Mind, Brain & Education

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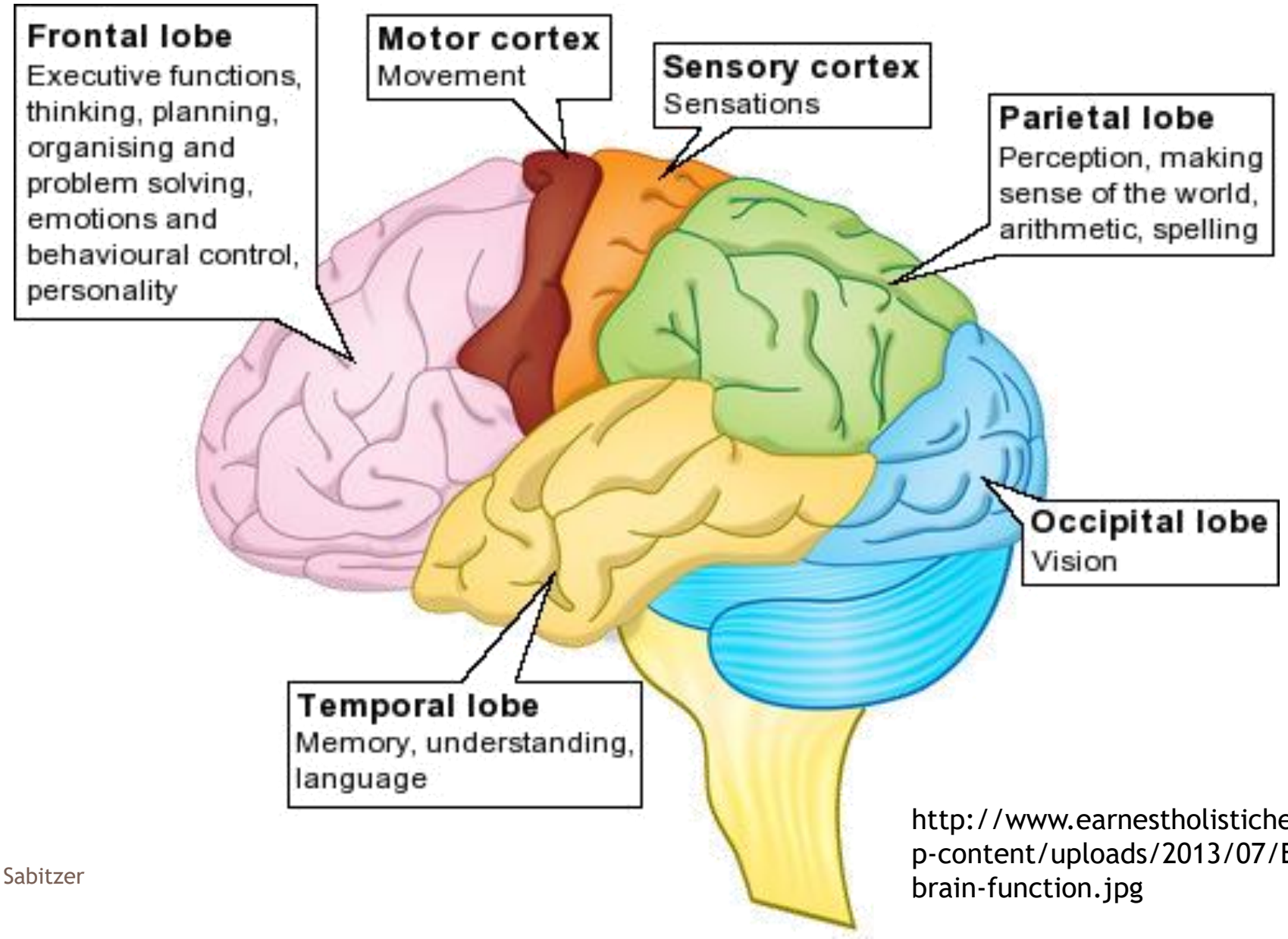
Brain Areas



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Learning & Brain

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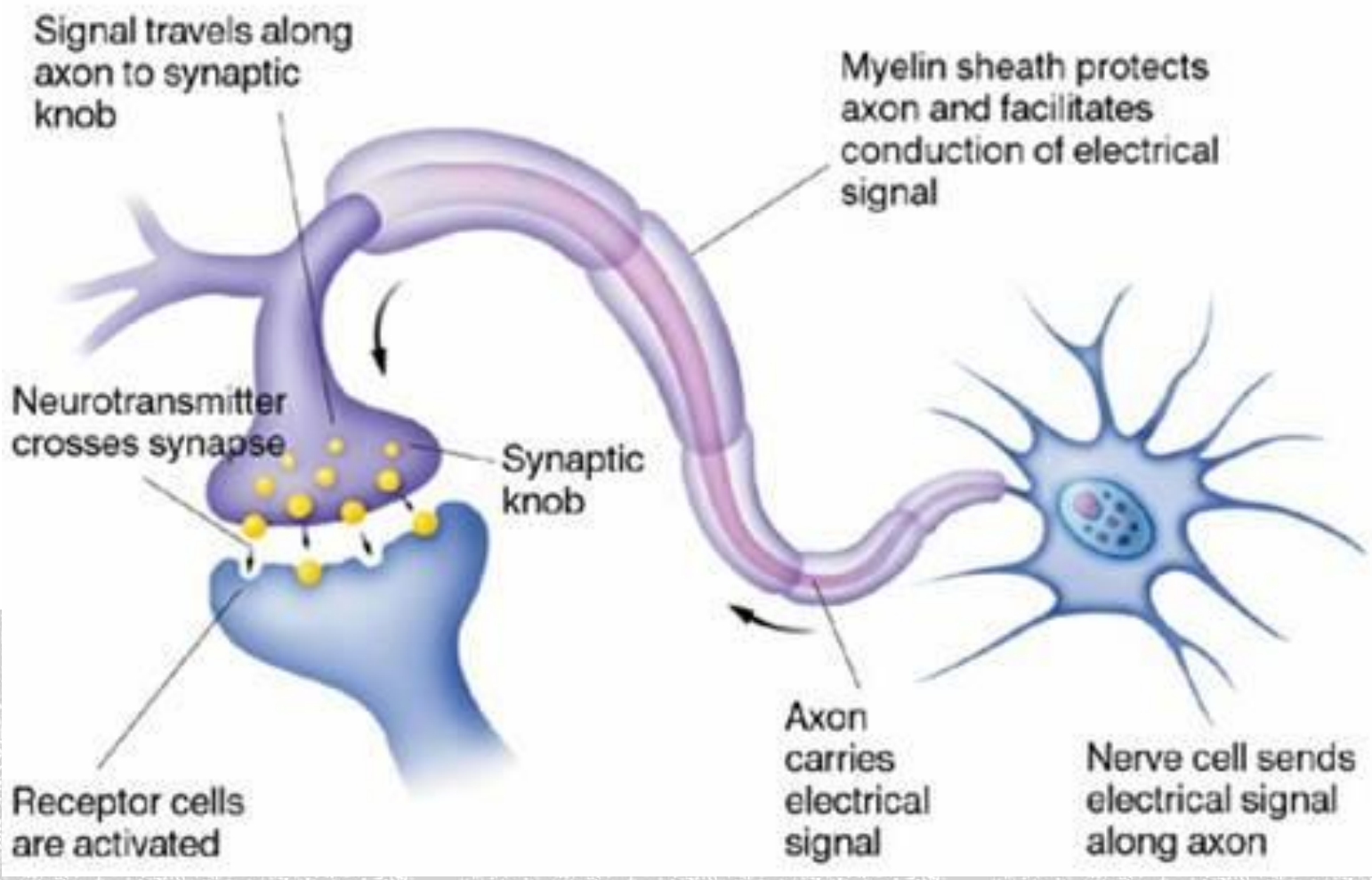
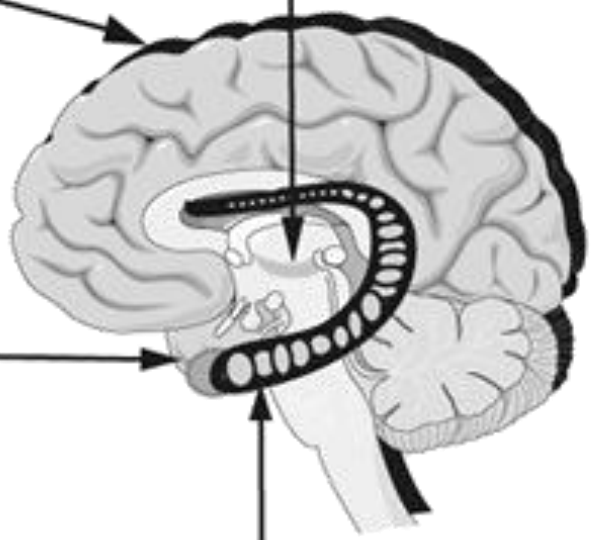


