Integration of Traditional-based Approaches to Technology-based Approaches for Clinical Practices and Future Directions

Dr Graham Pluck
Faculty of Psychology, Chulalongkorn University

Chula
Chulalongkorn University

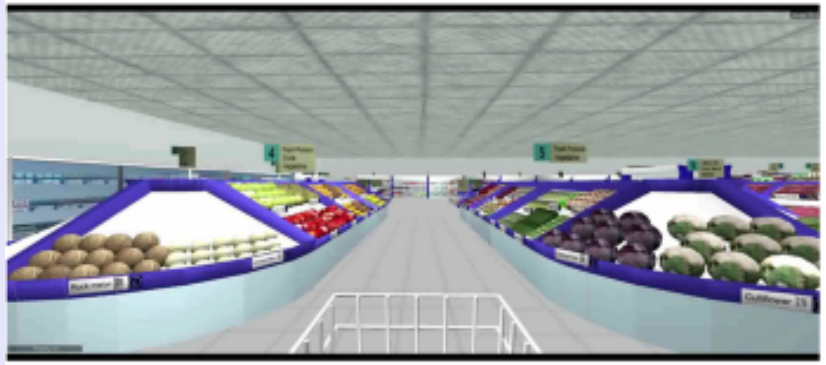
CLINICAL COGNITIVE SCIENCES LAB

2nd Thailand Neuropsychology Conference, 18th August 2023

Japan: Concern over dementia-related railway accidents

13 January 2014

a



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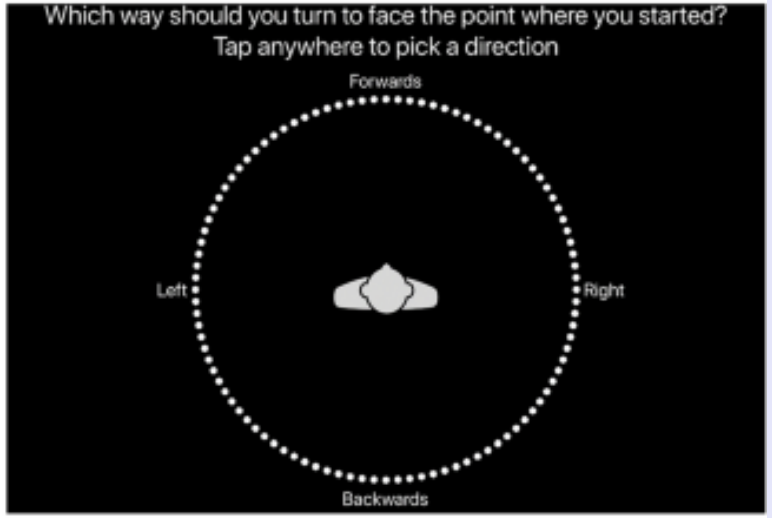
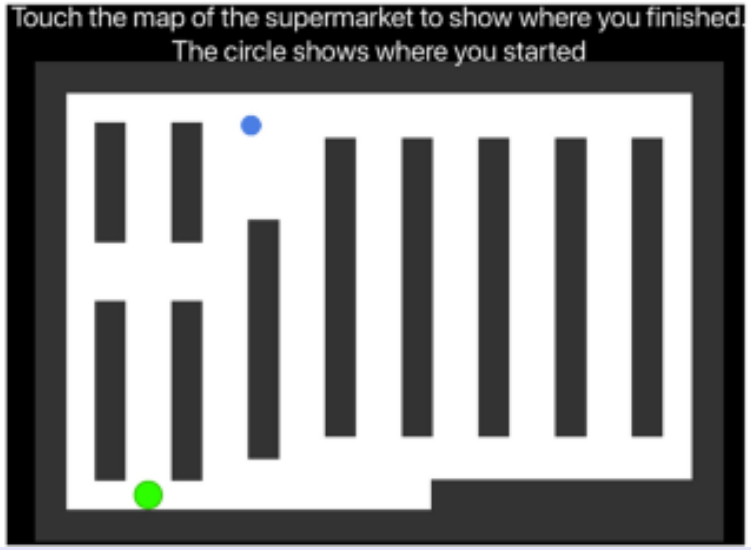
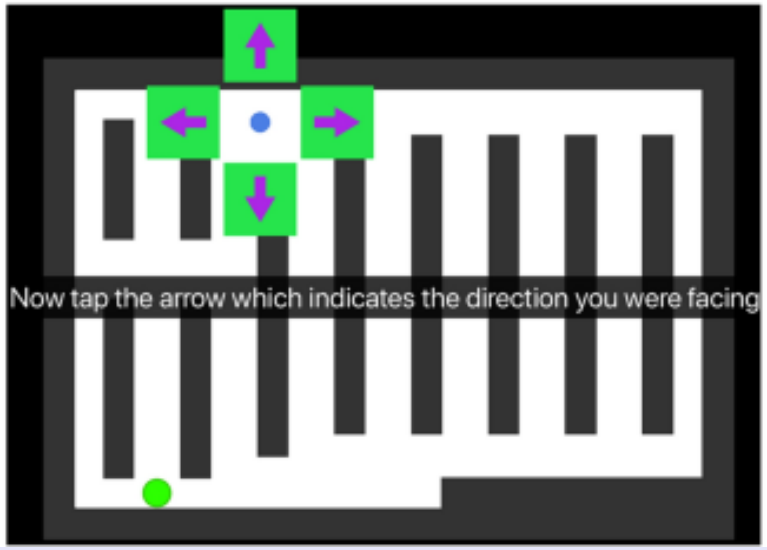
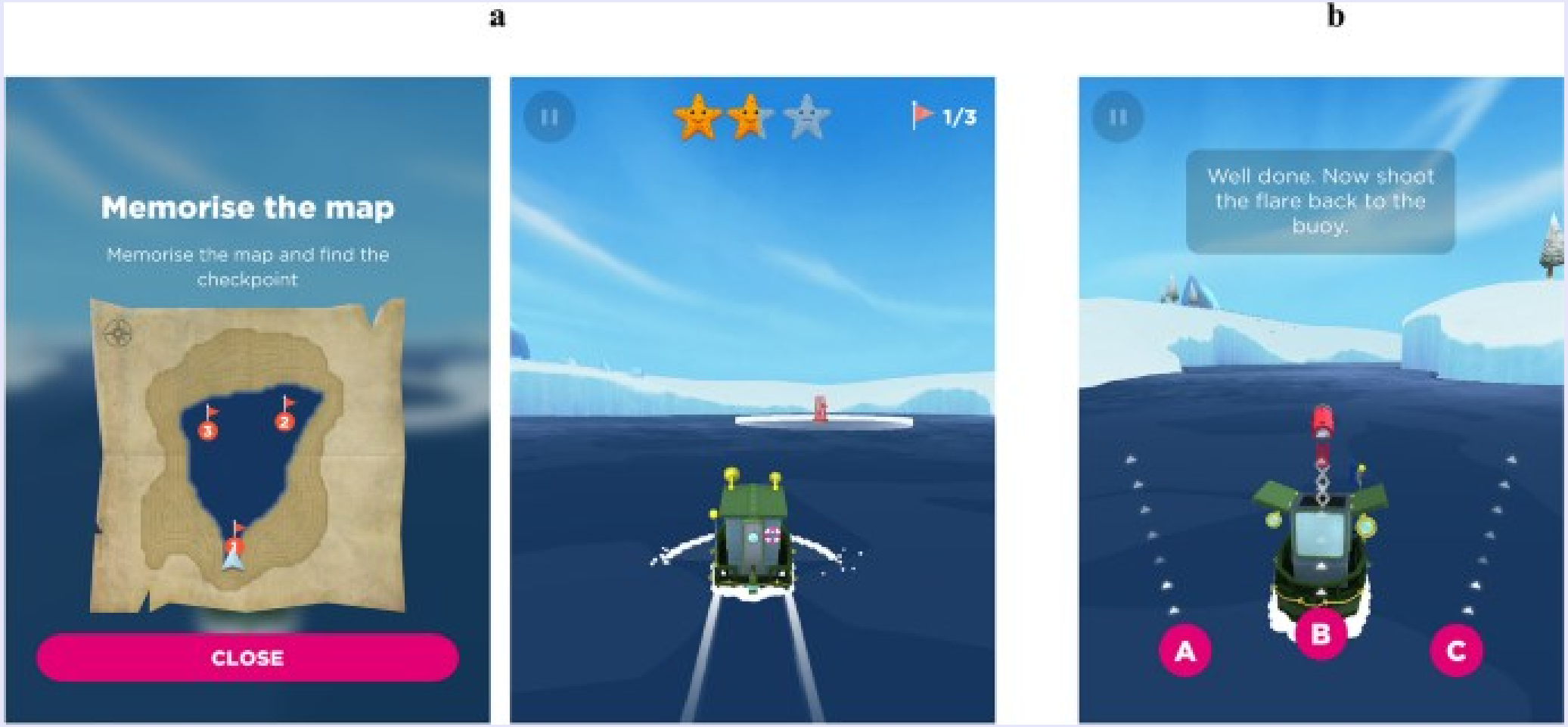

Which way should you turn to face the point where you started?
Tap anywhere to pick a direction
Forwards
Left
Right
Backwards

c


Touch the map of the supermarket to show where you finished.
The circle shows where you started

d


Now tap the arrow which indicates the direction you were facing



Puthusseryppady et al., (2022). Predicting real world spatial disorientation in Alzheimer's disease patients using virtual reality navigation tests. *Scientific Reports*, *12*(1), 13397.

Brain (1991), **114**, 727–741

DEFICITS IN STRATEGY APPLICATION FOLLOWING FRONTAL LOBE DAMAGE IN MAN

by TIM SHALLICE *and* PAUL W. BURGESS

(*From the National Hospital, Queen Square, London and the MRC Applied Psychology Unit, Cambridge*)

TABLE 5. ERRORS ON MULTIPLE ERRANDS

	Cases			
	1	*2*	*3*	*Control*
Inefficiencies	6*	9*	5*	1.4 (1.1)
Rule breaks	5*	8*	8*	1.6 (1.3)
Interpretation failures	1	1	1	0.4 (0.7)
Task failures	0	5*	4*	1.1 (1.4)
Total errors	12*	23*	17*	4.6 (2.1)

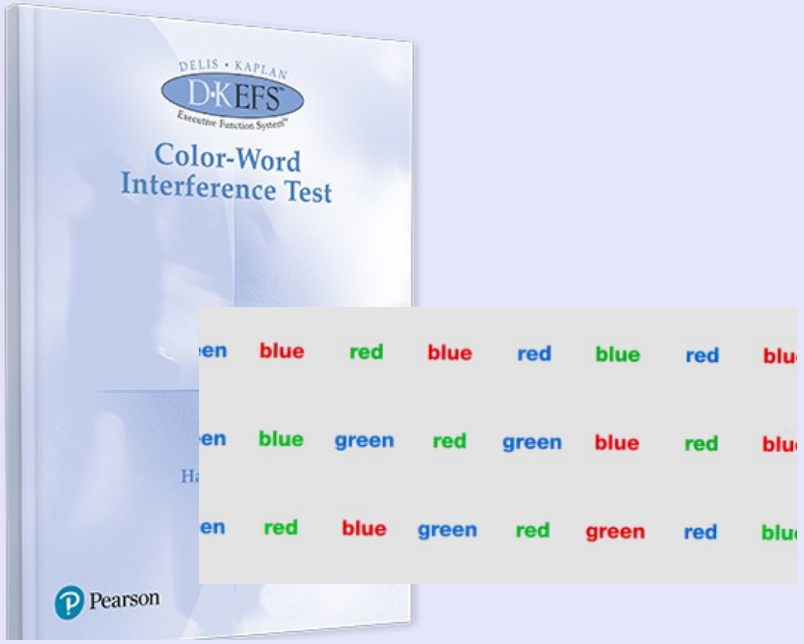
* More than 2 SD worse than the control subjects.

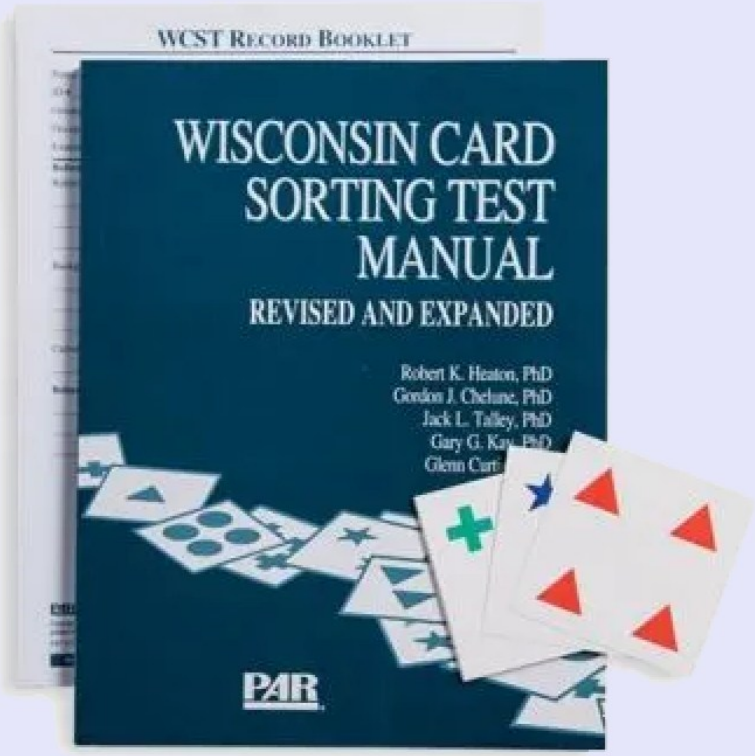
Shallice and Burgess gave three patients with extensive frontal lobe lesions the ‘Multiple Errands Test’. Sent to a shopping area in London with a list of tasks, such as:

- Buy a loaf of brown bread
- Be at a certain place 15 minutes after starting.
- Find the name of the shop likely to stock the most expense item.

Multiple Errands Test

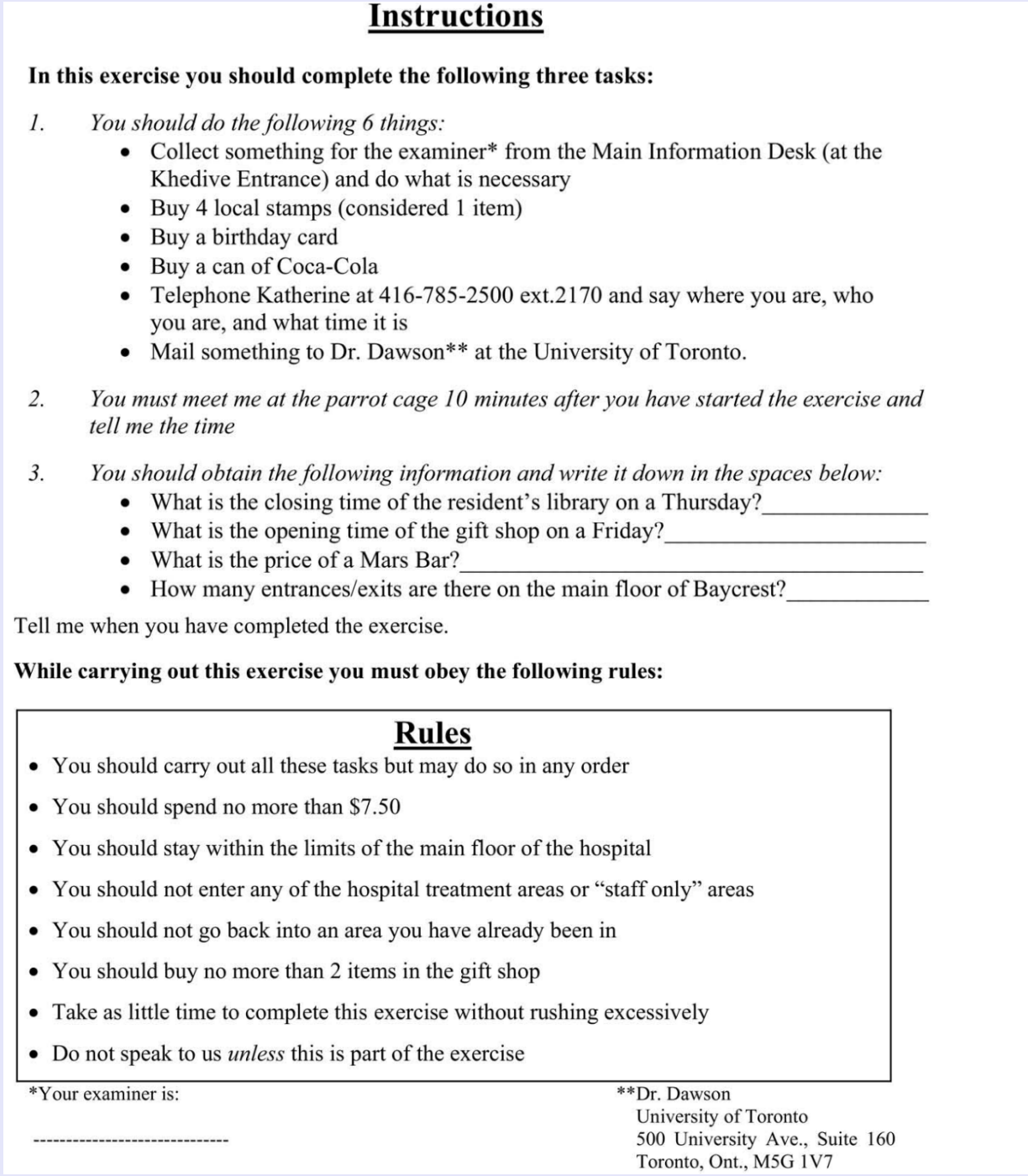
- Notably, all three patients had current IQ scores > 120.
- Performed standard tests of ‘frontal lobe’ function well, often better than control participants.





