Kognitionspsychologie II: Session 12
Q&A

Rui Mata, FS 2021

Today

- Go over details about the exam and provide a couple of example questions
- Overview of the semester given the questions posted on ADAM

Kognitionspsychologie I & II

20 A-prim, 20 MC

[Einleitung: Propädeutische Klausur: Kognitionspsychologie I & II

Für die Beantwortung aller Fragen steht **120 Minuten Zeit** zur Verfügung.

Wichtige formale Punkte
- Sie erhalten zwei Dokumente – die Klausur mit den Prüfungsfragen und einen separaten Antwortbogen.
- Vorname, Name, und Matrikelnummer sind bereits eingetragen und müssen nicht manuell ausgefüllt werden.
- Sowohl den Frage- als auch den Antwortbogen nach der Prüfung in den Umschlag versorgen – fehlt eines der beiden Dokumente gilt die Prüfung als nicht bestanden!

Allgemeines
- Die Antworten müssen **innerhalb der Prüfungszeit** auf den Antwortbogen übertragen sein, indem Sie die entsprechenden Kästchen ankreuzen.
- Verwenden Sie nur die schwarzen Filzstifte, die sie vor der Klausur erhalten.
- Auf dem Antwortbogen sind Korrekturen zu vermeiden (maschinelle Auswertung). Falls Korrekturen notwendig sind, malen Sie die falsch angekreuzten Felder aus und kreuzen Sie die richtigen Felder an.
- Es ist daher ratsam, die Lösungen zunächst auf dem Fragebogen zu markieren und dann zu übertragen. **Es zählen jedoch nur die Lösungen auf dem Antwortbogen.**

Anzahl und Typen der Klausurfragen
Die Klausur enthält 40 Fragen, welche in zwei Fragetypen gegliedert sind. Bei beiden Fragetypen kann maximal je ein Punkt erworben werden. Die Prüfung besteht aus folgenden Frage-Typen:

A-Fragen:
- Bei Fragetyp A kann die Frage nur korrekt (ein Punkt) oder nicht korrekt (kein Punkt) beantwortet werden.
- Es ist jeweils genau eine der Antwortalternativen korrekt.
- Diese wird auf dem Antwortbogen markiert.

Multiple-Choice-Fragen (korrekte Antwortkombination):
- Bei diesem Fragetyp können mehrere Antworten entweder korrekt oder nicht korrekt sein.
- Bei jeder Antwortalternative ist eine Auswahl zu treffen.
- Haben die Teilnehmenden die korrekte Kombination von Antworten angekreuzt bzw. nicht angekreuzt, erhalten sie die volle Punktzahl (1). Fehlt nur ein Kreuz oder ist auch nur ein Kreuz nicht korrekt gesetzt, bekommen die Teilnehmenden für die gesamte Frage keinen Punkt (0).

Kognitionspsychologie II

Sessions 1-10 are equally covered…

#	Date	Topic	Slides	A	MC
1	02.03.2021	Session 1: Introduction	pdf	1	1
2	09.03.2021	Session 2: What is intelligence?	pdf	1	1
3	16.03.2021	Session 3: Intelligence: Nature & Nurture	pdf	1	1
4	23.03.2021	Session 4: Space	pdf	1	1
5	30.03.2021	Session 5: Number	pdf	1	1
6	06.04.2021	Session 6: Language	pdf	1	1
7	13.04.2021	Session 7: Facts	pdf	1	1
8	20.04.2021	Session 8: Emotion	pdf	1	1
9	27.04.2021	Session 9: Motivation	pdf	1	1
10	04.05.2021	Session 10: Consciousness	pdf	1	1
11	11.05.2021	Session 11: What's next?	pdf		
12	18.05.2021	Session 12: Q&A	pdf		
13	25.05.2021	Exam		**10**	**10**

