



Typical & Atypical Cognitive Development

Unit 0. Introduction into course topics and course structure

15th February 2019

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COURSE STRUCTURE AND REQUIREMENTS

- **Structure**
 - 60 minutes lecture in English (introducing the topic); Paul Seitlinger
 - 30 minutes break
 - followed by a 60 minutes seminar in Estonian (deepening the introduced course content); Grete Arro and Kati Aus
- **Requirements**
 - Reflecting on previous unit (answering 1-2 questions)
 - Preparing for the next unit by reading a topic-related (short) article (answering 3-5 questions)
 - Taking part in the seminar
- Taking online exam
 - Answering open-ended questions on presented course contents (to be returned within one week)
- **Course materials**
<https://seasense.github.io>

COURSE TOPICS

Unit 0 (15th of February, T-412)

- Introduction: Why does Cognitive Science matter in the educational context?

Unit 1 (8th of March, T-412)

- Cognitive development from the nature-nurture perspective? What is the impact of genes versus environment?

Unit 2 (15th of March, T-412)

- How does the cognitive system develop? What are typical developmental stages? How do these stages relate to different cognitive components?

Unit 3 (22nd of March, T-412)

- What are potential reasons for individual differences in (typical and atypical) cognitive development?

Unit 4 (5th of April, lecture provided as video; seminar in T-412)

- How can we diagnose/measure and how can we train cognitive abilities?

Unit 5 (12th of April, lecture provided as video; seminar in T-412)

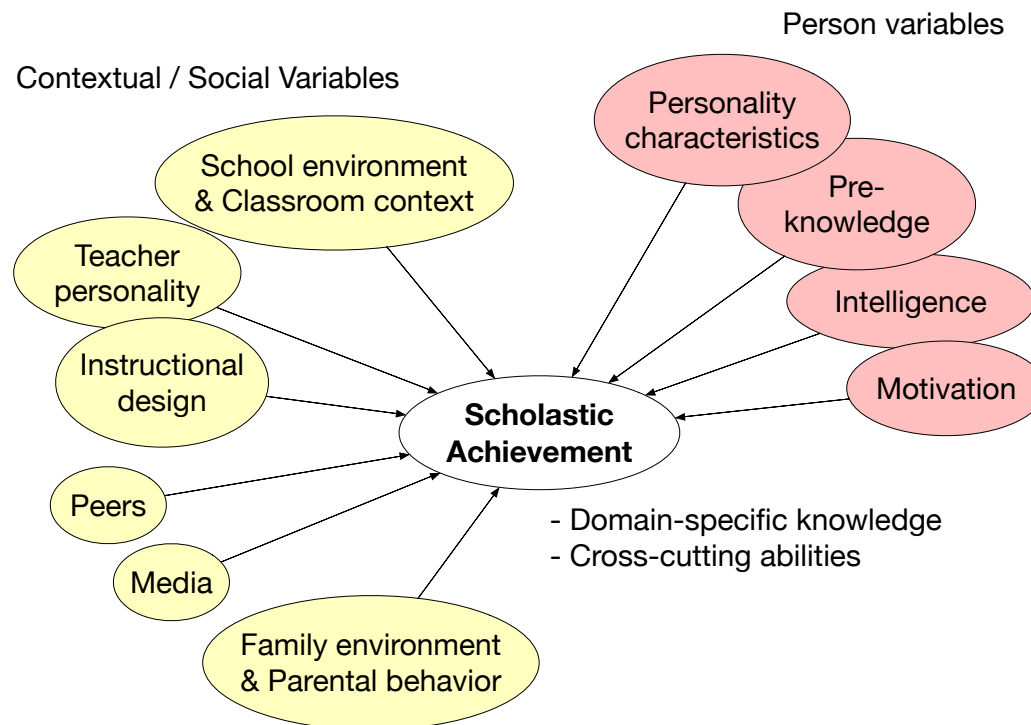
- How can we design Discovery Learning in an inclusive way?