Multiple Errands Test (MET)

- Despite its complexity, MET has been applied in at least 32 subsequent research studies.
- Usually in hospital environments, but also, private homes, museums, shopping malls and therapeutic communities.
- Effect sizes large for distinguishing patients from controls.



Instructions

In this exercise you should complete the following three tasks:

1. *You should do the following 6 things:*
   - Collect something for the examiner* from the Main Information Desk (at the Khedive Entrance) and do what is necessary
   - Buy 4 local stamps (considered 1 item)
   - Buy a birthday card
   - Buy a can of Coca-Cola
   - Telephone Katherine at 416-785-2500 ext.2170 and say where you are, who you are, and what time it is
   - Mail something to Dr. Dawson** at the University of Toronto.
2. *You must meet me at the parrot cage 10 minutes after you have started the exercise and tell me the time*
3. *You should obtain the following information and write it down in the spaces below:*
   - What is the closing time of the resident's library on a Thursday?_____
   - What is the opening time of the gift shop on a Friday?_____
   - What is the price of a Mars Bar?_____
   - How many entrances/exits are there on the main floor of Baycrest?_____

Tell me when you have completed the exercise.

While carrying out this exercise you must obey the following rules:

Rules

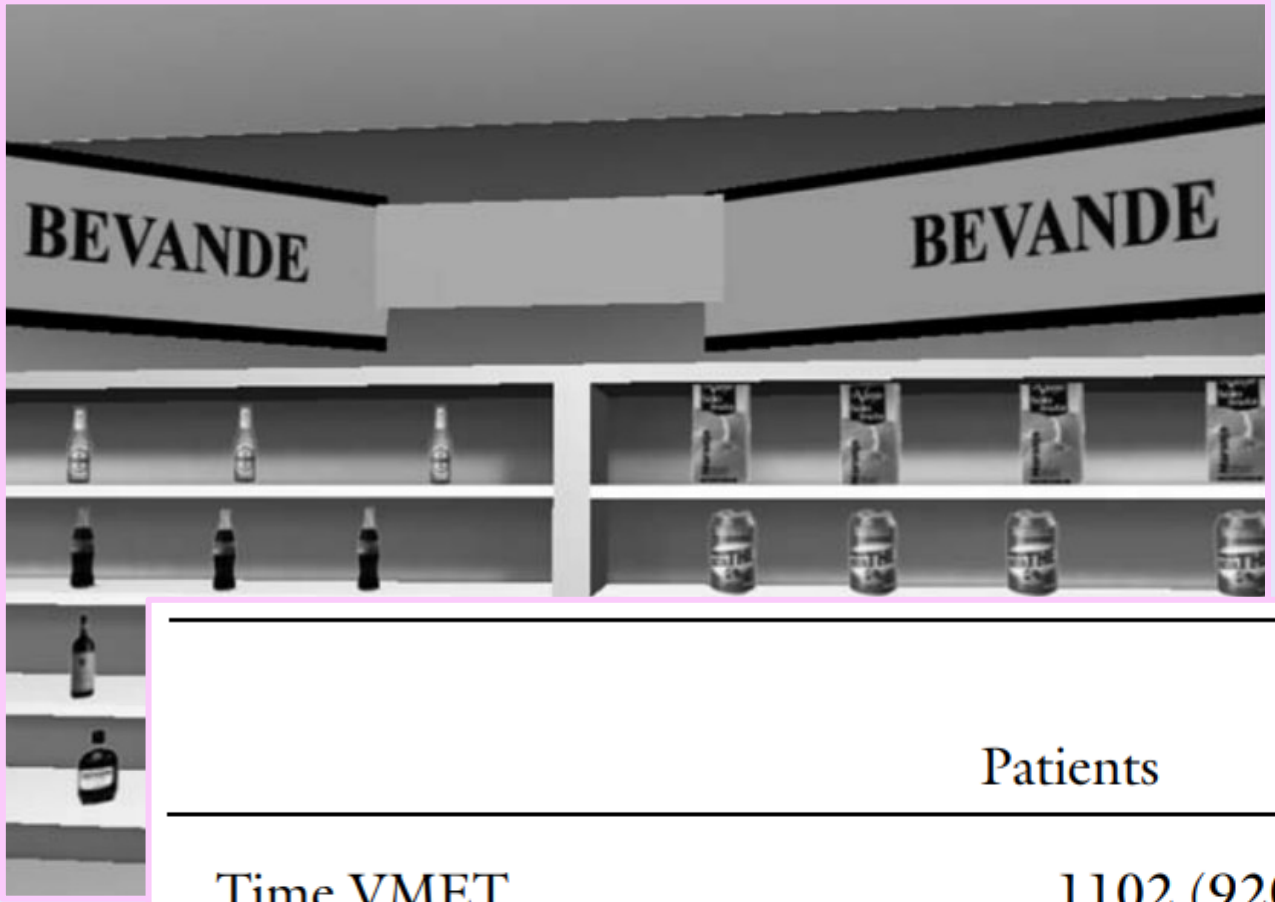
- You should carry out all these tasks but may do so in any order
- You should spend no more than $7.50
- You should stay within the limits of the main floor of the hospital
- You should not enter any of the hospital treatment areas or "staff only" areas
- You should not go back into an area you have already been in
- You should buy no more than 2 items in the gift shop
- Take as little time to complete this exercise without rushing excessively
- Do not speak to us *unless* this is part of the exercise

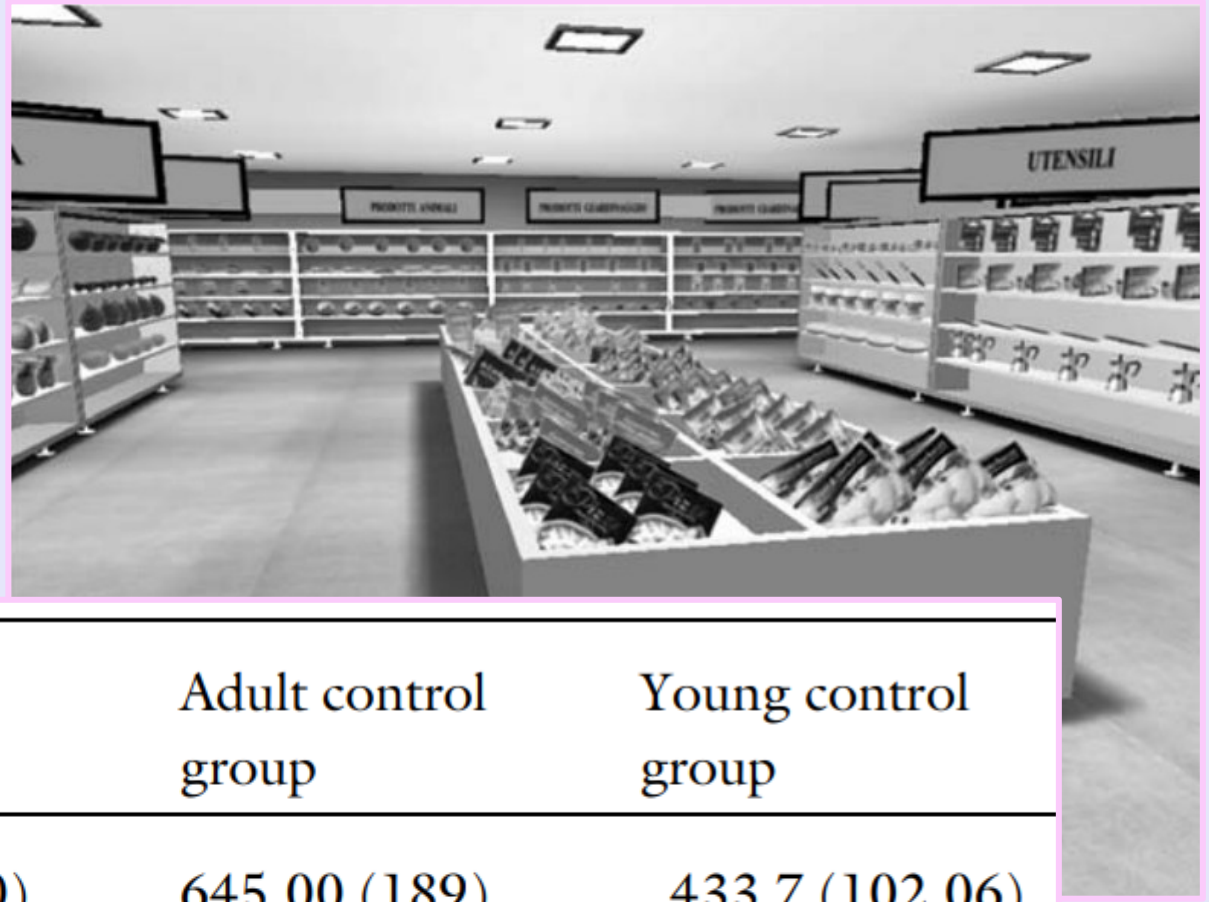
*Your examiner is:

**Dr. Dawson
University of Toronto
500 University Ave., Suite 160
Toronto, Ont., M5G 1V7

Rotenberg, et al. (2020). Measurement properties of the Multiple Errands Test: A systematic review. *Archives of Physical Medicine and Rehabilitation*, *101*(9), 1628-1642.

Non-immersive Virtual Reality MET





	Patients	Adult control group	Young control group
Time VMET	1102 (920)	645.00 (189)	433.7 (102.06)
Errors VMET	17.67 (4.09)	13.8 (1.81)	13.6 (1.26)

Raspelli et al. (2012). Validating the Neuro VR-based virtual version of the Multiple Errands Test: preliminary results. *Presence, 21* (1), 31-42.

Jansari, A. S., Devlin, A., Agnew, R., Akesson, K., Murphy, L., & Leadbetter, T. (2014). Ecological assessment of executive functions: a new virtual reality paradigm. *Brain Impairment*, *15*(2), 71-87.


In-tray
Completed
Post To Be Sent
Post Diary
My Notes For Manager

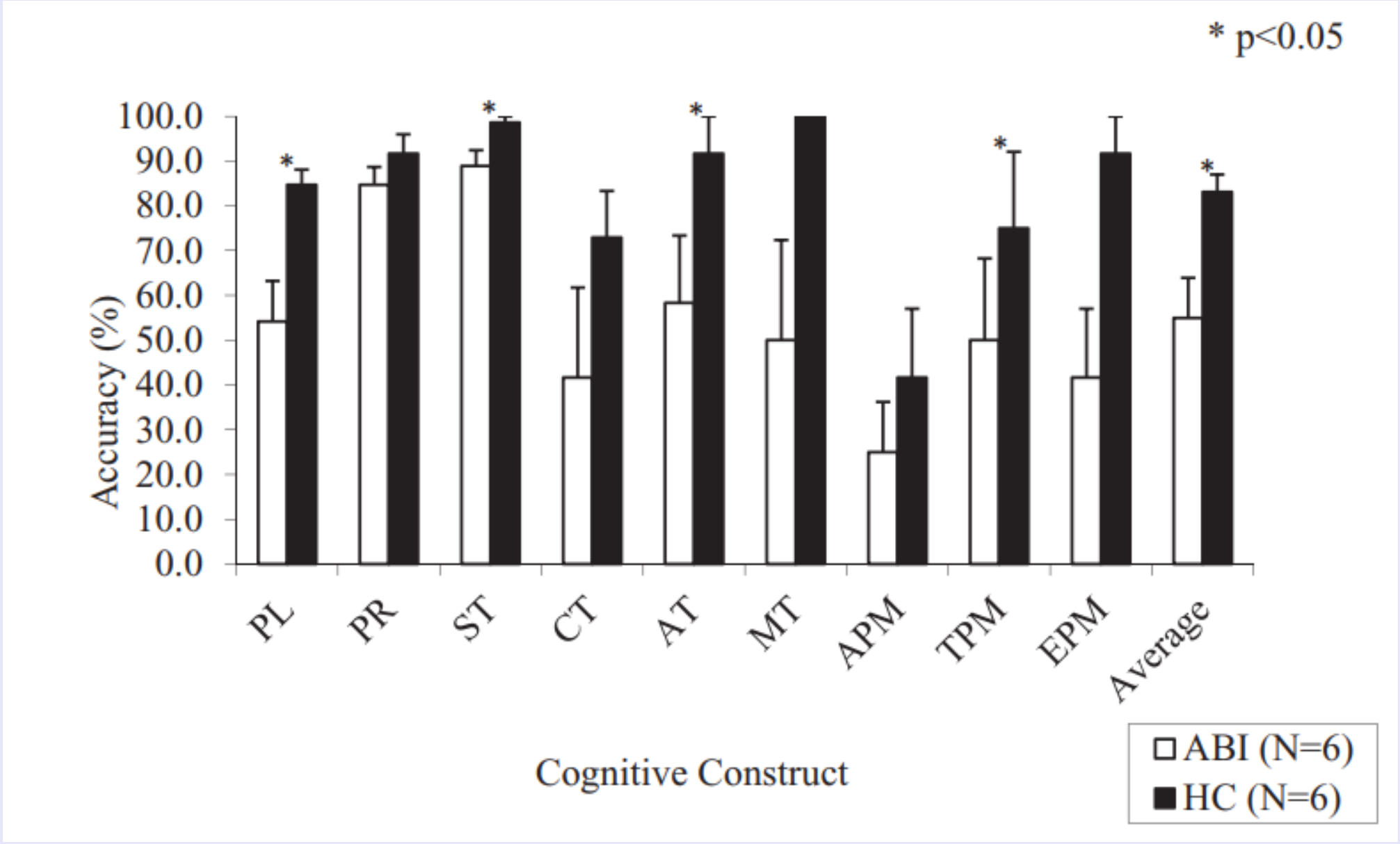

Student License. Commercial use is illegal

Jansari Assessment of Executive Functions (JEF©)

Non-immersive VR

- *Planning* (write a plan, arrange furniture)
- *Prioritization* (e.g., set a meeting agenda)
- *Selective thinking* (organize outgoing mail)
- *Creative thinking* (solve unexpected problems)
- *Adaptive thinking* (produce alternative plans when things go wrong)
- *Multi-tasking* (dealing with two simultaneous tasks)
- *Action-based prospective memory* (record equipment breakdowns)
- *Time-based prospective memory* (turn on equipment before meeting starts)
- *Event-based prospective memory* (record details of when fire alarms sound)

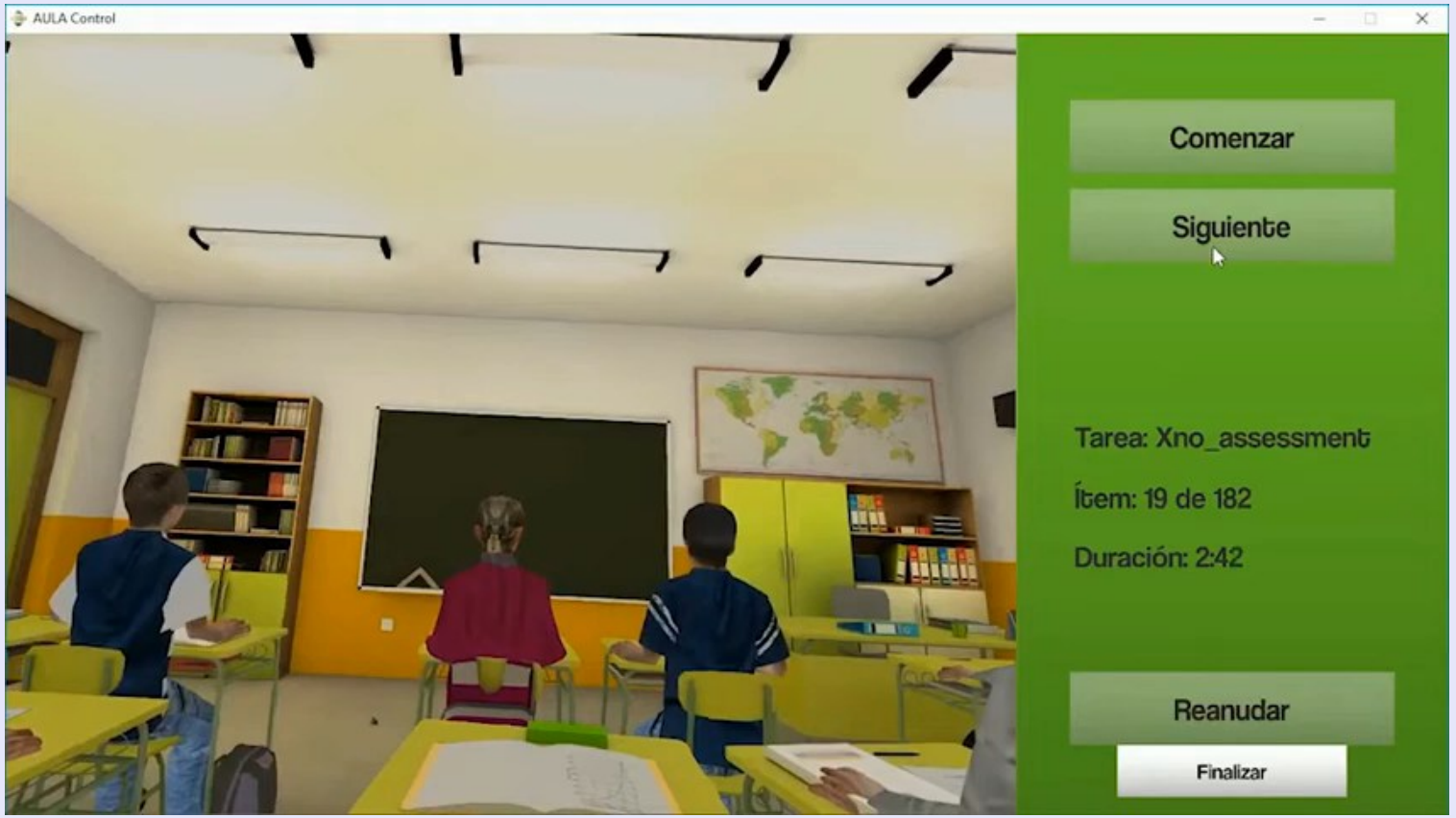
Jansari et al. (2014). Ecological assessment of executive functions: a new virtual reality paradigm. *Brain Impairment*, *15*(2), 71-87.