Kognitionspsychologie II

Example questions

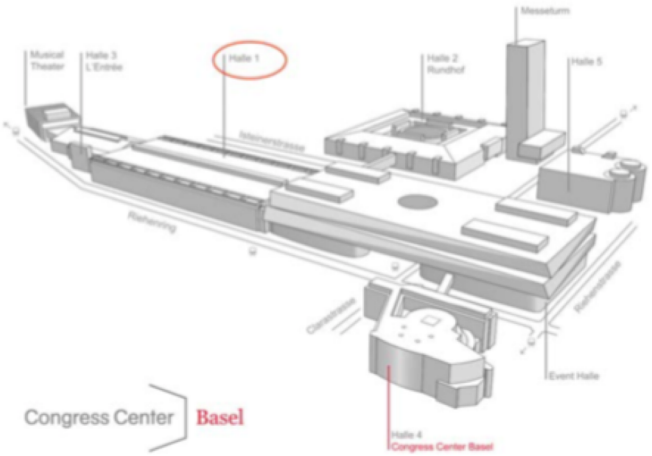
Identify the CORRECT statement

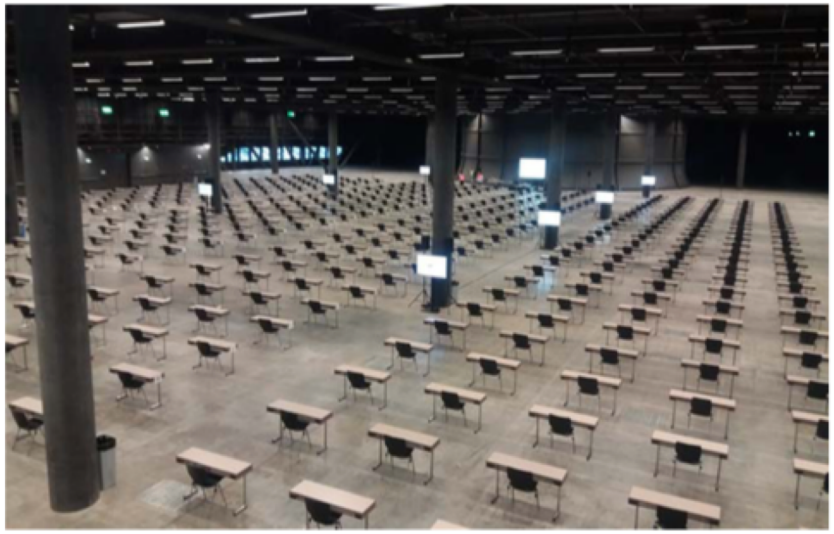
A) By convention, about 30% of individuals have an IQ between 85 and 115.
B) Meta-analytic evidence suggests that the correlation between intelligence and job performance is small ($r \approx .2$).
C) The correlation between different measurements of *g* of the same individuals using different intelligence batteries has been shown to be large ($r > .9$) in several studies.
D) The more IQ deviates from 100, the more people can be found with similar IQ values.
E) Spearman suggested that *g* is a statistical artifact because every intelligence test taps into different capacities, which can lead to a negative manifold captured by statistical procedures, such as factor analysis.

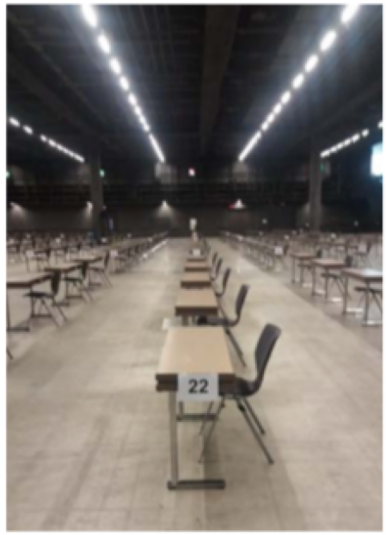
Which of the following statements is/are correct?

A) The first models of semantic memory, such as the one by Collins and Quillian (1969), proposed that long-term memory can be described as being composed of connections between units and that such connections are based mostly on personal experience rather than logical or taxonomic relations.
B) The domain-specific hypothesis of Caramazza and colleagues proposed a series of conceptual categories that are represented independently in the brain, such as “animals”, or “tools”.
C) Semantic dementia is usually associated with semantic knowledge deficits as revealed through naming or other non-verbal tests, and can result from disease of the anterior portions of the temporal lobes.
D) According to the hub-and-spokes model of semantic cognition, the lesion of modality-specific components often leads to general semantic deficits.

