



Cognitive Psychology

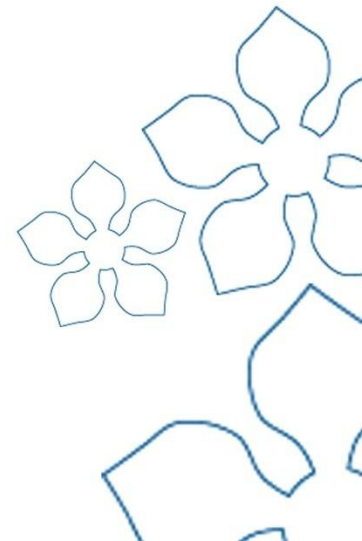
M5X00908 Brain, Behaviour, and Cognition (BBC)

Short-Term Memory

Dr Kate Williams



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Essential Reading!!!!

- Eysenck, M. W., & Keane, M. T.
Cognitive psychology: Chapter 6.

Additional Reading:

- Baddeley, A. D. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology*, 63, 1-29.
- Della Sala, S. (2010). *Forgetting*. Hove: Psychology Press.



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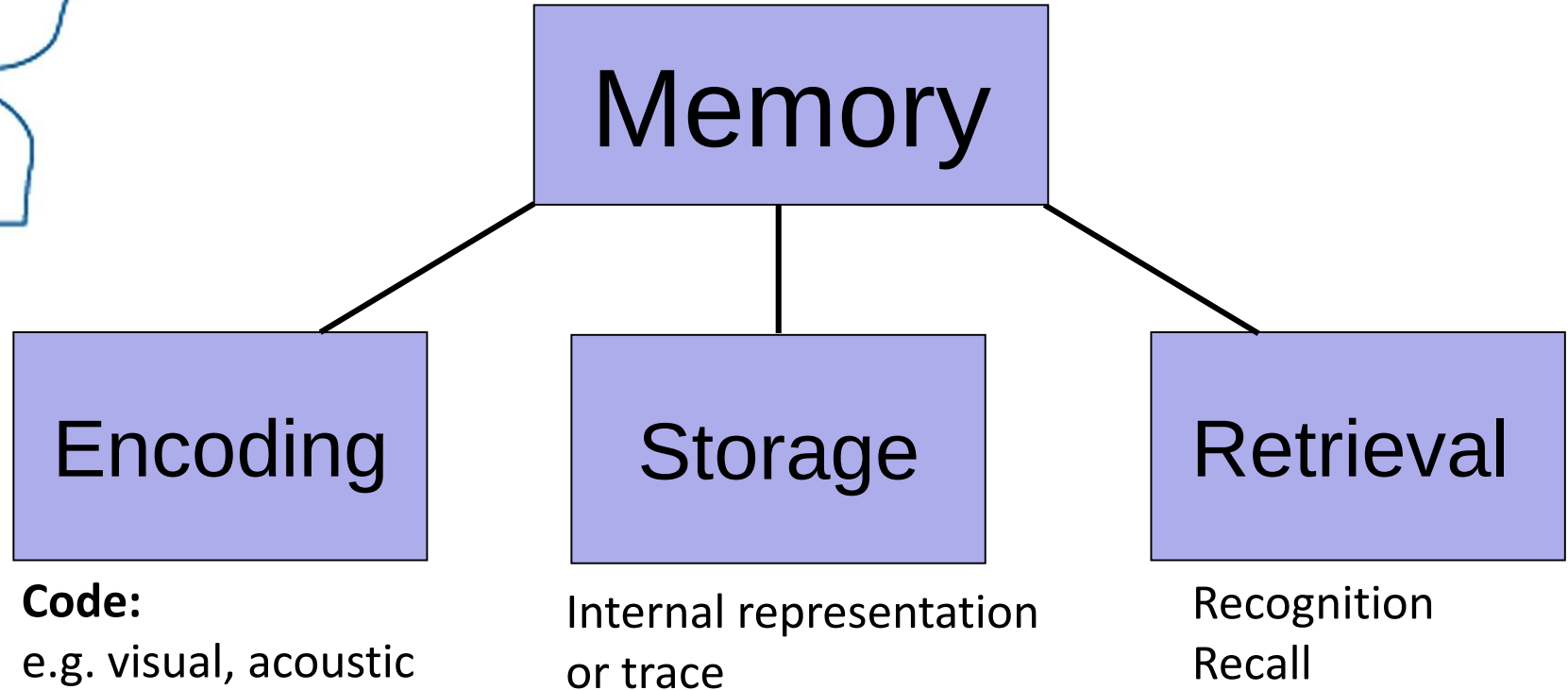
What is Memory?

