

## How People Learn: Final Exam Revision

### Kahneman's System 1 (Intuition) and System 2 (Attention) Thinking Model :

- **System 1** (Type 1 processes):  
*Operates **fast and automatically**, requiring little or **no** voluntary **control**. System 1 is involved in **physical movement** (riding a bike), **cognitive tasks** (assigning meaning to words) and **emotional reactions**. (PEC)  
It uses heuristics and makes predictable mistakes. It is **confident** in its judgments.*
- **System 2:**  
*Involves **mental effort** and **attention**. It is **slow** and uses **logic** and **reason**. It provides justification for judgement after an event.*
- **Predictable errors of problem solving heuristics :**  
*System 1 operates heuristics which allows you to come to quick judgement without carefully considering all the evidence or following a structured reasoning process.  
In learning terms, **if we want to ensure** that we **maximise our learning** in any given situation, **we need system 2** to be involved in making the decisions as to how to proceed.*
- **"Lazy controller" :**  
*If System 2 is 'the controller', in the words of Daniel Kahneman it is 'the lazy controller': System 2 seems to **avoid kicking-in** when possible, and will take a break and let System 1 take over if it can. So, while we are capable of doing "slow" thinking, **our tendency is to rely on our fast intuitions**. This means that System 1 is hugely powerful – all day, every day, it is busily making judgements and decisions below the surface of our own awareness. In fact Haidt argues that one of the functions of System 2 is that it uses its rational capacity to justify judgements made by System 1; in other words, **we often make the judgement intuitively and then afterwards come up with reasons as to why the judgement was correct**.*

### Long Term Memories :

- **Explicit/Declarative Memories (Things you remember that you know you remember) :**  
*Memories of things we can explicitly describe or 'declare', like remembering the day you first went to school. It is relatively easy to describe what it is that we remember.*
  - **Episodic Memories (First time you learned to ride a bike) :**  
*A memory of an episode or personal story. You can consciously describe and recall it.*
  - **Semantic Memories (Names of bike parts):**  
*Memories of meanings, facts or general knowledge. The word 'semantic' means 'related to signification or meaning'. Very often it is semantic memories that are the focus of learning and assessment in schools, and universities.*
- **Implicit Memories (Things you remember but don't know you remember) :**
  - **Procedural Memories (Steering a bike):** *Learned skills of a procedure*
  - **Emotional Memories (Fear of falling off a bike):** *Feeling an emotion when an event might happen, even though you don't remember the first occurrence of a similar event.*

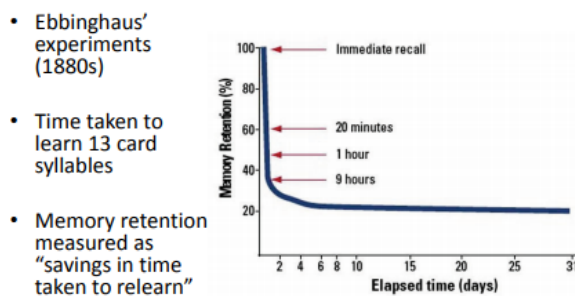
## Ideas:

- **Discrete Ideas:** *Facts and propositions.*
- **Schema:** *Ideas organised and related to each other.*
- **Mental Models:** *Sets of interrelated schema that can be used to make predictions (if this, then that).*

## Storing Explicit Memories:

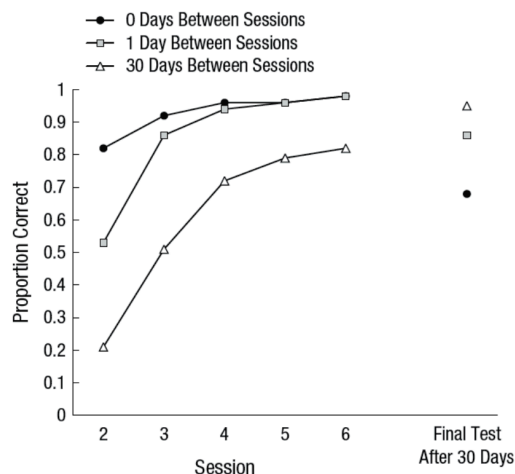
- **Prior Knowledge:** *Activate prior knowledge before dealing with a topic in order to better assimilate new information. Example: A group of young learners are going to read about dolphins. First they talk about what they already know in a brainstorm activity.*
- **Prior misunderstandings ?**
- **Concept Maps (Organise & Link for LMT Storing) :** *Organised ideas allow for rapid retention of new material. Graphical representations of knowledge. They create a **hierarchy** between elements, with **named connections** between each of them, which are sometimes in the form answers to a question. i.e. Long term memories **include** implicit memories **such as** procedural memories **which make** System 1 mental processes.*
- **Ebbinghaus' Forgetting Curve :**

### We rapidly forget



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- **Role of Repetition in Learning :**

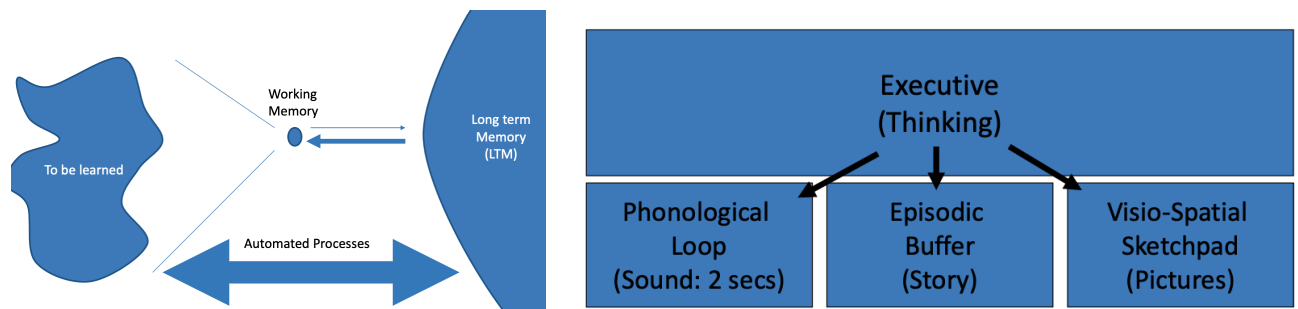


- **Repetition:** *a key process for storing in the long term memory.*
  - **All repetition has an effect.**
  - Research Evidence: *Experiment with repetitions spaced over 1 day, 6 days, and 6 months.*
  - *Long-term memory was best aided by longer spacing.*
- **Spaced Repetition:** *Repetition of a skill or knowledge spread over a period of time. It is in contrast to 'mass practice', in which a number of repetitions happen around the same time. **Spaced repetition is the best for memorisation.***
- **What can we remember? P-R-O-L-E :**
  - What we **Practice** remembering
  - What we **Repeat**
  - What we **Organise**
  - What we **Link** to other ideas/ experiences
  - What is **Emotionally** forceful