Exam @ Congress Center Basel // Messe







1. Strict timing for entry
2. Photo-Id
3. Numbered seating
4. Corona rules apply (masks; cold symptoms – stay home or show negative PCR result)

DIRECTIONS AND SEATING INFORMATION OVER EMAIL BY THE END OF THIS WEEK…

After the exam

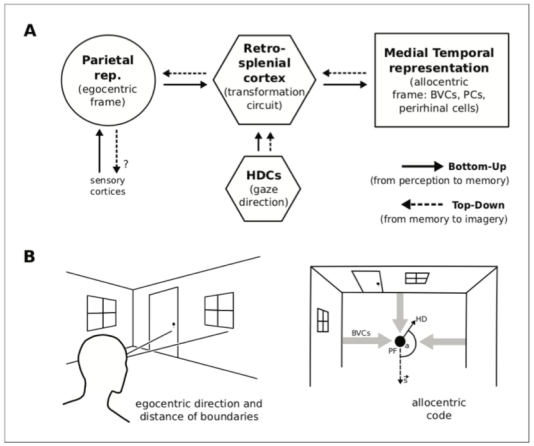
- Questionnaire about exam over email
- Exam inspection (Einsicht) July 6th

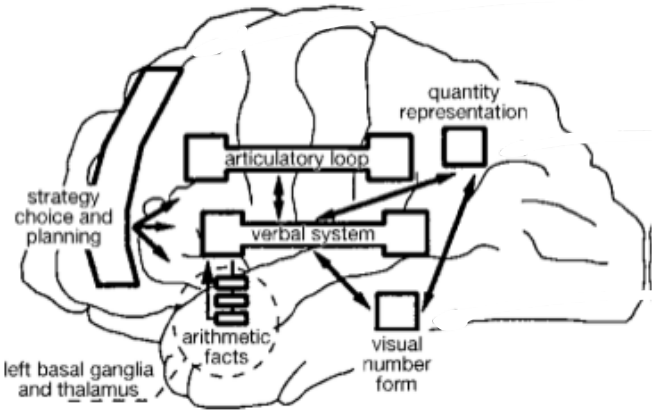
Questions on ADAM

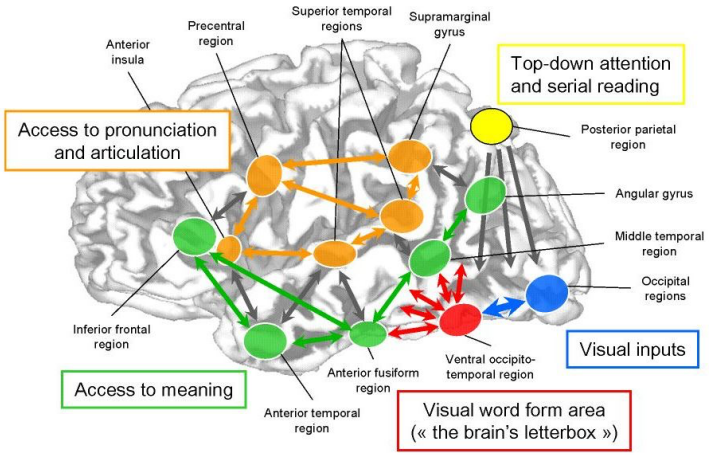
Your lectures usually contain some very explicit informations about certain brain regions connected to certain functions (for example in this weeks lecture we learned about dopamine being released in the nucleus accumbens, increasing the motivation for drug use).