- Integral part of Cognitive processing
 - Concerned with the organisation of time
 - Keeps a record of the past and future
- Why are memories important?
 - Essential for learning
 - Affects the future
 - Contributes to our identity



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Memory processes



Processes interact: e.g. encoding influences recall



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Forms of Storage in Memory

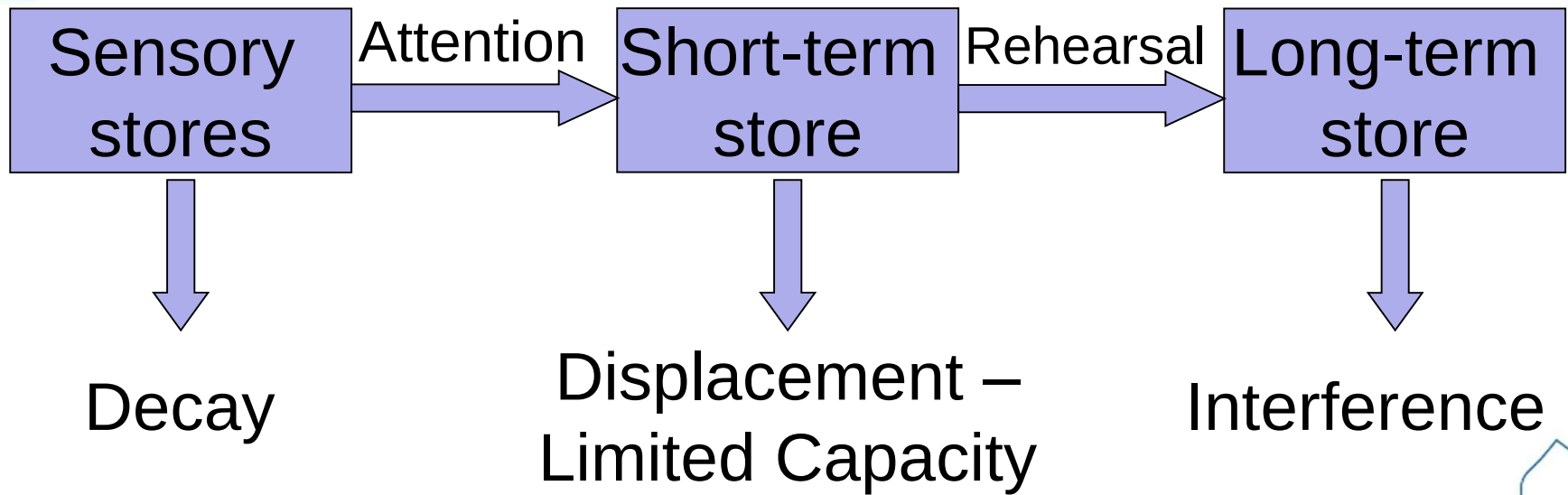
- James (1890) – Primary & Secondary memory
 - Information perceived which remains in consciousness
 - Information which has left consciousness
- Atkinson & Shiffrin (1968, 1971) Multi-Store Model
(AKA as *Dual-Memory Theory*)
 - Three types of memory store were proposed



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Atkinson and Shiffrin (1968/1971)

The multi-store model of memory



Evidence for division of memory stores:

- 1. Behavioural Experiments**
- 2. Neurological Case Studies**



Sensory stores

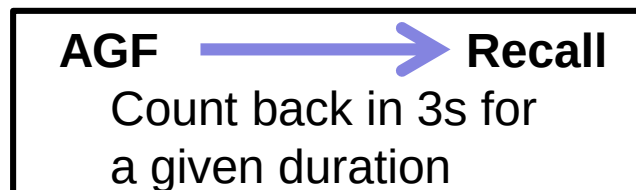
- **Modality specific**
 - **Information**
 - Literal/un-coded
 - **Capacity**
 - Unlimited
 - **Duration**
 - Iconic memory (Visual) - 0.5 seconds (Sperling, 1960)
 - Echoic memory (Verbal) - 1-2 seconds (Triesman, 1964)
 - **Sensory attention**
 - Transfer to short-term memory
 - **Info from sensory memory lost through decay when attention has not transferred the info to STM**
- 

Short-Term Memory (STM)

- **Capacity = Limited**
 - Evidence = Miller (1956): Digit span technique.
 - Ps listen to random sequence of numbers & repeat them back in same order: E.g., 6 7 3 6 5 1 3 8 5 2 3 7 1 4
 - Typically only 7 items +/- 2 can be repeated back:
 - “magic number” 7 (± 2)
 - BUT: Cowan (2000) suggests “magic” number is inflated:
 - Ps can rehearse info –
 - Cowan et al., (2005) conducted similar digit span task but exp. could stop at any time & Ps would have to recall the last item first & work back.
 - They found that Ps could now only recall roughly 3 to 4 items.
 - Also, Ps may use LTM whilst performing STM tasks:
 - E.g., CIAFBIIBM BMI can become CIA FBI IBM BMI thanks to LTM.
- **Duration**
 - About 15-30 seconds

How is info forgotten from STM?

