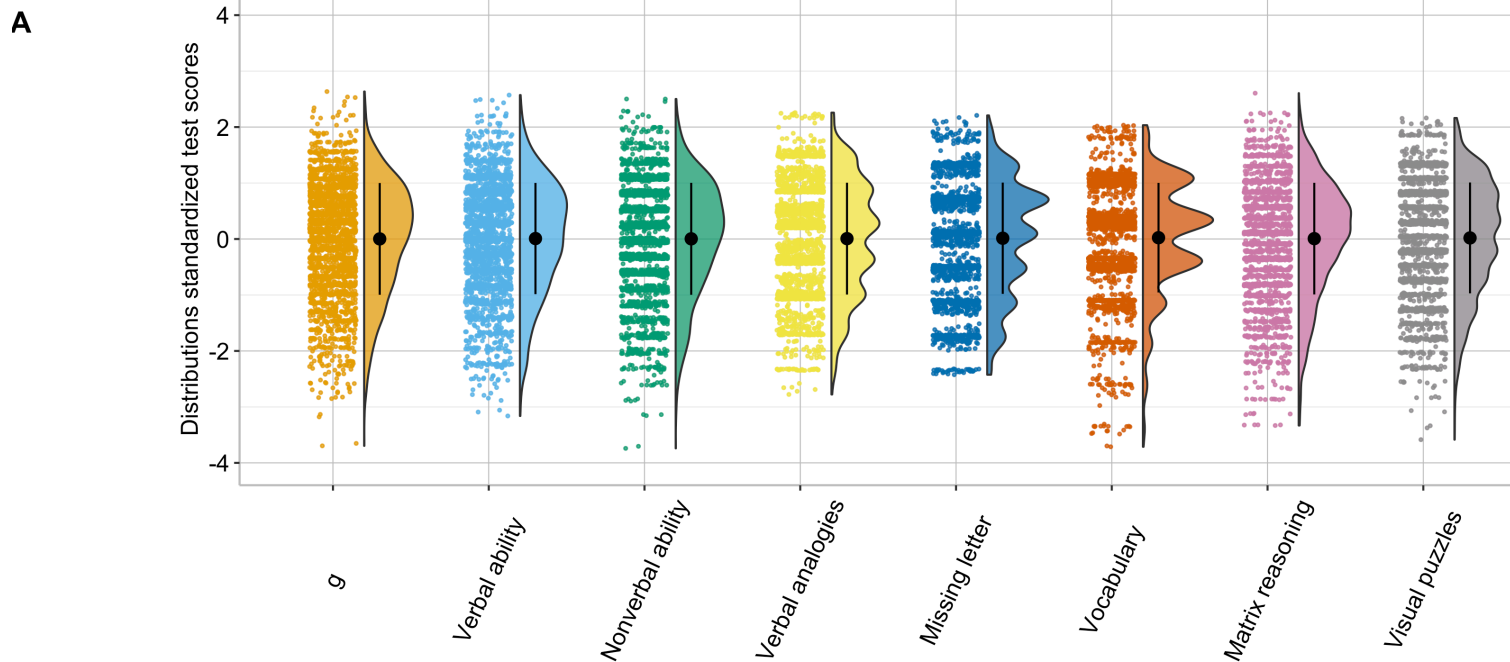
Study 4: test-retest reliability (40 items) **gamified** version, $N = 123$