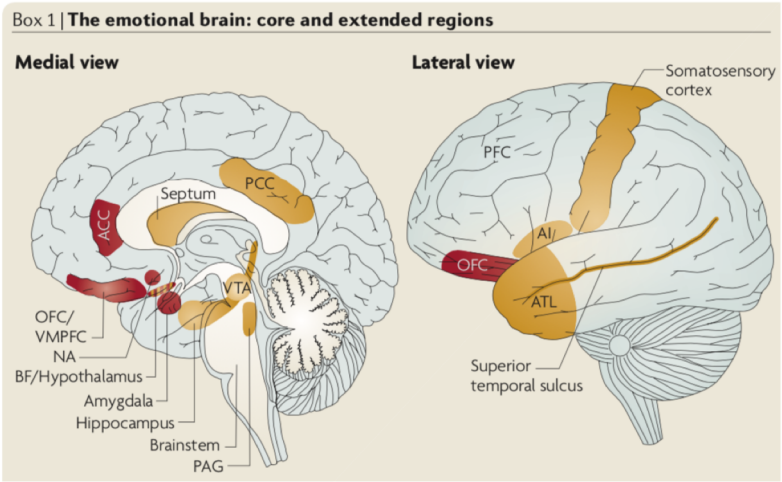
How important is this type of information regarding the exam? Are the specific brain regions (and their functions related to your lecture) important to learn or is it sufficient to undestand the concept behind it?

Concepts + regions…







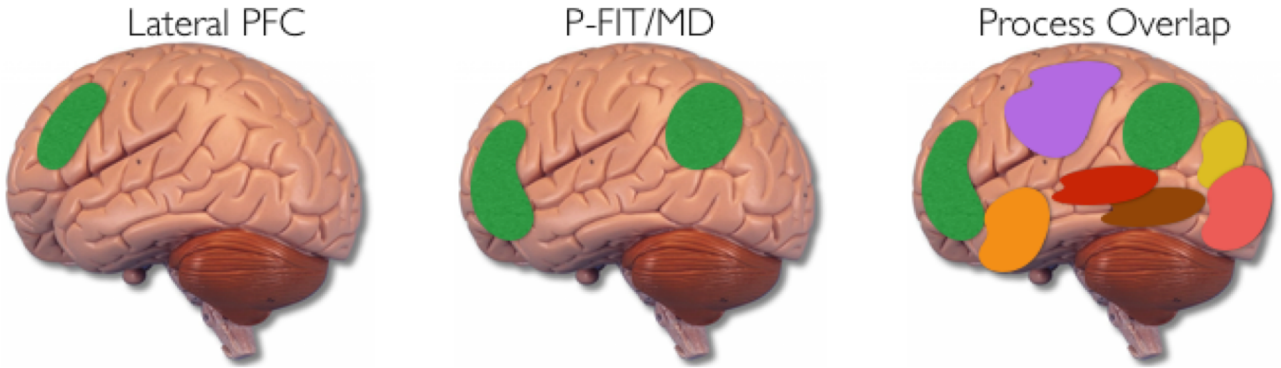


I just read both the recommended readings for the lecture of yesterday and I don't quite get the difference between process overlap theory and NNT. So, I think that maybe I didn't understand the Network Neuroscience theory. I was wondering if you could maybe try to explain the central aspects of the NNT (again) with other words than they use in the paper (since thy practically use the same sentences every time they state the central finfings/concepts)?

Neural Theories of Intelligence

Table I. Summary of Cognitive Neuroscience Theories of Human Intelligence

	Functional localization			System-wide topology and dynamics		
	Primary region	Primary network	Multiple networks	Small-world topology	Network flexibility	Network dynamics
Lateral PFC Theory [103]	✓	x	x	x	x	x
P-FIT Theory [75]	x	✓	x	x	x	x
MD Theory [82]	x	✓	x	x	x	x
Process Overlap Theory [83]	x	x	✓	x	x	x
Network Neuroscience Theory	x	x	✓	✓	✓	✓



Network Neuroscience theory (NNT), like process overlap theory, assumes there are multiple networks relevant to intelligence but NNT emphasises system-wide topology (structure) and dynamics (function) that ensure the capacity to flexibly transition between network states

Barbey, A. K. (2018). Network Neuroscience Theory of Human Intelligence. *Trends in Cognitive Sciences*, 22(1), 8–20. http://doi.org/10.1016/j.tics.2017.10.001

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NNT emphasizes network topology and dynamics….