Learning Brain

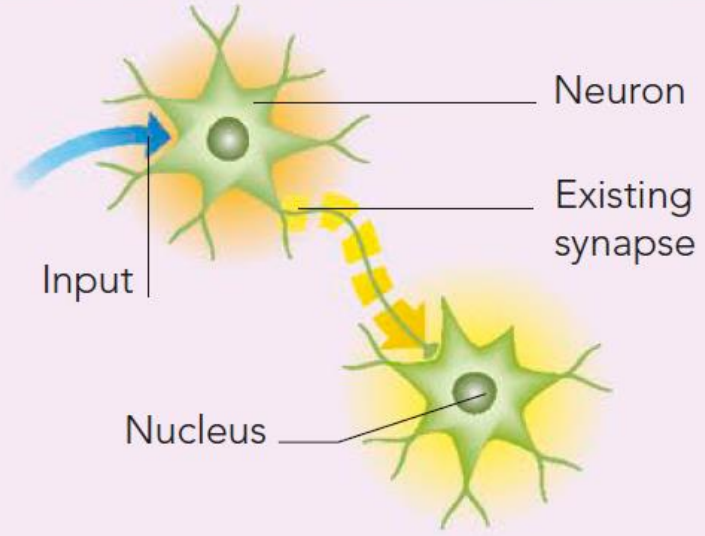


1. Input comes from our senses or is activated by thinking or memory.
2. Information is routed to the thalamus for initial processing.
3. Simultaneously, the information is routed to the appropriate cortical structures for further processing (occipital, temporal lobes, etc.).
4. It is also immediately routed to subcortical areas (i.e., the amygdala).
5. If it is an emergency stimulus, the amygdala will respond ASAP and recruit other brain areas.
6. Later, information is sent to the hippocampus for more subtle evaluation and is held over time.
7. Over time the hippocampus will organize, distribute, and connect the memories with other appropriate areas of the cortex for long-term storage.

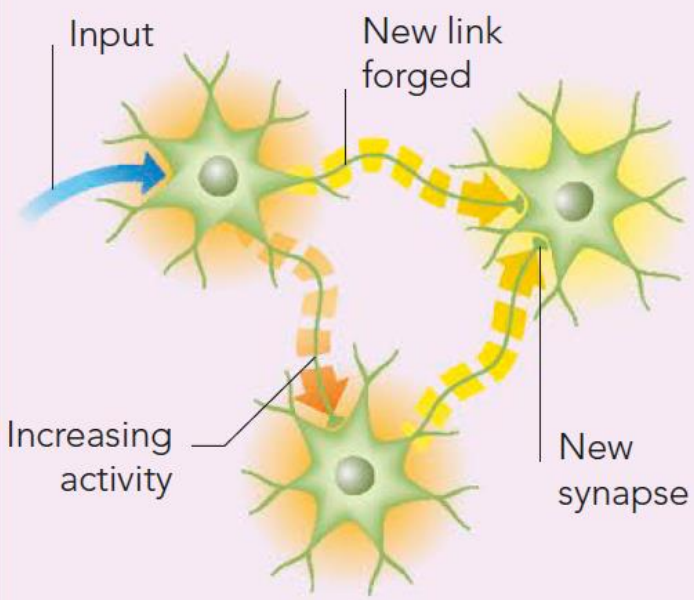
How the Brain Learns New Content (Jensen, 2005, p. 15)

FORMING MEMORIES

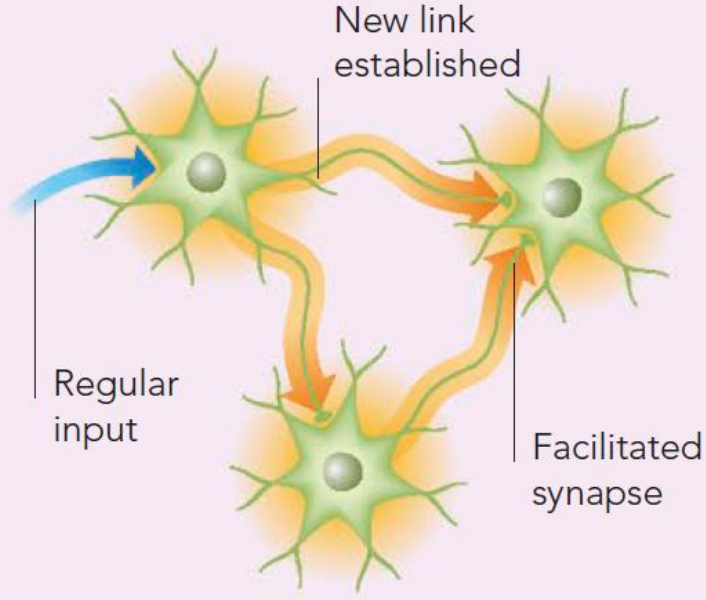
The initial perception of an experience is generated by a subset of neurons firing together. Synchronous firing makes the neurons involved more inclined to fire together again in the future, a tendency known as "potentiation," which recreates the original experience. If the same neurons fire together often, they eventually become permanently sensitized to each other, so that if one fires, the others do as well. This is known as "long-term potentiation."



1 INPUT
An external stimulus triggers two neurons to fire simultaneously. In future, if one fires, the other is likely to fire, too.