- Info that's not rehearsed appears to **decay** or be **displaced** from STM.
 - Brown (1958); Peterson & Peterson (1958).
 - Ask Ps to recall a string of non-sense words (trigrams) after varying lengths of time.
- Likely to recall more after short time gap between study & test.
 - E.g., Ps can recall roughly 6 items after 3 sec delay but only around 1 item after 12 sec delay.
 - BUT: Distinctiveness of stimuli & constraints of task should be considered:
 - e.g., Peterson & Peterson used all letters of the alphabet repeatedly which may have led to interference and Ps were asked to remember stimuli in order making the task very difficult.



How is info forgotten from STM?

- **Interference:**

- Could come from items on previous trials &/or from info presented during the retention interval.

- Berman et al. (2009) argue interference is more important than decay:

- STM performance on any given trial was disrupted by words presented on previous trial,
 - Not by increasing the inter-trial time interval,
 - But disruption effects could be eliminated when interference from previous trials was reduced.

How is info forgotten from STM?

- **However:** Campoy (2012) found that Decay effects are strongest at time intervals shorter than 3.3 sec:
 - So, a limitations to Berman et al.'s (2009) research was that the design of the exp. didn't allow the observation of any decay within 3.3 sec of an item being presented.
- Therefore, it's thought that:
 - decay occurs at short retention intervals and interference at longer ones.

Long-term memory (LTM)

- Memory in which information is represented on a permanent or near permanent basis
- **Capacity**
 - Infinite?
- **Duration**
 - Permanent?
- Information is stored in different forms
 - *We will explore LTM in more detail next week*
- But: what other evidence distinguishes STM & LTM?
 - Let's do a quick memory test.
- Try to remember as many of the following words...

Guillotine

Whale

Clock

Guitar

Bottle

Pillow

Orange

Hat

Cushion

Shower

Calculator

Mouse

Bike

Table

Leaf

Pen

Mirror

Sky

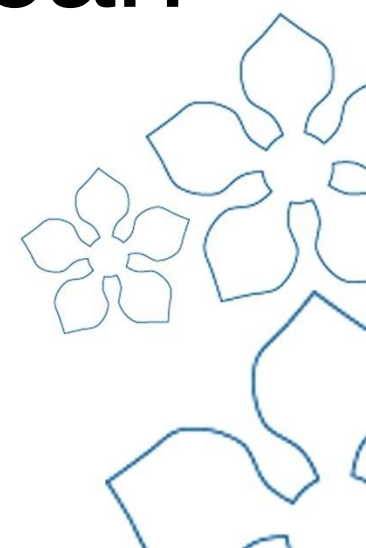
Oven

Box



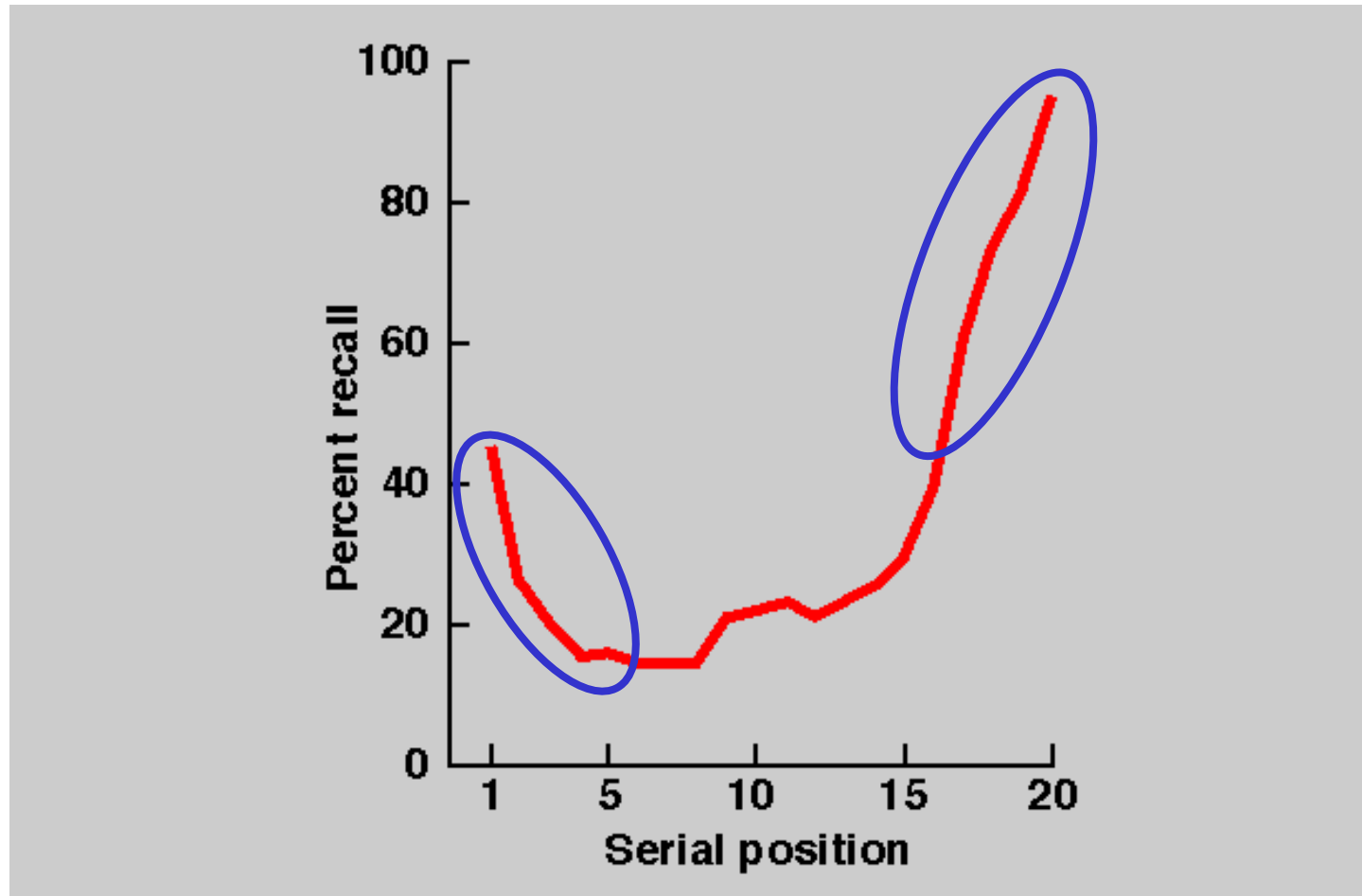
List all the words you can
remember.