Would you put the Network Neuroscience Theory as a formative, reflective or mechanistic approach to discover g?
I thougt it could be a mix between mechanistic an formative.

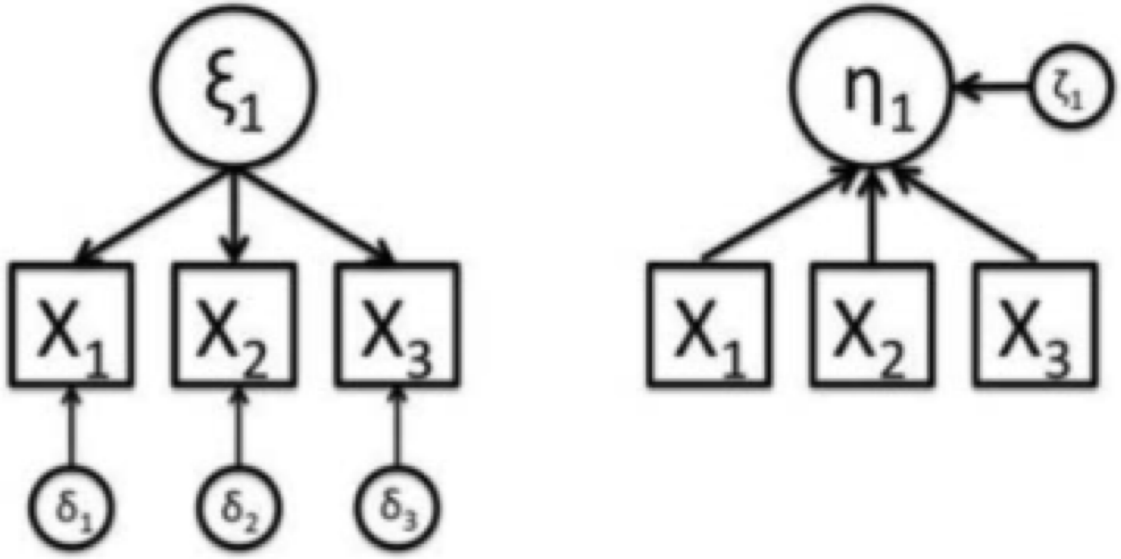


Figure 7. A reflective (left) and a formative (right) model.

Is there any guarantee at all as to how close falconer's formula is to reality? The principle assumes identical twins have the same upbringing, but they often have different environments (they often slip into roles as early as in the womb, then get different treatment, different friends, etc. etc.) Doesn't it then become near impossible to eliminate possible variables and make causal statements on genetics?

Estimating heritability from familial studies

Familial studies use a subtraction logic…

Formula	explanation
$A = 2 (r_{MZ} - r_{DZ})$ Falconer's formula	MZs and DZs differ by half a genome, consequently the difference in the similarities between MZs (quantified by r_{mz}) and DZs (quantified by r_{dz}) that is determined by genetics is half a genome. In numbers: half of a genome explains ½ A = .86 - .60 = .26 of the variance, and, therefore, a whole genome explains, A = 2 × .26 = **.52** of the variance.
$C = r_{mz} - A$	MZs similarities (quantified by r_{mz}) are due to both 100% shared genetic material and their shared common environment, consequently, subtracting the similarity due to genetics (A) leads to an estimate of the similarity due to the common environment. In numbers, C = .86 - .52 = **.34**
$E = 1 - r_{mz}$	The unique environment (E) is responsible for the observed differences between MZs because they share 100% of genetics and common upbringing. In numbers, E = 1 - .86 = **.14**