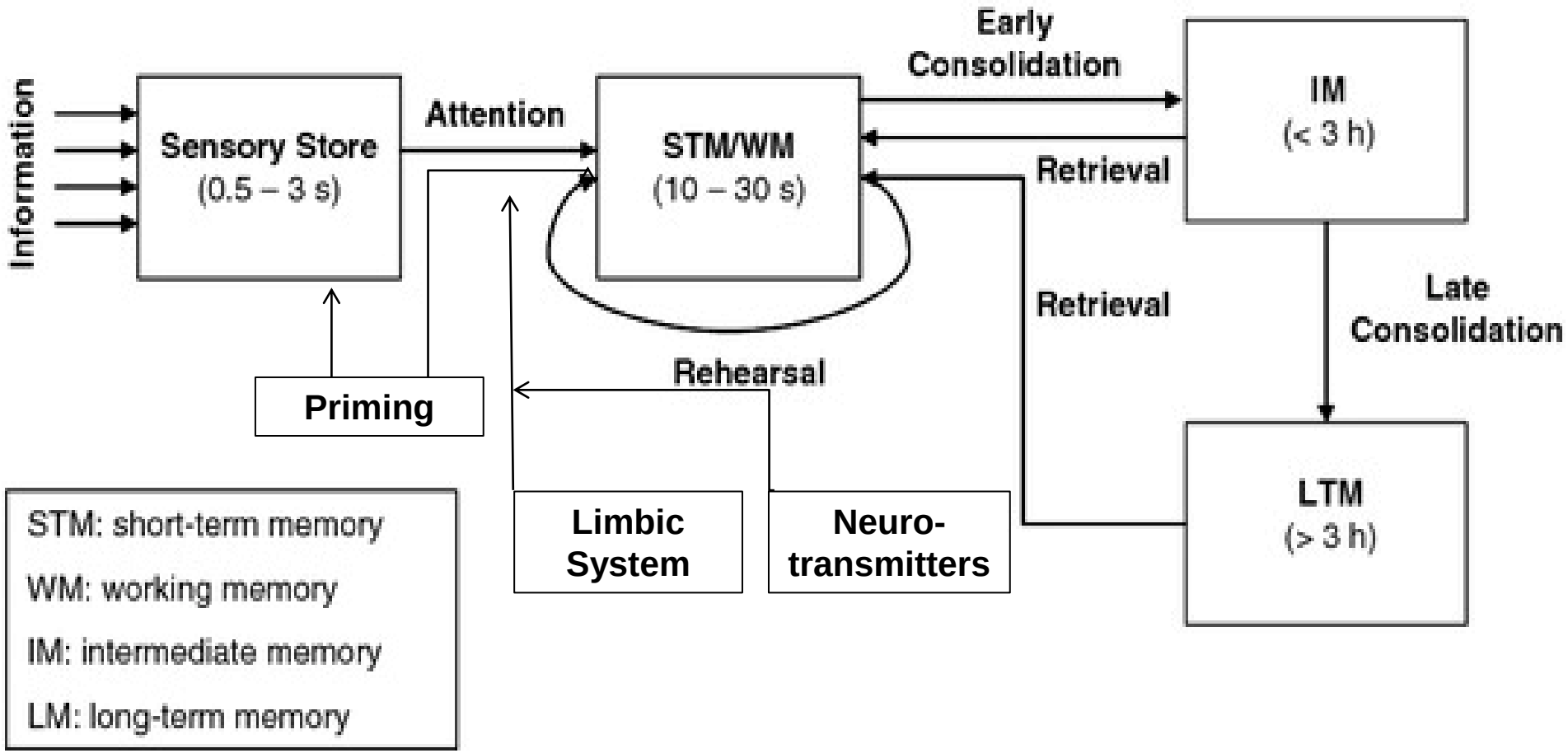


2 CIRCUIT FORMATION
A third neuron fires. One of the initial pair is stimulated to fire with it, triggering the second, so the three become linked.



3 INCREASING ACTIVITY
The three neurons are now sensitized to one another, so that if one fires, the other two are likely to fire as well.

Learning & Memory



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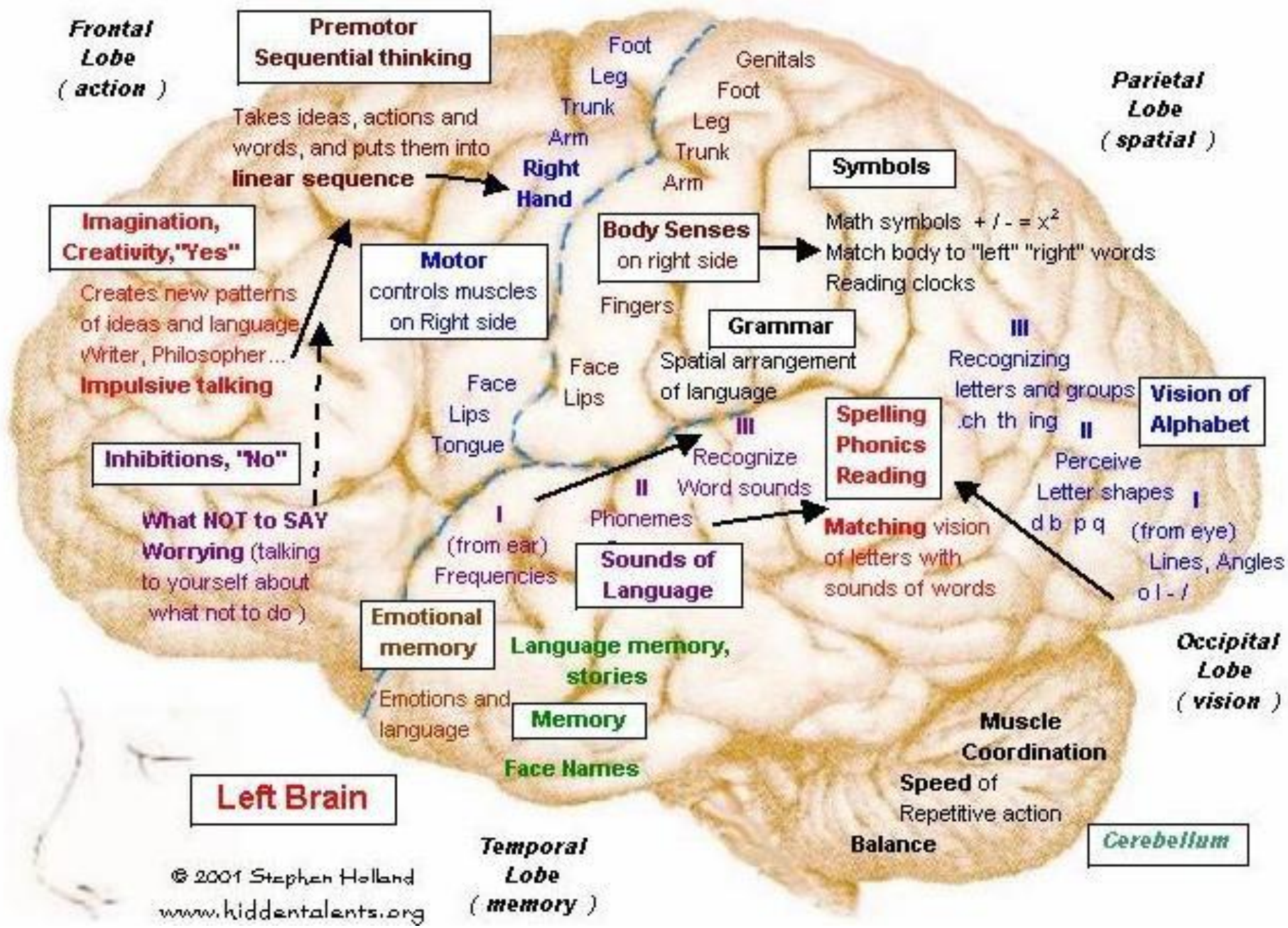
Left Brain


