

COGNITION IN ACTION

COGNITION IN LEARNING AND EDUCATION SETTINGS

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LEARNING AND MEMORY

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INTERACTIVE TASK

- Your first task of the session is very important.
- It does not require any reading or writing, but it does require you to use your brain.
- Make sure you pay attention and make an effort, as it will likely pay off in the end.
- You are now going to be shown a number.....

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- What number did you just see?
- Your task will now be to **forget** this number
- Do you think you will be able to forget the number?

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LEARNING AND MEMORY:
SKILLED PERFORMANCE



- From learning, we infer change in processing representing learning.
- Even without verbal report of learning
 - E.g., controlling a pushbike
- Need to consider type(s) of memory involved in performing different tasks.
- Implicit and procedural memories.
 - Relate to unconscious memories.

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MEMORY STRATEGIES FOR
LEARNING



- McDougall and Gruneberg (2002):
 - Notes made before writing essay in exam: indicator of memory strategy.
 - No notes: indication of no memory strategy
 - Ps who wrote down researcher names at start performed better than those who did not
 - Provides a cue.

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MEMORY STRATEGIES FOR LEARNING



- McDougall and Gruneberg (2002):
- Effects of spaced revision:
 - Memory is better if info is practiced over spaced amount of time than massed into one session.
 - If spending X number of hours learning material, better to learn spread over days/weeks rather than learn all at once.

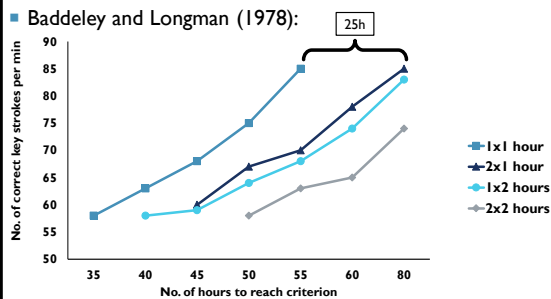
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EFFECTS OF SPACING

- Instead of spending one day revising everything for exam, better to spend few hours per day over weeks.
- Baddeley and Longman (1978):
 - Teaching postal workers to type.
 - Placed into four different learning groups:
 - 2x2 hour sessions per day;
 - 1x2 hour session per day;
 - 2x1 hour session per day;
 - 1x1 hour session per day.

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EFFECTS OF SPACING



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WHY DOES SPACED LEARNING WORK?

■ Prominent Theoretical Account:

- Encoding Variability (Benjamin & Tullis, 2010; Raaijmakers, 2003)
 - When we re-engage with info after a long delay, it is encoded differently to the first encounter
 - More variable representations encoded = more ways to access the info
 - Increases likelihood of retrieval

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ENCODING VARIABILITY THEORY: EVALUATION

If encoding variability is only factor, memory performance would improve with more spacing.

However, research shows as time between encoding encounters increases, benefit of spacing reverses.

Leading to inverted U relationship (Cepeda et al. 2009).

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THEORIES OF SPACED LEARNING: EVALUATION



- Most theories only based on behavioural data.
 - Also, only cover short period of time.
- Not directly informed by evidence for how spacing influences neural representations.

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THEORIES OF SPACED LEARNING: EVALUATION



Zou et al. (2025):

- 1st large-scale study of spaced learning neural evidence.
- Used Natural Scenes Dataset (Allen et al., 2022) to integrate neural and behavioural measures.
- In fMRI, 30-40 sessions over 8-10-months
- 9,209–10,000 natural scene images presented x3 with recognition memory decisions at each.
- Range of spacing between 1st two exposures, from 4 seconds to 302 days

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THEORIES OF SPACED LEARNING: EVALUATION

Zou et al. (2025):

- RQ 1: How does spacing between T1 & T2 influence neural similarity.
- RQ 2: Do neural measures of similarity parallel and predict behavioural benefits of spacing (recognition memory at T3).
- Analyses focused on ventromedial prefrontal cortex (vmPFC).
- Known to be involved in LTM & Schemas

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THEORIES OF SPACED LEARNING: EVALUATION



Zou et al. (2025):

Key Findings:

Behavioural Results:

- Spaced learning improved memory (only with Hit at T2).