### **Recalling Memories (When Needed):**

- **Mnemonic:** *Associate **original** information with something more accessible or **meaningful** - which, in turn, provides **better retention** of the information. Common mnemonics include short poems, acronyms, memorable phrases.  
**The human mind remembers "relatable" information instead of abstract or impersonal forms of information.***
- **Two Types of Remembering:**
  - **Controlled Recall:** *Active process of spreading activation. Aided by deep processing of ideas. Requires attention.*
  - **Spontaneous (Cued) Recall:** *No active monitoring. Idea "pops into your mind". Does not require attention.*
- **Forward and backward-looking memories:**
  - **Retrospective Memories:** *Remembering past episodes and meanings.*
  - **Prospective Memories :** *Remembering to remember something in the future. **Visualizing** ourselves whilst performing the future action may help us to remember it. We use **visual** and **verbal codes**.*
  - **Practiced recall:** *For a given subject, write on a blank page all that you can remember about it, before re-reading your notes.  
**Testing** (and not studying) **is the critical factor for promoting long-term recall.***
  - **Recall of Mentally Re/Constructed Memories of Past Events:**  
*The reconstructive process of memory recall is subject to **distortion** by other intervening cognitive functions such as individual **perceptions**, **social influences** and **world knowledge**, all of which can lead to **errors** and **missing details**.*
- **Recall and context:** *Recalling information is poorer when tested in a different context than the one in which it was learned. (Conceptual, Emotional, Geographical contexts.).  
**Learning in multiple contexts and conceptual schemas increase the recall of information.***

## Attention and Working Memory:



- **Working Memory Model (Baddeley and Hitch) :**

- Working memory is a **brain function**, not a physical location. It's a **system for managing attention**.
- It involves focusing and has a very limited capacity (~4 'slots'). If something takes your attention, it will eject things out of your working memory.

- **Components :**

- **Central Executive:** Decision making process; allocates attention.
- **Phonological loop:** holds circa 2 seconds of **sound**.
- **Episodic Buffer:** integrates sound and image into **narrative**, begins process of transfer to LTM.
- **Visio-Spatial Sketchpad:** holds memory of images.

- **Attention:**

Working memory allocates attention.

- Prior knowledge (or schema) is used to filter out unimportant information.
- Two Types of Attention:
  - **Controlled Attention:** Choose what you pay attention to and what you ignore. It is central to studying.
  - **Stimulus Driven Attention:** Things that unexpectedly take your attention. i.e. A loud noise, a scare, an unusual event.
- **Miller's magic number: 7+- 2** is the number of discrete things that we can memorise in the working memory. Recent research states that it is actually only 4.
- **Memory Palace technique :** We build a complete memory piece of a palace with rooms and we make a very precise description of it, including the location and/or our interaction with the elements we want to remember. i.e. **The door handle is a banana.**
- **Chunking :** Breaking things into chunks makes them easier to remember. i.e. Organise a sequence of numbers into groups in order for them to look like phone number. It is much easier to remember 4 chunks of numbers instead of 14 individual digits.
- **Cognitive Load :** Cognitive load is the total of **attentional resources** being occupied by the new information that we are currently processing. It is the way information or tasks are presented to a learner. For instance a really complicated exam question with obsolete details vs a question going straight to the point with minimal details.

- **Overcoming Cognitive Load:**

- *Use examples*
- *Use dual channel/dual mode (for instance text and imagery)*
- *Keep words close to relevant images (contiguity)*
- *Reduce useless information*
- *Provide cues (pitch and tone of voice, facial expressions, hand gestures)*
- *Show progression*

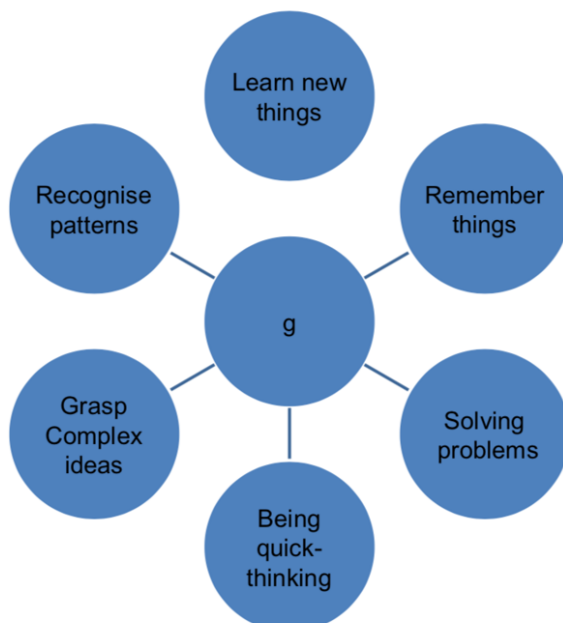
## **Being 'Bright' - Intelligence:**

- **Intelligence :**

- *Ability or abilities to **acquire** and use knowledge for **solving problems** and **adapting** to the world. **Cognitive function** associated to a certain part of the brain.*
- *Intelligence is related to school attainment. It is usually measured using pencil and paper tests as well as one-to-one interviews. It measures the range of learning and problem solving skills. Its properties emerge from statistical test. It is scored based on the norm for a population. It tries to use culture-free tests.*

- **'g' (general intelligence/mental ability) :**

- *It is a variable that summarises **positive correlations** among different cognitive tasks, reflecting the fact that an individual's performance on one type of cognitive task tends to be comparable to that person's performance on other kinds of cognitive task.*
- **Learn/Remember/Solve/Think quickly/Grasp complex ideas/Recognise patterns.**