Frontal Lobe (action)
Premotor Sequential thinking
Takes ideas, actions and words, and puts them into linear sequence
Foot
Leg
Trunk
Arm
Right Hand
Genitals
Foot
Leg
Trunk
Arm
Parietal Lobe (spatial)
Symbols
Math symbols + / - = x²
Match body to "left" "right" words
Reading clocks
Body Senses on right side
Imagination, Creativity,"Yes"
Creates new patterns of ideas and language
Writer, Philosopher...
Impulsive talking
Motor controls muscles on Right side
Fingers
Grammar
Spatial arrangement of language
Face
Lips
Face
Lips
Tongue
III
Recognizing letters and groups
.ch th ing
Vision of Alphabet
II
Perceive Letter shapes
d b p q
I
(from eye)
Lines, Angles
o l - /
Spelling Phonics Reading
III
Recognize Word sounds
II
Phonemes
Matching vision of letters with sounds of words
Inhibitions, "No"
What NOT to SAY
Worrying (talking to yourself about what not to do)
I
(from ear)
Frequencies
Sounds of Language
Emotional memory
Language memory, stories
Emotions and language
Memory
Face Names
Occipital Lobe (vision)
Muscle Coordination
Speed of Repetitive action
Balance
Cerebellum
Left Brain
Temporal Lobe (memory)
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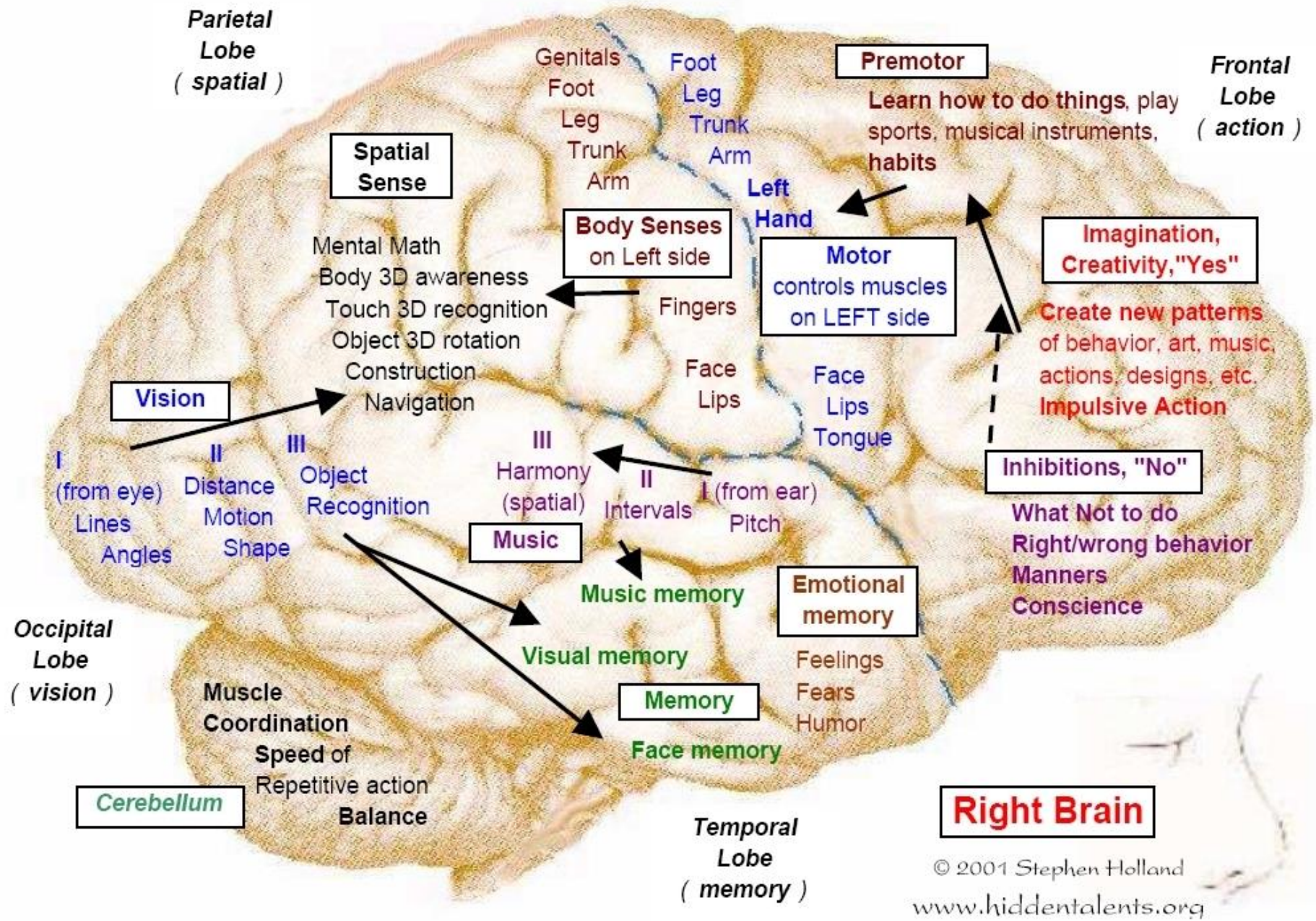
Right Brain



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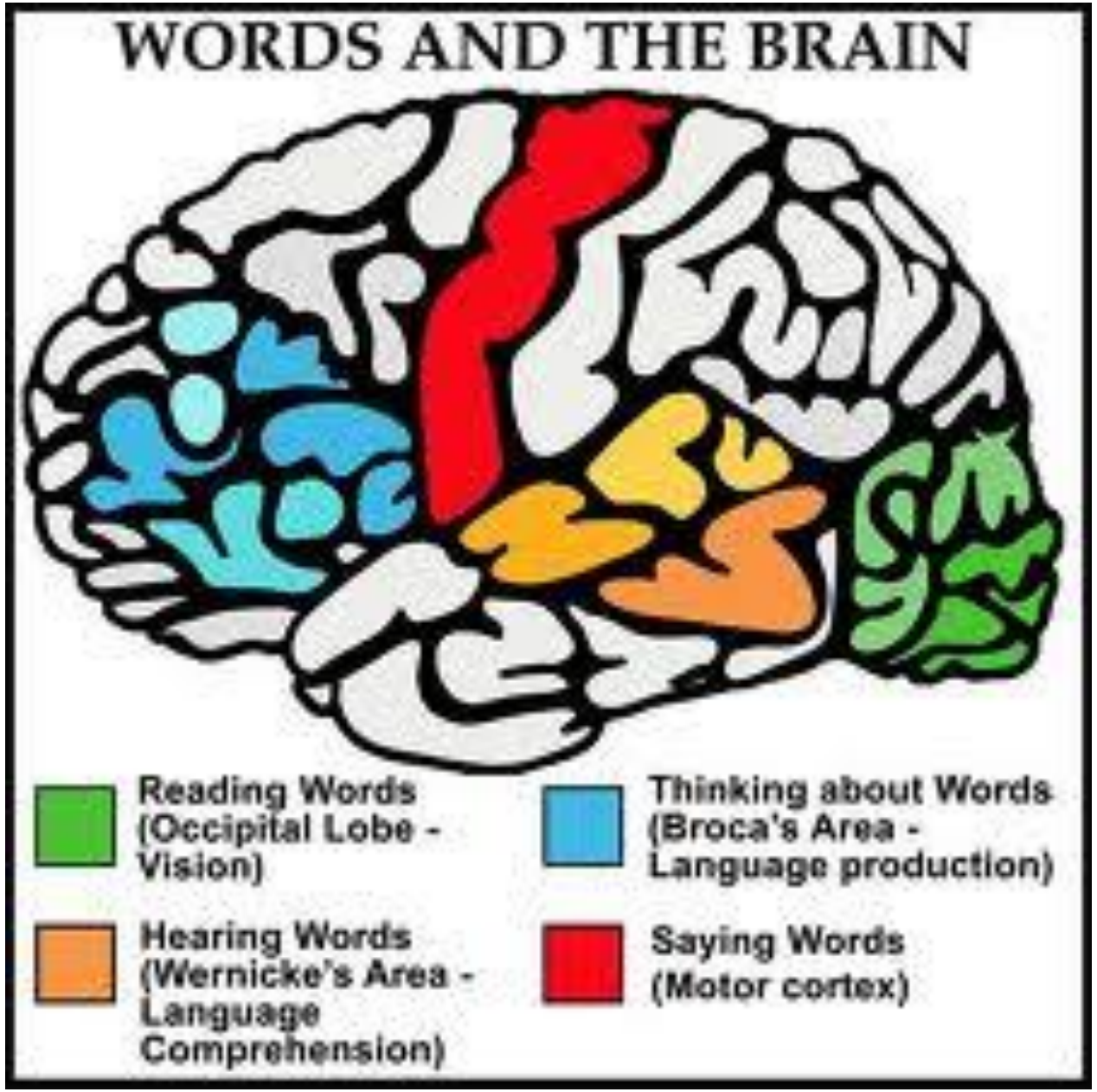