Exam (20th of April)

WHY COGNITION MATTERS

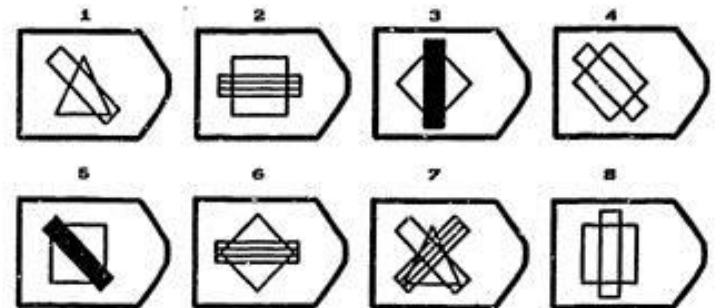
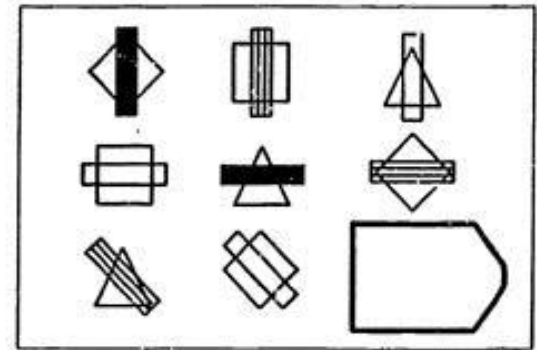
Determinants of scholastic achievement (based on Brühwiler & Helmke, 2018)

Which of these variables has the strongest impact?



WHY COGNITION MATTERS

- Intelligence is one of the strongest predictors of educational achievement (e.g., Hattie, 2009)
- What is intelligence?
 - A general mental capacity to draw conclusions, to plan, to solve problems, to reason in abstract categories, to acquire new knowledge
 - Typically, the performance in tests with mentally demanding tasks
 - Relatively stable personality trait



Example of the Raven matrices IQ test

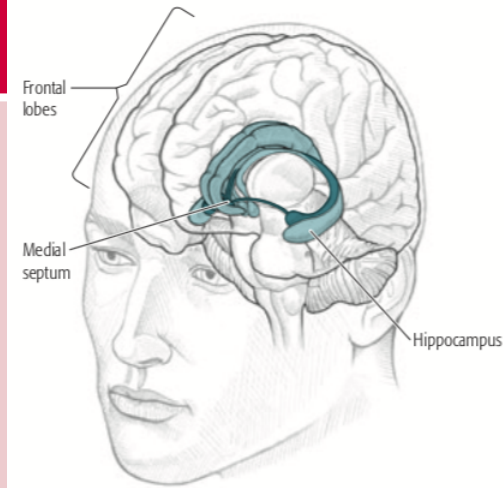
WHY COGNITION MATTERS

- More intelligent/gifted students are better (faster and more effective) in
 - recognizing regularities and rules relevant for solving problems
 - acquiring and organizing knowledge (Hattie, 2009)
 - *Learning scenarios of future school curricula become more challenging*
 - *E.g., Discovery Learning: Self-directed information search in addition to knowledge acquisition*
- *Performance differences between more and less gifted students might become larger*
- Urgent questions in education:
- How to design future education in an inclusive way?
 - What are effective strategies to help less well-equipped children in school?

POTENTIAL APPROACH TOWARDS INCLUSIVE EDUCATION

- Looking at intelligence in a more nuanced way: what are the cognitive components that bring about intelligent behavior?