Pathfinder gamified tests

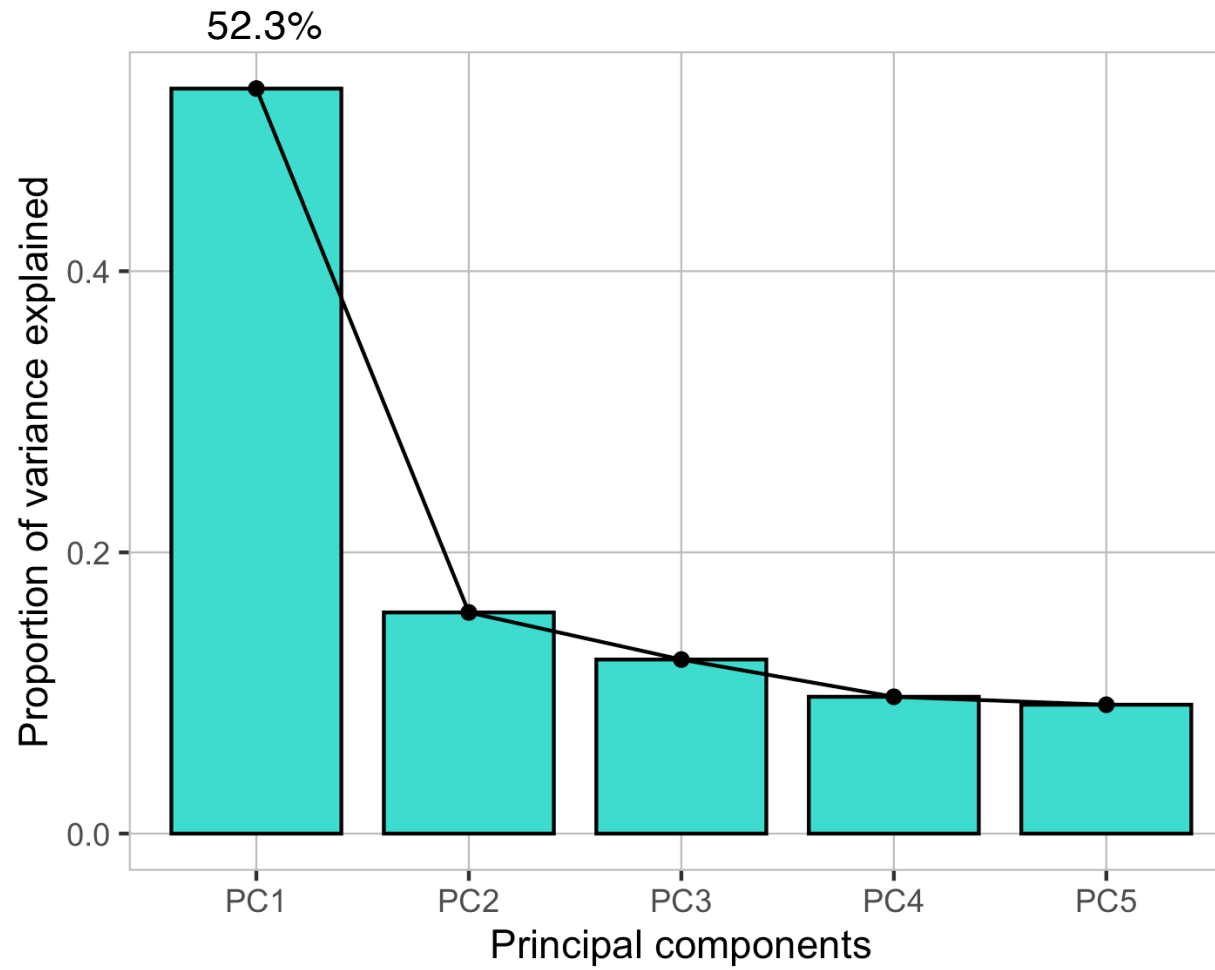


Study 5 – Pathfinder in a large, longitudinal sample

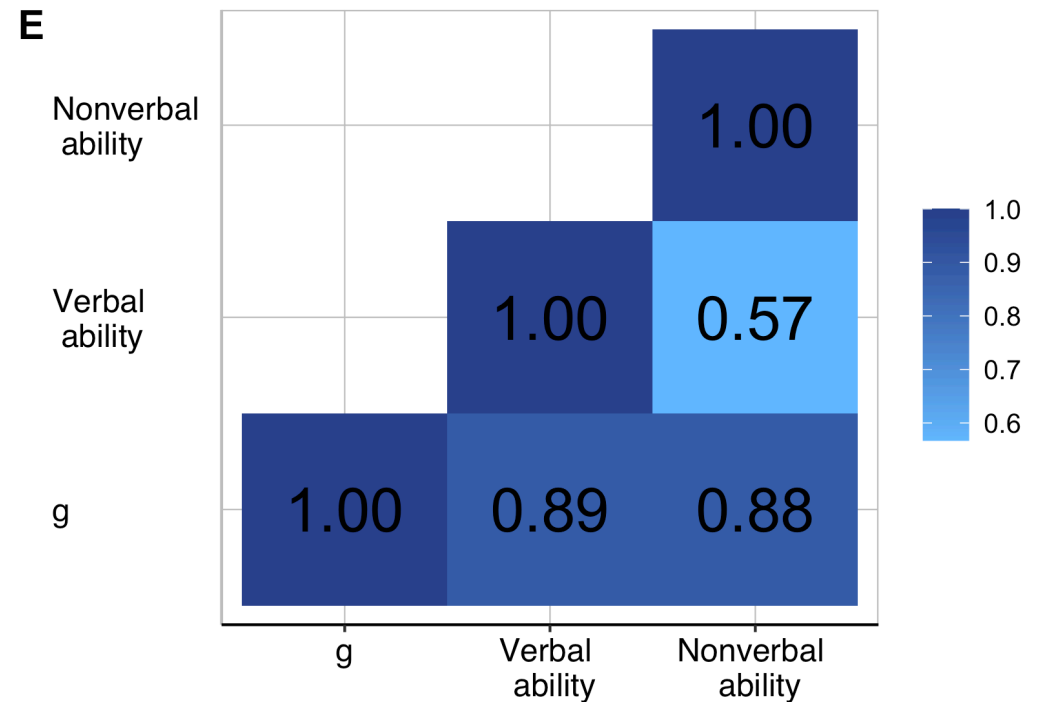
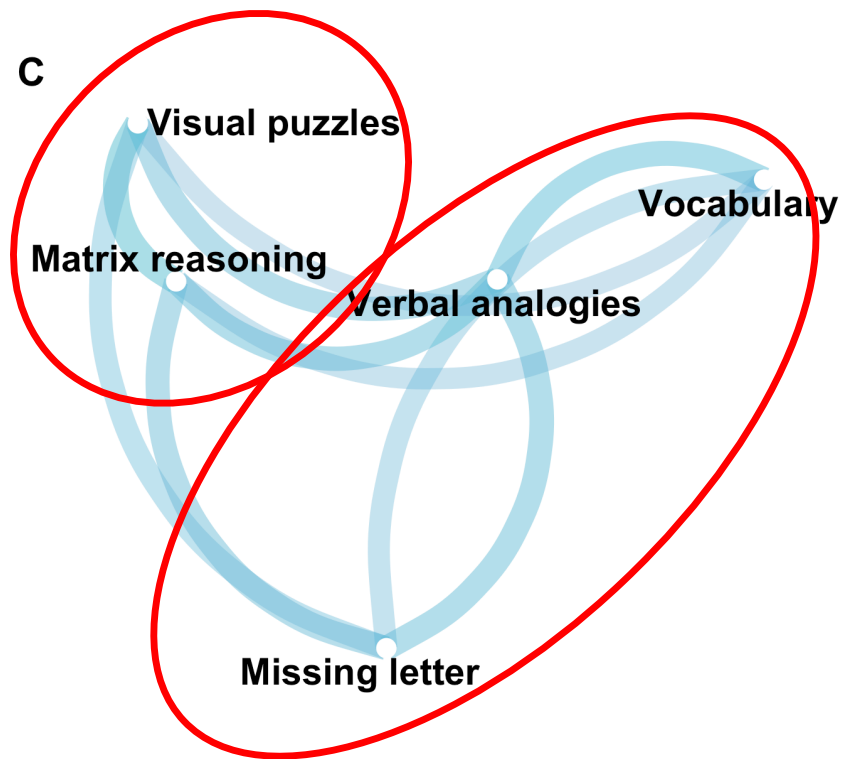