Performance on the real-life version of JEF© (Experiment 1) as a function of group and cognitive construct. PL, planning; PR, prioritisation; ST, selective-thinking; CT, creative-thinking; AT, adaptive-thinking; MT, multi-tasking; APM, action-based prospective memory; TPM, time-based prospective memory; EPM, event-based prospective memory

Full Immersive Virtual Reality: Nesplora

Full Virtual Reality: Nesplora



Areces, et al., (2018). Efficacy of a continuous performance test based on virtual reality in the diagnosis of ADHD and its clinical presentations. *Journal of Attention Disorders*, *22*(11), 1081-1091.

Cybersickness

- Nausea, disorientation, and oculomotor discomfort.
- Most users suffer some level of cybersickness.
- About 10% leave the VR environment because of it.

Cybersickness

- Likely caused by a mismatch of visual and vestibular signals.
- Appears to be associated with reduced blood flow to the brain.

- The good news is that high cognitive load appears to reduce severity of cybersickness.

Gavgani, et al. (2018). Cybersickness-related changes in brain hemodynamics: A pilot study comparing transcranial Doppler and near-infrared spectroscopy assessments during a virtual ride on a roller coaster. Physiology & Behavior, 191, 56-64.
Pöhlmann, et al. (2023, April). I think I don't feel sick: Exploring the Relationship Between Cognitive Demand and Cybersickness in Virtual Reality using fNIRS. In Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (pp. 1-16).

Tele-medicine

Journal of the International Neuropsychological Society (2022), **28**, 210–215

doi:10.1017/S1355617721000436

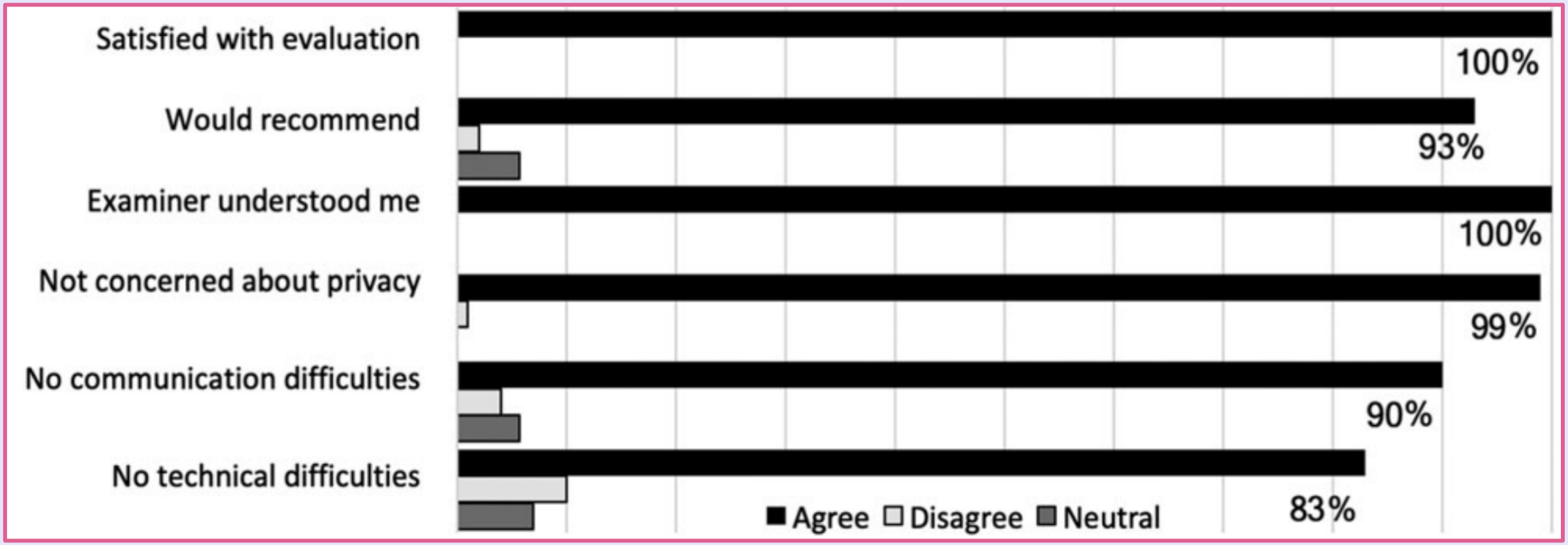
BRIEF COMMUNICATION

Feasibility and Acceptance of Direct-to-Home Tele-neuropsychology Services during the COVID-19 Pandemic

Michael W. Parsons[1,2,*], Melissa M. Gardner[1], Janet C. Sherman[1], Kathryn Pasquariello[1], Julie A. Grieco[1], Christina D. Kay[1], Lauren E. Pollak[1], Amy K. Morgan[1], Britt Carlson-Emerton[1], Karen Seligsohn[1], Sigurros Davidsdottir[1], Margaret B. Pulsifer[1], Giuliana V. Zarrella[1], Sarah M. Burstein[1] and Sarah M. Mancuso[1]

[1]Psychology Assessment Center, Department of Psychiatry, Massachusetts General Hospital/Harvard Medical School, 1 Bowdoin Square Suite 701, Boston, MA 02114, USA

[2]Stephen and Catherine Pappas Center for Neuro-Oncology, Massachusetts General Hospital/Harvard Medical School, 55 Fruit Street, Yawkey 9E, Boston, MA 02114, USA

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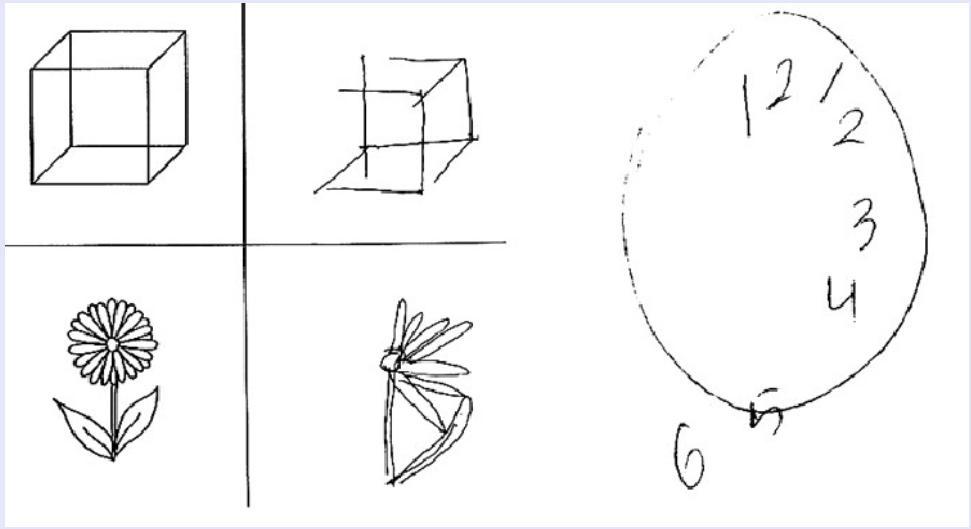
In-tray
Completed
Manager's Tasks For Completion
Plan Of Action
Agenda Topics
Post To Be Sent
Post Diary
My Notes For Manager

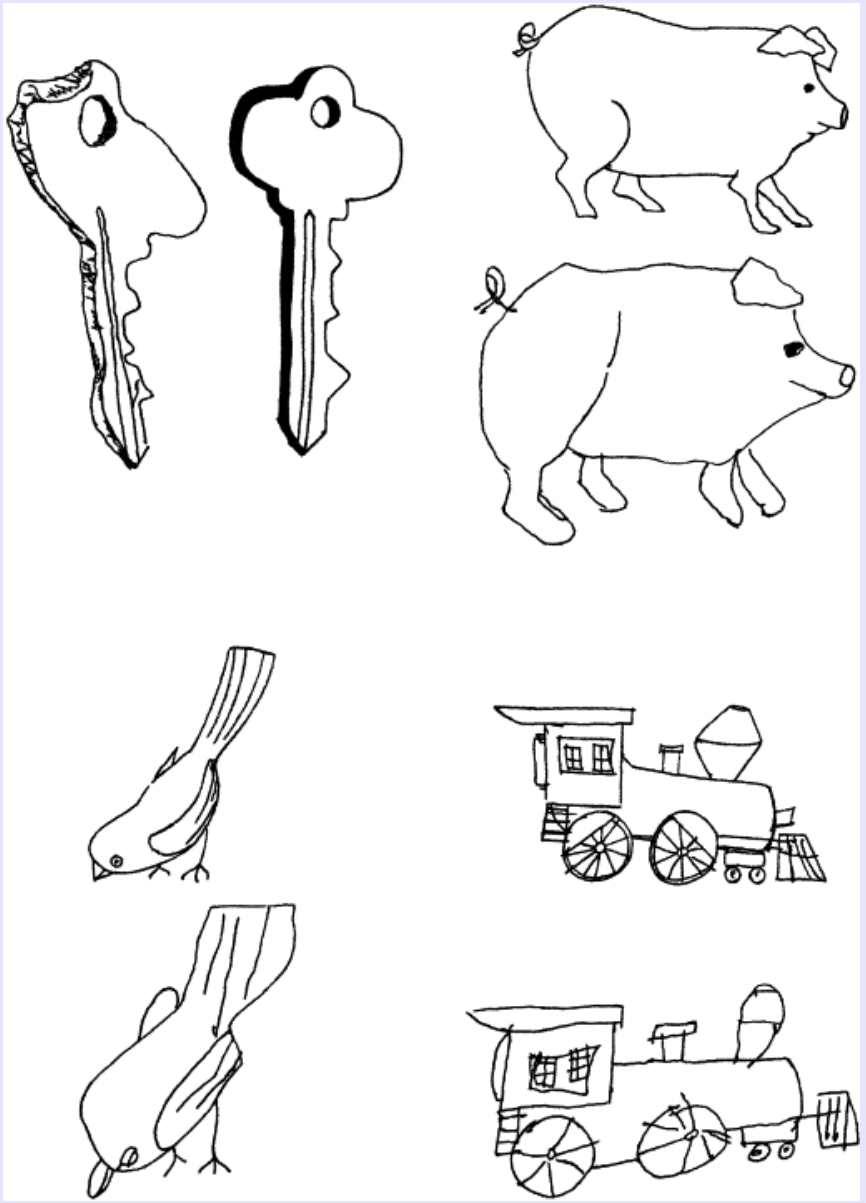

THIS
MEETING
SUCKS!


การประชุม
ครั้งนี้
แย่มาก

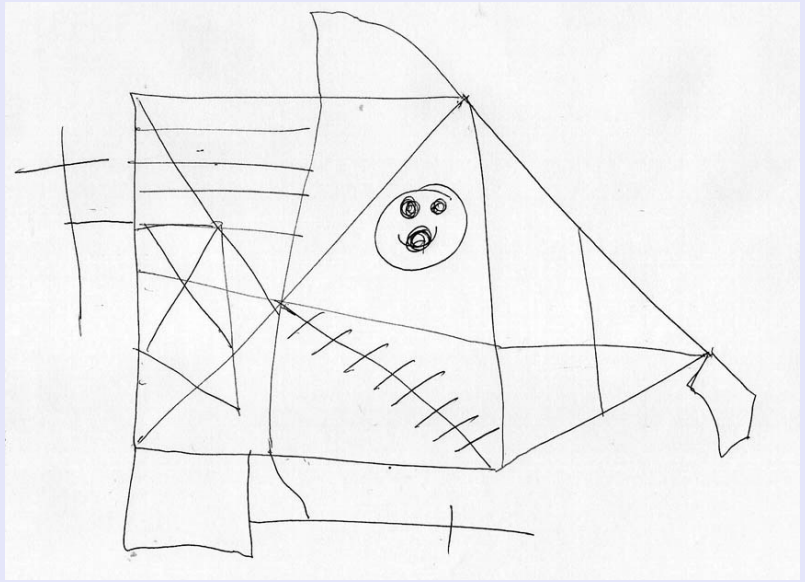
Neglect



Agnosia



Memory



Wechsler Block Design Task

Wechsler Block Design Task

APPLIED NEUROPSYCHOLOGY: ADULT, *21*: 297–309, 2014
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ISSN: 2327-9095 print/2327-9109 online
DOI: 10.1080/23279095.2013.811671

Routledge
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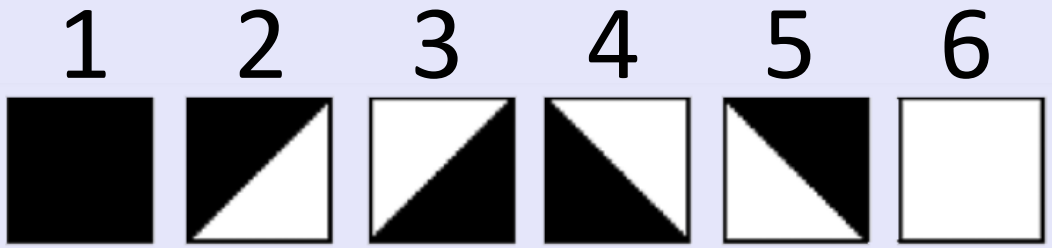
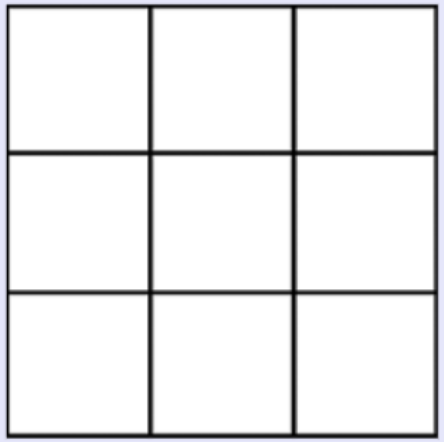
The Design Organization Test: Further Demonstration of Reliability and Validity as a Brief Measure of Visuospatial Ability

William D. S. Killgore
Center for Depression, Anxiety, and Stress Research, McLean Hospital, Belmont, Massachusetts and Department of Psychiatry, Harvard Medical School, Boston, Massachusetts

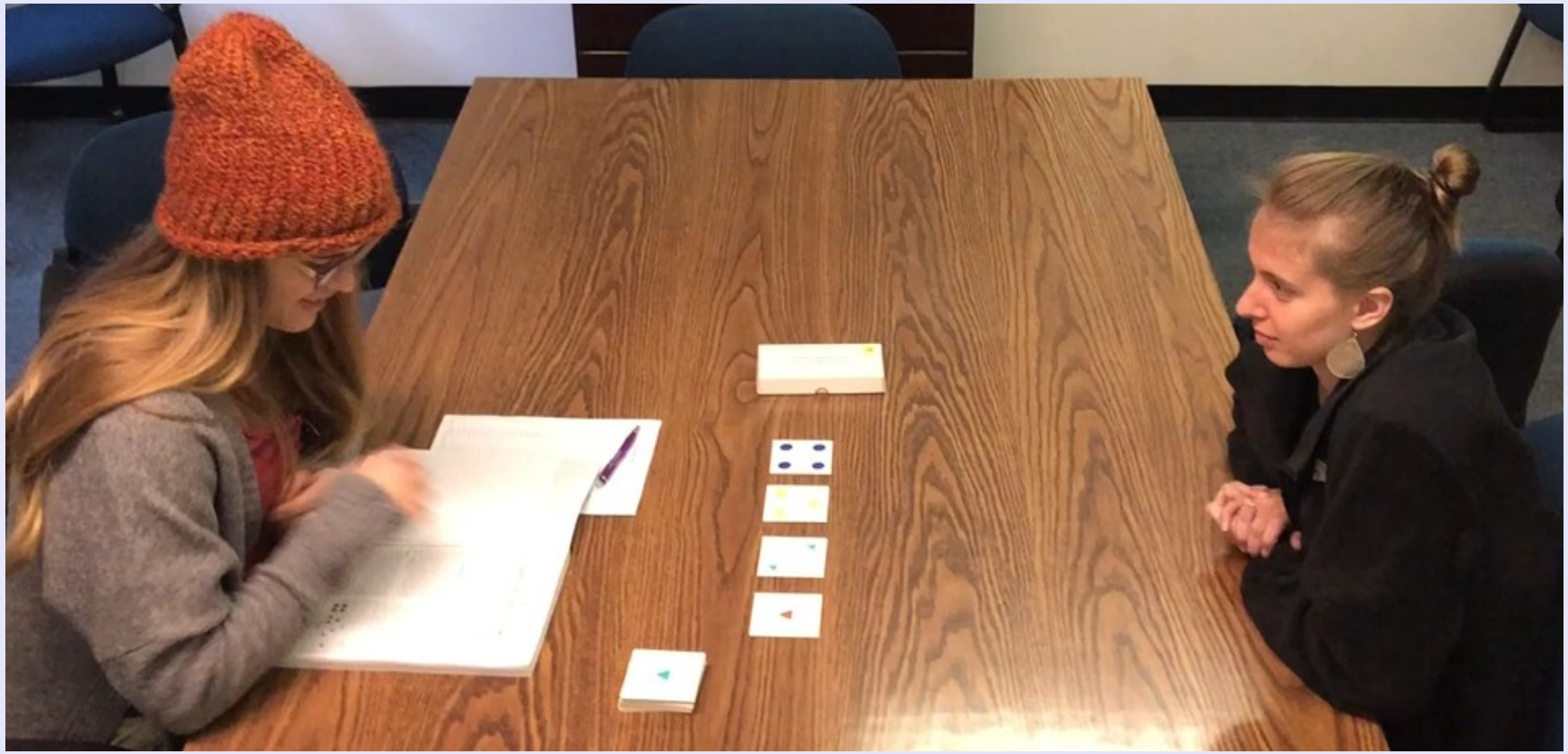
Hannah Gogel
Center for Depression, Anxiety, and Stress Research, McLean Hospital, Belmont, Massachusetts