Basic functions (examples)	Emerging cognitive processes (examples)	Involved brain structures (examples)
Controlling attention	<ul style="list-style-type: none">Drawing conclusionsImaginationPlanningDecision-makingProblem solving...	<p>Interplay of</p> <ul style="list-style-type: none">Working Memory (at the front of the brain = Pre-Frontal lobe)Long-Term Memory (e.g., Hippocampus, temporal lobe)
Retrieving from memory		
Mentally manipulating pieces of information		
Integrating new thoughts into memory		

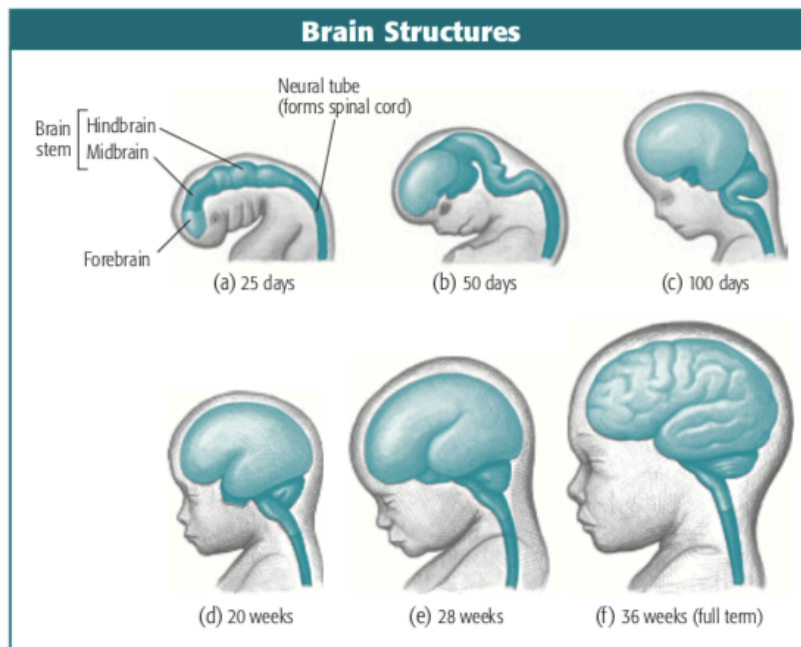


- Identifying regularities in how these components develop during childhood
- Deriving ways and strategies to support cognitive development

WHY WE CAN INFLUENCE COGNITIVE DEVELOPMENT

Bio-psychological facts on our learnability (neural plasticity)

- Humans have large brains relative to their body size
 - **Much of neural development postponed until after birth**

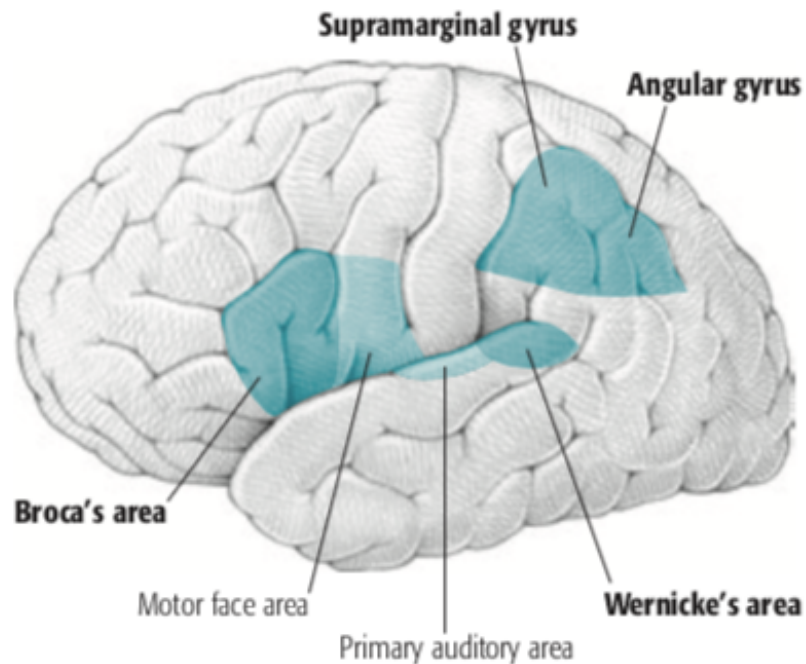


- Though birth canal expanded to its limits, brain size can't be larger than 350 cm³ at birth
- Doubles in 1st year of life: 700 cm³
- Soon after, growth rate slows down but the volume again doubles before reaching puberty: 1.400 cm³
- **Prolonged time of development**
 - about 15 years ~ 1/5 of the human life span
 - **needed to acquire complex cultural practices, such as language**