WORDS AND THE BRAIN
Reading Words (Occipital Lobe - Vision)
Thinking about Words (Broca's Area - Language production)
Hearing Words (Wernicke's Area - Language Comprehension)
Saying Words (Motor cortex)

Brain Development (1)

- 0 – 1 years: capability of learning every language
- 1 - 3 years: grey matter = main structure of brain, more than necessary
- 3 – 6 years: more grey matter in prefrontal cortex
  (Planning, organization, concentration)
- 6 years: brain has already 90 % of final size
- 6 – 12 years: more grey matter in posterior parts, development of verbal skills and spatial intelligence
- Girls develop earlier

Brain Development (2)

- > 12 years: capability of language learning decreases
- Adolescence (15 – 20 years):
  - brain under reconstruction
  - Pruning – up to 50 % of synapses disappear - Use it or loose it!
  - White matter: Myelination – myelin layer gets thicker, faster stimuli transfer
- Surge in growth of prefrontal cortex
- Hormones influence talents and performance
  - Estrogen – verbal and spatial intelligence
  - Testosterone & cortisol – memory

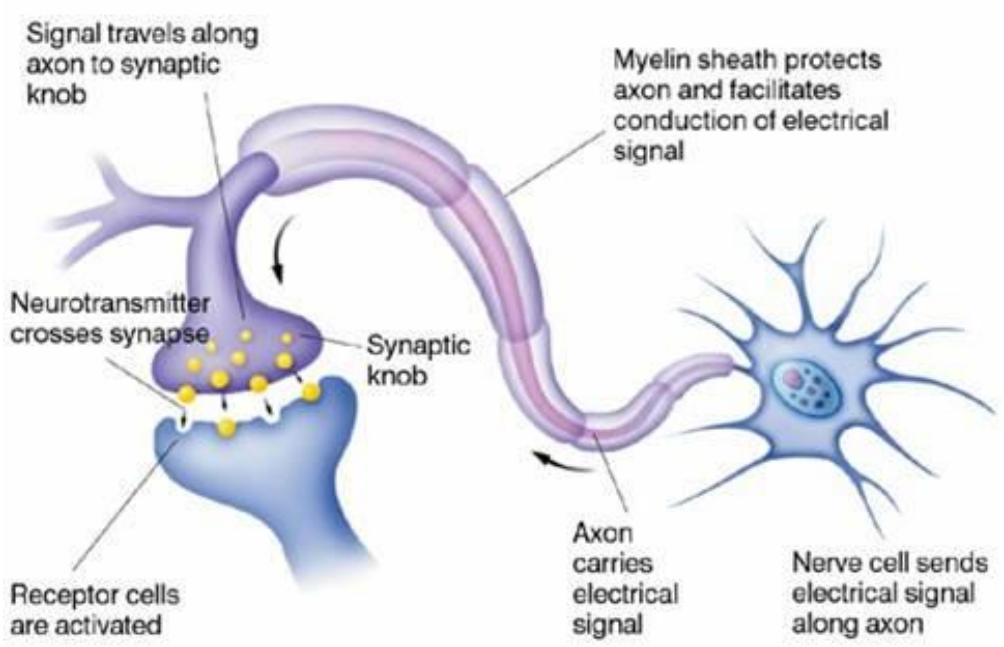
Gender Differences

- Girls develop faster
- Language aptitude and empathy are female
- Math and spatial intelligence are male
- Hormones influence talents and performance
  - Higher estrogen – better verbal performance
  - Lower estrogen – better spatial orientation
  - Aptitude & performance vary in female hormonal cycle
  - Higher testosterone – better memory
  - Lower cortisol level during sleep – better long-term memory
- Brain structure is different – Females:
  - Thicker corpus callosum (connection brain hemispheres)
  - Language procession distributed in both hemispheres
  - Broca & Wernicke area proportionally larger
  - Higher density of neurons in Wernicke-Area

Hormones & Neurotransmitters

Regulate motivation, interest, attention, learning capacity

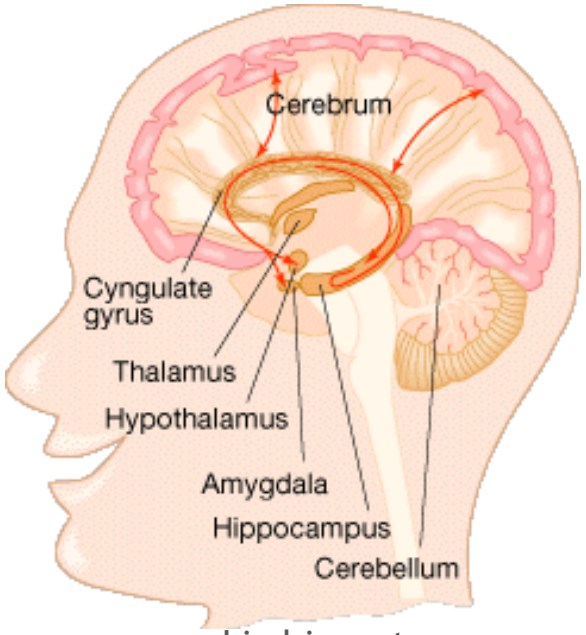
- Estrogens:
  - High level: verbal intelligence
  - Low level: spatial intelligence
- Testosterone:
  - Memory
- Serotonin:
  - “ feel good ” chemical
- Glutamate:
  - Concentration, memory
- Acetylcholine:
  - Fosters learning, selected attention
- Noradrenalin:
  - General attention, alertness, concentration
- Cortisol
  - Stress-hormone, low level – better memory
- Dopamine:
  - Stimulates motivation and pleasure centers