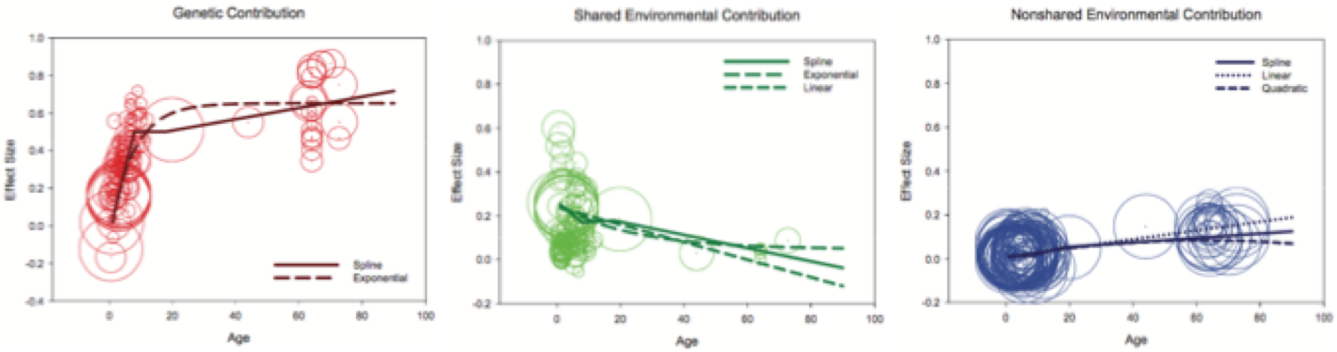
Note that the numbers in **bold** are a ballpark estimate based on part of the data of Bouchard and McGue (1981). More recent meta-analytic results and slightly different methods, produce quite similar but somewhat different estimates (cf. Polderman et al., 2015).

Falconer's formula assumes the equal contribution of environmental factors in MZ pairs and DZ pairs (not that twins have the necessarily the same upbringing…).

- Concerning "Intelligence: Nature & Nurture", slide 22: Looking at the table in the middle, shared environmental contribution decreases over lifetime. But in the text below it is written that the shared environmental contribution remains high from adolescence through late adulthood. Which one is correct?

Environmentality

Heritability is not constant across the life span!



Tucker-Drop and Briley meta-analysed 15 longitudinal samples, involving monozygotic twin pairs raised together, dizygotic twin pairs raised together, monozygotic twin pairs raised apart, dizygotic twin pairs raised apart, adoptive sibling pairs, and nonadoptive sibling pairs, ranging in age from infancy through late adulthood.

"Cross-time correlations for genetic and shared environmental components were, respectively, low and moderate during early childhood, increased sharply over child development, and remained high from adolescence through late adulthood. Cross-time correlations for nonshared environmental components were low across childhood and gradually increased to moderate magnitudes in adulthood. "

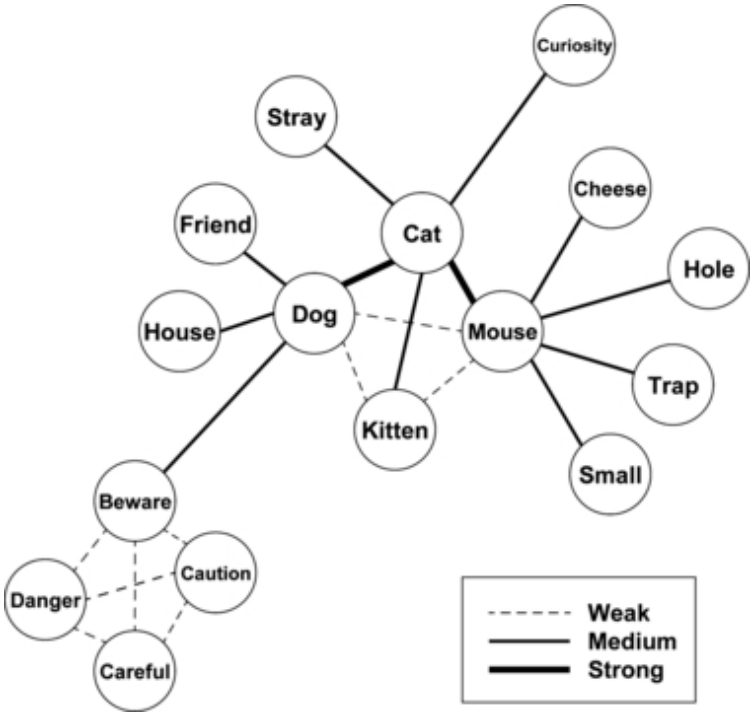
only applies to genetic (not shared)

Tucker-Drob, E. M., & Briley, D. A. (2014). Continuity of genetic and environmental influences on cognition across the life span: A meta-analysis of longitudinal twin and adoption studies. ***Psychological Bulletin, 140***(4), 949–979.