Do you notice anything about
which of the words you can
remember?



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Serial position effect



Murdock (1962):

Primacy (rehearsal – transferred to LTM)

Recency (still in short-term memory)

Primacy Effect

- Can be affected by:
- Presentation Rate: Fast-less rehearsal; Slow-more rehearsal
- Word Frequency: Rare-long rehearsal; common-less rehearsal
- Inter-item relatedness: similar = better; different = harder
- List Length: longer = less rehearsal; shorter = more rehearsal

RECENCY EFFECT

- Can be affected by:
- Delaying recall by 10 seconds/introducing a distraction (Glanzer & Cunitz, 1966)
- Anything requiring concentration directly following the end of task.

“Chunking”

- Though STM limited to around 7 items...
- Capacity of STM can be overcome by organisation & rules - "Chunking"
- 0385672635 can become 0385 672 635 –
- Each chunk imposes same memory load as each individual unit.
- Numerous ‘chunks’ may be held in STM
 - Larger number of items in total
 - Larger ‘working’ capacity in short-term store



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Problems with Multi-store model

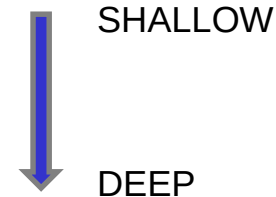
- The model is too simplistic:
 - Assumes STM & LTM are separate unitary structures:
 - BUT: Remember our “Chunking” example – LTM can assist STM with tasks (not just a one-way stream from STM to LTM).
 - Assumes information can only be transferred to LTM through rehearsal.
 - BUT: Rehearsal does not guarantee transfer of information to LTM.
- Phonological code only? What about visual code?

Levels of processing: Craik & Lockhart (1972):

- Transfer of info to LTM is dependent on the level/degree to which it is processed in STM.
- There are 2 types of rehearsal:
 - Maintenance: simple repetition of info, passive, less likely to lead to LTM. (Shallow processing)
 - Elaborative: Attends to meaning, forms associations, more likely to lead to LTM. (Deep Processing)

CRAIK AND TULVING (1975):