$N = 4,548$ young adults (age 23-25)
 N complete twin pairs = 1,416

PCA

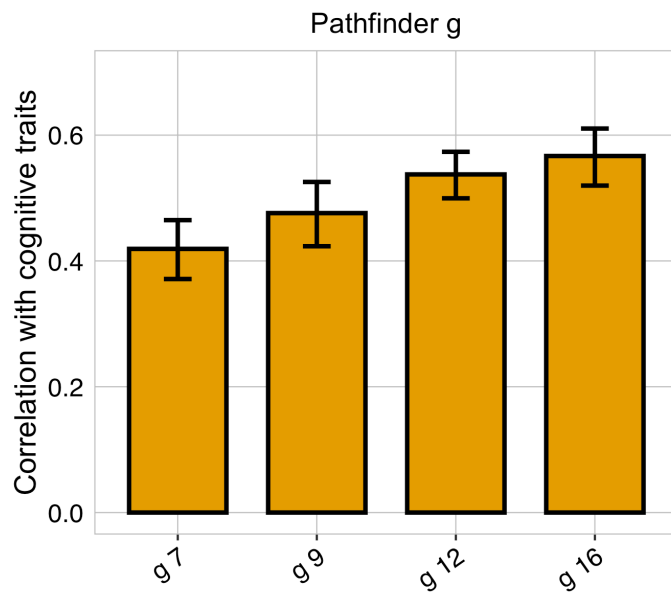


Associations between tests and domains

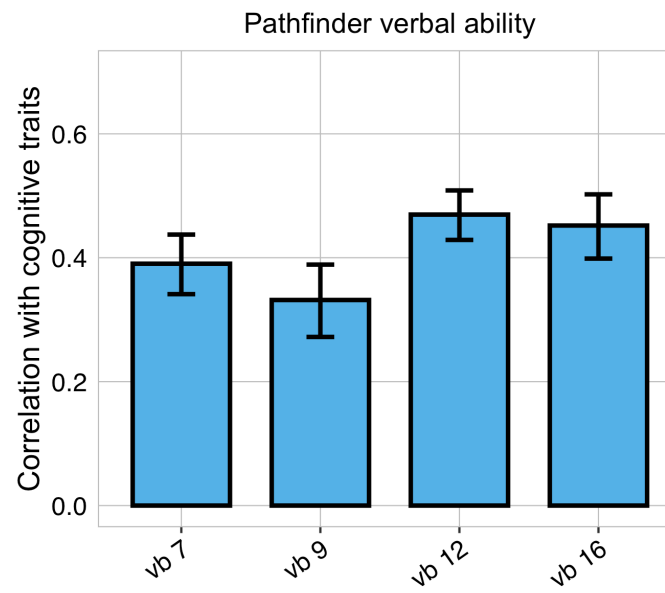


External validity 1: Correlations with cognitive ability over development

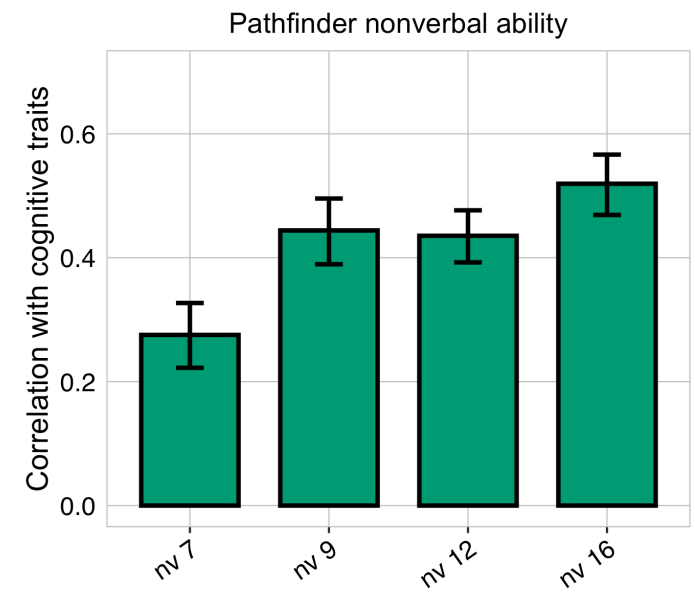
A



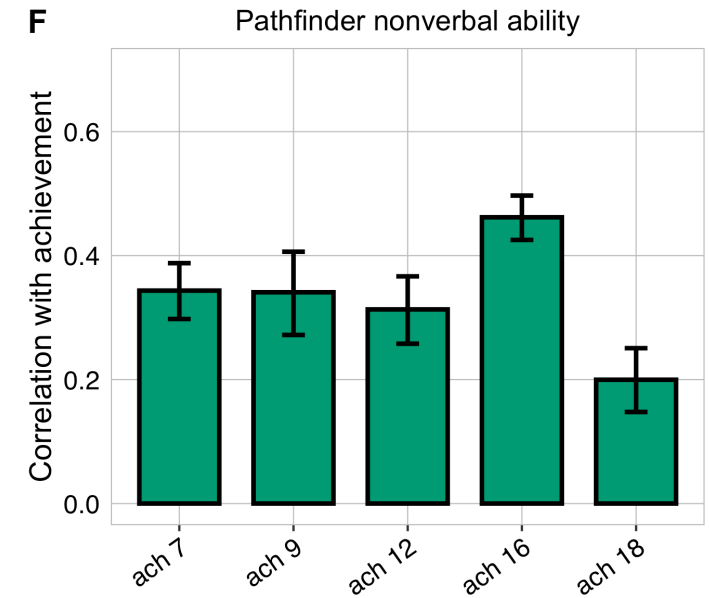
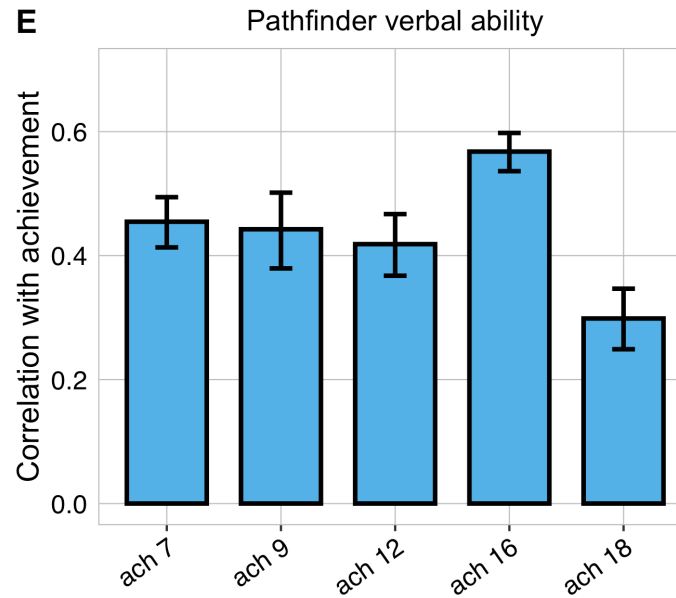
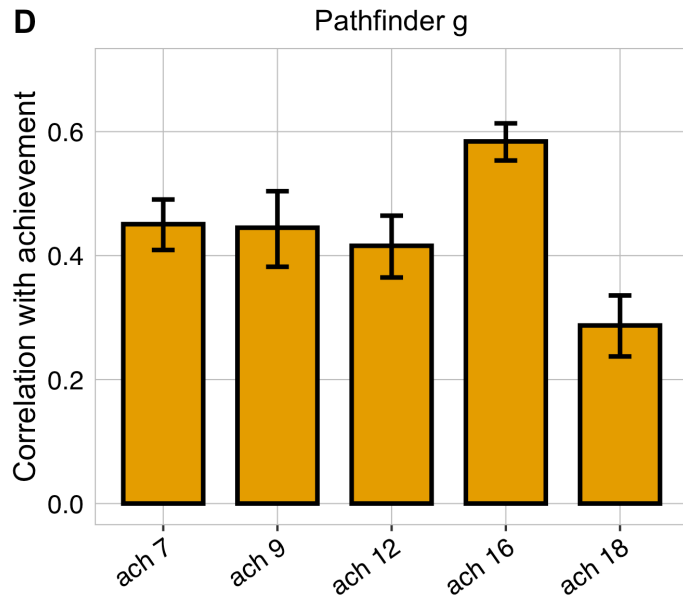
B



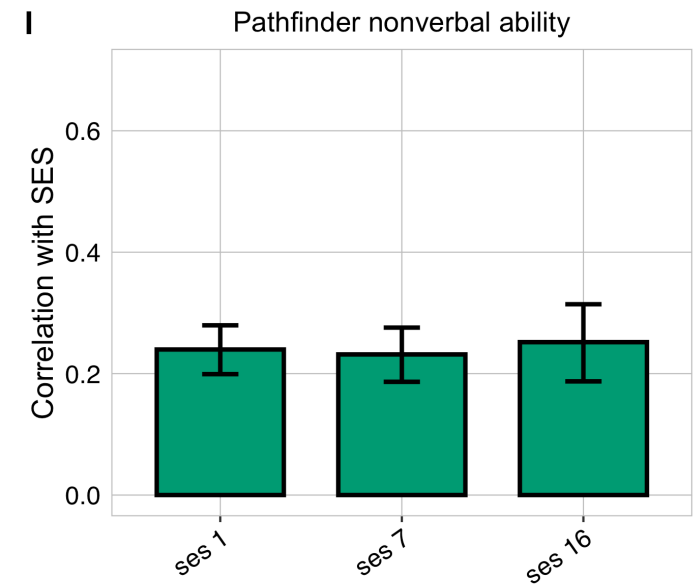
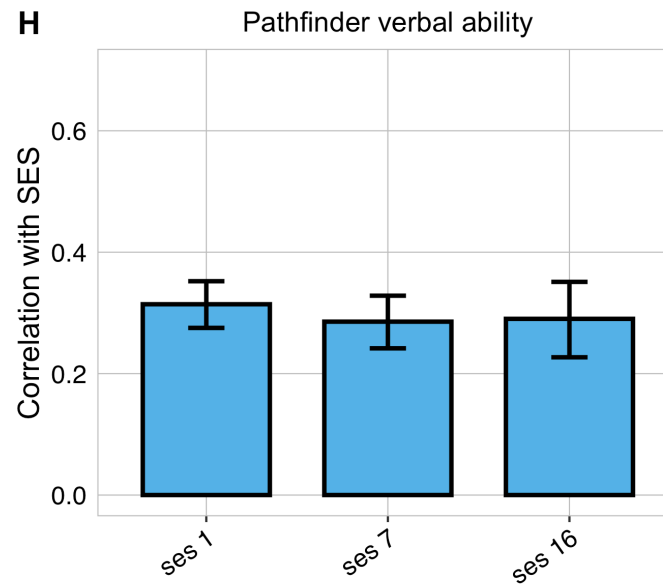