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THEORIES OF SPACED LEARNING: EVALUATION



- Zou et al. (2025):
 - Neural Results:
 - Spacing increased stimulus-specific vmPFC neural similarity (only with Hit at T2).
 - vmPFC similarity predicted T3 memory, particularly for long (>24-hour) intervals.
 - vmPFC similarity = stronger activation in encoding-related regions and reduced activation in retrieval-related regions
 - Spacing helps memory not by adding variability, but promoting re-encoding
 - Opposite to encoding variability theories

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MEMORY STRATEGIES

ROTE LEARNING Vs. **EXPANDED RETREIVAL**

Benefits of Expanded Retrieval:

1. Long-term retention of info:

- Strengthens item to greater extent
- Requires less retrieval attempts to remember

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MEMORY STRATEGIES

ROTE LEARNING Vs. **EXPANDED RETREIVAL**

Benefits of Expanded Retrieval:

2. Maximises strength of trace

- Based on idea of spacing effect: increased spacing
- Longer interval between retrieval attempts, less likely success but greater benefit for long-term retention
- Read notes, put away and write down anything you can remember → makes use of LTM: Active learning.

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ROTE LEARNING VS EXPANDED RETRIEVAL

THE NAME GAME

- Interactive Task –
 - Pick a new name for yourself:
 - First name and Surname only.
 - In turn say your “name” out aloud.
 - However, you must also say all the previous names heard in order before saying yours.

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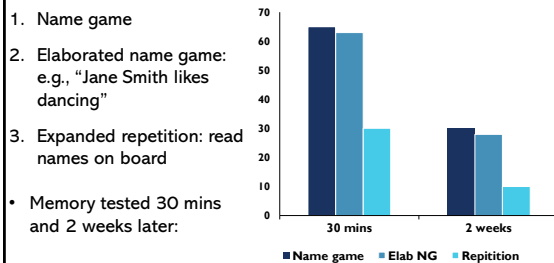
THE NAME GAME

- Time between 1st name and last name continually increases
- E.g., 6th member hears 5th members name once but must recall first 4 names before retrieving the 5th
- Makes retrieval of 5th name difficult but beneficial to learning

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THE NAME GAME

- Morris and Fritz (2000): Three conditions:



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EFFECT OF SELF-TESTING

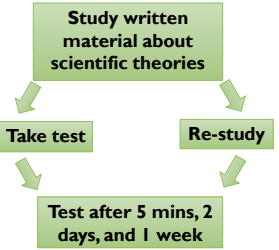
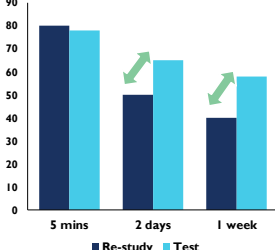


- Testing yourself on learnt material increases retention
- Retrieval practice effect.
- But does testing benefit memory more than revision episode?

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EFFECT OF SELF-TESTING

- Roediger and Karpicke (2006):

Time Interval	Re-study (%)	Test (%)
5 mins	~80	~78
2 days	~50	~65
1 week	~40	~58

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MEMORY STRATEGIES AND EXAMS

- Selective Revision: Macrae and MacLeod (1999)
- Can be useful to save time and resources.
- However, success depends on assumption that revised material will appear in exam.



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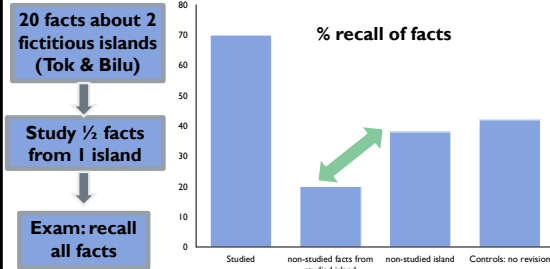
MEMORY STRATEGIES AND EXAMS

- If studied material does appear, performance in exam should be good:
 - Retrieval practice effect - facilitation
- However, what if revised material does appear?
 - Would performance be as bad as not revising at all
 - Or could it be even worse
 - Retrieval-induced forgetting effect.

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RESEARCH EXAMPLE IN EDUCATION: MACRAE AND MACLEOD (1999)

Ps told they were to take a geography exam



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MEMORY STRATEGIES AND EXAMS

- What can be done if RIF occurs in exam?
 - Integration of information protects memories from RIF.
 - Make connections across materials
 - Work out what constitutes connections during revision (not during the exam – too late).