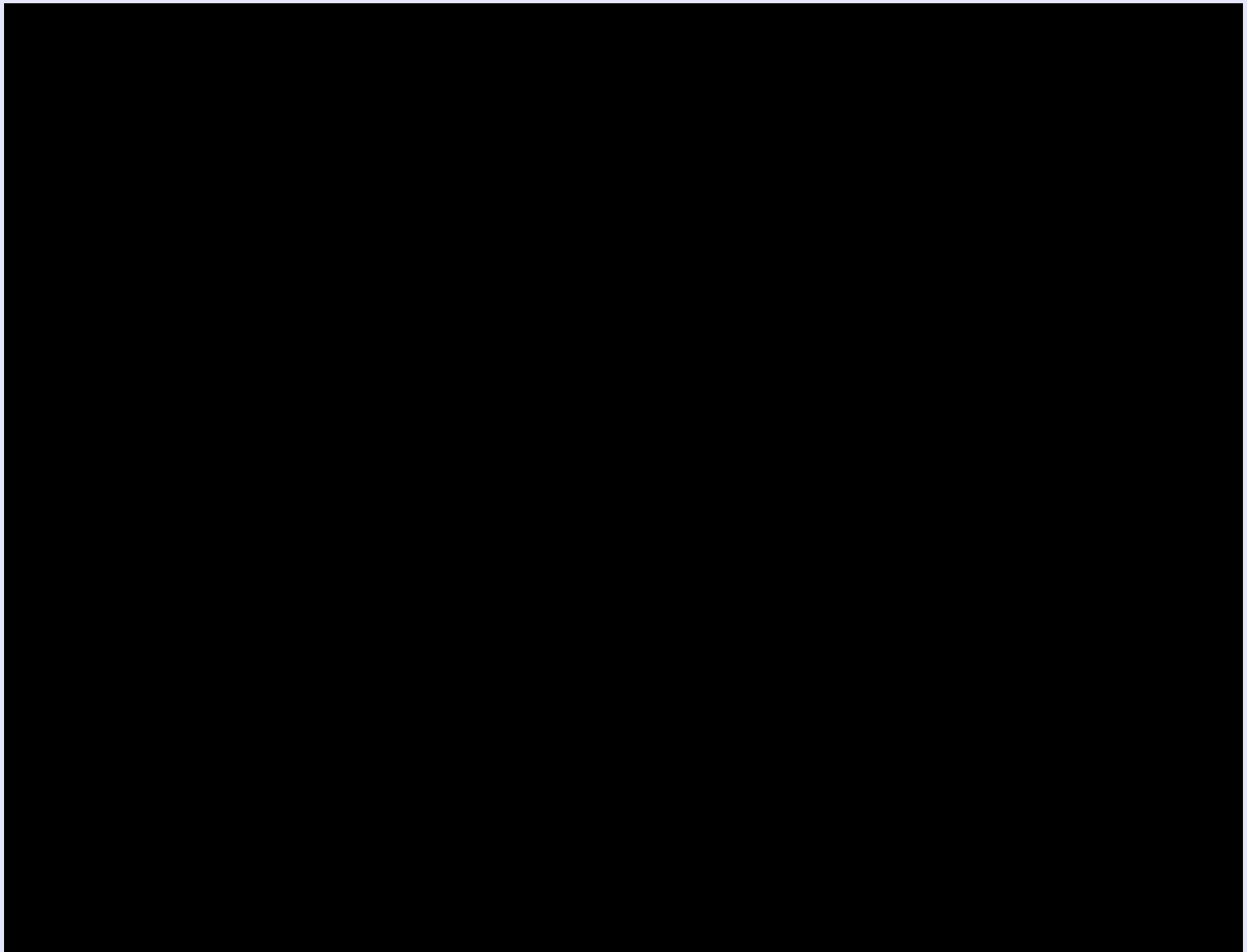


Equivalent tests may be available that don't require handling equipment

Wisconsin Card Sorting Test
Traditional method of administration



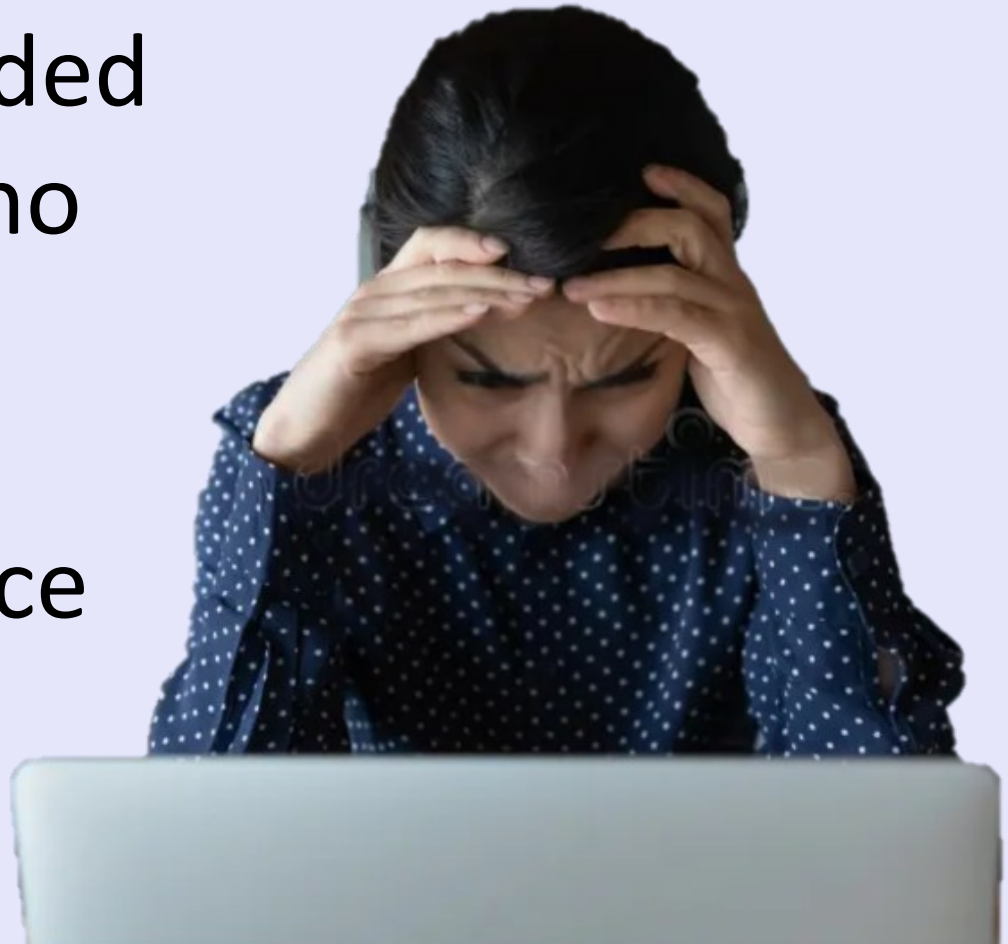
Wisconsin Card Sorting Test
Computerised administration



Supported (not self) administration

Neuropsychological assessment can be perceived as being oppressive

Clinical skill is needed monitor clients who may be becoming distressed, and to provide reassurance as necessary.



‘I felt let down by psychology’

We hear from a brain injury survivor, researchers and a practitioner

Niamh Lowe suffered a severe TBI, aged 21. She wrote about her experience of neuropsychological assessment in *the Psychologist*.

“The psychologists produced a range of memory, attention and executive function neuropsychological tests without telling me the names of the tests or why it was important for me to complete the assessment. I performed these tests obediently while feeling immense frustration and confusion inside.”

https://www.bps.org.uk/psychologist/i-felt-let-down-psychology

‘I felt let down by psychology’

We hear from a brain injury survivor, researchers and a practitioner

This is her experience of the Behavioral Assessment of the Dysexecutive Syndrome (BADS).

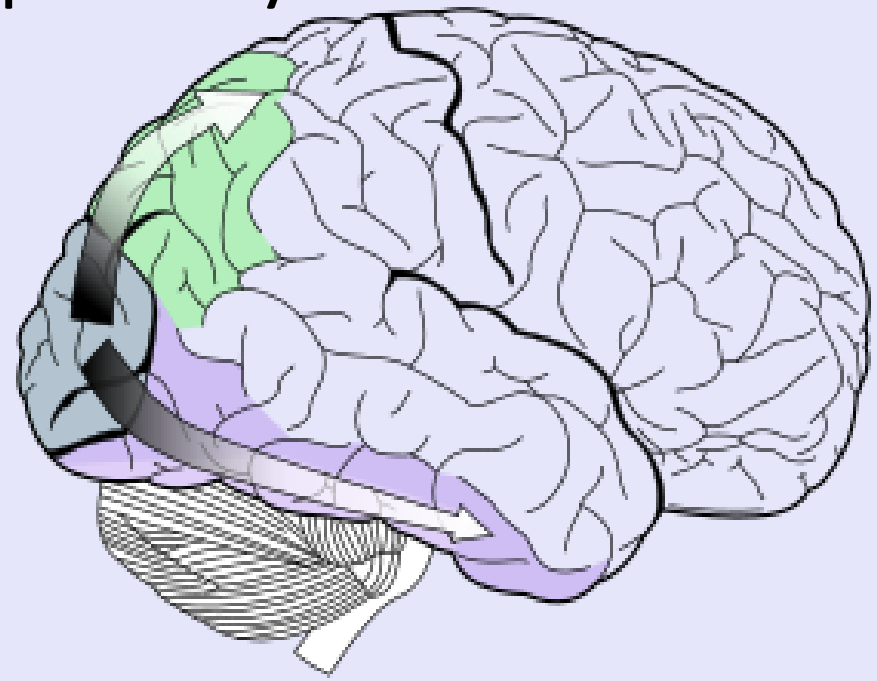
“The test apparatus was set up on the table. She was nice and polite, but did not explain the purpose of the test, and she did not enquire how I felt about participating in this assessment. When she finished reading the instructions out of the booklet, I remember holding back tears while she started the stopwatch.”

“I completed the assessment, someone wheeled me upstairs to my bedroom, and I cried.”

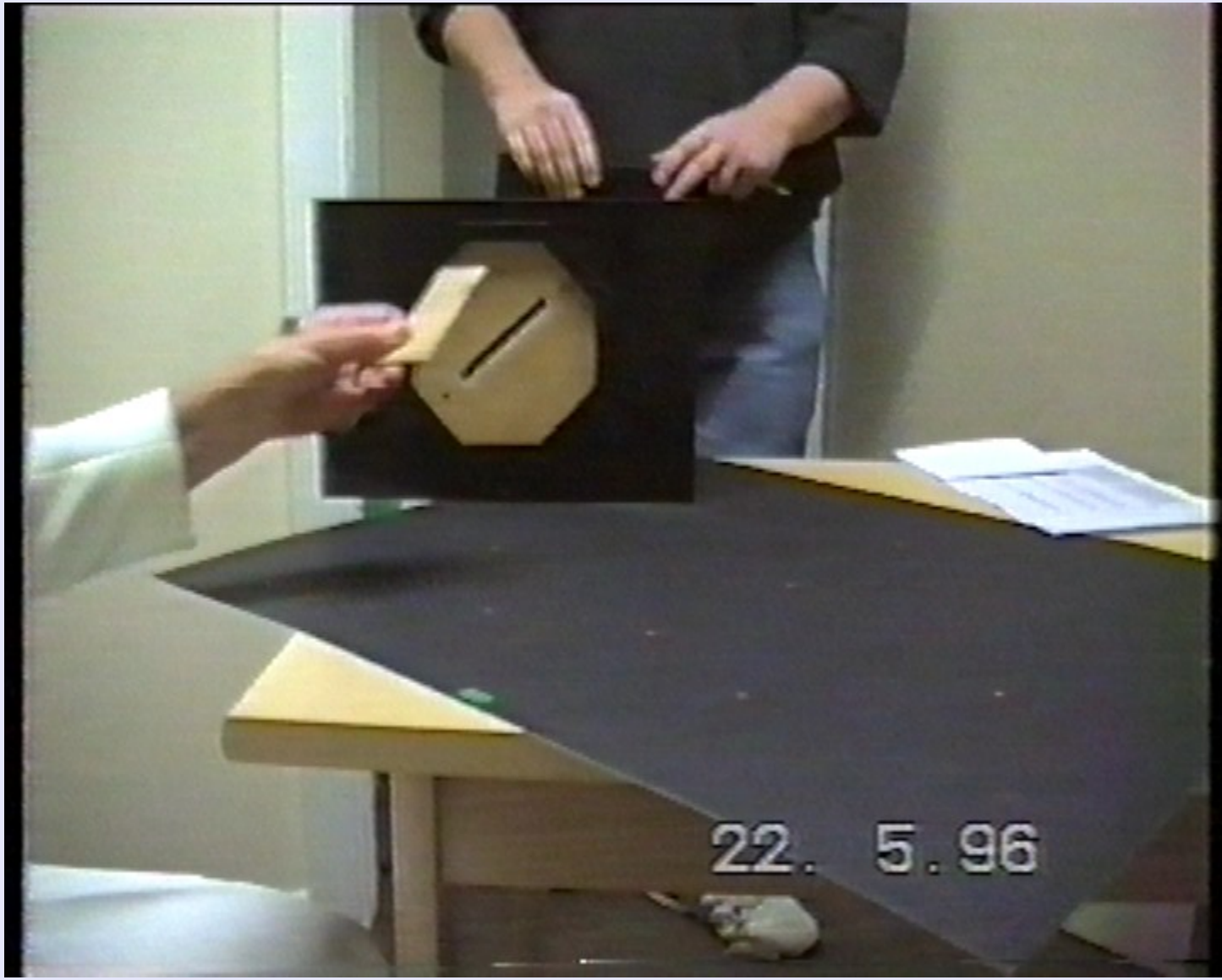
https://www.bps.org.uk/psychologist/i-felt-let-down-psychology

A lesson learned early

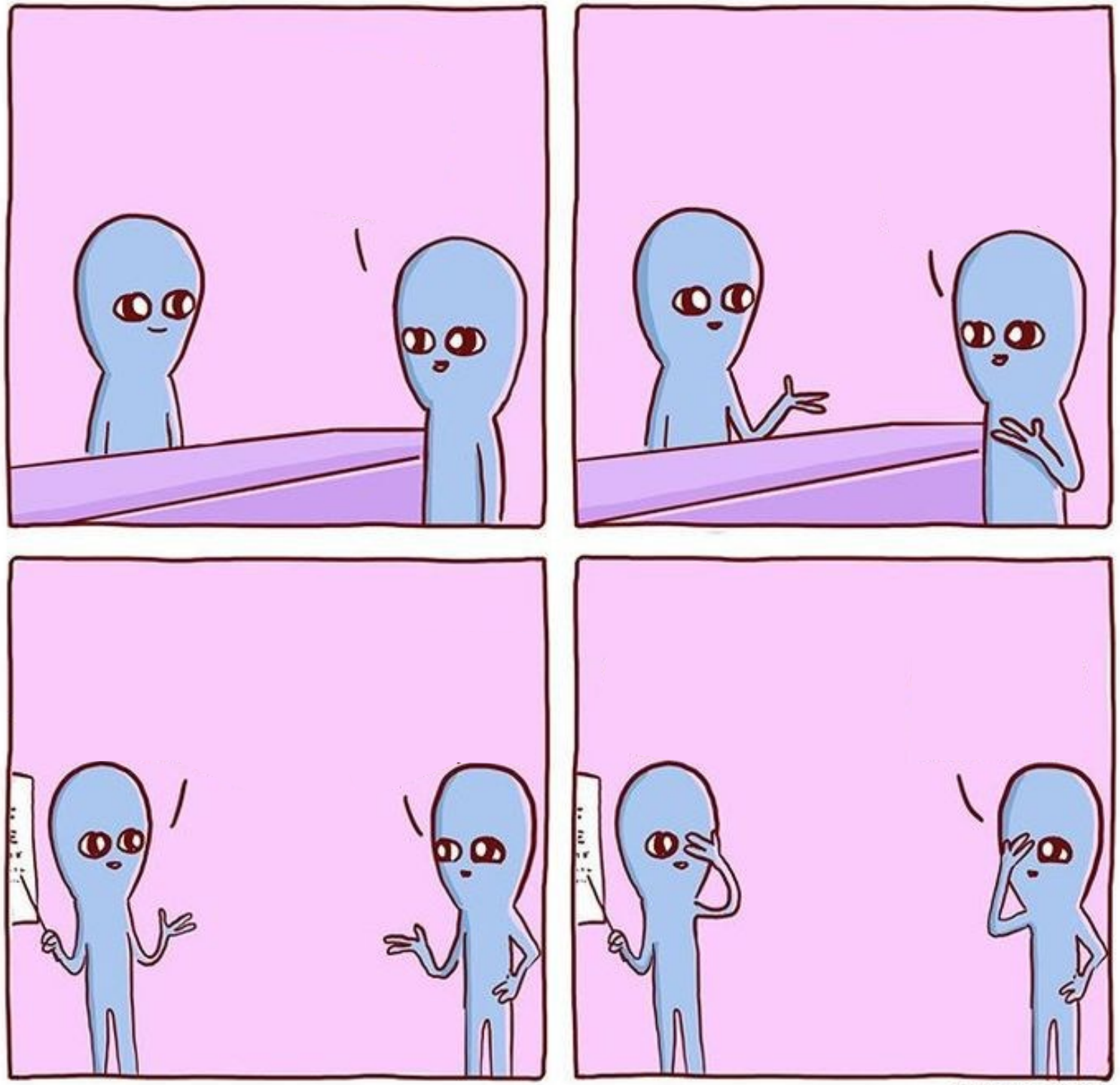
Dorsal ‘How’ pathway



Ventral ‘What’ pathway



- In cognitive assessment we often focus on skills that the patient has difficulty with.
- This can be frustrating for them.
- Maintaining patient engagement is a challenge.