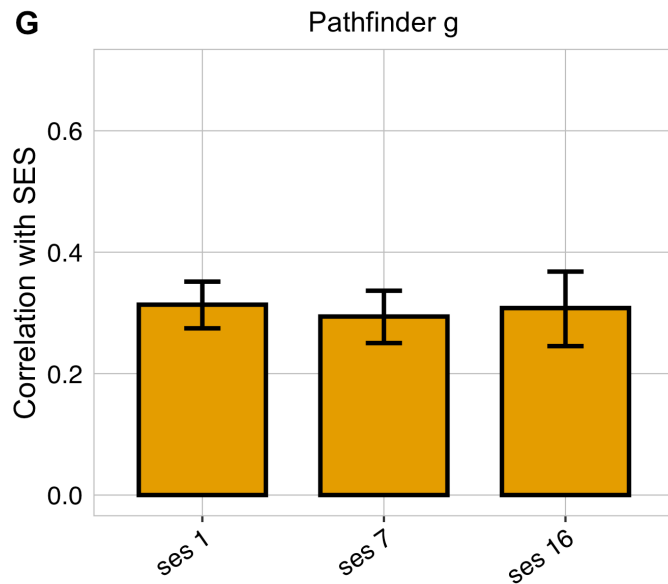
C



External validity 2: Correlations with academic achievement over development



External validity 3: Correlations with SES over development





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bioRxiv is receiving many new papers on coronavirus SARS-CoV-2. A reminder: these are preliminary reports that have not been peer-reviewed and should not guide clinical practice/health-related behavior, or be reported in news media as established information.