- **IQ (methods of scoring IQ tests) :**

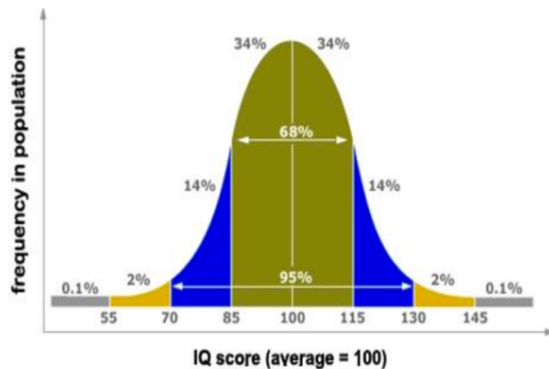
- Original Measure = mental age/actual age x 100.
- Average Score = 100.
- Standard Deviation = 15.

- **Question: What is a score of 70 in terms of IQ?**

*A score of 70 is two standard deviations below the mean score for the population.*

**Alternative answer:** *A score of 70 is in the lowest scoring 2% of the population.*

**Partially correct answer:** *mean of an IQ test is 100, standard deviation is 15.*



Stern Scoring Method

- **Correlation:** In any collection of test items that make up an IQ test, the score that best measures *g* is the **composite score** that has the **highest correlations** with all the item scores. Typically, the "g-loaded" composite score of an IQ test battery appears to involve a **common strength in abstract reasoning across the test's item content**.

- **'Culture free' IQ testing:** In order to circumvent language issues, we need to do 'culture-free' tests. IQ tests are often criticised to be **bestist** (only select the top performers), **westist** (favoring the western culture) or **testist** (new tests are always used to classify people and put them into boxes)

- **2 Component of Intelligence (Cattell):**

- **Fluid intelligence (Raw processing) :**

*The capacity to **think logically** and **solve problems** in **novel situations**, **independent of acquired knowledge**. It involves the ability to **identify patterns and relationships** that underpin novel problems and to **extrapolate** these findings using logic. It decreases slowly after 18 years of age.*

- **Crystallized Intelligence (Learned learning & solving skills):**

*Ability to **use skills, knowledge and experience**. It relies from **accessing information** from long-term memory. It increases with age.*

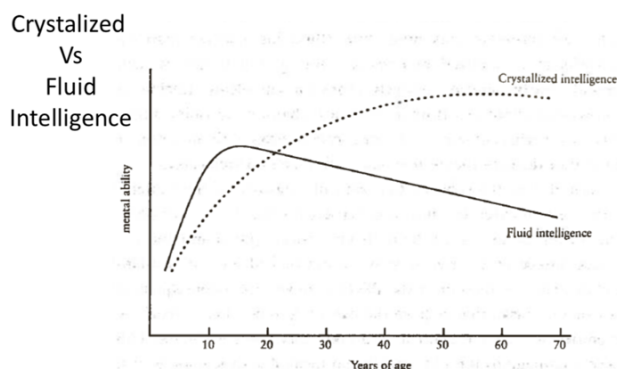


Figure 1.2. Schematic rendering of fluid intelligence and crystallized intelligence over the life span. From Cattell (1987).

- **3 Levels of Intelligence (Carroll):**

- **General intelligence ('g')**

- **Broad abilities:** 8 broad abilities - fluid intelligence, crystallized intelligence, general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness, and processing speed.

- **Specific intelligence:** More specific factors under the broad abilities.

- **Correlation between academic attainment and IQ :**

- "Intelligence tests...do in fact **predict school performance fairly well**; the **correlation** between IQ scores and grades is about **0.50**. Note, however, that correlations of this magnitude account for only about **25%** of overall **variance**" (Neisser, 1996) .

- People tend to learn more quickly but it is practice that determines our overall performance.

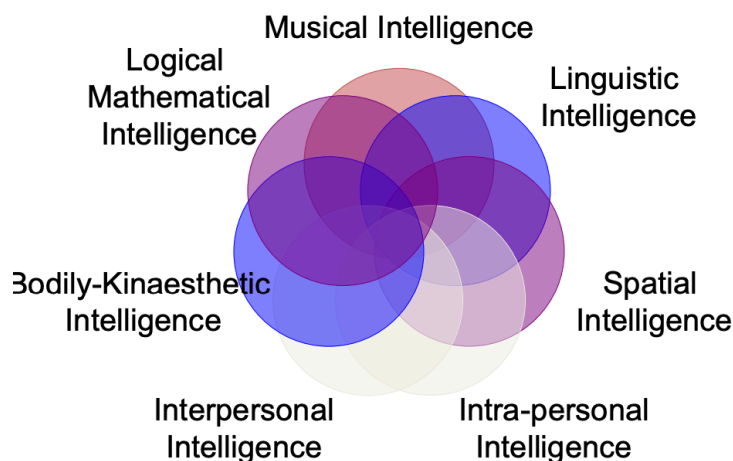
- **Genetics and IQ (Twins Studies) :**

*In order to test if genetics influences IQ, we test the following groups:*

*The same person tested twice (87%), Identical twins that grew up together (86%), identical twins that grew up apart (76%), non-identical twins that grew up together (55%), siblings that grew up apart. (26%). This test was performed in Minnesota, and we note that the adoption conditions in the united states are very strict, so even if the siblings grew up apart, they most probably grew up in the same social environment. In Europe and France, the system is different and we spot greater differences between siblings that grow up apart.*

- **Flynn Effect:**

*Richard Nisbett summarises a number of studies that question the lack of cultural bias in tests like the Raven's matrices. He points out that IQ scores have been rising every decade since the 1950s, so much so, that **tests are periodically re-scored downwards** (this is called 'the Flynn effect' as its implications were first teased out by the political scientist Jim Flynn). Between 1947 and 2002, average scores on the Raven's matrices rose from **100 to 128**. Since it is hard to imagine a biological change of that magnitude in the space of two generations, it suggests that the changes are more likely to be **cultural than physical** in origin. He argues that the type of **tasks** that children now routinely do in school, the **skills** required by certain types of video games, and the **focus** on teaching children to maintain attention in schools all are likely to contribute to improvements in the Raven's matrices scores.*