Picture taken from Anderson (2015)

WHY WE CAN INFLUENCE COGNITIVE DEVELOPMENT

Cognitive development (like learning your mother tongue) = Development of neural “communication structure”



- All **cognition** (e.g., understanding and producing words) is **distributed** across **specialized areas** that
 - **play specific roles**, such as
 - comprehension of words (Wernicke's area)
 - production of words (Broca's area)
 - **communicate** to exchange their processing products (e.g., meaning and sound of a word)

Picture taken from Anderson (2015)

WHY WE CAN INFLUENCE COGNITIVE DEVELOPMENT

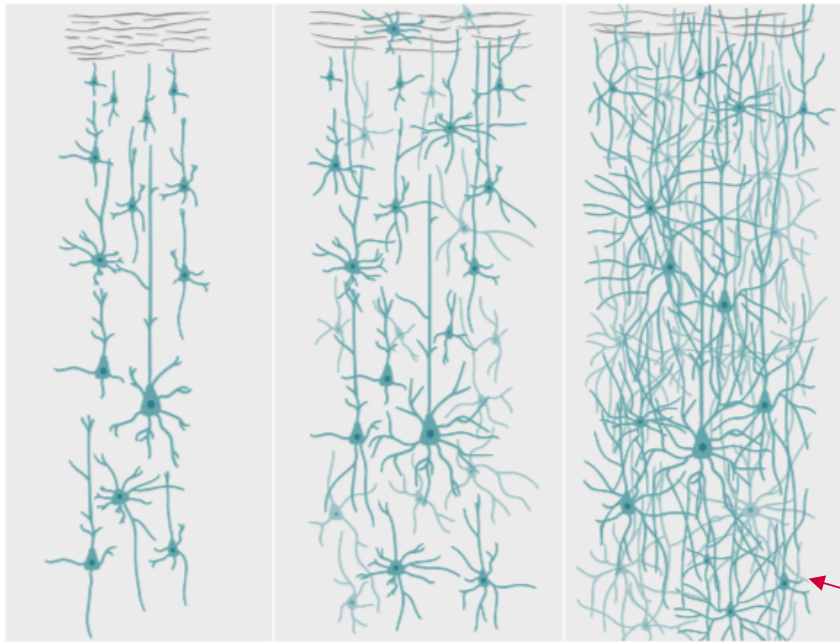
Cognitive development = Development of neural “communication structure”

*Brain development around **Broca's** area*

Newborn

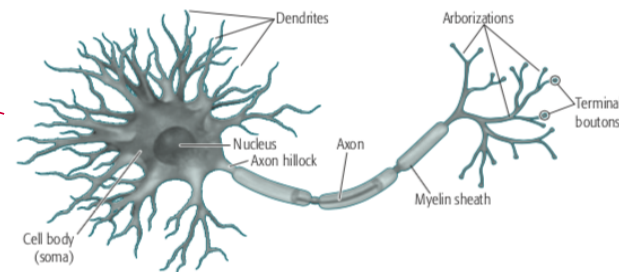
3 months

24 months



Picture taken from Anderson (2015)

- Neural communication is based on
 - neurons (basic processing units)
 - connections between neurons = **Synapses**
- Learning to represent knowledge (e.g., word meaning) by building up new synaptic connections between neurons
 - **Synaptogenesis** peaks around the age of 2
 - Soon after, elimination of unnecessary structure = **Synaptic pruning** for **neural efficiency** (saving energy)