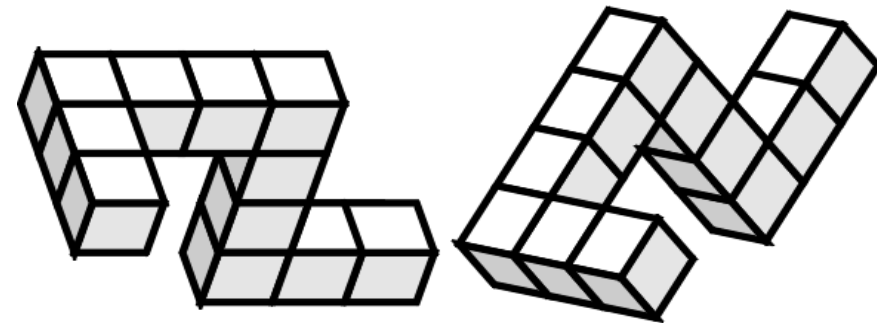
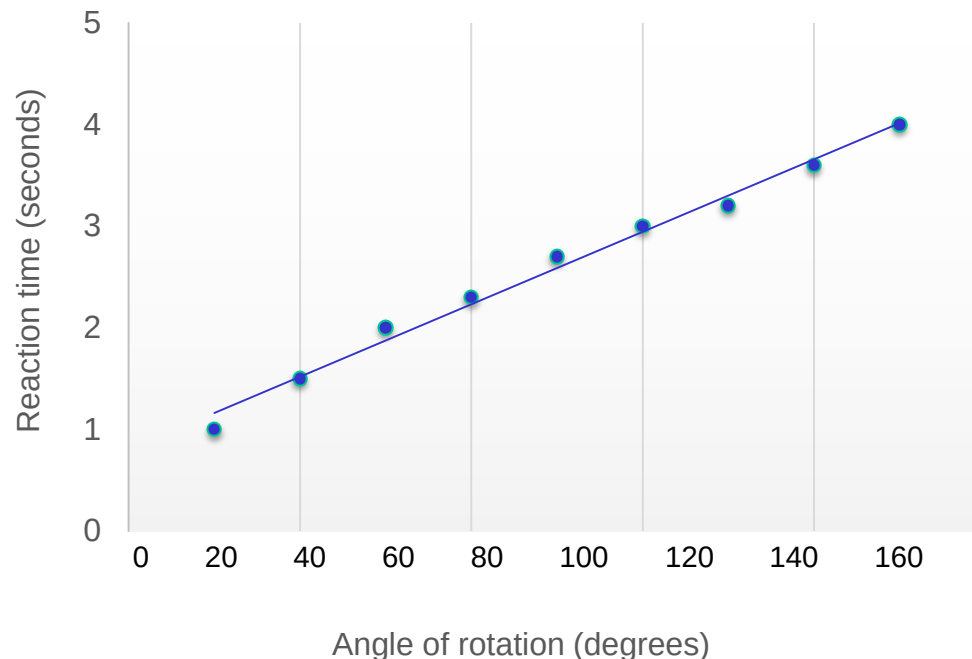
- ▶ Ps asked questions about a series of words: e.g., SPEECH, BRUSH, CHEEK, FLOUR
 - ▶ Is the word in capital letters? (Visual)
 - ▶ Does the word rhyme with.....? (Acoustic)
 - ▶ Does the word fit in to the following sentence....? (Semantic)



Deeper Processing through Elaborate Rehearsal is more likely to lead to info being transferred to LTM & subsequently recalled.

Is storage in STM only acoustic?

- It was thought that STM relied on auditory codes alone.
- Shepard & Metzler (1971): Conducted an experiment requiring Ps to mentally rotate objects.
 - Found that the more an object was rotated from the original the longer it took to recognise.
 - Verbally formatted codes would not have a linear dependency on reaction time.
 - Suggested that info must also be encoded visually in the “mind’s eye”



Neurological evidence

Patients with damage to particular areas of the brain, show “Double dissociation”: deficit performing 1 type of task but not another.

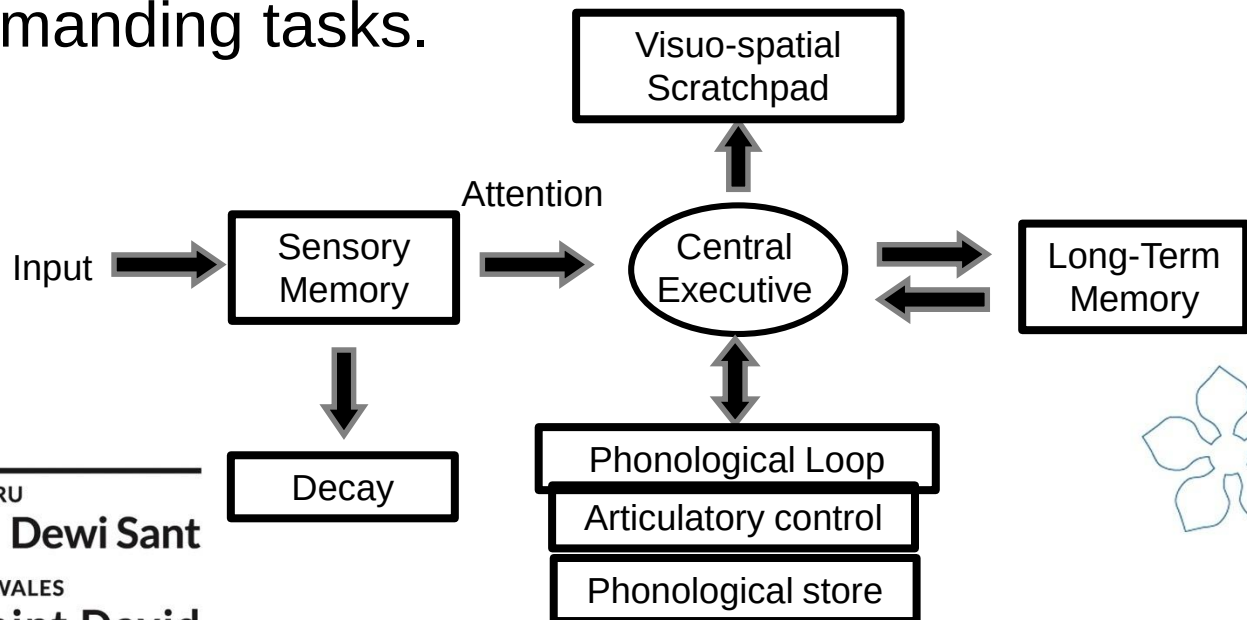
The case of Clive Wearing: Life without memory: Unable to remember for more than a few minutes at a time: <http://www.youtube.com/watch?v=Vwigmktix2Y>