- **Multiple Intelligence (Gardner) :**

- *Intelligence means the cognitive ability that is valued and has a basis in the biology of the brain.*
- *We do not have a general intelligence ('g') but we have multiple intelligences ('MI').*

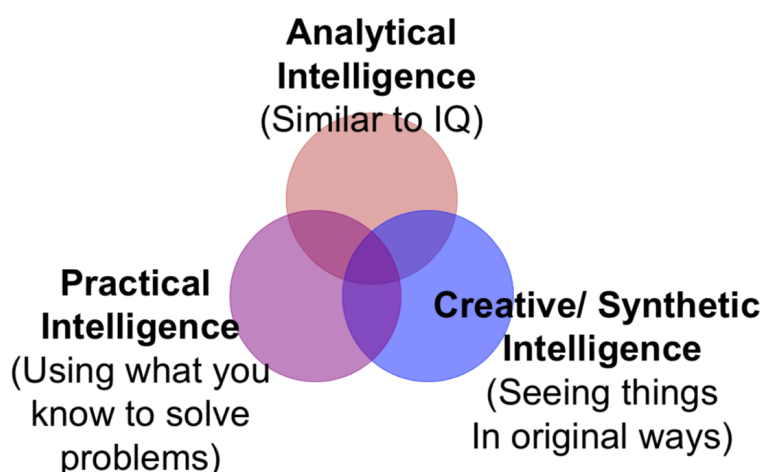
- **7 Types of Intelligence (S-L-I-M-B-I-L):**

- **Musical Intelligence**
- **Linguistic Intelligence**
- **Spatial Intelligence**
- **Intra-personal Intelligence:** *Understanding our own self and our emotions.*
- **Interpersonal Intelligence:** *Understanding how others feel and how we can adapt ourselves to them.*
- **Bodily-Kinaesthetic Intelligence:** *Knowing how to use our bodies to perform well. (i.e. professional athletes.)*
- **Logical Mathematical Intelligence**
- *It values more types of skills than traditional intelligence, but does it value things that aren't intelligence but talents?*
- *It doesn't limit to things that can be measured using paper and pen tests but if things can't be measured in such a way, are they still intelligence?*
- *Are there more than 7? But is 7 too many?*

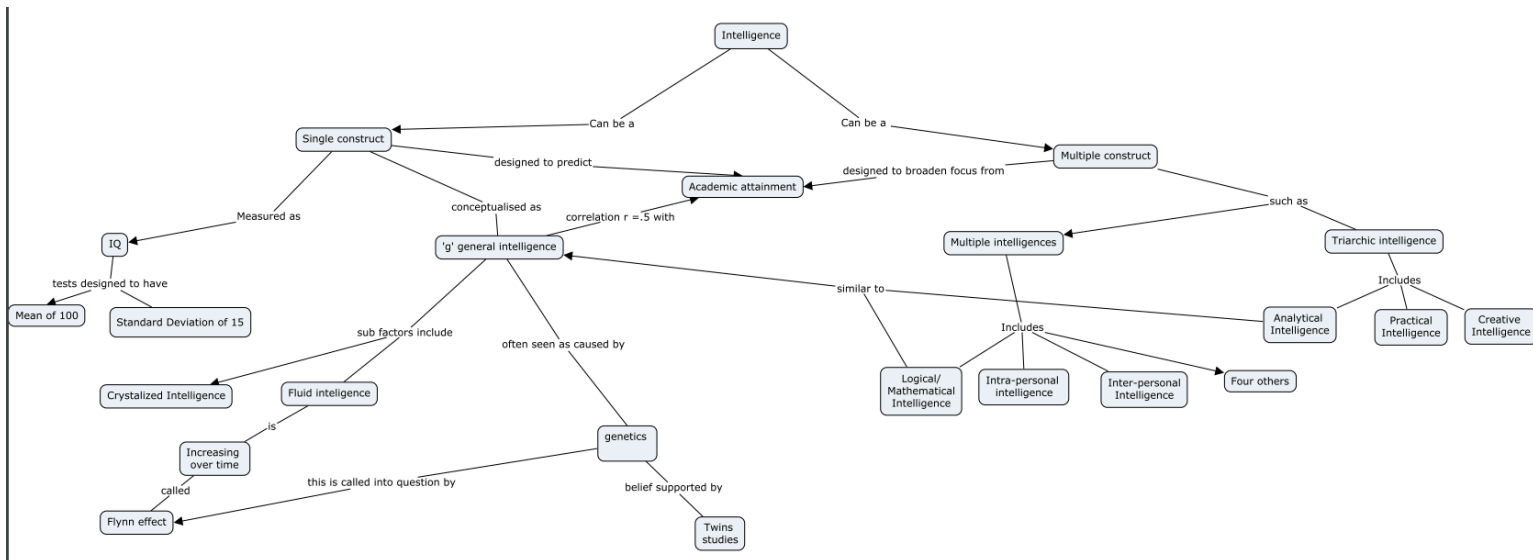
- **Triarchic Intelligence (Sternberg) (C-A-P):**

- *Intelligence means underlying mental abilities used to solve real-life problems.*
- *Analytical Intelligence (~IQ), Creative/Synthetic Intelligence (seeing things in different ways), Practical Intelligence (using your knowledge to solve problems).*
- *It values more types of skills than traditional intelligence, but they look more like traditional intelligence skills than Gardner's ideas.*
- *It uses pen and paper tests.*
- *The available tests do not meet the criteria for being accepted as a psychological test.*
- *The ideas have not been as widely applied as Gardner's.*

Model de Robert Sternberg







## Learning:

### • Learning Styles:

#### • Perceptual styles (VAK):

- Visualisers
- Verbalisers (auditory)
- Tactile learners (kinaesthetic)

#### • Thinking Styles:

- Serialist (subtasks) vs holists (complex whole)
- Conceptual vs. applied thinkers