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MEMORY STRATEGIES AND EXAMS

- Compose structures for mock essays
 - Make links explicit between items.
- If info is forgotten, cues provided by retrieval of other info/related connection, should help cue related forgotten info.
 - Make use of sub-headings.



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COGNITION, BILINGUALISM, & EDUCATION

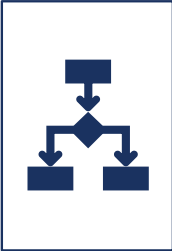
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WHAT IS BILINGUALISM?

-  Ability to understand and use 2 languages fluently
-  Specific definition can vary depending on context and language background.
-  Encompasses wide range of language proficiencies and usage patterns.
-  Individuals who can speak, read, and write in two languages with varying degrees of fluency.
-  May use language in different contexts (at home, at work, or with friends).

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TYPES OF BILINGUALISM?



- By timing of acquisition
 - Simultaneous vs Sequential (Early/late)
- By proficiency
 - Balanced vs Dominant
- By function/social use
 - Additive vs Subtractive
- By Skill Profile
 - Receptive vs Productive
- By social distribution
 - Individual vs Societal

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Discussion Question

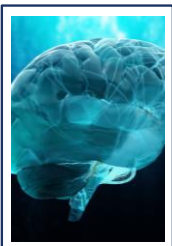


Why does defining bilingualism matter for research?

Bilingualism ≠ perfect fluency in both languages
Bilingualism exists on a continuum

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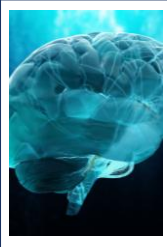
STRUCTURAL DIFFERENCES IN THE BILINGUAL BRAIN



- **Grey Matter (outer part):**
 - Increased density in bilinguals compared to monolinguals.
 - Associated with language processing, memory, and attention.
- **White Matter (inner part):**
 - Enhanced connectivity between brain regions in bilinguals.
 - Facilitates efficient communication and information processing.

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STRUCTURAL DIFFERENCES IN THE BILINGUAL BRAIN



- Bilinguals display stronger whole-brain connectivity than monolinguals.
- Connectivity especially pronounced when learning second language young
- Enhanced brain connections can benefit attention, aging, and resilience.
- Increased neural plasticity

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COGNITIVE CONSIDERATIONS OF BILINGUALISM

01

Both languages actively co-activated even when using only one.

02

Word recognition can activate items from both languages.

03

This creates a competition that must be resolved.

04

Not 2 separate aspects, instead 2 systems operating together.

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COSTS OF BILINGUALISM

- Lexical Access and Speed
- Bilinguals often show:
 - Slower picture naming
 - Less vocabulary in each language
 - but overall no. of words similar or more
 - More tip-of-the-tongue states
- Why?
 - Experience is distributed across languages
 - Interference from the non-target language
 - Reduced frequency of use for each item



(Bialystok et al., 2010)

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COGNITIVE DEVELOPMENT



(Bialystok et al., 2010)

- Negative impact on vocabulary
- But: Important to differentiate between home (everyday) and school setting
- Do bilinguals perform better or worse in cognitive tasks?.....

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Verbal fluency



"Name as many words as possible starting with /f/"



Results:



Bilinguals had lower response times



Less accurate



Fewer words generated



e.g. Gollan, Montoya and Werner, 2002

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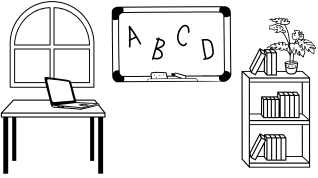
Picture naming:



- "What is this?"
- Results:
- Bilinguals named pictures more slowly in dominant language
- Being bilingual is analogous to having a lexicon full of lower frequency words relative to monolinguals

e.g., Gollan, Montoya, Fennema-Notestine & Morris, 2005

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COGNITIVE BENEFITS OF BILINGUALISM

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EXECUTIVE CONTROL

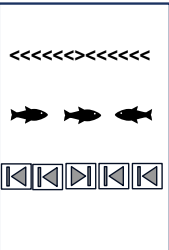


Costa & Sebastián-Gallés (2014)