- ▶ **Patient HM**
- ▶ Underwent surgery to hippocampal area of brain to control severe epileptic seizures.
- ▶ During surgery front half of both sides of hippocampus & amygdala removed.
- ▶ After Surgery: Had normal STM span & memory for events before surgery were intact - suggesting normal STM & LTM function:
 - ▶ BUT: unable to transfer new info in to LTM (known as Anterograde Amnesia).
- ▶ **Patient KF – Shallice & Warrington (1970):**
- ▶ Damage to the temporal parietal lobe of the brain
- ▶ Intact LTM
- ▶ But profound STM impairment – digit span of only 2
- ▶ STM deficit was limited to verbal material but not to meaningful sounds:
 - ▶ **Suggests not just one single STM unit!**

Alternative Model: working memory

(Baddeley & Hitch, 1974; Baddeley, 1986; 2000)

- Multiple sub-systems within STM, seen as a set of processes rather than static unitary structure
- Acts on material we have just encountered & allows us to manipulate it.
- Plays an active role in learning & is involved in performing resource demanding tasks.



Working Memory: Dividing STM

CENTRAL EXECUTIVE

- Modality free
- Uses PL and VSS as slave systems

PHONOLOGICAL LOOP

- Holding information in phonological form (speech based)

VISUO-SPATIAL SKETCHPAD

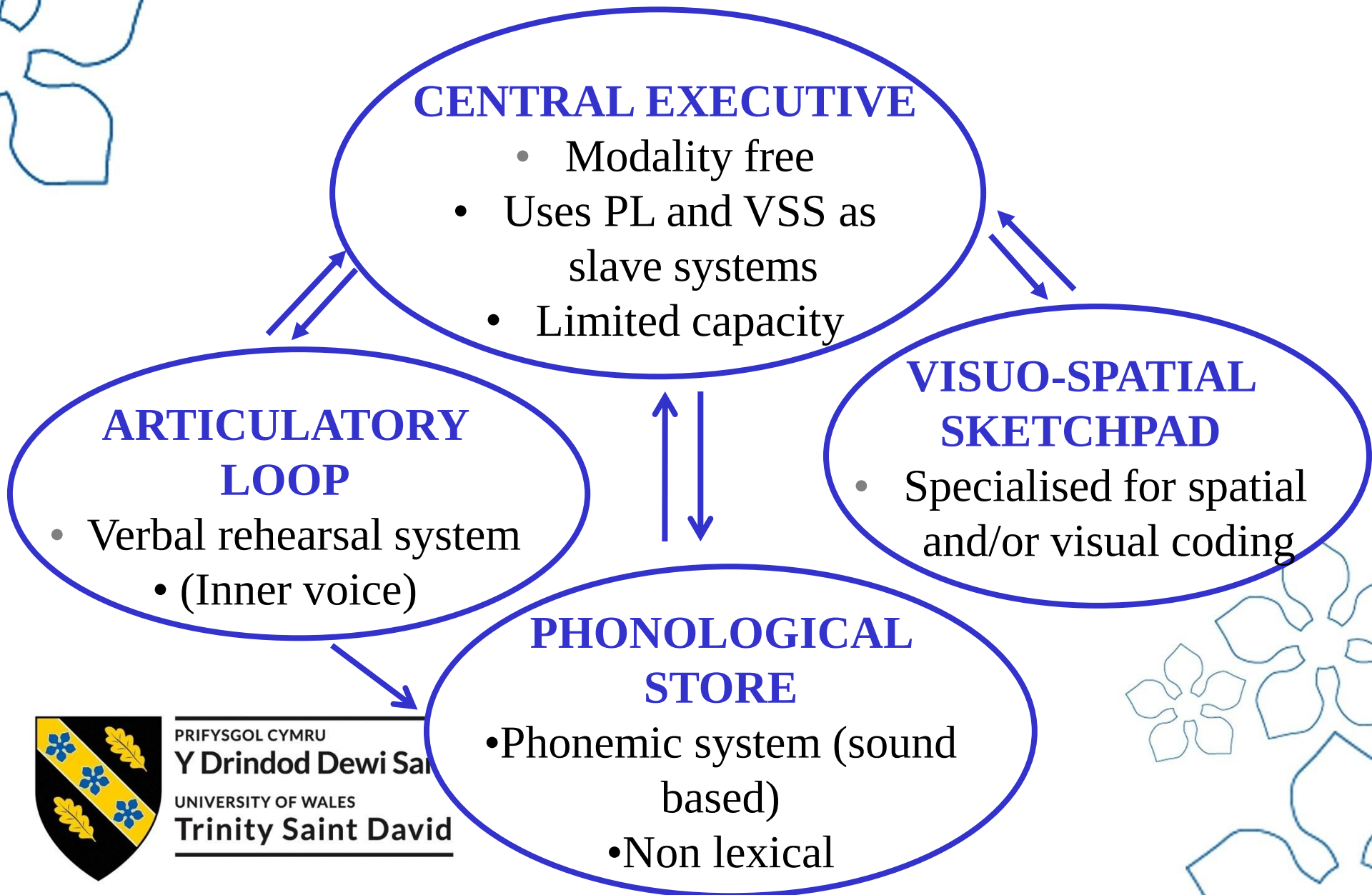
- Specialised for spatial and/or visual coding