New Results

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Pathfinder: A gamified measure to integrate general cognitive ability into the biological, medical and behavioural sciences

[ID](#) Margherita Malanchini, [ID](#) Kaili Rimfeld, Agnieszka Gidziela, [ID](#) Rosa Cheesman, [ID](#) Andrea G. Allegrini, Nicholas Shakeshaft, Kerry Schofield, Amy Packer, Rachel Ogden, Andrew McMillan, [ID](#) Stuart J. Ritchie, [ID](#) Philip S. Dale, [ID](#) Thalia C. Eley, [ID](#) Sophie von Stumm, [ID](#) Robert Plomin

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This article is a preprint and has not been certified by peer review [what does this mean?].

Abstract

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Conclusions

- Over 4 pilot studies: Brief, reliable, **engaging** measure of g
- Freely available to all researchers
www.pathfindertestgame.com
- Advance discoveries across the biological, medical and behavioural sciences



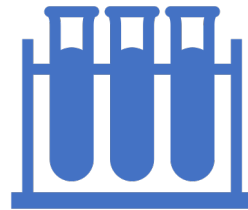
Spatial ability

- A strong predictor of several important outcomes, including success in science, technology, engineering, and mathematics (STEM) subjects and careers
- Multifactorial?
- Separable from g ?

Game development



From 27 varied tests → 10 test
(Pilot on pencil and paper, ~2.5 h)



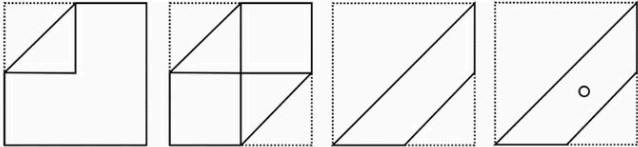
Test re-test on 10 tests ~.65



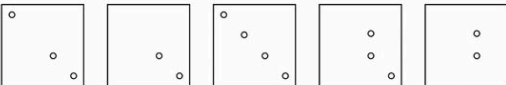
Gamification done by Helmes

King's Challenge

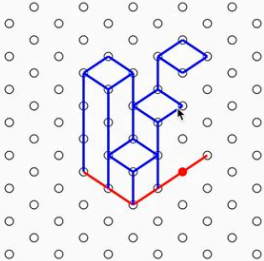
A



Choose the best answer:



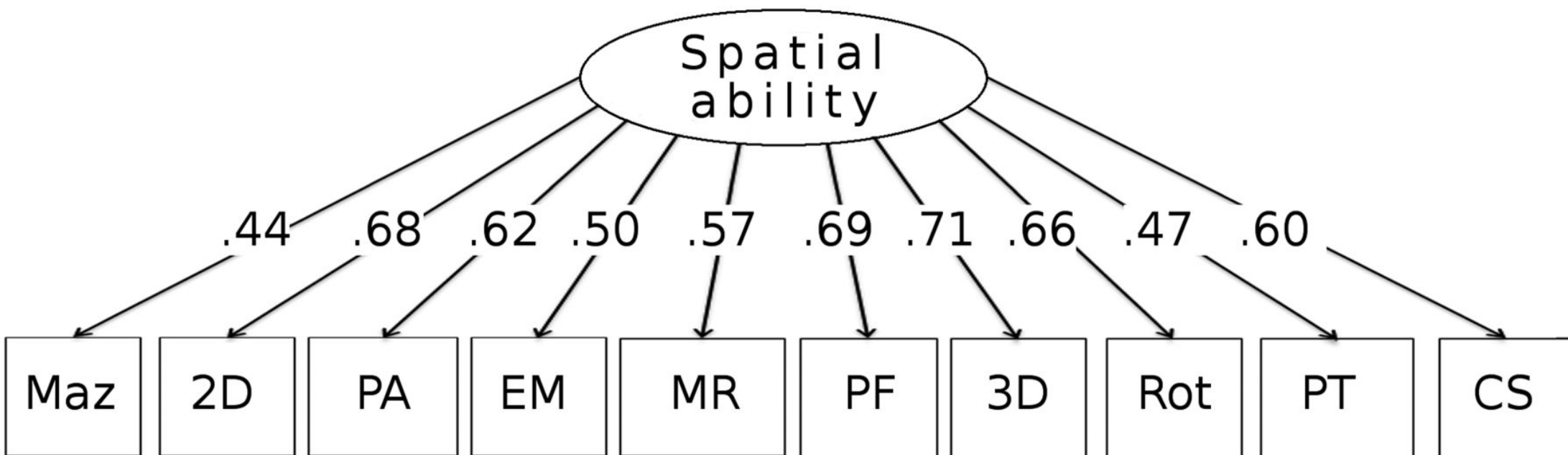
B



2	3
3	2
3	1

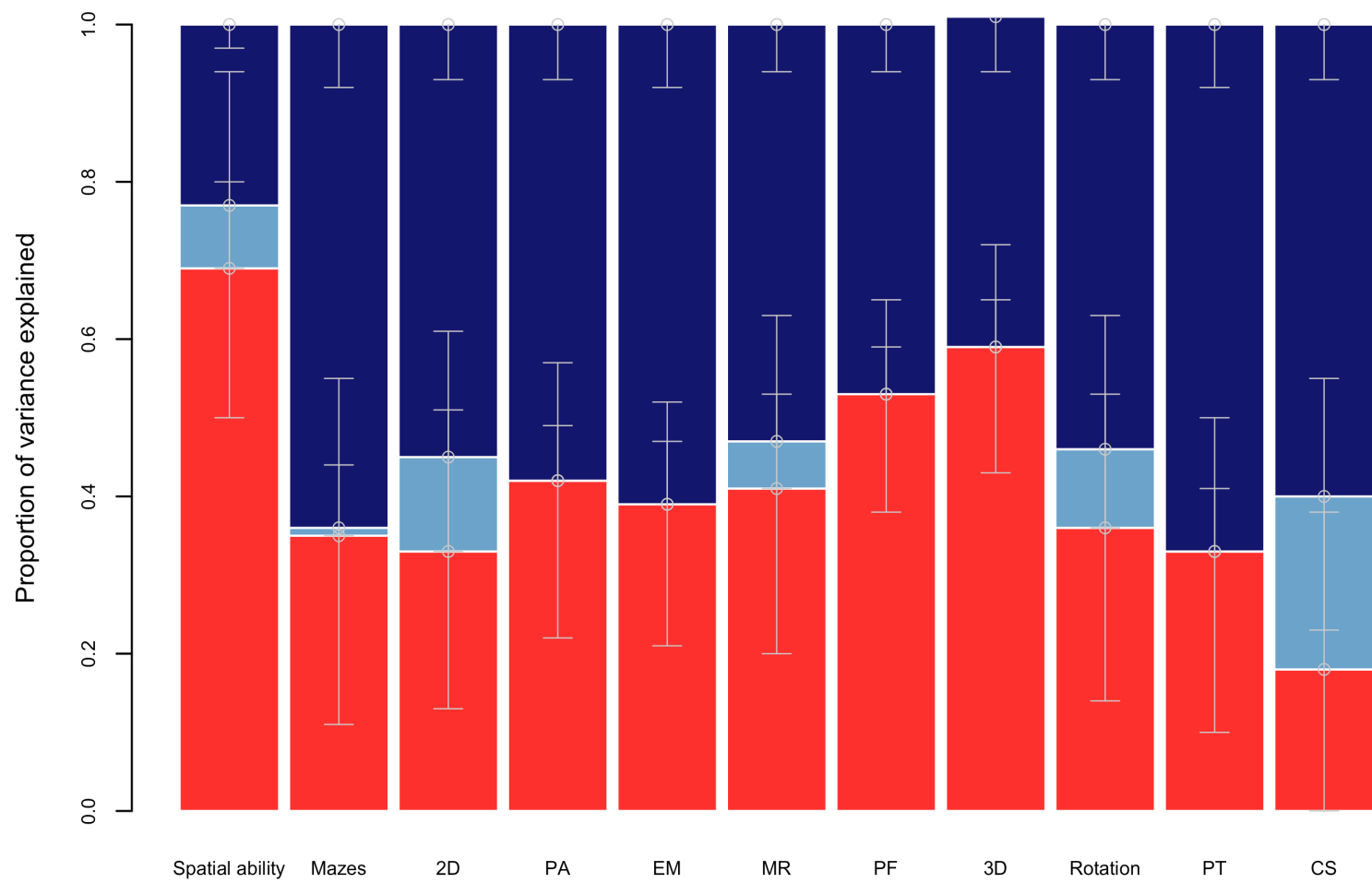
W X
Z y












N= 1,367 twin pairs (age 19–21)

Rimfeld et al. (2017) *PNAS*



Rimfeld et al. (2017) *PNAS*

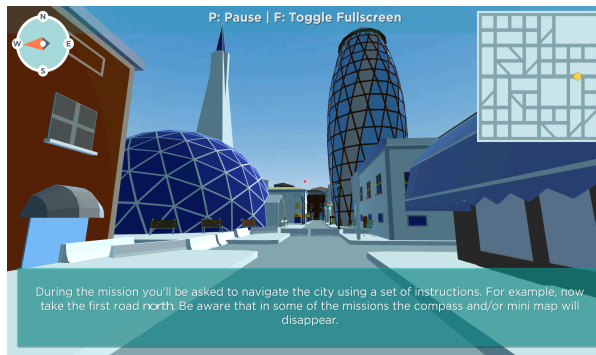
In hindsight: Evaluating the King's Challenge

- Web and mobile administration  
- Scientifically-grounded selection of the best tests available 
- Highly validity and reliability 
- Motivational component to the assessment (Fun/ Feedback)  
- Brevity (~45 minutes to complete) 

Phase 2: Spatial Spy –Navigation ability

- large vs. small scale spatial ability?
- Navigation ability different from spatial ability?
- Comprehensive literature search on navigation ability for web assessment through a 3D virtual environment
- Selection of main navigation abilities identified in the literature
- 4 navigation contexts + 1 scanning and 1 perspective taking
- Collaboration with the team of developers (Unity; ETT Ltd.)

Spatial Spy –Navigation ability



Navigating with a map
(most efficient route + time)

Test-retest $r = .603^{**}$



Navigating with map from memory
(most efficient route + time)

Test-retest $r = .686^{**}$



Navigating with cardinal points – compass (3 iterations + 2 no compass)
(efficacy, max 3 consecutive mistakes per iteration+ time) test-retest $r = .894^{**}$



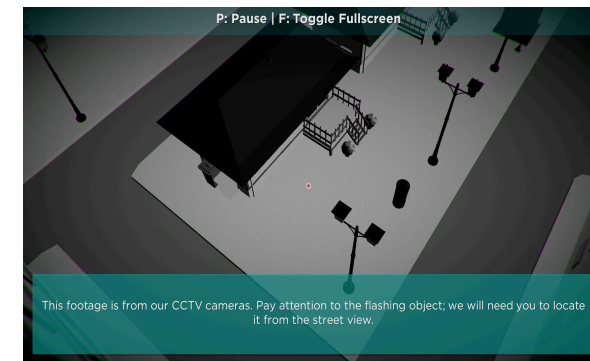
Navigating based on landmarks
(efficacy + time)