- Concerning "Facts", slide 16: Could you please explain again what is meant by "Spreading Activiation" and how this term is connected with the presented Cognitive Models of Semantic Representations?

“Activation may be interpreted metaphorically as a kind of mental energy that drives cognitive processing. Cognitive structures, such as concepts, are called *chunks.* Activation spreads from a set of chunks that are the current focus of attention through *associations* among chunks in memory. Generally, activation-based theories of memory predict that more activated knowledge structures will receive more favorable processing. Spreading activation is the name of the process that computes activation values over a set of chunks. The spread of activation from one cognitive structure to another is determined by weighting values on the associations among chunks. These weights determine the rate of activation flow among chunks (analogous to pipes or wires with specific flow capacities).”

Peter Pirolli, in HCI Models, Theories, and Frameworks, 2003



- Concerning "Consciousness", slide 7: What does global broadcasting mean and why is a machine not able to do it? Could you give us an example?

> Dehaene et al: ”On top of a deep hierarchy of specialized modules, a “global neuronal workspace,” with limited capacity, evolved to select a piece of information, hold it over time, and share it across modules. We call “conscious” whichever representation, at a given time, wins the competition for access to this mental arena and gets selected for global sharing and decision-making. ”

> Carter et al: “Finally, when arguing that machines are not yet conscious, Dehaene *et al.* highlight the “feedforward”—i.e., sequential—nature of information processing typical of these computing systems. Although current machines may not exhibit propagation of information into the broadcasting network hub or formal Bayesian metacognition, many artificial intelligence systems involve global projection of winning representations and have metacognitive capacity, such as confidence estimates. If these types of processes were strongly indicative of consciousness, we would have to admit that some machines are already conscious.”

Carter, O., Hohwy, J., van Boxtel, J., Lamme, V., Block, N., Koch, C., & Tsuchiya, N. (2018). Conscious machines: Defining questions. *Science*, *359*(6374), 400. http://doi.org/10.1126/science.aar4163

Preparation: (Self)-testing and elaboration work best…

Table 4. Utility Assessment and Ratings of Generalizability for Each of the Learning Techniques

Technique	Utility	Learners	Materials	Criterion tasks	Issues for implementation	Educational contexts
Elaborative interrogation	Moderate	P-I	P	I	P	I
Self-explanation	Moderate	P-I	P	P-I	Q	I
Summarization	Low	Q	P-I	Q	Q	I
Highlighting	Low	Q	Q	N	P	N
The keyword mnemonic	Low	Q	Q	Q-I	Q	Q-I
Imagery use for text learning	Low	Q	Q	Q-I	P	I
Rereading	Low	I	P	Q-I	P	I
Practice testing	High	P-I	P	P	P	P
Distributed practice	High	P-I	P	P-I	P	P-I
Interleaved practice	Moderate	I	Q	P-I	P	P-I

Note: A positive (P) rating indicates that available evidence demonstrates efficacy of a learning technique with respect to a given variable or issue. A negative (N) rating indicates that a technique is largely ineffective for a given variable. A qualified (Q) rating indicates that the technique yielded positive effects under some conditions (or in some groups) but not others. An insufficient (I) rating indicates that there is insufficient evidence to support a definitive assessment for one or more factors for a given variable or issue.