#### • Learner in Context Habits:

- Deep
- Surface
- Strategic

### • Quantitative Social Research Methods:

#### • Experiments:

- Control for non relevant factors by selection of participants
- Non-realistic situations
- Allows observations
- Smaller numbers
- Test Hypotheses

#### • Surveys:

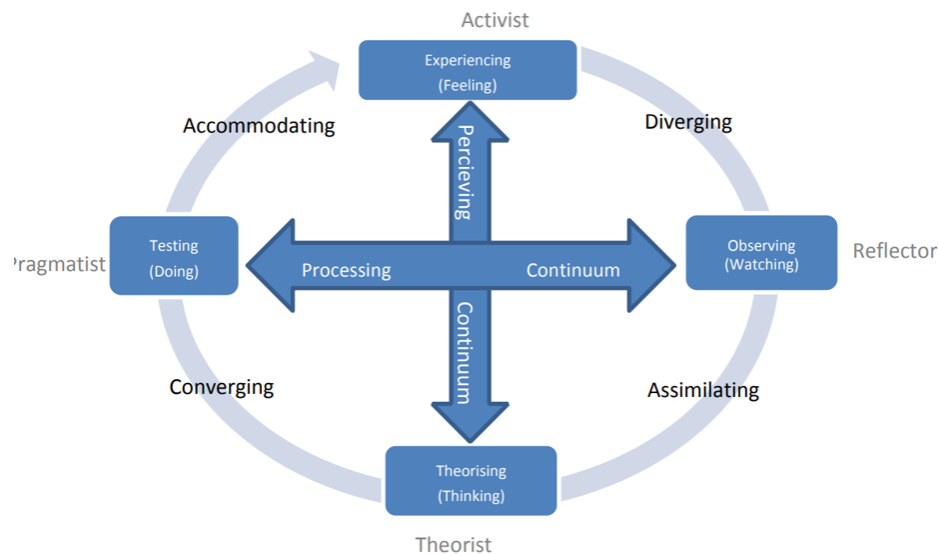
- Control for non-relevant factors by large numbers - analysis of said factors
- Real-life questions
- Claims about population can be made for a randomly selected sample
- Relies on self-reports
- Used for large numbers
- Used to develop and test hypotheses

### • Meshing Hypothesis about Learning Styles:

For some, the goal is to identify a person's learning preferences in order to seek to match teaching to their learning preference (this is called the meshing hypothesis: **a person will learn best when the teaching they experience matches their learning style**).

- **Kolb's Active Learning Cycle :**

- He recognised that some students seemed to prefer activities (exercises) to more formal lecture type learning.



- **Model of Experiential Learning:** it involves **four stages**: a stage of concrete **experience**, a stage of **observation** and reflection, a stage of formalising/**theoretising** 12 abstract concepts and generalisations and a stage of **testing** these conceptions. (**Experience-Observe-Theorise-Test**).
- People develop preferences for how to learn in one of **four quadrants (D-A-C-A)**:
  - **Diverging Style:** (Feeling and Watching) emphasises **concrete experience** and **reflective observation**, tends to **prefer watching over doing**.
  - **Assimilating Style:** (Watching and Thinking) prefers **abstract conceptualisation** and **reflective observation** and likes to **reason** things through and to generate their own **theories**.
  - **Converging Style:** (Thinking and Doing) prefers **abstract conceptualisation** and **testing ideas** in practice, likes **problem solving**.
  - **Accommodating Style:** (Doing and Feeling) prefers **concrete experience** and **trying things out**; solves problems in **intuitive, trial-and-error** fashion.
- Although Kolb developed a test to assess these four learning styles, it is generally not regarded as having a high degree statistical validity and reliability.
- **Assessing Learning Styles:**
  - **Reliability:** Do you get the same answer if you give the test a number of times to the same person at different time intervals? (Cronbach's alpha).  
If the test is good, we should expect it to give the **same score for the same person**. This is called **reliability**. To test that, Cronbach developed a method called **split-half reliability** which involves randomly splitting a scale into two and comparing the two halves. If the two compare reasonably well, then it can be concluded that the scale is reliable. Cronbach's alpha is scored from **0 to 1**, with scores **closer to 1** being **regarded as more reliable**. For many types of test a **cut-off point of 0.7 or higher** is regarded as **desirable**, though for **intelligence tests 0.8** is often required. **0.7 is the minimum cut off point expected for psychological scales with more than 3 items**. This scale is therefore **reliable enough for broader use**.

- **Validity:** Does it assess what it says it assesses?

- **Factorial validity:** If different items measure the same underlying feature, are they correlated?
- **Face validity:** Does it look like it measures what it says it measures?
- **Predictive validity?:** If the theory says people who score well will also score highly on something else, do they?
- **Example of Validity Assessment :** This can be done by asking a panel of participants to rate how well the scale item assesses an underlying factor. If items look like they **assess what they are supposed to assess** then the scale is said to **have face validity**.

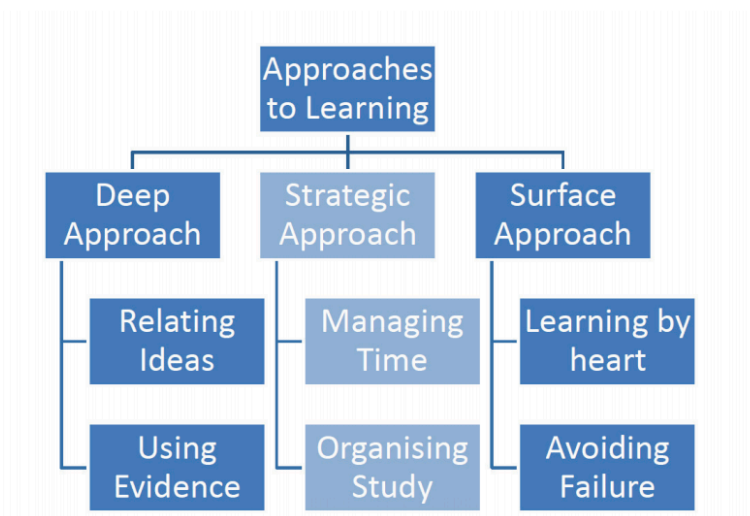
A second validity test is more statistical: given the scale design, the researcher would expect that the scores for items 1, 3 and 5 (same scale) would be highly correlated with each other and that, likewise, the score of items 2, 4 and 6 would be highly correlated. If this is the case, then we can conclude that the scales do **actually assess the underlying factor that they claim to assess**. In other words, it can be concluded that the scales have **factorial validity**.