Test-retest $r = .799^{**}$



Large scale Scanning
(correct -max 4 attempts- + time)

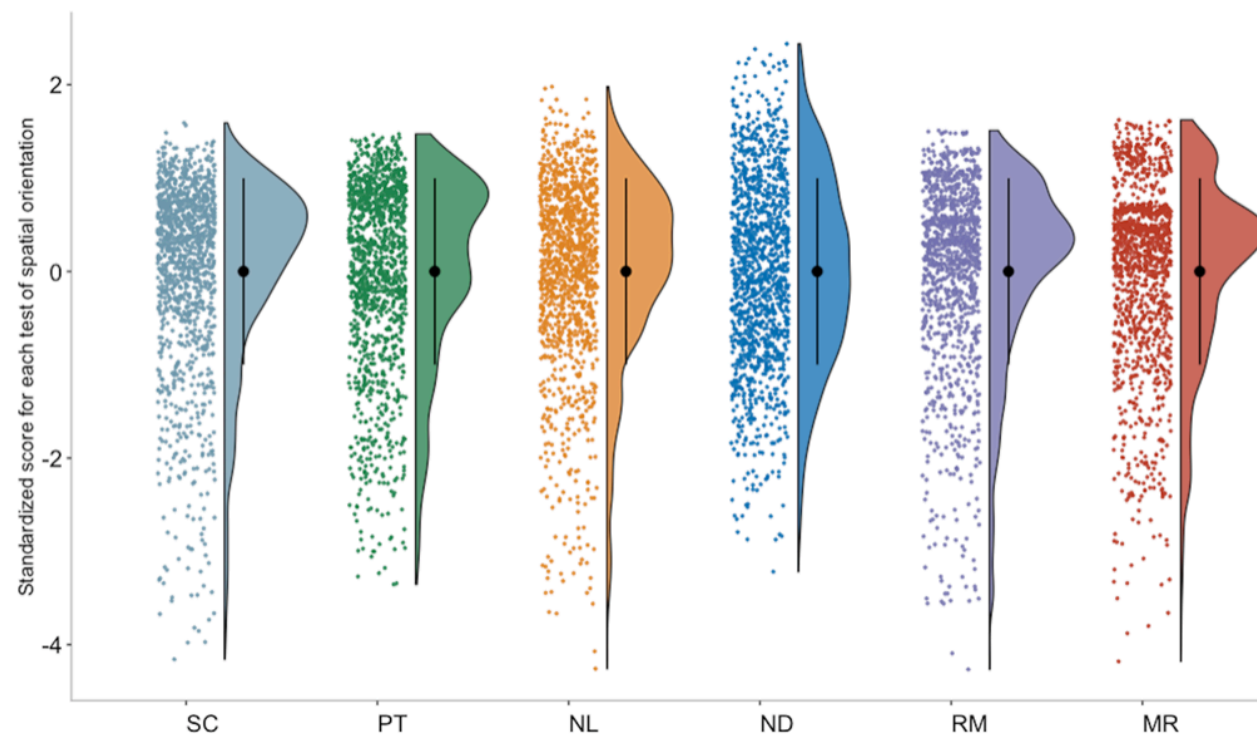
Test-retest $r = .798^{**}$



Large scale Perspective taking
(correct -max 4 attempts- + time)