http://jordan-tesch.wikispaces.com/Chapter+four

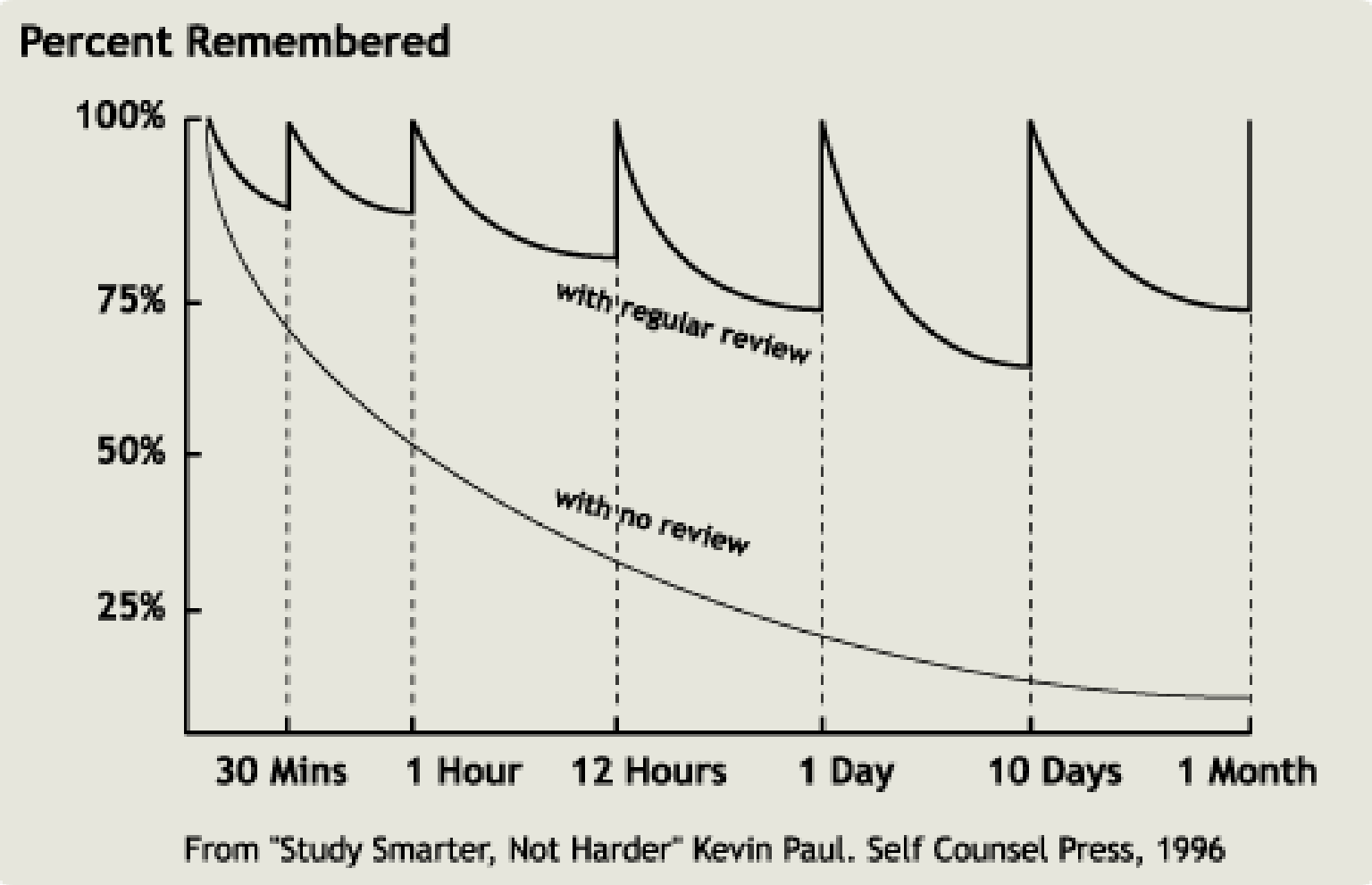
Neurodidactics – Proposals

- Considering *biological facts*:
  - Age, gender, hormones, neurotransmitters, limbic system etc.
  - Different tasks, roles, methods, approaches, material, topics,
- Influencing *personal facts*:
  - Motivation, attention, emotions, dopamine, adrenalin
  - Interesting & useful topics, products, games, competitions
- Creating *supportive environment*:
  - Lesson structure, breaks, room, varied material, tools, ICT
  - COOL: COoperative & COmputer-supported Open Learning
- Supporting *brain functioning* and *memory process*:
  - Pattern recognition – discovery learning
  - Mirror neurons – observational learning,
  - Recall = new learning – learning by teaching, peer tutoring, cooperative learning
  - Cognitive effects e.g. primacy-recency, modality effect, priming