The problem of normative data

Table B.1. Scaled-Score Equivalents of Raw Scores by Each Age Group: Condition 1–Letter Fluency Total Correct

Scaled Score	Age Group																Scaled Score
	8	9	10	11	12	13	14	15	16–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	
1	—	0	0	0–2	0–3	0–5	0–6	0–8	0–8	0–8	0–10	0–10	0–8	0–7	0–6	0–3	1
2	0	1	1–2	3–5	4–6	6–8	7–9	9–11	9–11	9–11	11–13	11–13	9–11	8–10	7–9	4–6	2
3	1	2–4	3–5	6–8	7–9	9–11	10–12	12–14	12–14	12–15	14–17	14–17	12–15	11–14	10–13	7–10	3
4	2–3	5–6	6–7	9–10	10–11	12–13	13–15	15–16	15–17	16–18	18–20	18–20	16–18	15–17	14–16	11–13	4
5	4–5	7–8	8–10	11–13	12–14	14–16	16–18	17–19	18–20	19–21	21–23	21–23	19–21	18–20	17–19	14–16	5
6	6–8	9–11	11–13	14–16	15–17	17–19	19–21	20–22	21–23	22–25	24–27	24–27	22–25	21–24	20–23	17–20	6
7	9–10	12–13	14–15	17–18	18–20	20–22	22–23	23–25	24–26	26–28	28–30	28–30	26–28	25–27	24–26	21–23	7
8	11–12	14–15	16–18	19–21	21–23	23–25	24–26	26–28	27–29	29–31	31–33	31–33	29–31	28–30	27–29	24–26	8
9	13–15	16–18	19–21	22–24	24–26	26–28	27–29	29–31	30–32	32–35	34–37	34–37	32–35	31–34	30–33	27–30	9
10	16–17	19–20	22–23	25–26	27–28	29–30	30–32	32–33	33–35	36–38	38–40	38–40	36–38	35–37	34–36	31–33	10
11	18–19	21–22	24–26	27–29	29–31	31–33	33–35	34–36	36–38	39–41	41–43	41–43	39–41	38–40	37–39	34–36	11
12	20–22	23–25	27–29	30–32	32–34	34–36	36–38	37–39	39–41	42–45	44–47	44–47	42–45	41–44	40–43	37–40	12
13	2[illegible]										48–50	48–50	46–48	45–47	44–46	41–43	13
14	2[illegible]										51–53	51–53	49–51	48–50	47–49	44–46	14
15	2[illegible]										54–57	54–57	52–55	51–54	50–53	47–50	15
16	3[illegible]										58–60	58–60	56–58	55–57	54–56	51–53	16
17	3[illegible]										61–63	61–63	59–61	58–60	57–59	54–56	17
18	3[illegible]										64–67	64–67	62–65	61–64	60–63	57–60	18
19											>67	>67	>65	>64	>63	>60	19

Example, a 74-year-old patient produces a total of 35 words in the letter fluency task

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Archives
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NEUROPSYCHOLOGY

To Err is Human: "Abnormal" Neuropsychological Scores and Variability are Common in Healthy Adults

Laurence M. Binder[a,*], Grant L. Iverson[b,c], Brian L. Brooks[b]

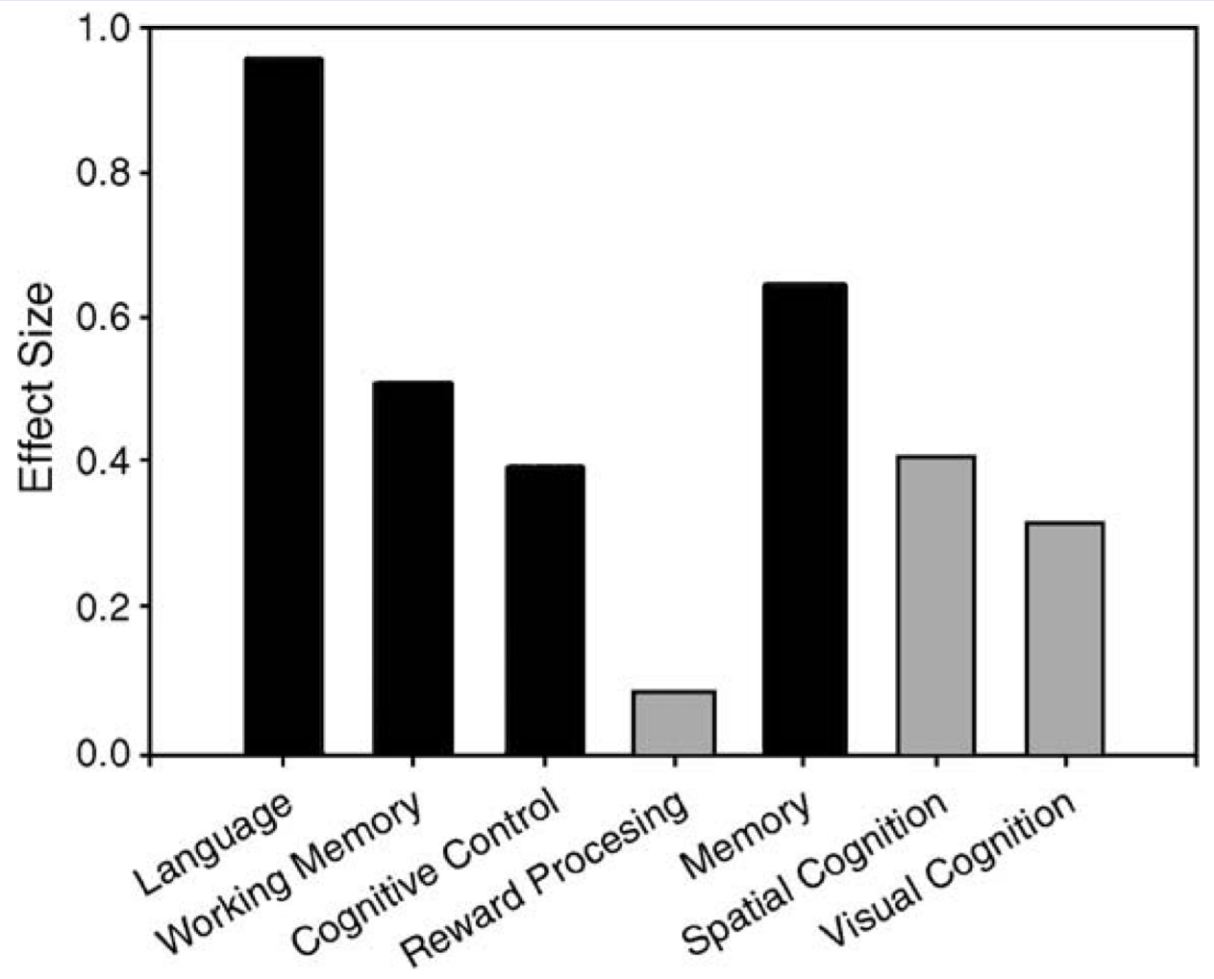
[a]*Department of Neurology, Oregon Health & Science University, Beaverton, Oregon, USA*
[b]*British Columbia Mental Health & Addiction Services, Vancouver, BC, Canada*
[c]*University of British Columbia, Vancouver, BC, Canada*

Accepted 19 November 2008

If the criteria for abnormal is more than one standard deviation below average, in a typical battery of more than 20 neuropsychological tests, most people will have at least one 'abnormal' score.

"abnormal performance on some proportion of neuropsychological tests in a battery is psychometrically normal."

Variation in neuropsychological function and socioeconomic status



Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Giannetta, J. M., Brodsky, N. L., ... & Hurt, H. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research, 1110*(1), 166-174.

Martha Farah

Brain researcher

Martha Julia Farah is a cognitive neuroscience researcher at the University of Pennsylvania. She has worked on an unusually wide range of topics; the citation for her lifetime achievement award from ... Wikipedia

Place of birth: New York, New York, United States

h-index: 102

Education: Harvard University (1981–1983), Massachusetts Institute of Technology (1973–1977)

Edited works: Behavioral Neurology and Neuropsychology, MORE

Awards: Guggenheim Fellowship for Social Sciences, US & Canada

Results from a middle-income country- Ecuador:

- Vocabulary very highly correlated with SES
- Executive function (Tower Test, Design Fluency) correlated with SES
- Theory of Mind correlated with SES

Table 4. Zero-order correlations of the demographic and cognitive measures (age-adjusted scores) with SES and hair cortisol levels

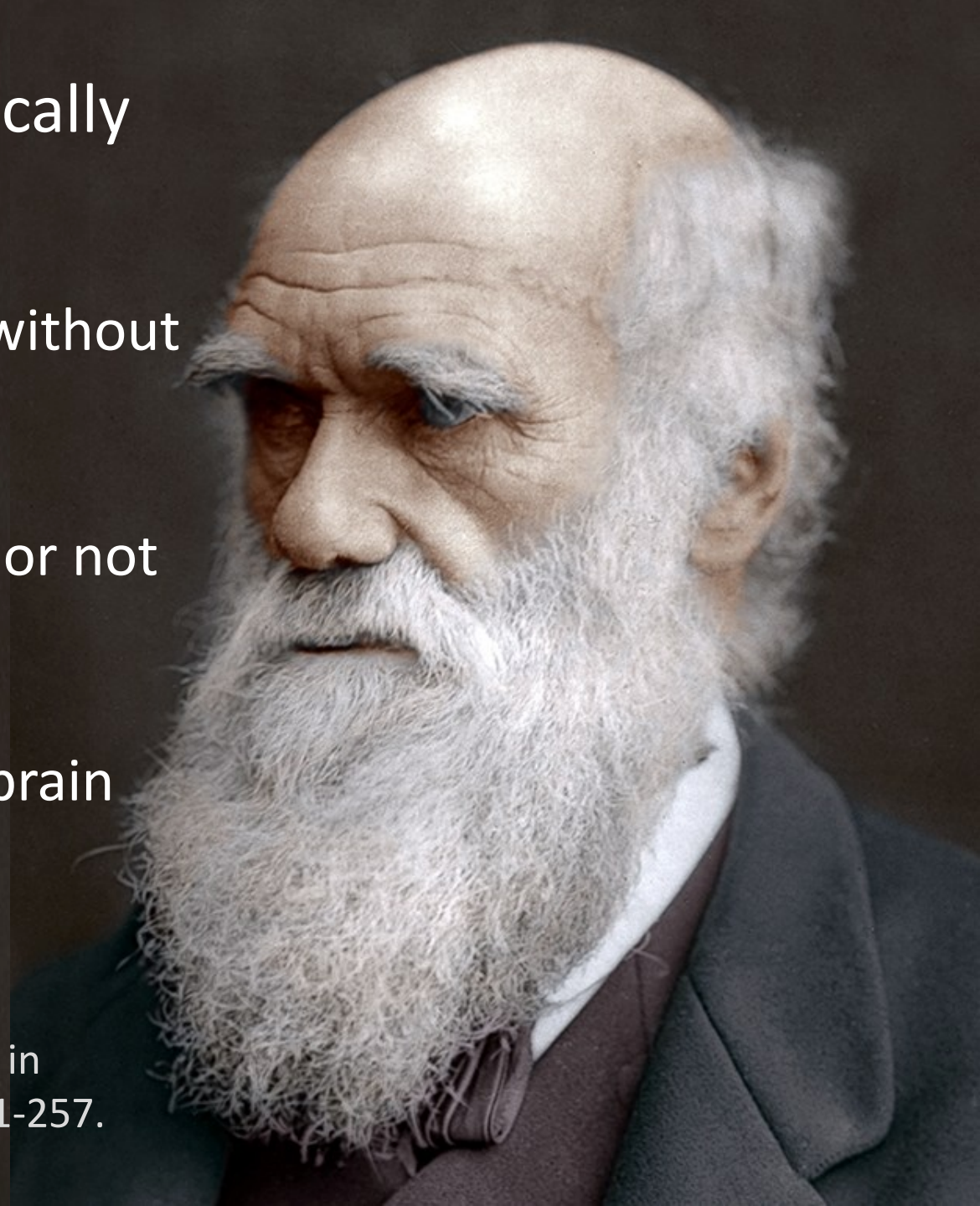
Measure		SES	Cortisol
Demographics	Female[a]	.06	−.05
	Age	−.07	.05
	Minority[a]	−.24*	.24
Vocabulary	Total	.67***	−.18
Design fluency	Motor planning	.33***	−.11
	Repeats	−.06	−.02
Tower	Time-per-move ratio	−.36***	.01
Reading the mind in the eyes	Total	.32***	−.38*

A ‘normal’ average point is not biologically reasonable.

Variation in abilities is completely normal, without it there could be no evolution.

Whether an ability or trait is advantageous or not depends on the environment.

Identifying absolute optimum positions of brain states is therefore impossible.



Holmes, A. J., & Patrick, L. M. (2018). The myth of optimality in clinical neuroscience. *Trends in Cognitive Sciences*, *22*(3), 241-257.

The problems with normative data, the example of race

It is now known that sports that involve blows to the head can cause dementia.

American football is one example.

70% of players in the US National Football League (NFL) are Black.

So many players have developed dementia that a compensation scheme is in operation.

For the same level of cognitive test performance, White players are more likely to receive compensation, than Black players.

This is because of normative data methods in neuropsychological assessment.

If a Black NFL player and White NFL player score exactly the same on a neuropsychological test, then the White player will be identified as having greater impairment, and therefore, be more likely to receive compensation from the NFL.

This is because, due to racism, and related lack of opportunity etc. at the group level, black people in the USA score lower than White people.

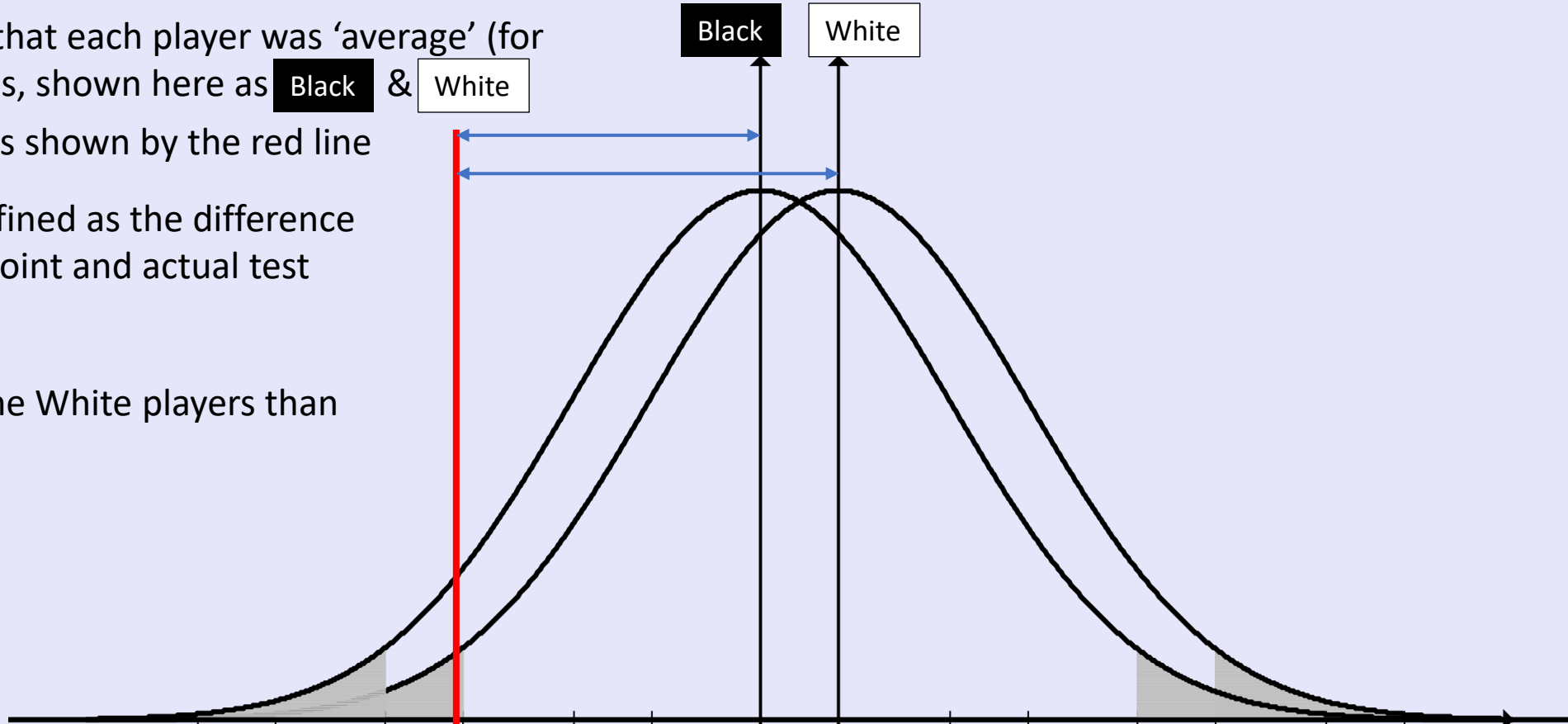
The NFL legal settlement that provides compensation uses the Black normative table for Black players, and the White normative table for White players.