How many windows are there in your house?



- To set up and manipulate the image we need the...
 - Visuo-spatial scratchpad
- To sub-vocally count the number of windows we need the...
 - Phonological loop
- To organise the whole operation we need the...
 - Central executive

Working Memory: Dividing STM



Separating the components

- Assumption that separate components:
- **Dissociation** between components via suppression/disruption:
- **Visuospatial Sketchpad** – visual suppression
 - E.g. Pressing keys clockwise
- **Phonological loop** – phonological suppression
 - E.g. Task to speak word (e.g. 'the') repeatedly
- **Central Executive**
 - E.g. Random number generation (planning)



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Separating the components

Dual task methodology:

- Tasks using same component disrupt
- Tasks using different components disrupt less
- Can test through various versions of dual-task



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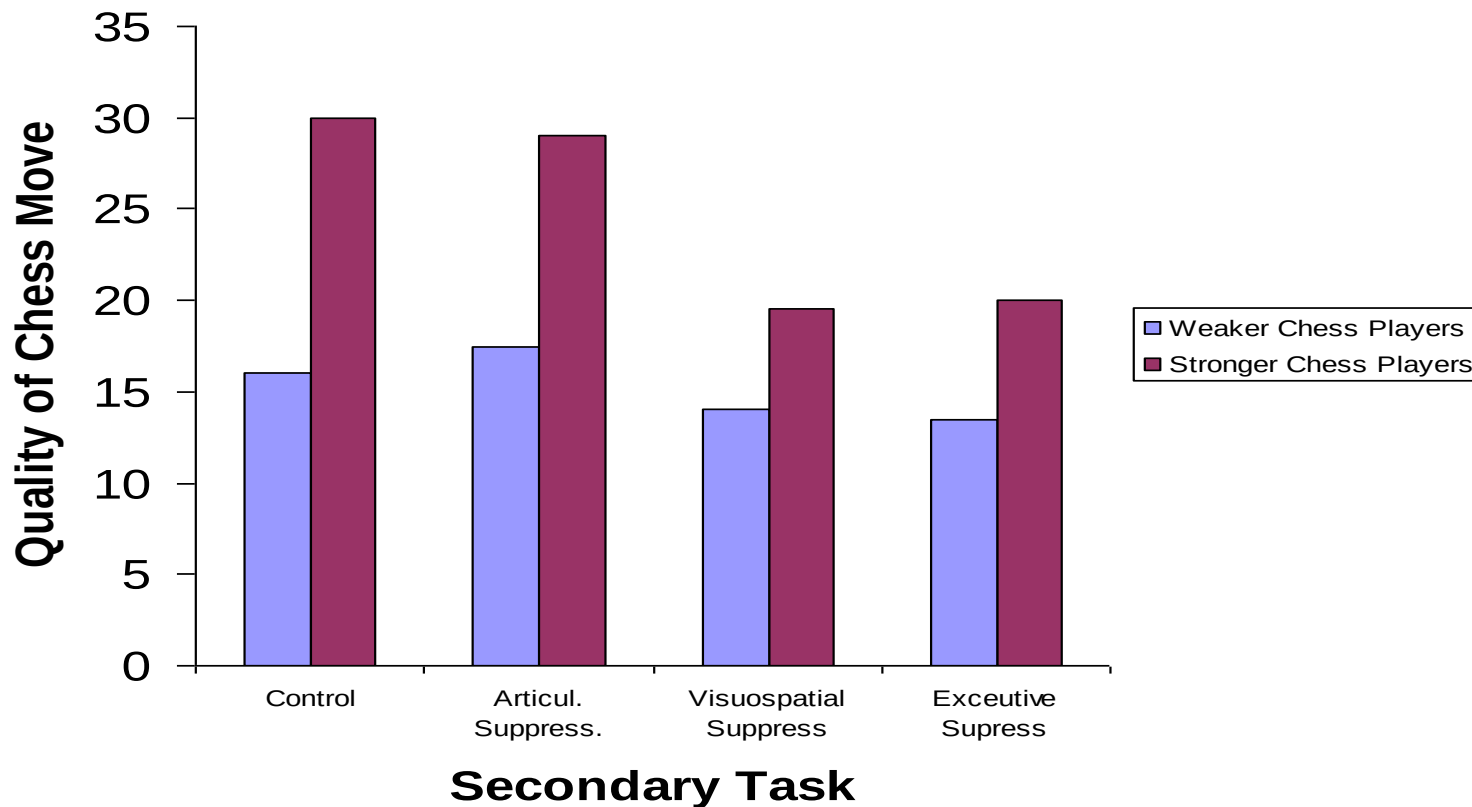
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Robbins et. al. (1996)