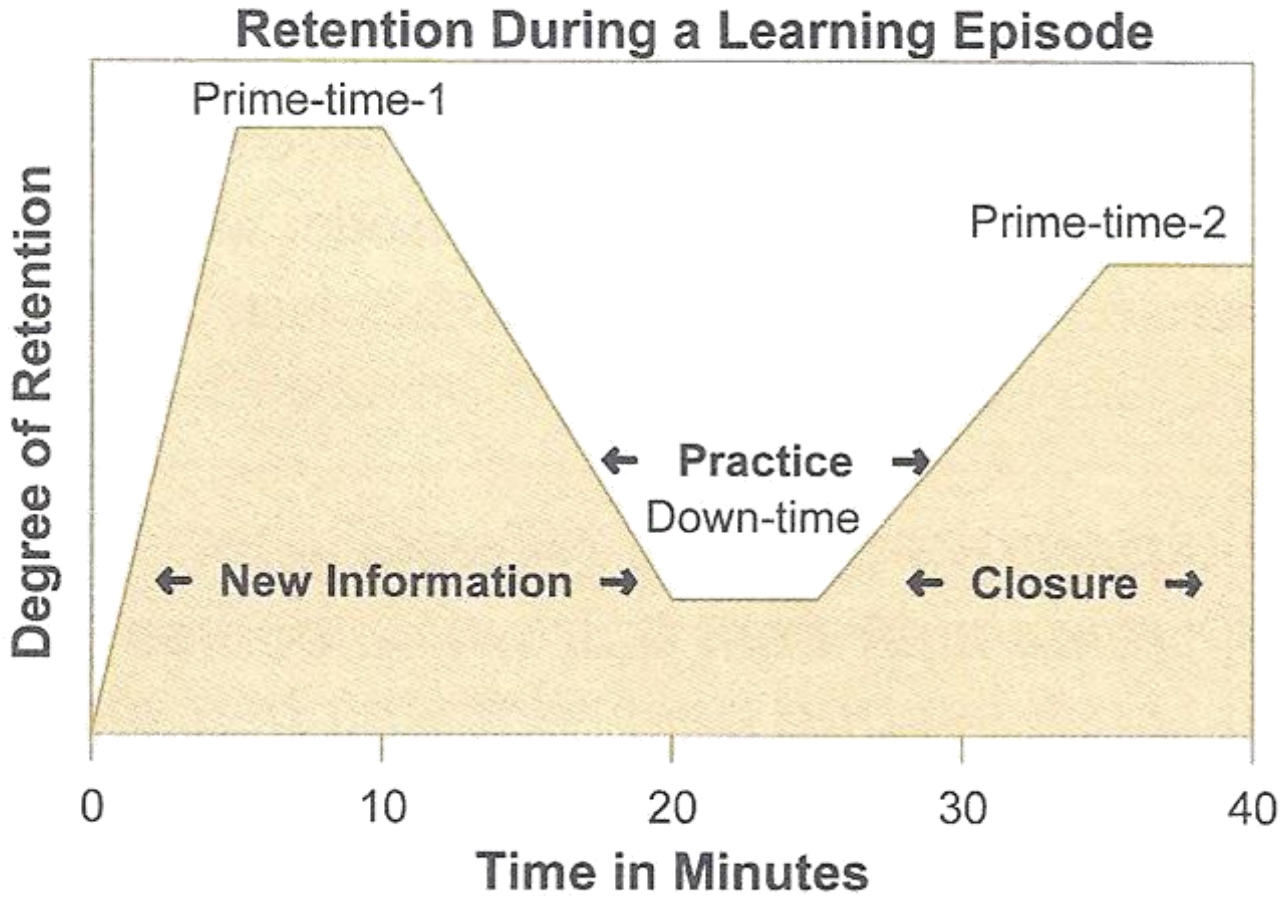


Limbic system

Forgetting & Remembering

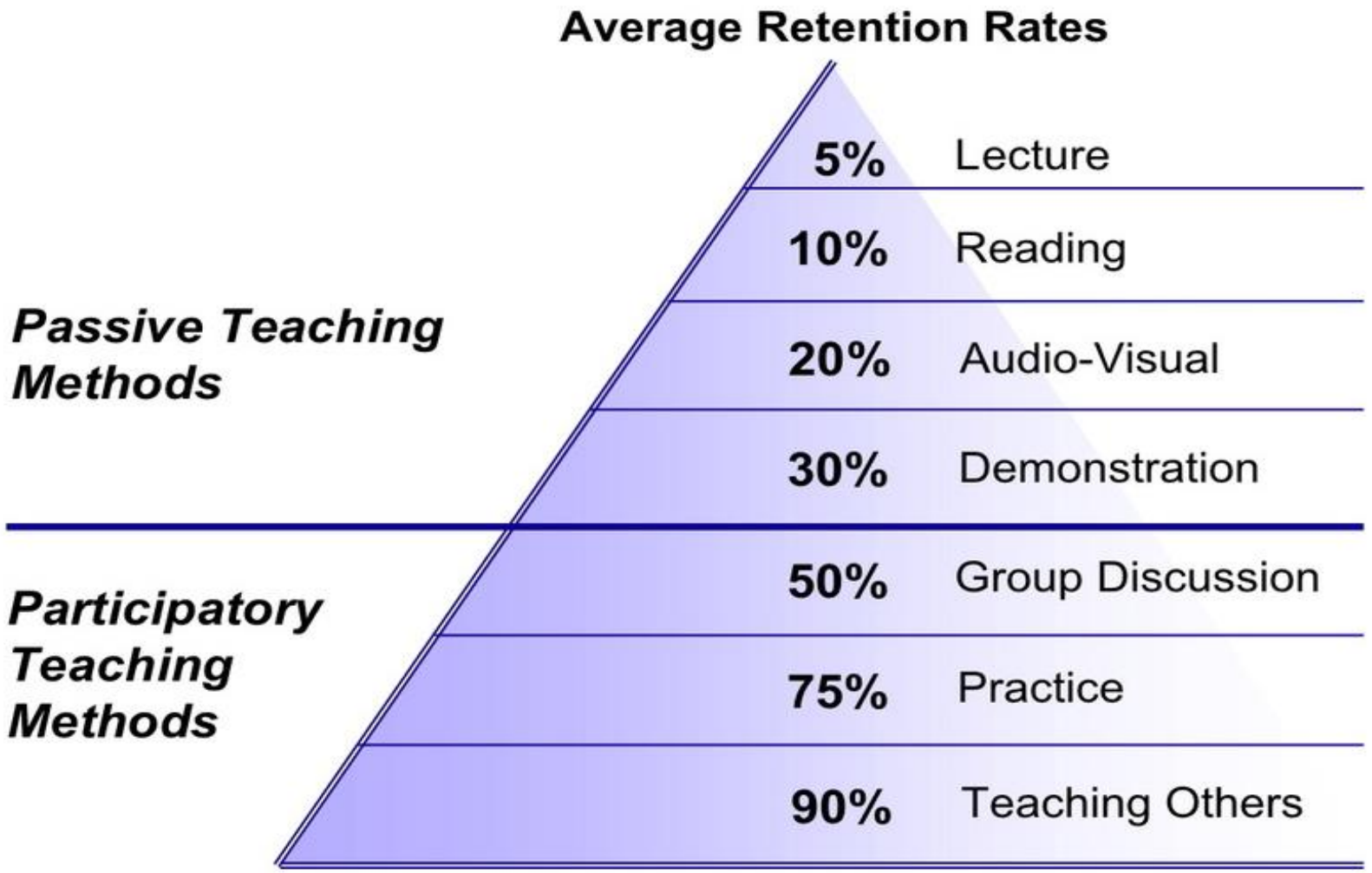


Lesson Structure



Integrating consolidation phases in classroom (Sousa, 2006)

Retention: The Learning Pyramid



*Adapted from National Training Laboratories. Bethel, Maine

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Brain-based Programming

Improving Understanding of Programming

Enhancing Learning Outcomes in Bachelor Programming Courses

Barbara Sabitzer

The Project

- Development of
  - A brain-based **teaching concept** for programming courses (nominated for Ars docendi 2013 - National Award for excellent teaching at Universities)
  - Appropriate **teaching material** as a self-learning booklet
- Evaluation of
  - Acceptance and satisfaction
  - Learning outcomes

	Experimental groups (EG)	Control groups (CG)
Pilot Project 2012/13	1 EG (n=21, n_f=7, n_m=14)	6 CG (n=105, n_f=29, n_m=76)
Extended Project 2013/14	3 EG (n=71, n_f=24, n_m=47)	4 CG (n=88, n_f=37, n_m=51)

Course Organization

- Students act according to competencies
  - Professionals = Peer tutors, peer teachers
  - Amateurs = sometimes peer tutors
  - Beginners
- Lesson structure in each unit (90 – 120 min.)
  1. Question phase (ca. 10 min) in groups with 1 peer tutor
     consider previous knowledge, recall = re-storage
  2. Discovery phase (10-20 min) in groups with 1 peer tutor
     Pattern recognition, learning rhythm (memory consolidation)
  3. Laboratory (Pair-Programming)
     Practice makes perfect, recall = re-storage
  - (lecture max. 20 minutes only if and where necessary)

Teaching Methods & Tasks

- Reading exercises for discovery learning
  - Reading corner (complete program code and guiding questions),
  - Puzzles of program code
  - Step-by-step tutorials and exercises
  - Short tasks including a sample solution
- Competence-oriented tasks for cooperative learning
  - Mini exercises
  - Solutions
  - Peer tutoring
- Programming exercises for indipendent practice
  - Short complete programs, topics of every day life
  - Parts of a complex semester topic

D

```
public class sum {
        public static void main (String[] args) {
            int a = 5, b = 3;
            int c = a + b;
            System.out.println("a    = " + a);
            System.out.println("b    = " + b);
            System.out.println("c    = " + c);
        }
}
```

Output:
a = 5
b = 3
c = 8

```
public class mult {
      public static void main (String[] args) {
            int a = 3, b = 2;
            int c = a * b;
            System.out.println("a    = " + a);
            System.out.println("b    = " + b);
            System.out.println("c    = " + c);
      }
}
```

Output:
a = 3
b = 2
c = 6

1. Which parts (lines / terms) are necessary in all Java-programmes?
2. Can you discover the structure of a Java programme?
3. How do we have to indicate the name or title of the programme?
4. How does a Java programme begin, how does it end?
5. What do these two programmes calculate?
6. How can we get an output?