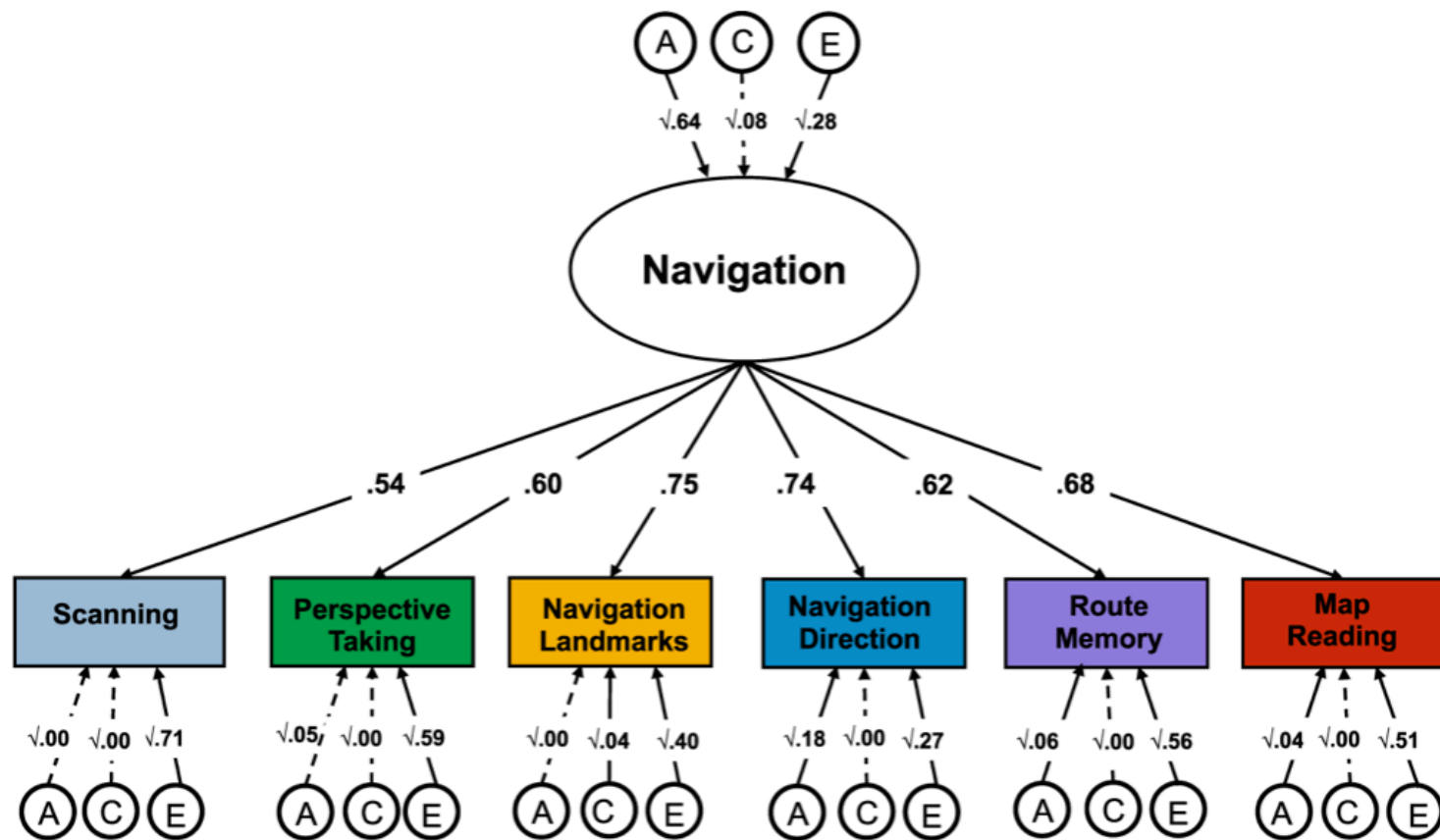
Test-retest $r = .671^{**}$

Spatial Spy

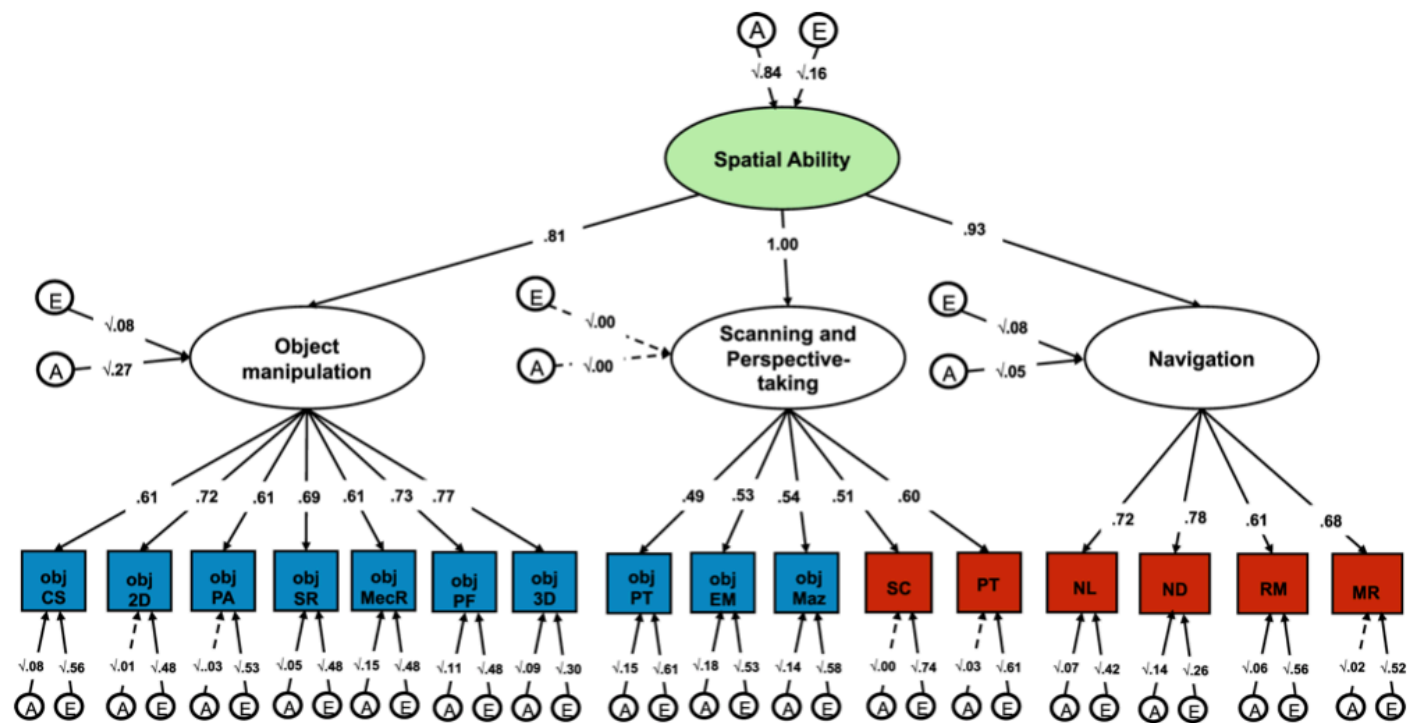


$N = 2660$; aged 19–22

Malanchini , Rimfeld et al (2020)
npj Science of Learning



Malanchini , Rimfeld et al (2020)
npj Science of Learning



Malanchini , Rimfeld et al (2020)
npj Science of Learning

Gamified tests for large samples

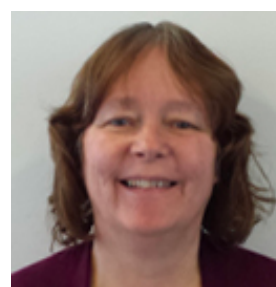
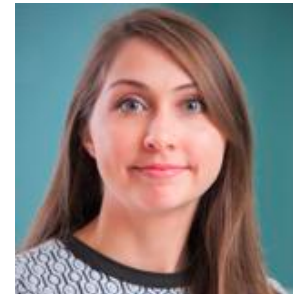
- Gamified tests ideal to be administered to large cross-cultural samples and Biobanks (**fast and fun**)
- Gamification is a complex process (but really quite fun!) that **MUST** be imbedded within a solid scientific methodology from literature to reliability and validity
- Private companies currently on the market that develop 'cognitive games' mostly don't apply scientifically grounded approaches

Their mantra: Let's be innovators NOT scientists



- Scientifically grounded gamified assessments are a real possible avenue for psychological assessment (**Not only for cognitive skills?**)

Acknowledgements



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