Two more complex procedures for doing this are called **exploratory** and **confirmatory** factor analysis. If 1 (and the other) is not correlated with 2 or 4 or 6 (elements of other scale), then we can conclude that the **scales measure factors which are distinct from each other** – in other words that they have **discriminant validity**. (Although discriminant validity is an important idea, it is sometimes neglected in practice by researchers).

If a scale does a good job at predicting such outcomes in practice, then it can be said to have **predictive validity**: person who has a verbal style would learn well when things are taught verbally and learn less when things are taught visually.

- **Is there value in learning style questionnaires?**

A reliable and valid instrument which measures learning styles and approaches could be used as a tool to encourage self development, not only be diagnosing how people learn, but by showing them how to enhance their learning”



- **Deep, Surface, Strategic Approaches to Learning :**  
**Depend on context and experience**

- **Deep Approach:** See students **seeking to understand** ideas by relating course activities and content to their own experience, engaging with and evaluating evidence, looking for **patterns and underlying principles**, seeing how specific ideas are linked to broader theories and hypotheses, **searching for meaning** and doing so with a sense of intrinsic motivation.
- **Surface Approach:** Involves **completing assessments with minimum effort**, memorisation of information, accurately reproducing what teachers say, while **motivated only by the grade**. The argument here is that we should not be trying to match teaching to learning style, but **should instead be teaching in ways that encourage a deep approach to learning**.
- **Strategic Approach:** While a surface approach involved trying to do the minimum necessary to pass, a strategic approach was focused on **maximising grades and attainment through identifying the course goals and requirements** and managing time and resources to address them.

## **Personality and Learning:**

- **Personality :**

- *Personality consists of personal characteristics: It is the person in the situation that is being described.*
- *Personality is relatively stable, it changes with time but not always. It is dynamic.*
- *Personality impacts upon our thoughts, feelings and actions.*
- *Gordon Allport defined personality as “a dynamic organisation, inside the person, of psychophysical systems that create a person’s characteristic patterns of behaviour, thoughts and feelings”.*
- *Maltby et al. highlight that the key features of personality are stability, endurance and importance:*
  - **Stability:** *it is assumed that someone who is confident and sociable in one context will generally be confident and sociable in the other too*
  - **Endurance :** *it is assumed that a person’s personality does not change overnight or from minute to minute.*
  - **Important :** *a person’s characteristic patterns of behaving, thinking and acting are important.*

- **16PF (Surface traits vs source traits) :**

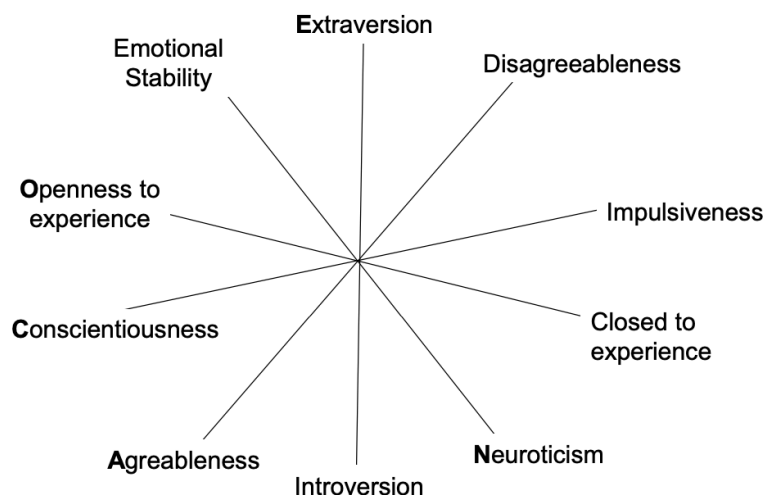
*Raymond Cattell: Starting with a list of **4,500 personality terms**, he made a list of **16 relevant words** to describe personality (removing synonyms(171), through having people rate how important each was and through a further search for missing terms - **46 - known as surface traits**). He used a range of different types of data to see if these **46 traits clustered together**: people who scored high on some of these traits were the same people who consistently scored high on others also. These underlying traits were called **source**. Traits were generally organised in terms of a **continuum** with two opposing terms and with people scoring somewhere between the two. Cattell developed a test called the **Sixteen Personality Factor Questionnaire** (16PF for short) which continues to be used today.*

- **Big five model (Traits vs facets; O-C-E-A-N)** : As Maltby et al. conclude, psychologists “increasingly agree that five supertraits may adequately describe the structure of personality” (2010: 170). The five factors are typically identified as:

- **Openness:** This refers to **openness to new experiences**. Typically it includes questions looking at **how curious** a person is to understand how ideas fit together. It also includes elements on **enjoyment of learning, willingness to consider new ideas and imagination**. Openness can be seen as being related to intelligence - indeed the two constructs are often correlated with each other (i.e., people who score high on one tend to score high on the other).
- **Conscientiousness:** This refers to **self-discipline, control and organisation**. People scoring high on this factor tend to be well organised, consistent in following through with a plan or with staying on task. They tend to want to achieve. Conscientious people often perform well in work situations.
- **Extraversion:** This is a measure of a **person’s sociability**. People who score high on extraversion tend to be energetic, outgoing, friendly, and optimistic.
- **Agreeableness:** This refers to the characteristic way in which **the person engages with others**. Those who tend to be trusting, to value being straightforward, and to care for others score high on agreeableness.
- **Neuroticism:** This is a measure of **emotional stability**. People that are angry, feel vulnerable, or tend to react strongly to emotional situations score high on neuroticism (or low on emotional stability, depending on how you look at it).