The procedure is to assume that each player was 'average' (for race) before the brain injuries, shown here as Black & White

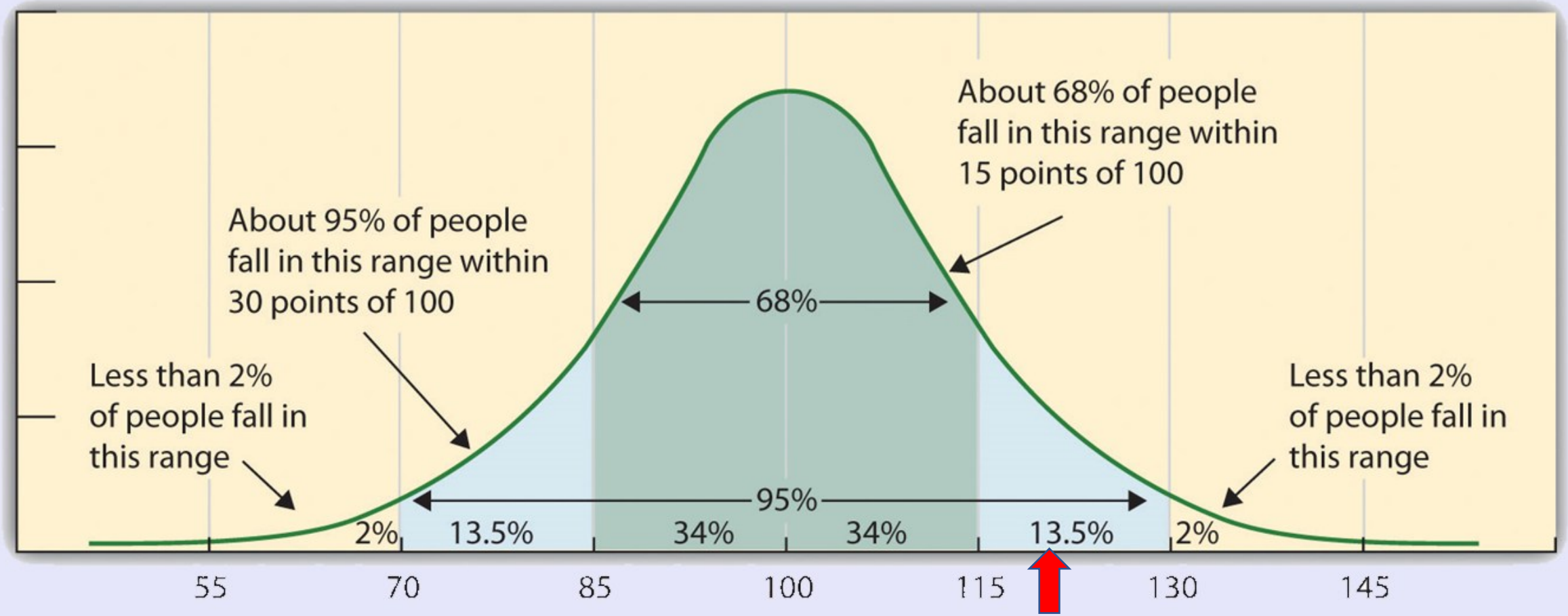
The actual test performance is shown by the red line

The level of impairment is defined as the difference between the 'before injury' point and actual test performance.

This difference is bigger for the White players than for the Black players.



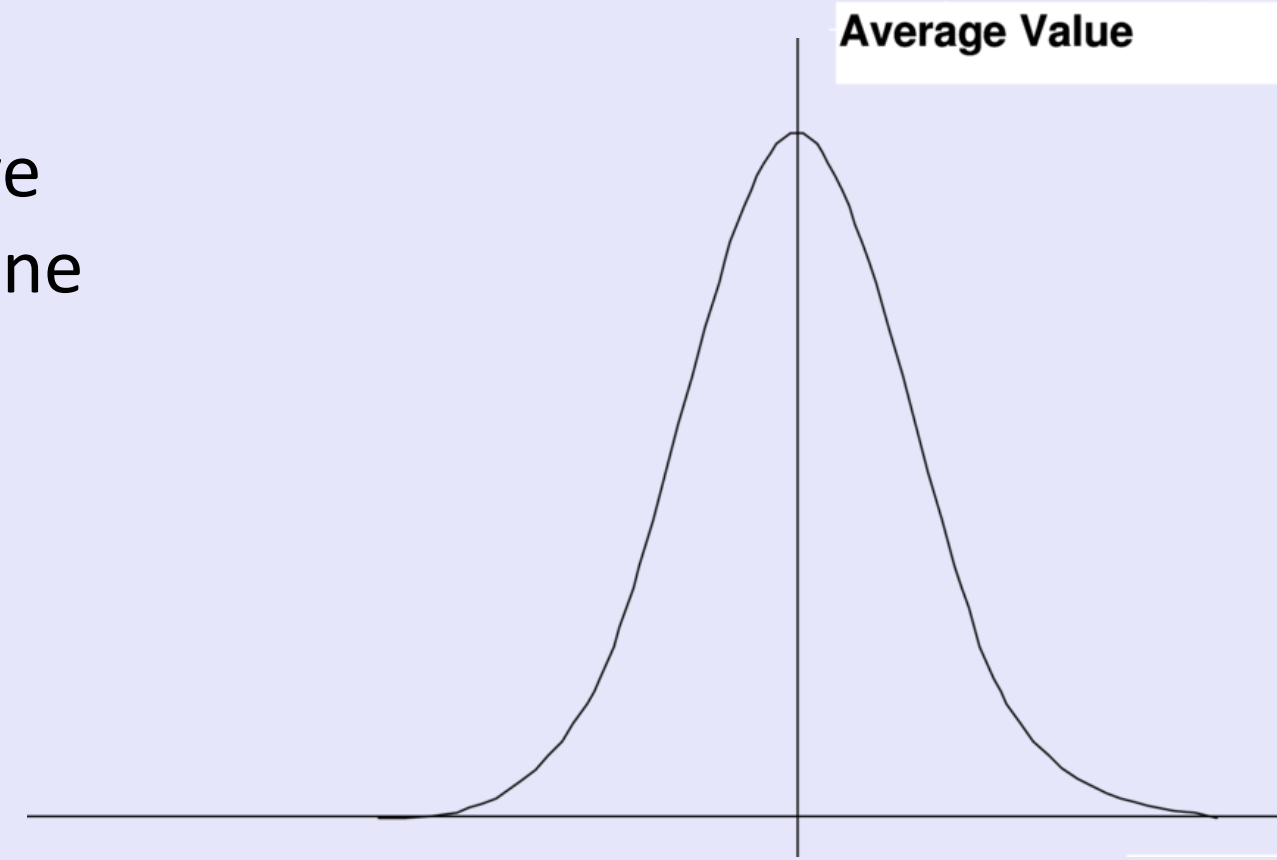
Normal cognitive performance for the population overlaps impaired performance of individuals



E.g. A patient with neurological illness could suffer a large drop in cognitive ability and still score 'normal'

- The problem is caused by neuropsychological procedures, which use the population average as an estimate of a person's premorbid ability.
- There are much better ways to do this that don't cause as much mismeasurement of impairment.

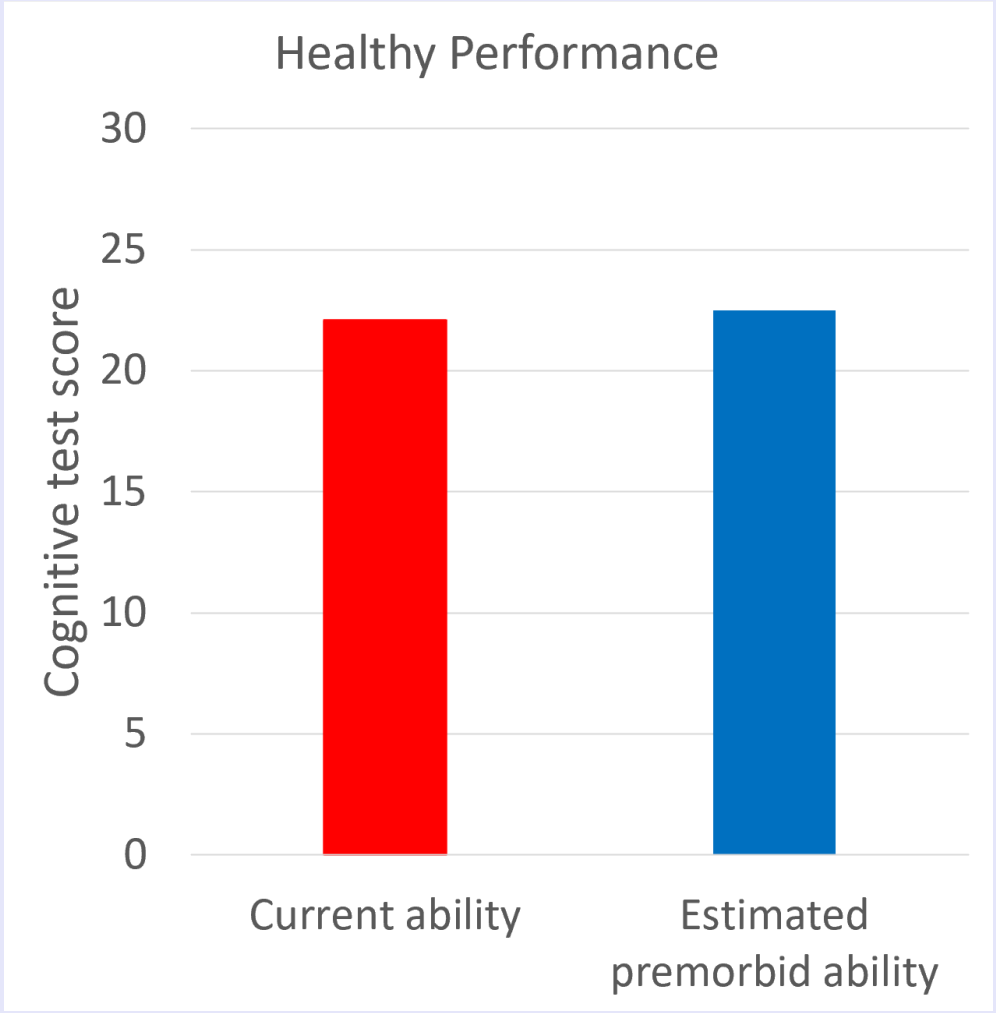
- These issues, in regard to race, have been explored recently by Gasquoine (2022) and Possin et al., (2021).
- What are needed are personalized estimates of individual premorbid ability.

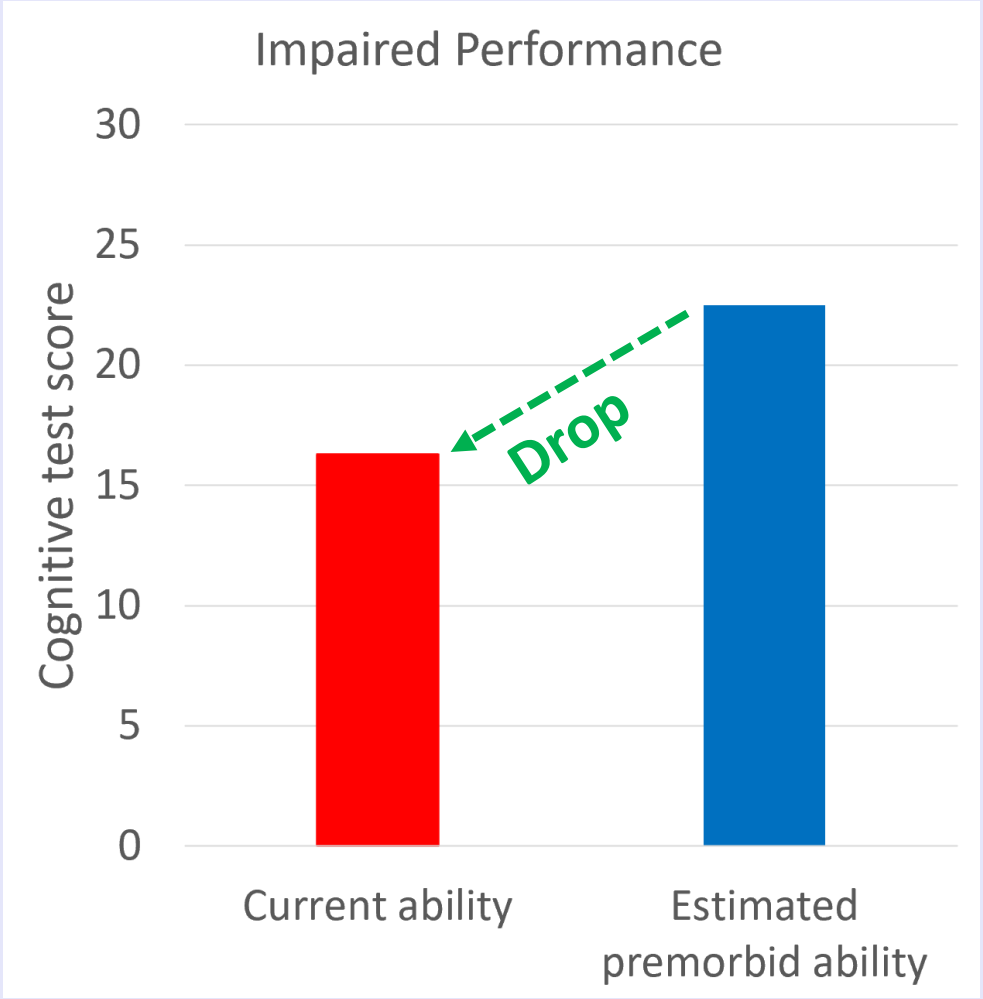


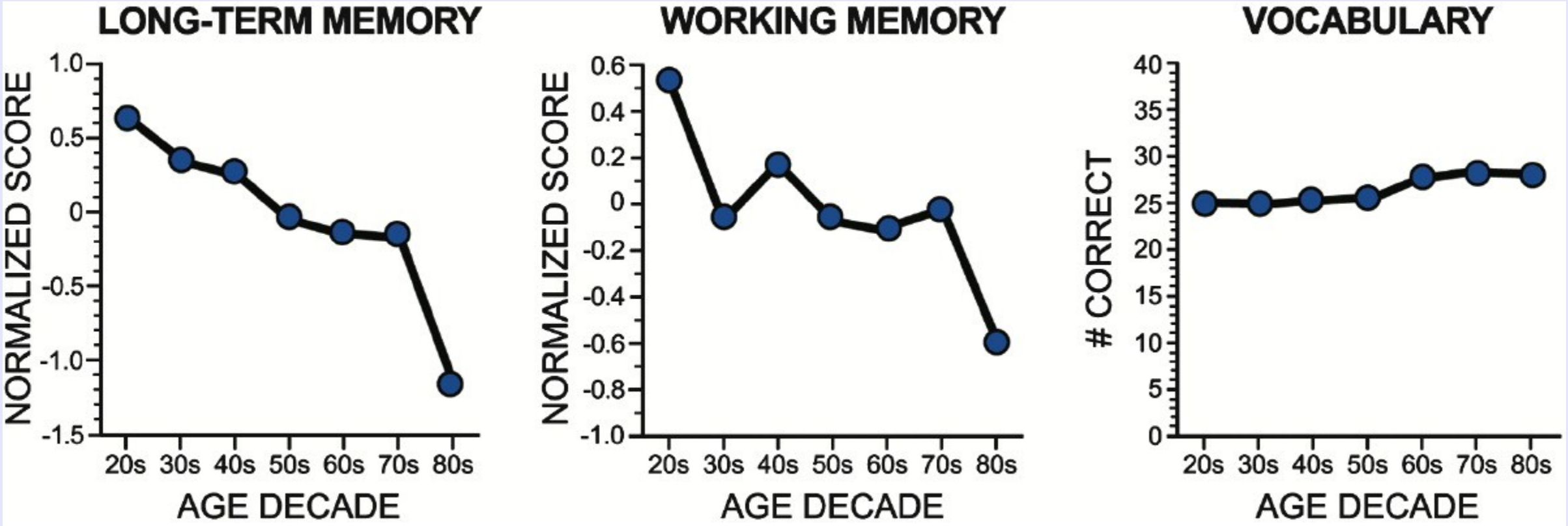
Gasquoine (2022). Performance-based alternatives to race-norms in neuropsychological assessment. *Cortex,* 148, 231-238
Possin et al. (2021). Perils of race-based norms in cognitive testing: The case of former NFL players. *JAMA Neurology*, *78*(4), 377-378.