Chess move task + secondary task

- Visual task disrupts visual working memory necessary for chess
- Verbal task (phonological) does not disrupt visual information in visual working memory



Evidence for components

- Phonological Store:
 - Phonological/acoustic similarity effect (Conrad & Hull, 1964)
 - Similar sounding items = worse serial recall
 - E.g. D, V, C, P... lower than X, D, S, M... etc.
 - Supports acoustic (sound) form of store
 - Similar items interfere in encoding
 - Phonological loop is interested in sound and not meaning.



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Pit, Day, Cow, Pen, Top
VS.
Mat, Map, Can, Man, Cap
VS.
Huge, Big, Wide, Large, Tall

Evidence for components

- Articulatory loop:
 - Word length effect (Baddeley et al., 1975)
 - Longer words in list = lower items recalled E.g.:
 - cat, shoe, log, car vs.
 - helicopter, university, calibration, antibiotic
- Supports: time based articulation
 - Longer words = longer to articulate each
 - Some items not (or less) rehearsed
 - More time for each item to decay in STM



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Neurological support

- Henson, Burgess & Frith (2000) fMRI scan supported separate areas for Phonological Store and Articulatory Process
 - Phonological store: Left interior parietal area
 - Articulatory process: Left prefrontal lobe area



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Visuo-spatial sketchpad

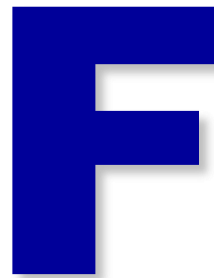
- Visual secondary tasks disrupt tasks that require holding visual information (e.g. Robbins et. al.; 1996) but not verbal suppression
- Possible that some deficits associated purely with spatial working memory
 - Williams syndrome (Jarrold et. al.; 2007)
- Separate components proposed for:
 - Spatial information
 - Form and colour information (visual)
 - (Logie, 1995)



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Visuo-spatial sketch pad

- Tasks to examine this type of processing (Brooks, 1968):
 - Participants asked to mentally scan and classify each corner of letter as involving (or not) a line directly connected to either top or bottom lines by stating 'yes' or 'no' as they mentally scanned the object



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Visuo-spatial sketchpad

- Task had 2 conditions (Brooks, 1968):
 - **Speak** each choice 'yes' or 'no'
 - **Point** to words 'yes' or 'no'
- Worse performance in pointing condition
- Interpretation: Pointing uses some capacity of a visuo-spatial processing system
- Verbal response **not** interfere with task
 - Separate processing system
 - **Dissociation** between the verbal and visuo-spatial



Central executive

- Control mechanism in WM system
- Operating the other parts of the WM system
- Has been compared to concept of 'attention'
- Dysexecutive syndrome (Baddeley, 1996)
 - Neurological frontal lobe damage
 - Difficulty directing memory process
 - Planning, changing tack, new problems
- Tasks such as counting backwards in 3's
 - Require attention to information
 - But hard to dissociate from other components (visual/verbal) during tasks (Towse, 1998)



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More recent addition

- Episodic Buffer (Baddeley, 1996, 2000):
- Aimed at function difficult to account for in central executive
 - CE control but not storage?
 - EB provide storage and integration from other systems (visual and phonological)
 - Combining information into one form of code (as opposed to verbal/visual)
 - May pass information to LTM



Summary

- Structural accounts of memory
 - Lead to distinction of short-term store
 - Processes interact with the 'store' account
 - Attention
 - Rehearsal
 - Early accounts of unitary STM
 - Working memory model dissociated different components and their function
 - Phonological and Visual subsystems
 - Control system in Central Executive
 - Episodic buffer to hold and integrate information
- Theories regarding forgetting in STM
 - Decay and Interference



Next week...

Long-term Memory

Reading: Eysenck, M. W., & Keane, M. T.
Cognitive psychology: Chapters 6 & 7



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