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology. *Psychological Science in the Public Interest*, *14*(1), 4–58. http://doi.org/10.1177/1529100612453266

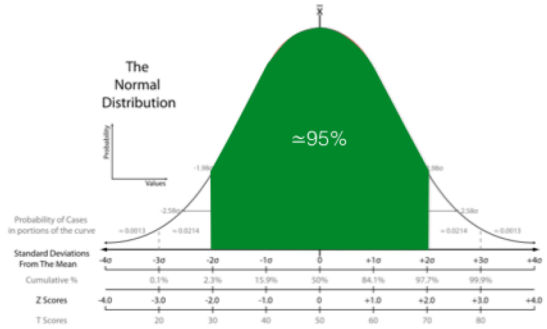
Preparation: (Self)-testing and elaboration work best…

slides **+** **readings**

The Psychometric Approach to Intelligence

Intelligence (as IQ) is a relative statement

"without variation in mental abilities there would be no latent variables—the last survivor of a meteor collision with Earth would still have cognitive abilities and mental limitations but would not have g." (Kovacs & Conway, 2016, p. 153)



The distribution of test results is standardized as having a mean of 100 and a standard deviation of 15. Consequently, about 2/3 of the population have an IQ between 85 and 115. The larger the distance from 100, the fewer individuals can be found with a given IQ.

http://de.wikipedia.org/wiki/Intelligenzquotient

$$IQ = 100 + 15 \times \frac{\text{Raw score - Mean}}{\text{Standard Deviation}}$$

9

Opinion

Network Neuroscience Theory of Human Intelligence

Aron K. Barbey[1,2,3,4,5,6,*,@]

An enduring aim of research in the psychological and brain sciences is to understand the nature of individual differences in human intelligence, examining the stunning breadth and diversity of intellectual abilities and the remarkable neurobiological mechanisms from which they arise. This Opinion article surveys recent neuroscience evidence to elucidate how general intelligence, *g*, emerges from individual differences in the network architecture of the human brain. The reviewed findings motivate new insights about how network topology and dynamics account for individual differences in *g*, represented by the Network Neuroscience Theory. According to this framework, *g* emerges from the small-world topology of brain networks and the dynamic reorganization of its community structure in the service of system-wide flexibility and adaptation.

Trends

Accumulating evidence from network neuroscience indicates that *g* depends on the dynamic reorganization of brain networks, modifying their topology and community structure in the service of system-wide flexibility and adaptation.

Whereas crystallized intelligence engages easy-to-reach network states that access prior knowledge and experience, fluid intelligence recruits difficult-to-reach network states that support cognitive flexibility and adaptive problem-solving.

The capacity to flexibly transition between networks states therefore provides the basis for *g* – enabling rapid information exchange across networks and capturing individual differences in information processing at a global level.

This framework sets the stage for new approaches to understanding the neural foundations of *g*, examining individual differences in brain network topology and dynamics.

Spearman's Enigmatic *g*

Research in the psychological and brain sciences has long sought to understand the nature of individual differences in human intelligence, examining the stunning breadth and diversity of intellectual abilities and the remarkable cognitive and neurobiological mechanisms from which they emerge. The foundations of modern research in this effort were established in the early 20th century by Charles Spearman, who developed the correlation method and applied this technique to examine academic achievement within four branches of school study (i.e., English, French, classics, and mathematics) [1,2].

Spearman discovered that correlations in performance reflected characteristics of each discipline, observing that 'English and French, for instance, agree with one another in having a higher correlation with Classics than with Mathematics' [1]. Evidence that all branches of school study were not equally correlated motivated Spearman to conclude that they were influenced, in part, by mental abilities that were specific to each discipline. Beyond identifying the contribution of specific mental abilities, Spearman observed that the correlations among the four branches of school study were always positive. This finding, which is now well-established and named the positive manifold, provided evidence that all cognitive tests measure something in common. Spearman referred to this commonality as the general factor, *g*, which represents the component of individual differences variance that is common across all tests of mental ability.

These early findings motivated Spearman's two-factor model which held that performance on tests of mental ability jointly reflect (i) a specific factor, *s*, that is unique to each test, and (ii) a general factor, *g*, that is common across all tests [1,2]. Contemporary research has further elaborated Spearman's model to include an intermediate level of broad abilities that account for the variance that is shared across similar domains of cognitive ability. For example, the well-established Cattell–Horn–Carroll theory distinguishes between performance on tests of prior knowledge and experience, referred to as crystallized intelligence, from those that require

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