O-C-E-A-N

## Big five personality model



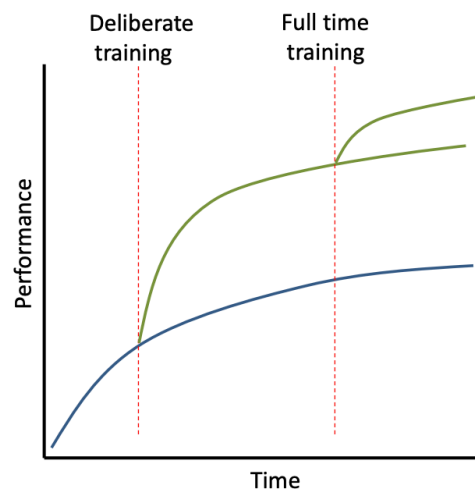
O – C – E – A – N 6

Together, these are often known as the ‘Big Five’.

- **Openness to Experience** : open to new experiences, curious to learn, enjoy learning, playing with new ideas, imagination, aware of own feelings.
- **Conscientiousness** : orderly, organised, disciplined, controlling, reliable.
- **Correlation of Personality Factors with Academic Attainment** :  
 It is evident that **conscientiousness** is the factor most often found to be associated with **attainment** (the mean average population correlation coefficient is  $r = .24$ ).  
 Some studies found that **openness to experience** was associated with attainment, but on average the association was very weak ( $r = .06$ ). **Neuroticism**  $= -.03$ .  
 Personality can explain some of the differences in how much people learn, with **striving** ( $r = .15$  to  $.39$ ) and **self-discipline** ( $r = .18$  to  $.46$ ) as a subset of conscientiousness being associated with attainment.

## Deliberate Practice and Expertise:

- **Expert vs Novice Knowledge** :  
 Experts know a lot . They **organize** knowledge into a schema, this allows recall of blocks ('**chunks**') of information and **quick integration of new material**. Expert performance typically comes after **many years of practice**.  
**Expert Violinist: 10,000 hours = 2 hours 45 minutes per day X 10 years.**
- Performance can improve rapidly in early stages, but often reaches a plateau. This is the **maximum innate ability**. Unless deliberate or full time training is launched, the progress will stagnate.



- **Deliberate Practice** :  
 Highly **structured activities** that are **created specifically to improve performance** in a domain through **immediate feedback**, that require a **high degree of concentration**, and that are **not inherently enjoyable**.  
 We thus need to **identify** our **weaknesses**. It's a question of **deep work** on one's self. It's annoying but we must do it. It should be constructed in a **progressive manner**.  
 First, 30' per day to create a habit and then increase the time slowly.  
**Mastery goals** (objectives) must be fixed to stay motivated and to know why we are studying, but we also need a **feedback system** (score) to evaluate our performance.  
**The key to deliberate practice is the role of the coach/teacher – that is where we turn next.**

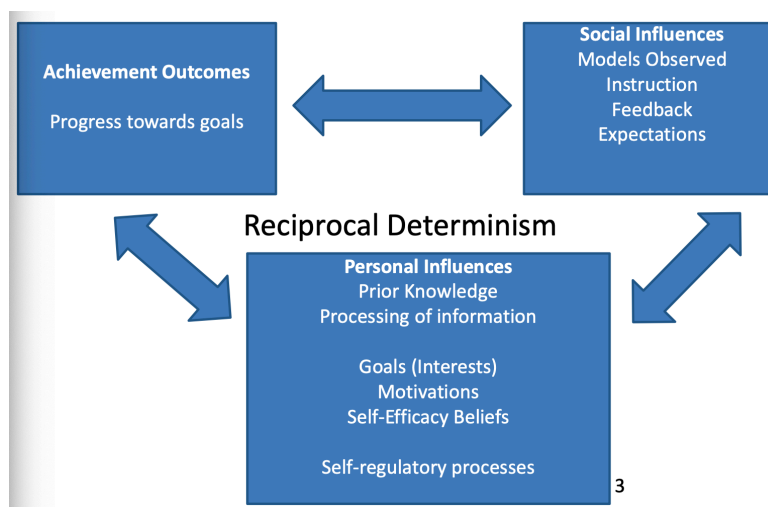
- **Expert Intuitive Judgements:** *The value depends on the person and their experience. Intuition can be the internalized knowledge of an expert, that has been embodied to the point that it is tacit knowledge (**known but not explained procedurally**). Tacit is part of System 1, we do not need to think since we internalised the information. Knowledge can condense a whole history of experience into an at-once understanding and decision.*

- **Correlation of Deliberate Practice with Academic Attainment :**

*Deliberate practice for learning seems to be very efficient and effective if we want to improve ourselves and our performances. ‘Strategic Approach to Learning’ and ‘Conscientiousness’ data point to ‘something’.*

*Studies on expertise suggest the something is ‘deliberate practice’. Also elements of metacognition .*

## The Role of Others in Learning:



- **Self-Efficacy :**

- *It is associated with choosing more challenging tasks, putting in greater effort, increased persistence, reduced stress/anxiety/depression, higher self-monitoring and evaluation. It is the personal judgement of "how well one can execute courses of action required to deal with prospective situations".*
- *Expectations of self-efficacy determine whether an individual will be able to exhibit coping behaviour and how long effort will be sustained in the face of obstacles. Individuals who have high self-efficacy will exert sufficient effort that, if well executed, leads to successful outcomes, whereas those with low self-efficacy are likely to cease effort early and fail.*
- *Mastery of experiences (positive outcomes), vicarious experiences (comparing other peoples experience to our own), social persuasions (other's feedback), feelings of anxiety/stress/fatigue are all sources of self-efficacy.*  
**"Enactive mastery experiences are stated as the most powerful source of creating a strong sense of efficacy"**
- *$r = .38$ , account for approximately 14% of the variance in students' academic performance*



- **Locus of Control** : *Individuals differ in their appreciations and beliefs on what determines their success in a particular activity, what happens to them in a given context or, more generally, what influences their lives. It is the tendency that individuals have to consider that the events affecting them are the results of their actions, or in contrary, that they are the result of external factors on which they have little to no influence (i.e. luck, fate, others, the government, etc.)*

- **Mastery and Performance Motivations:**

- **Mastery-oriented goals** are defined in terms of a **focus on learning**, mastering the task according to **self-set standards or self-improvement**.