Personalized cognitive assessment:

- If current ability is lower than estimated premorbid ability, this is evidence of acquired impairment

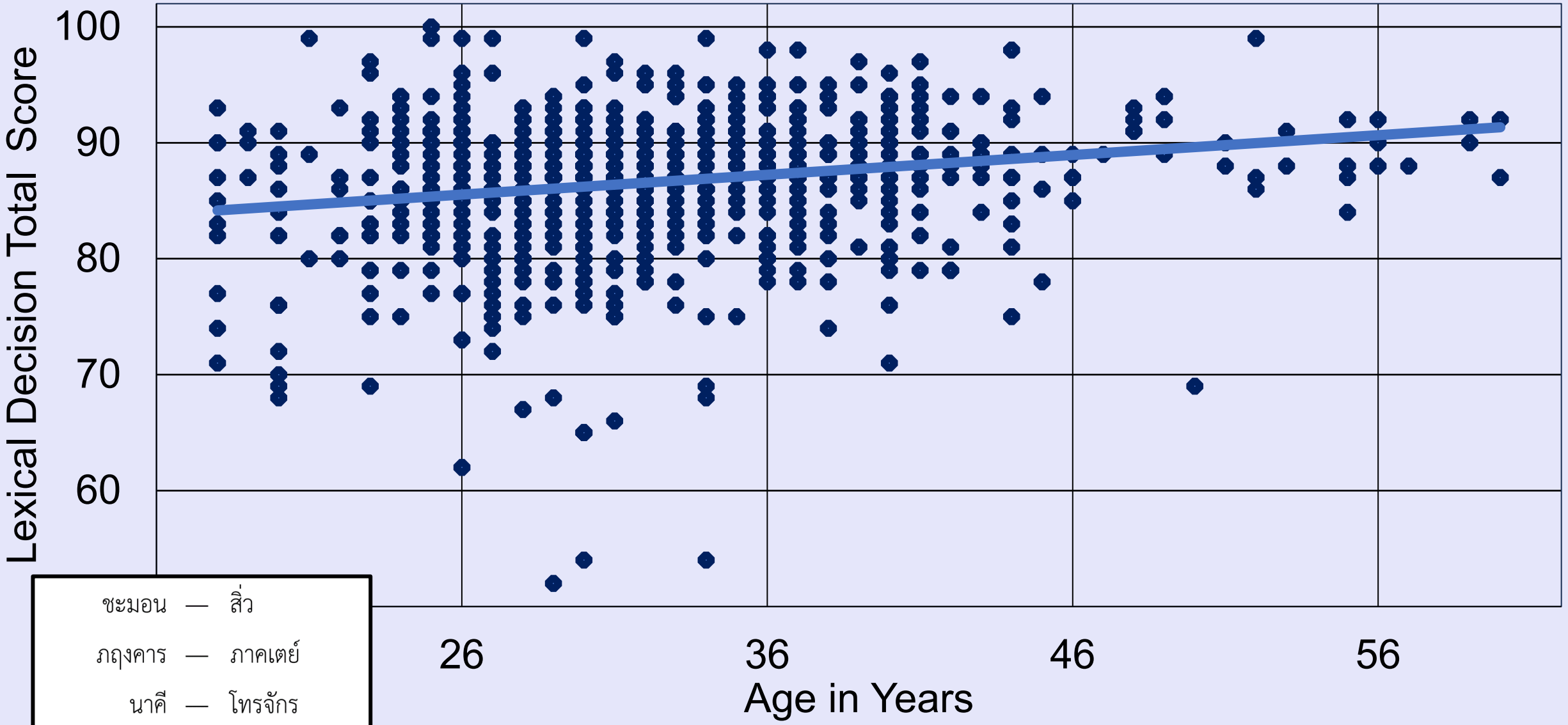






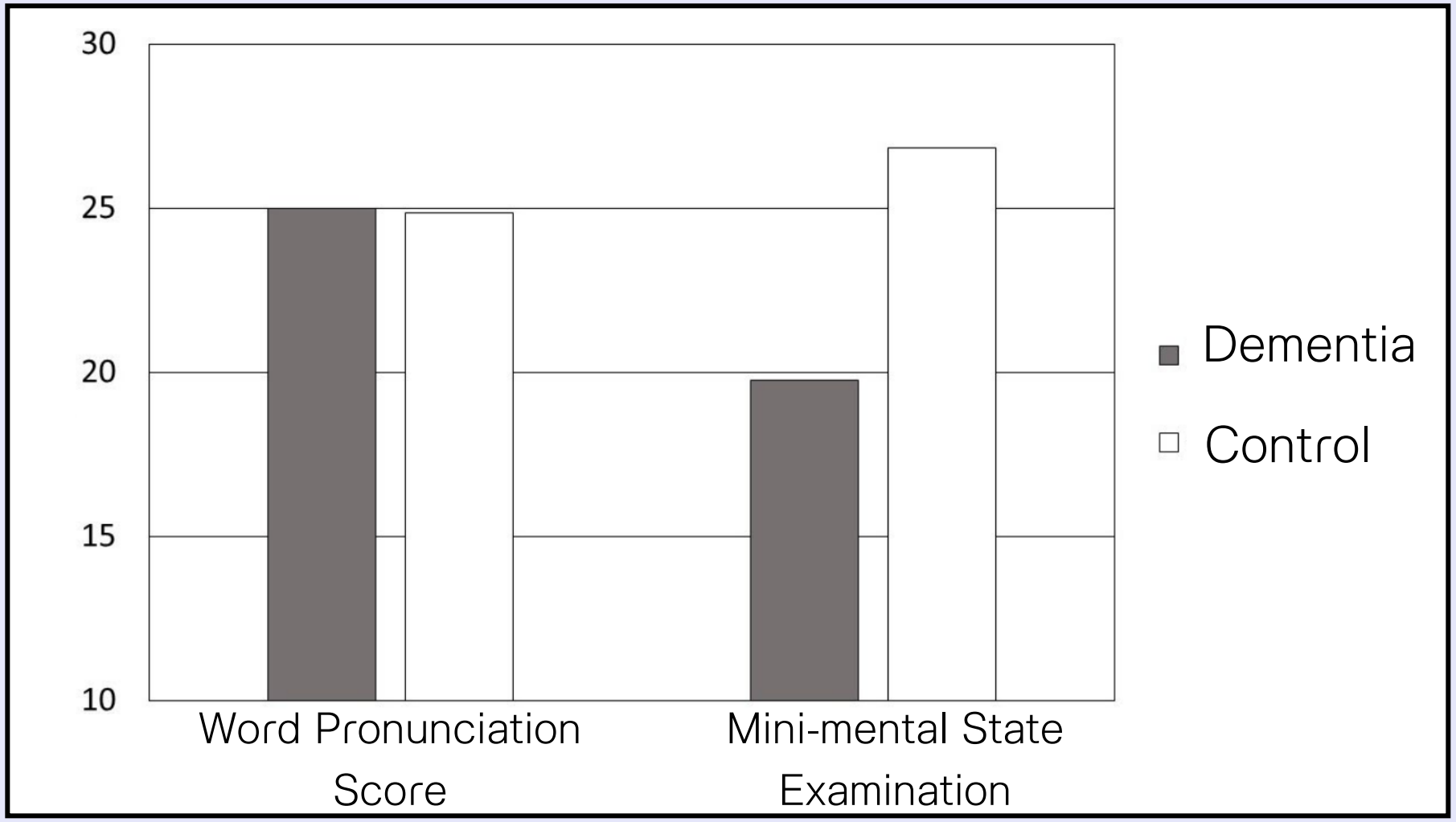
Buckner (2004). Memory and executive function in aging and AD: multiple factors that cause decline and reserve factors that compensate. *Neuron*, *44*(1), 195-208.

Unlike most cognitive abilities, vocabulary does not decline with normal ageing (it actually increases)



ชะมอน	—	สิ่ว
ภฤงคาร	—	ภาคเตย์
นาคี	—	โทรจักร
ราโนย	—	กาฬปักษ์
เขบ็ต	—	ปฐิวัลย์
จวัก	—	คเมช

N = 818 Thai adults: r = .20, *p* <.001



Word knowledge has the highest overall association with other cognitive tests

Reading words through lexical routes is resistant to dementia

Pluck et al., (2017). Estimación de la función cognitiva premorbida con el Test de Acentuación de Palabras. Revista Ecuatoriana de Neurología, 26(3), 226-234.

slank	–	chariot
lentil	–	glotex
stamen	–	dombus
loba	–	comet
pylon	–	stroin
scrapten	–	flannel

SUPERFLUOUS

SIMILE

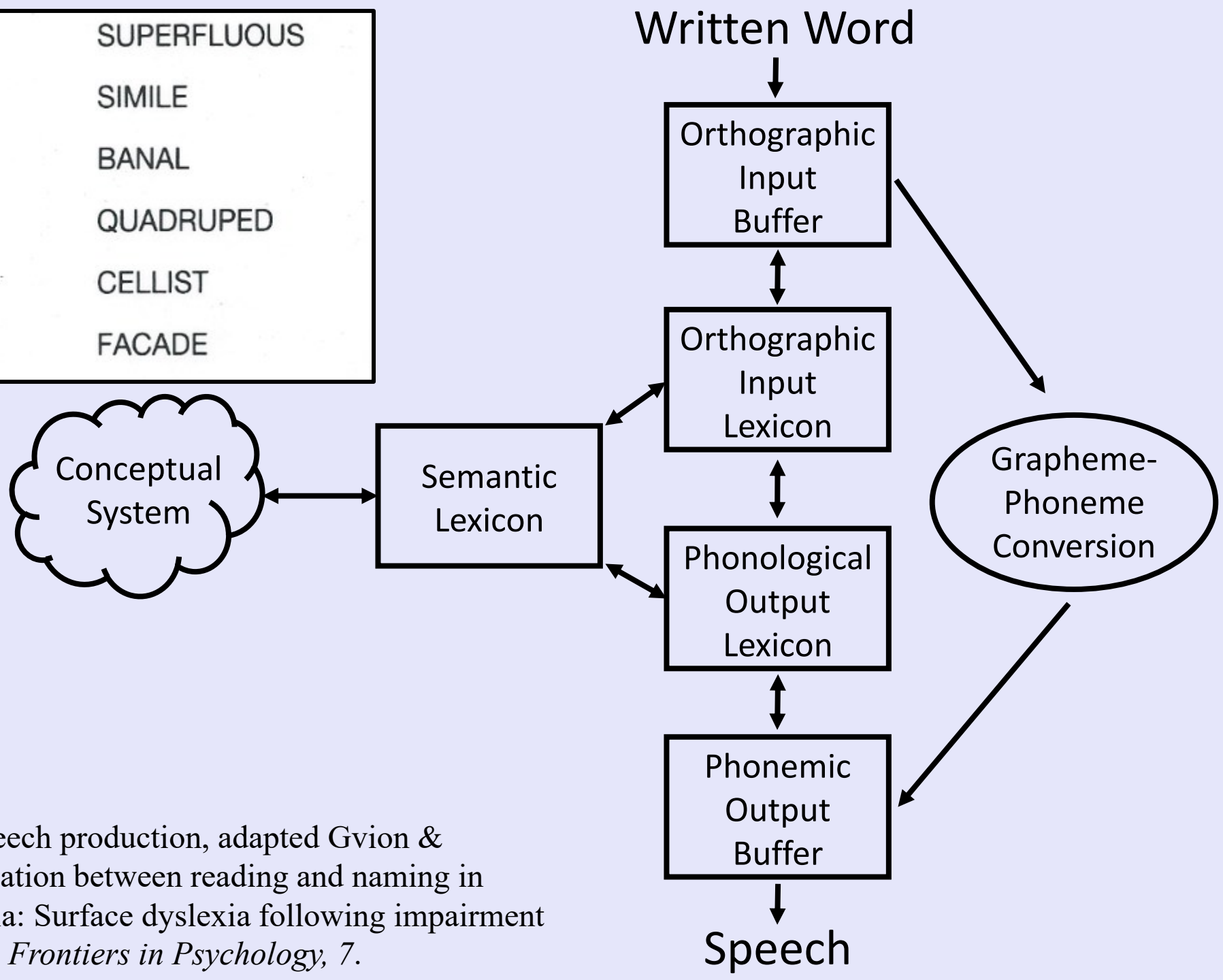
BANAL

QUADRUPED

CELLIST

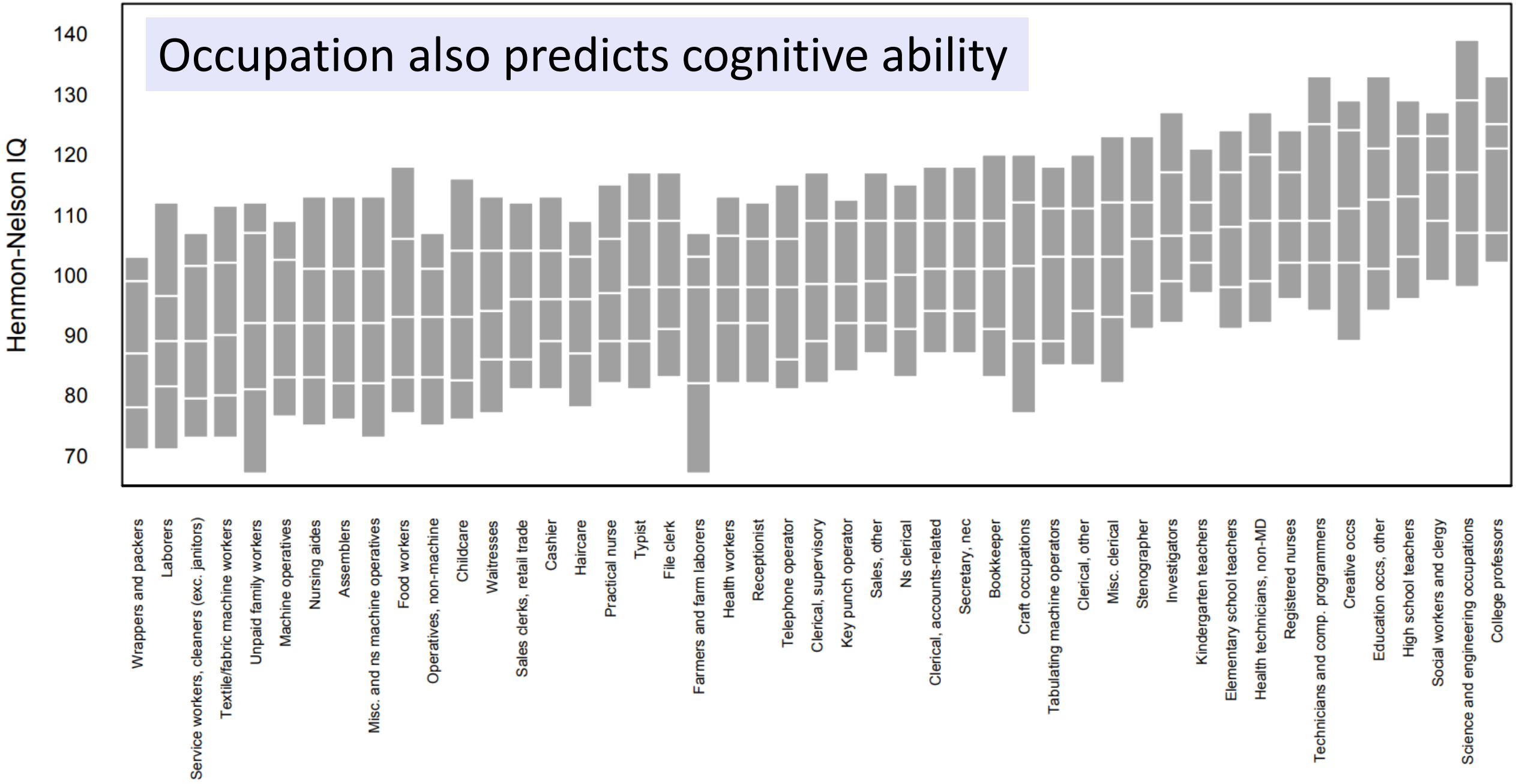
FACADE

ชะมอน	—	สิ่ว
ภฤงคาร	—	ภาคเตย์
นาคี	—	โทรจักร
ราโนย	—	กาฬปักษ์
เขบ็ต	—	ปฐิวัลย์
จวัก	—	คเมช



A neuropsychological model of speech production, adapted Gvion & Friedmann (2016). A principled relation between reading and naming in acquired and developmental anomia: Surface dyslexia following impairment in the phonological output lexicon. *Frontiers in Psychology, 7*.

Occupation also predicts cognitive ability



Hauser, R. M. (2002). *Meritocracy, cognitive ability, and the sources of occupational success*. Madison, WI: Center for Demography and Ecology, University of Wisconsin.

Regression-based norming allows personalised estimation of premorbid ability

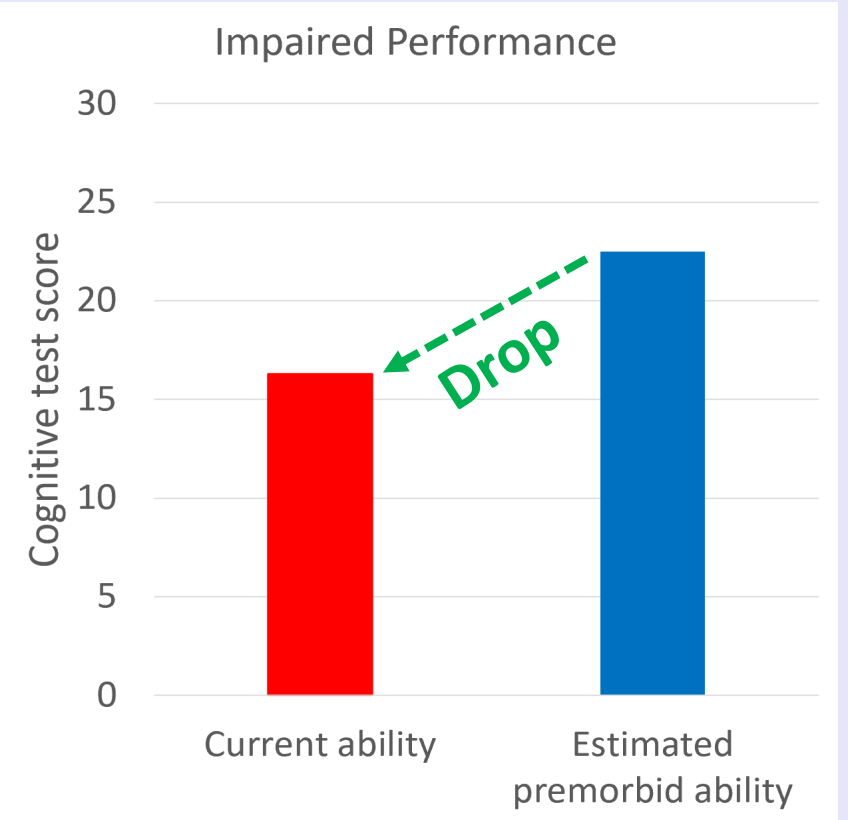
- Multiple factors can be used with linear regression to estimate premorbid ability on neuropsychological tests.
- This is easier to achieve than traditional norming. Smaller samples can be used.
- And less need to balance recruitment to the population demographics.
- Suitable where full norming is impractical.