- Bilinguals must constantly manage interference between languages to select the language to use in a particular situation.
- They may develop stronger:
 - Inhibitory mechanisms (suppress irrelevant language)
 - Shifting abilities (switching languages/tasks)
 - Updating (monitoring working memory)
- Can lead to strengthened cognitive control networks

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EXECUTIVE CONTROL



- Eriksen Flanker Task:**
 - Press arrow corresponding to central direction
- Results:**
 - Early bilinguals better than late bilinguals and monolinguals
 - Indexed by smaller incongruence effect
 - e.g., Luk, de Sa & Bialystok (2011)

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EXECUTIVE CONTROL

RED

GREEN

BLUE

YELLOW

BLACK

ORANGE

PURPLE

- **Stroop task:**
- Name colour of ink
- **Results:**
- Early bilinguals better than late bilinguals and monolinguals
- Indexed by smaller incongruence effect

e.g., Luk, de Sa & Bialystok (2011)

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EXECUTIVE CONTROL

- **Simon Task:**
- Measures how irrelevant spatial information interferes with reaction time.
- Click the link to have a go of the Simon Task in Psy Toolkit: [Simon task](#)
- Simon effect lower in bilinguals as age increases
- e.g., Bialystok et al., 2004)

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THE BILINGUAL ADVANTAGE DEBATE

- **For:**
- Early studies (e.g., Bialystok) showed strong advantages in:
 - Executive Function
 - Cognitive Flexibility
 - Protect cognitive decline
 - Metalinguistic Awareness
- Robust findings in older adults: delayed onset of dementia by ~4–5 years (observational studies).

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THE BILINGUAL ADVANTAGE DEBATE

■ For:

- Evidence suggests bilinguals must do something additional to prevent responses in other language
- May be at any stage of cognitive processing:
 - Perceptual identification
 - Evidence emerging from American Sign Language / Spoken English bilinguals (Giezen, Blumen, Shook, Mar & Emmorey, 2015)
 - Response selection
 - Inhibitory control

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THE BILINGUAL ADVANTAGE DEBATE



■ Against:

- Large-scale replication attempts failed to reproduce some early results.
- Advantages often disappear when:
 - Task complexity is low
 - Bilingual groups are not well defined
 - Socioeconomic status is controlled

(Bialystok, 2025; Degirmenci et al., 2022; Luo & Zang, 2026; Privitera, 2025)

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THE BILINGUAL ADVANTAGE DEBATE



■ Against:

- Hilchey & Klein (2011) reviewed 31 studies:
 - No evidence for bilingual advantage on inhibitory control tasks
- Paap & Greenberg (2013):
 - No coherence in claims for domain-general advantage for bilingual populations
 - If generally enhanced, inhibition should be better across tasks for same participants

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A NUANCE

- *"The research is complex. Who is bilingual? What tasks are decisive? How can individual differences be incorporated into the models? These are difficult questions, but they are essential to resolve to find some consistency to in the empirical record."*
(Bialystok, Kroll, Green, MacWhinney & Craik, 2015)
- Rather than considering bilingualism as being better or worse, it could be seen as a redistribution of cognitive resource.
- Some argue bilingualism does not create universal cognitive advantages but specific benefits depending on context and task (e.g., improved attention in environments requiring frequent switching).
- Others suggest neutral effects should not diminish value, as cultural, social, and practical benefits are significant (Bialystok, 2025; Degirmenci et al., 2022; Luo & Zang, 2026; Privitera, 2025)

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IMPLICATION FOR EDUCATION

Bilingual children may appear "behind" in vocabulary but may excel in reasoning tasks.

Literacy: bilingualism enhances phonological awareness.

Classroom strategy: dual-language instruction can strengthen both executive and linguistic skills.

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WHY THIS MATTERS IN WALES: WHERE COGNITION MEETS POLICY

- Welsh Govt's strategy Cymraeg 2050 seeks to:
 - Reach one million Welsh speakers by 2050
 - Double daily Welsh use from 10% to 20%
 - Expand access to Welsh-medium education and strengthen Welsh-speaking communities

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DISCUSSION QUESTIONS



- How should Welsh-medium schools use cognitive findings to support learning?
- Does the bilingual advantage debate matter for language policy?
- How might bilingualism support wellbeing in Wales?

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FINALLY!

What was the number
presented at the start
of the session?

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