READING EXERCISES 2: READING CORNER – CLASSES AND OBJECTS

Reading Corner Student

Class Student

```
public class Student {

   private String name;
   private boolean awake;

   public Student(String name) {
      this.name = name;
      this.awake = false;
   }

   public String getName() {
      return this.name;
   }

   public void setName(String name) {
      this.name = name;
   }

   public void wakeUp() {
      this.awake = true;
   }
}
```

Student

- name : String
- awake : boolean

+ Student(name : String)
+ wakeUp()
+ getName()
+ setName(name : String)

Class Day - Main

```
public class Day {

   public static void main(String[] args) {
      Student object1 = new Student("Jamie");
      Student andy = new Student("Andreas");
      Student randomName = new Student("Naomi");

      object1.wakeUp();
      andy.wakeUp();

      randomName.setName("Melanie");
      System.out.println(randomName.getName());
   }
}
```

Fig. 3. Reading corner "Student's day"

EXAMPLE TASKS FOR THE READING CORNER

1. Read the example classes and write a "cheat sheet" including the main information about classes and objects.
2. Mark the constructor in the class *Student* and its parameters. Which variables does it set? Which methods has the class *Student*? What are they doing?
3. How many objects are generated in the *main*-method (class *Day*)? What are their names?
4. How do the objects change? What will the console display?

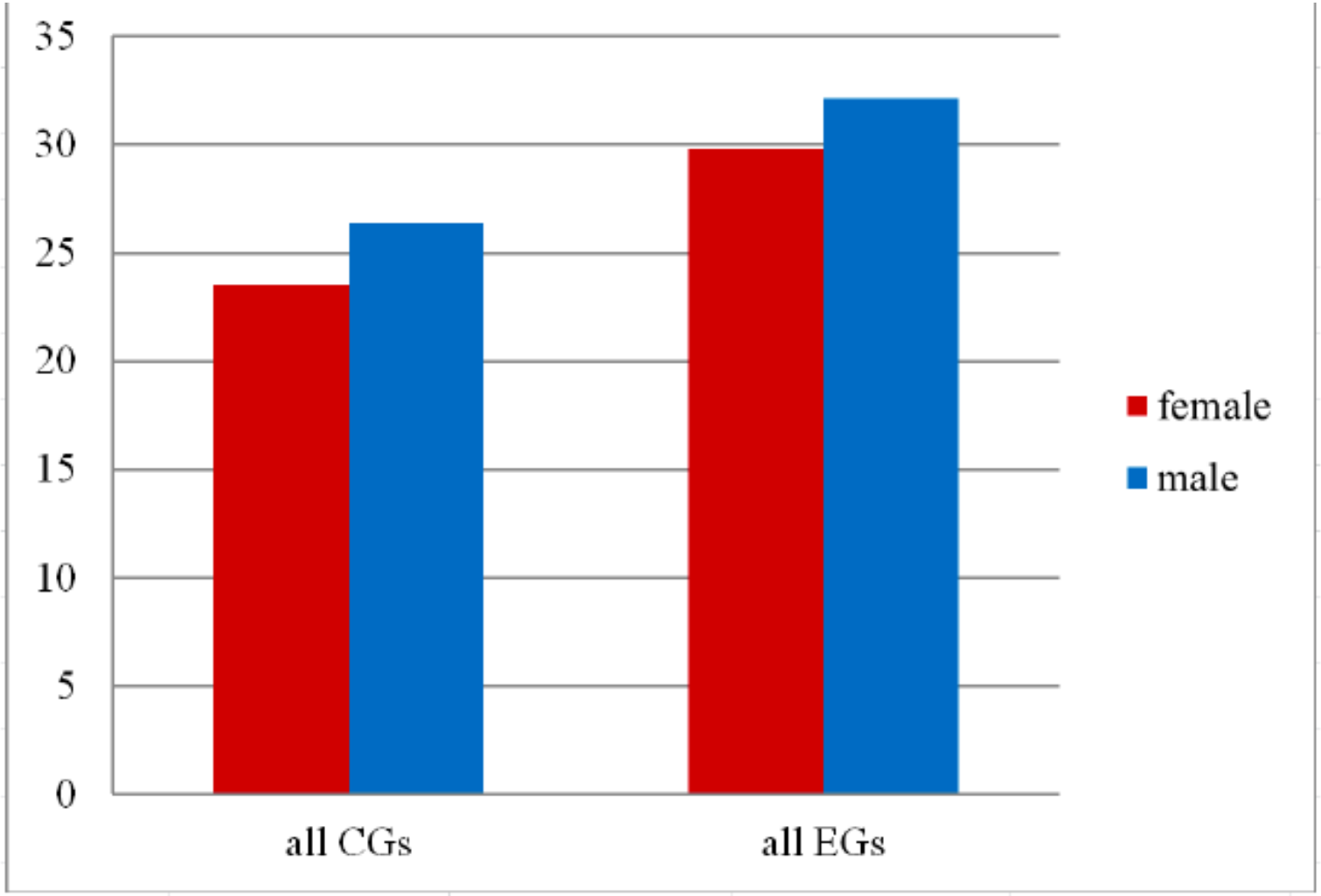
Results

Acceptance

+ Students & teachers liked **relaxed atmosphere** in the courses.
+ Learners & peer tutors appreciate the possibility to **get help** anytime and from different people.
+ **Free choice** concerning tasks, topics and material.
+ Most useful methods: **discovery learning, peer tutoring**, **pair programming** and team work.
+ Most useful tasks: all forms of discovery learning: **step-by-step** tasks, reading corners, video-tutorials, mini exercises & **solutions**
+ **Peer tutors learned more** than in a traditional setting: even contents exceeding the frame of the actual course content because they had to check the in books or to ask the teacher.

– The preparation of different material is too **much work** for teachers.

Learning Outcomes 2014



Total average points (both exams, max. 50, less than 25 = failed)

Exams 2014

- Higher **success rate** in the EG: 52% (usually 40%)
- Significantly **better results** (achieved points) in the first exam (t-test for independent groups, p = 0.008, Cohens d = 0.42)
- Better results (points) in the second exam:
  average in EG: 10.73 (CG 8.82)
  standard deviation in EG: 6.98 (CG 8.64)
- Female students benefit even more (**no** significant **gender difference** in brain-based groups;
  significantly better results for males in control groups: Cohens d = 0.58).

Gender

TABLE 3: GENDER DIFFERENCES IN CONTROL GROUPS (ACHIEVED POINTS)

Sex	*N*	*Mean*	*SD*	*T*	*p*	*Cohen's d*[1]
male	47	19,85	6,70	2,52	0,014	0,58
female	36	15,54	8,45			

TABLE 4: GENDER DIFFERENCES IN EXPERIMENTAL GROUPS

Sex	*N*	*Mean*	*SD*	*T*	*p*	*Cohen's d*
male	46	21,85	5,47	1,25	0,214	-
female	25	19,72	5,14			

References

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Thank you for your attention!

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