Journal of the International Neuropsychological Society (2009), **15**, 1012–1022.

doi:10.1017/S1355617709990713

Accounting for estimated IQ in neuropsychological test performance with regression-based techniques

S. MARC TESTA,[1] JESSICA M. WINICKI,[1] GODFREY D. PEARLSON,[1–3] BARRY GORDON,[4] AND DAVID J. SCHRETLEN[1,5]



Coutrot et al. (2018). Global determinants of navigation ability. *Current Biology, 28*(17), 2861-2866.

Huge amounts of cognitive data, from diverse samples can be achieved with online collection.
Gamified cognitive tests are attractive to the public.

COGNITIVE SCIENCE
A Multidisciplinary Journal

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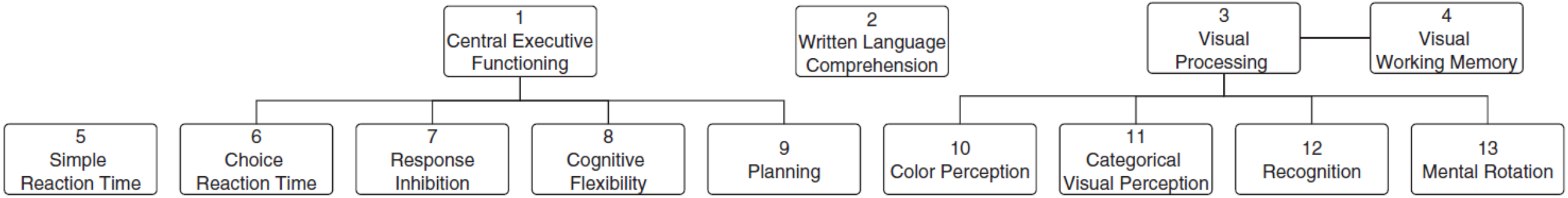
DOI: 10.1111/cogs.13308

Measuring Cognitive Abilities in the Wild: Validating a Population-Scale Game-Based Cognitive Assessment



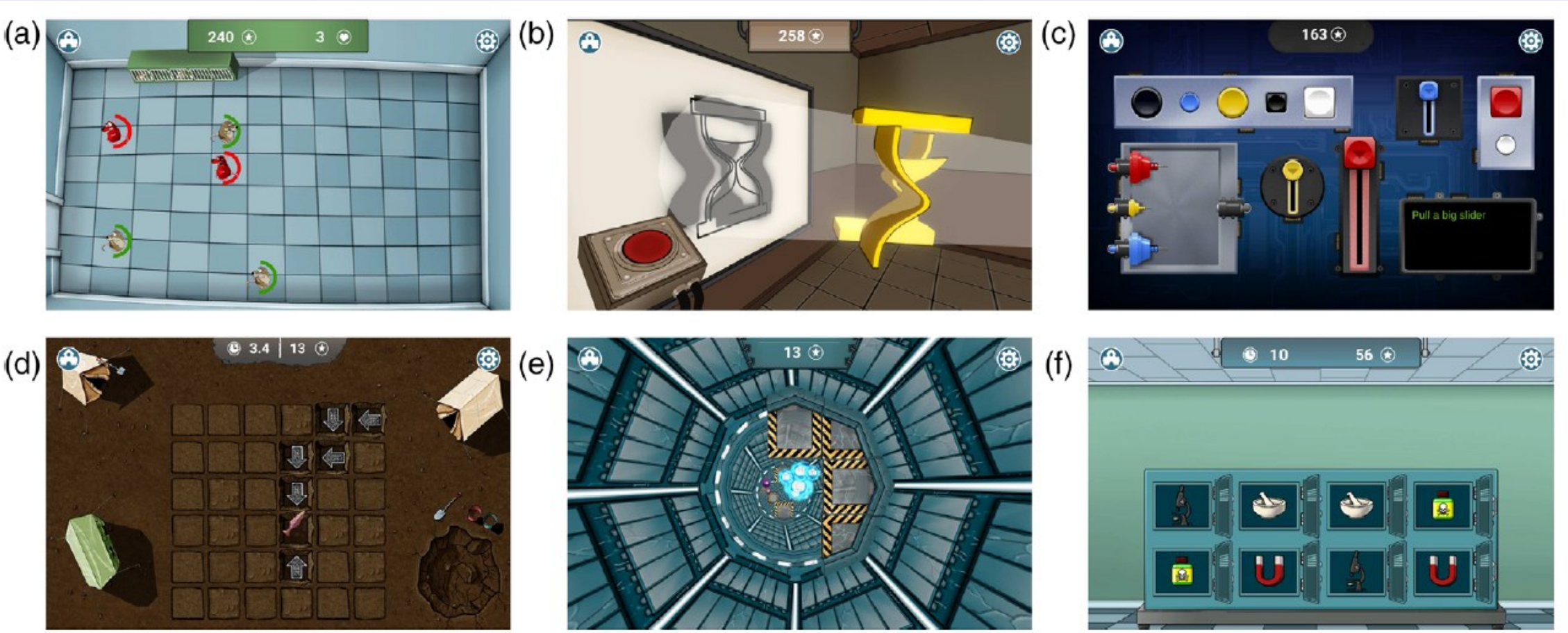
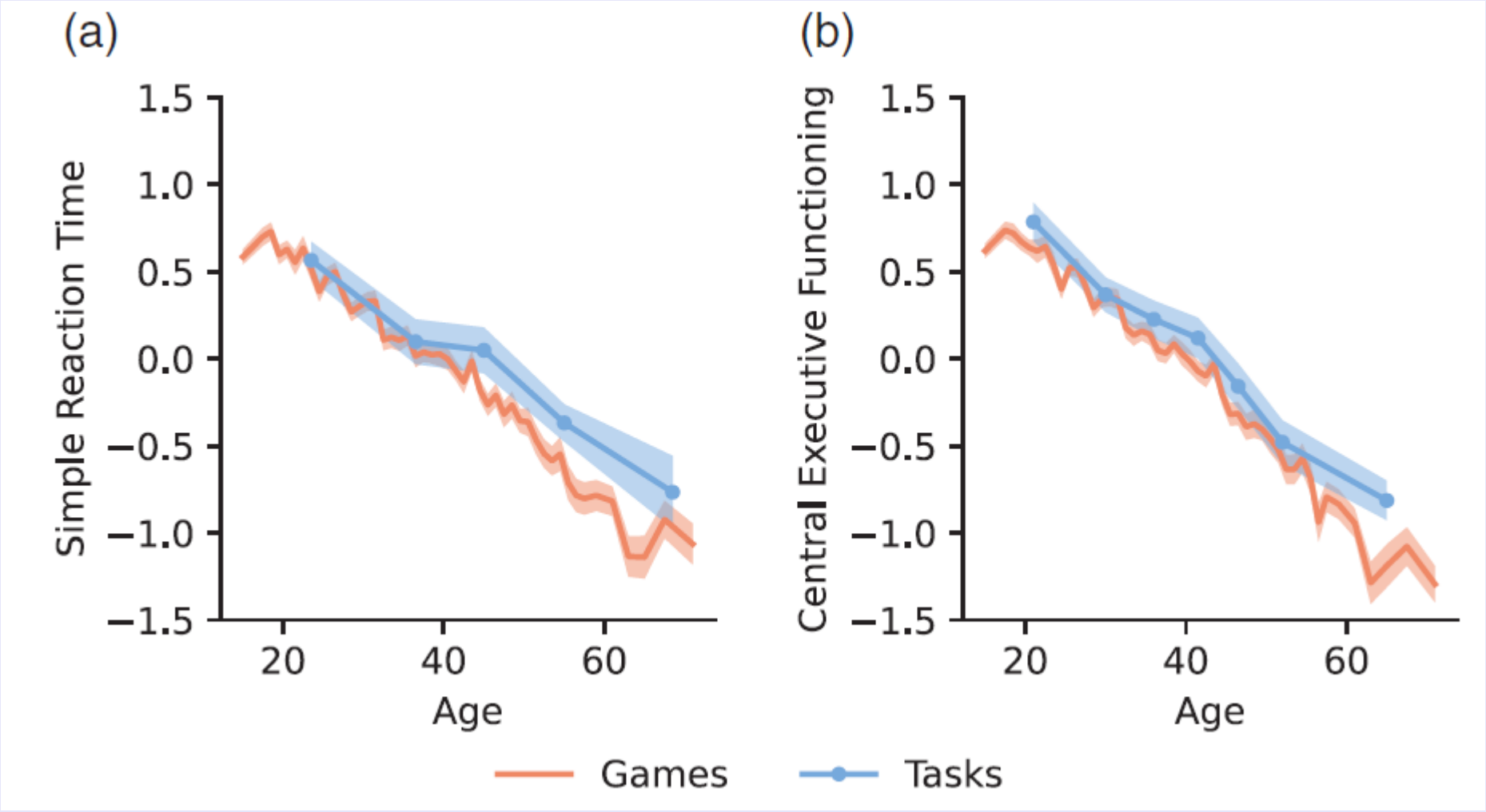


Fig. 2. The six games making up Skill Lab. (a) Rat Catch is designed to test response inhibition, simple reaction rime, and choice reaction time, (b) Shadow Match to test visuospatial reasoning in 3D, (c) Robot Reboot to test reading comprehension and instruction following, (d) Relic Hunt to test visuospatial reasoning and executive functions for simple strategy making in 2D visuospatial scenarios, (e) Electron Rush to test how people navigate and make decisions, and (f) Chemical Chaos to measure visual working memory.

Cognitive performance assessed within the games tracked performance on traditional neuropsychological tasks



And this doesn't have to be so technical, to be successful

TVTC Thames Valley Test Company

The Speed *and* Capacity *of* Language-Processing Test

The Spot-the-Word Test Version B

This is a test of your knowledge of words. You will be asked to decide which of two items, such as 'bread' and 'glot', is a real word and which is an invented item; 'bread', of course, is the real word.

Each of the pairs of items below contains one real word and one nonsense word, invented so as to look like a word but having no meaning. Please tick the item in each pair that you think is the real word. Some will be common words, most will be uncommon and some very rarely used. If you are unsure, guess, you will probably be right more often than you think.

Before you begin the main test try the following.

Practice

kitchen	–	harrick
puma	–	laptess
plorinum	–	levity
cuticle	–	andrinand
flonty	–	xylophone
craxent	–	sofa

Are there any questions?

ในแต่ละข้อของคู่คำศัพท์ต่อไปนี้ประกอบไปด้วย

- 1 คำศัพท์ที่มีความหมายในภาษาไทย และ
- 1 คำศัพท์ที่ไม่มีความหมายในภาษาไทย

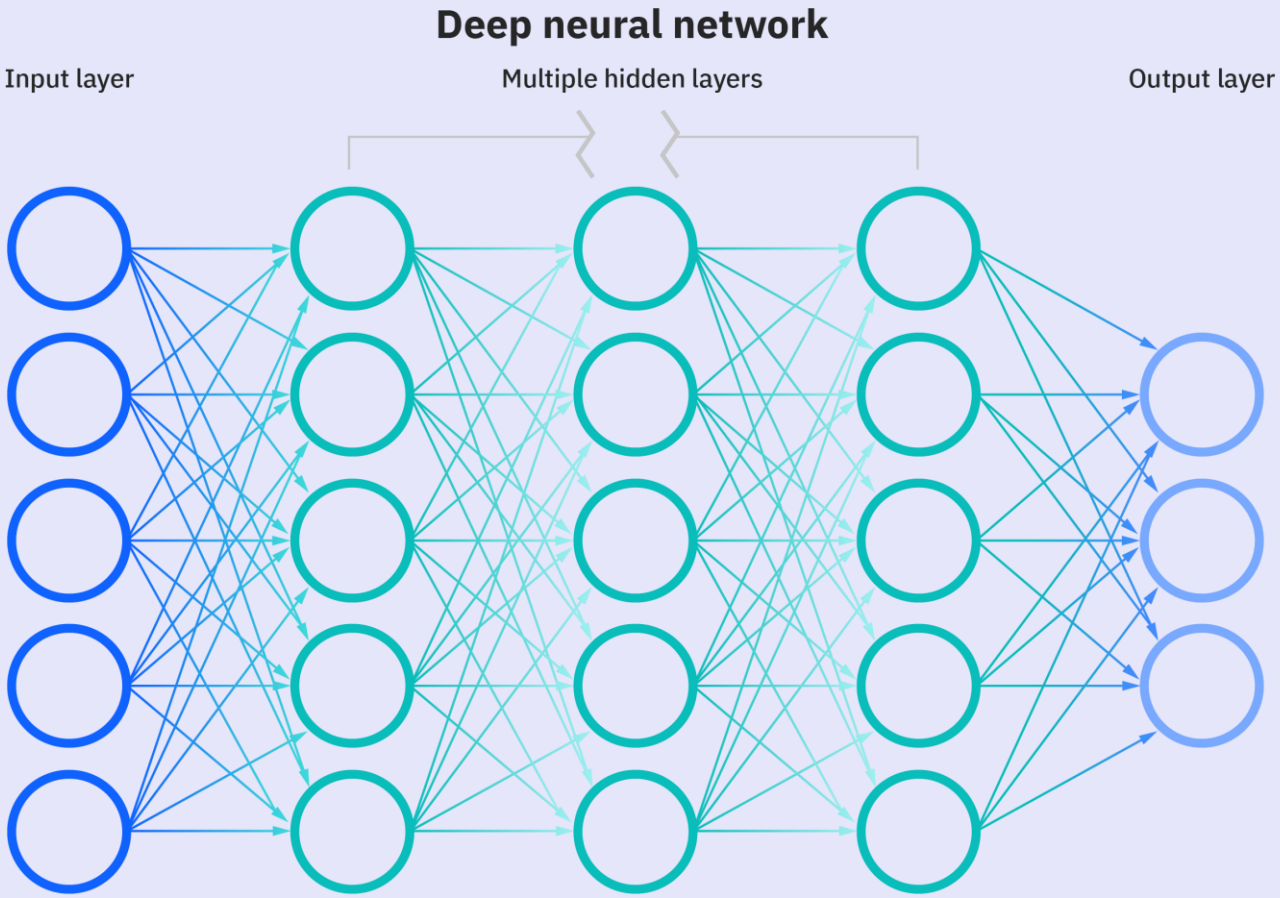
ยกตัวอย่างเช่น ประตู — ทราพิต ซึ่งประกอบไปด้วยคำศัพท์จริง (ประตู) และ คำที่ไม่มีความหมาย (ทราพิต)

โปรดเลือกคำที่มีความหมายในภาษาไทย **(เป็นคำศัพท์จริง)**

ศกุนี	—	ขจัก
บุหงัน	—	ณักข์
เกษฐ	—	มัคคุเทศก์
แฝน	—	เขียะ
มัจฉา	—	ษุพรี
ศีรษะ	—	ศยามาร
มักษา	—	นริศ
กบฏ	—	ชรกรรม์
เฌบง	—	ชลมารค
เนศไรย์	—	กรกฎ
วาพา	—	สรวง
นาเวศ	—	ปาษิต

- In 24 hours >900 Thai participants completed the task.
- It went viral on Facebook.
- The success of this is probably because it was perceived as a game / challenge.
- Methods like this can be combined with regression-based norming to provide estimated premorbid – current measures of neuropsychological ability.

Beyond linear regression



With very large data sets, machine learning methods, such as neural networks, could be applied to make personalised estimates of premorbid cognitive ability.

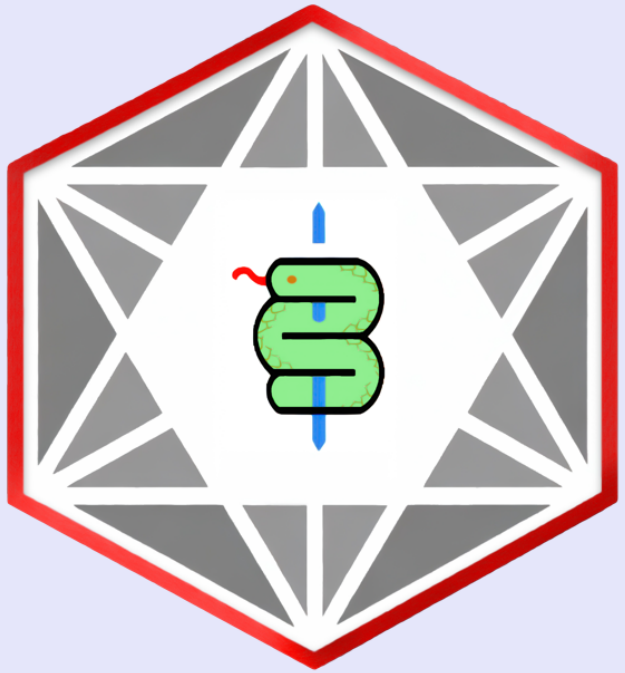
Summary

- Computerisation of test methods can improve the ecological validity of neuropsychological assessments.
- Virtual reality holds much potential, but still has some problems.
- Many cognitive tests can be adapted for tele-medicine application.
- Full automation can be a problem. A neuropsychologist will often still have to be present when assessing patients.

- Online data collection may allow for norming of tests, which would not have been feasible in the past.

Integration of Traditional & Technological Approaches in Clinical Practice

and Future directions



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