- It also encompasses **developing new skills, improving or developing competence**, trying to accomplish something challenging and trying to gain an understanding or insight.*

- **Performance-oriented goals** represent a focus on **demonstrating competence or ability and how the ability will be judged relative to others**.

- For example, trying to surpass normative performance standards, attempting to best others, using casual comparative standards or striving to be the best in a group or even avoiding judgments of low ability or appearing dumb are examples of performance-oriented goals.*

- **Gender Biases in Science research** : *Female applicants needed to be 2.5 times more productive than male applicants in order to receive the same rating. We also compared published papers from researchers and we see that male written papers have a higher impact factor, as well as a higher number of publishings. The gender bias is present in all domains, including science.*

- **Gender Biases in Science Education:**

- There are two studies:**

- *Female applicants needed to be 2.5 times more productive than male applicants in order for their lab to be selected.*

- *Women needed a killer CV in order to take a man's place.*

- *Women are just as sexist as men in this domain, meaning that they also tended to perceive men in higher positions than women.*

- *We also see the gap between Women and Men in Science is created when women become pregnant and then stop to work to take care of the children (in all domains, not only in science.)*

- There is also the cultural upbringing which tells boys to learn science and women to learn art starting from a low age. The bias is already there at age 12.*



## Research Tools:

### • Required Elements in Tables/Carts :

- A **table number** (Table 1) so that I can refer back to it easily in the text
- A **title** that actually explains what the table shows
- **Readable category labels** (Chemistry and Chemical Engineering rather than CGC)
- Clear **column headings**
- **Legend** for axes (title)
- **Note** to explain missing data.

### • Mean, Median, Mode :

The mean, median and mode are three different measures of **central tendency**.

- The **mean** average is suited to **continuous data** and so should not be used with nominal or ordinal data.
- The **median** (midpoint) makes sense to use if you can organize your data **hierarchically** and so works for ordinal and interval data but not for nominal data.
- The **mode** (most cited category) is the only option available for **nominal data**.

### • Pie charts, histograms, bar charts :

- A bar chart represents data as **discrete categories** so is more appropriate for **categorical data** (nominal or ordinal).
- A **histogram** represents data as **continuous** so is more appropriate for **interval data**.
- A **pie chart** does not have two poles and so does not represent hierarchy (more or less) well. It works fine when there are (a few) **categories and no hierarchy**. This suggest **nominal data**.

### • Scatterplots, boxplots, stacked bar charts :

- Scatter plots are used to represent the **relationship** between **two continuous variables**. It is a pretty **weak correlation**. For reference, Andy Field's textbook suggests that a correlation of magnitude  $r=.10$  is small/weak,  $r=.30$  is medium/moderate and an  $r=.50$  is large/strong. It would not be good to use correlation if the relationship does not look linear and if the variance is more or less the same across the range of x values
- A box plot can be used to visualize the relationship between a **categorical** variable (like control/experimental group) and a **continuous** variable (like score).
- **For mix of ordinal and nominal data** : Faculty of origin is nominal data. This means we are presenting two types of categorical data. **A stacked bar chart would be appropriate.**

### • Cross tabulation tables :

**Cross** tabulations enable you to examine relationships within the data that might not be readily apparent when analyzing total survey responses

- **Difference of proportion hypothesis test**

*This lesson explains how to conduct a hypothesis test to determine whether **the difference between two proportions is significant**.*

*The test procedure, called the **two-proportion z-test**, is appropriate when the following conditions are met:*

- *The sampling method for each population is **simple random sampling**.*
- *The samples are **independent**.*
- *Each sample includes at least **10 successes and 10 failures**.*
- *Each population is at least **20 times as big as its sample**.*

*This approach consists of four steps:*

- (1) state the **hypotheses**,*
- (2) formulate an **analysis plan**,*
- (3) **analyze** sample data, and*
- (4) **interpret** results.*

- **Difference of means tests (z test, t-tests for one or two samples, with paired samples and with similar and different variances) :**

*The standard tests used in relation to the mean average are z-test, t-test and F-test (ANOVA). Part (b) deals with a one sample situation. This suggests z-test or t-test. Part (c) deals with a two sample situation. This also suggests z-test or t-test. There are different rules of thumb regarding how sample size impacts on whether to use a z-test or a t-test and you can use any one that you can reference to a reputable source. Once the sample size reaches 25 the t-distribution is very close to the z-distribution, so I will use that as my rule of thumb and so we can use a z-test in this case. I use the following: "**If either sample size is less than 25, use t-test**".*

***T-test since the t-distribution is identical to the z-distribution with larger samples which means there is no difference in practice between t- and z- test for larger samples***. If we have to sample we need to decide if the variance is common. To do that : "If the sample variances differ by a factor of less than three, assume that there is a common population variance".

- **Chi-square Test of Independence :**

*The test is applied when you have **two categorical variables** from a single population. It is used to determine whether there is a **significant association between the two variables**.*

*We use 3 assumptions :*

- ***categorical data on both axis***
- ***expected value in all cells should be 5 or more***
- ***only raw data** .*

*The table has 2 rows and 3 columns.*

*The degrees of freedom is  $(r-1)*(c-1) = (1*2)=2$ .*

*The critical value for  $p=0.05$   $df=2$  for chi-square is 5.991 (you get this from a Chi-square distribution table).*

*Example of null hypothesis :  $H_0$ : Membership of the control/experimental group is **independent** from membership of the hi/lo score group.*

*Chi for Data categorical by categorical and can be presented in a **contingency table**.*

*Hence chi square is appropriate.*

Cronbach's alpha is computed by correlating the score for each scale item with the total score for each observation (usually individual survey respondents or test takers), and then comparing that to the variance for all individual item scores:

$$\alpha = \left( \frac{k}{k-1} \right) \left( 1 - \frac{\sum_{i=1}^k \sigma_{y_i}^2}{\sigma_x^2} \right)$$

...where:  $k$  refers to the number of scale items

$\sigma_{y_i}^2$  refers to the variance associated with item  $i$

$\sigma_x^2$  refers to the variance associated with the observed total scores

**z test : if one sample and  $n > 25$**

**t-tests for one or two samples if normal distribution**

**with paired samples if the same person do twice the test**

**and with similar and different variances if there is less than a factor 3 of difference**