WHY WE CAN INFLUENCE COGNITIVE DEVELOPMENT

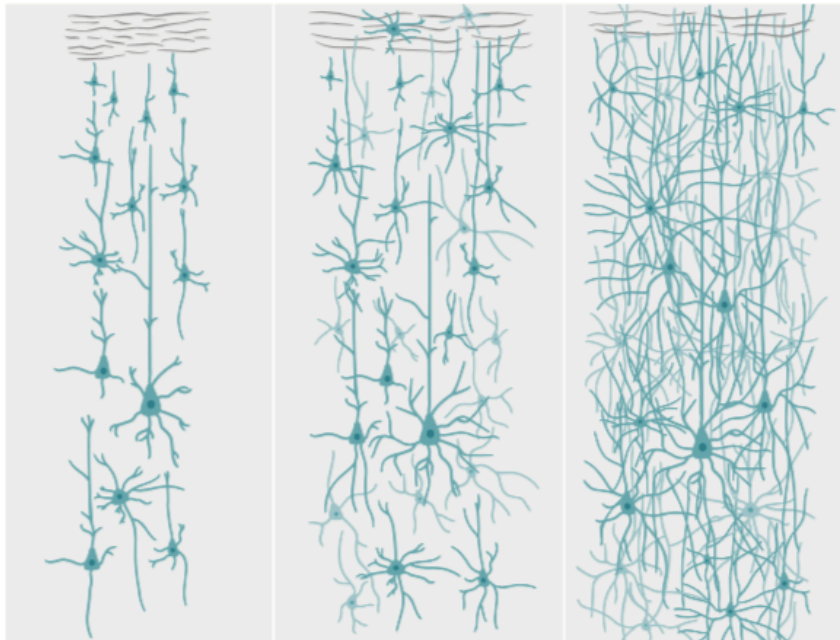
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Picture taken from Anderson (2015)

- **Synaptic pruning**
https://www.youtube.com/watch?v=rxPT78F_ZVE
- Between the ages of **2 and 16**
 - “**Use it or lose it**” principle
 - Constant stimulation → synapses become stronger and permanent
 - Little stimulation → elimination
- Interplay of biology (**nature**) and learning experiences (**nurture**)
- Education: helping to separate the important from the less important experiences / neural stimulations

WHY DOES COGNITION MATTER FOR EDUCATION?

Summary and some first conclusions

- New learning scenarios place high cognitive demands on students
 - *A need for strategies to let less gifted students participate and benefit as well*
- Human cognition
 - is distributed across communicating and specialized brain areas
 - Neural communication based on synapses connecting simple processing units (neurons)
 - Synaptic pruning
 - helps to save energy and fine-tune the brain
- Learning and cognitive development takes place as an interplay between
 - the formation of important and the pruning of unimportant synapses
 - genetic factors and environmental learning experiences
 - *Specific knowledge about our cognitive system and how it develops to realize beneficial learning experiences in everyday school life*

ASSIGNMENT

- Assignment 1a
 - Go to <https://seasense.github.io> and select the link ‘Courses’
 - Go to ‘CogniDev’ and then,
 - click on ‘Slides’ to recapitalize today’s course content
 - click on ‘Reflection’ to open a document providing further instructions
- Assignment 1b
 - Download and read the article for the next session (Unit 1)
 - click on ‘Questions’ to open a document providing further instructions
- Send your reflections and answers (in English) to me (paul.seitlinger@tlu.ee) by the 1st of March the latest.

LITERATURE OF TODAY'S SESSION

- Anderson, J. (2015). *Cognitive psychology and its implications (8th edition)*. New York, NY: Worth Publishers.
- Parts of chapter 1 (“The Science of Cognition”) and chapter 14 (“Individual Differences in Cognition”)
 - Can be retrieved from <https://tamlyvanbang2k04.files.wordpress.com/2017/08/cognitive-psychology-and-its-implications-john-r-anderson.pdf>