Multimedia Learning:
From Endocrinology to Virtual Reality

Cyril Brom
Charles University
Faculty of Mathematics and Physics
Advanced Multimedia Learning Laboratory

brom@ksvi.mff.cuni.cz
ksvi.mff.cuni.cz/amulab

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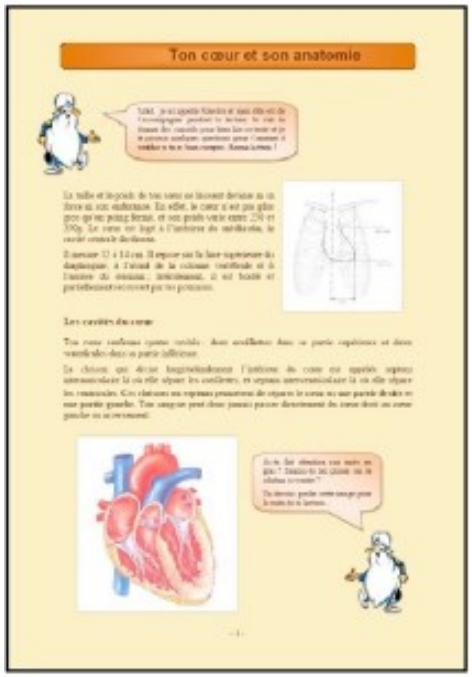
Outline

- Multimedia learning
- Challenge 1: Boundary conditions
- Challenge 2: Emotions
- Challenge 3: Process measures
- Conclusions

Multimedia learning

- Combines words and pictures (Mayer 2014)
- **Words**: written, spoken
- **Pictures**: illustrations, graphs, animations…
- Traditional:
  - textbooks, slides, animations, videos
- Interactive:
  - simulations, video games, tutoring systems, conversational agents



(Andery et al., 2016, SIG2)

Multimedia learning: Context

- Quantitative comparisons
- Science, Engineering, Technology, Mathematics
  - acquisition of mental models
- Knowledge outcomes
  - memorization (retention)
  - understanding (transfer)

Theories of Multimedia learning

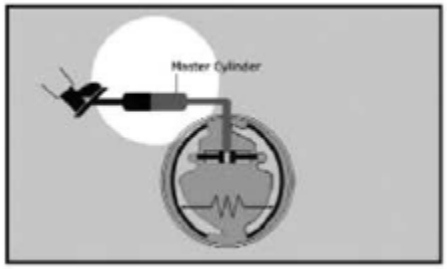
- Cognitive Theory of Multimedia Learning (Mayer 2014)
- Cognitive Load Theory (Sweller et al. 2011; Kalyuga 2011)

Principles of Multimedia learning

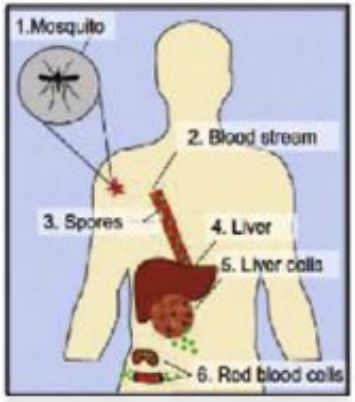
- Do this: **"Highlight key information"**
  - Retention: Cohen's *d* = **0.53** [0.42 – 0.64]
  - Transfer: Cohen's *d* = **0.33** [0.22 – 0.43]

95% confidence interval for *d*

(Schneider et al 2018 Edu Res Rev)



(Doolittle & Alstaedter 2009 J Res Innov Teach)



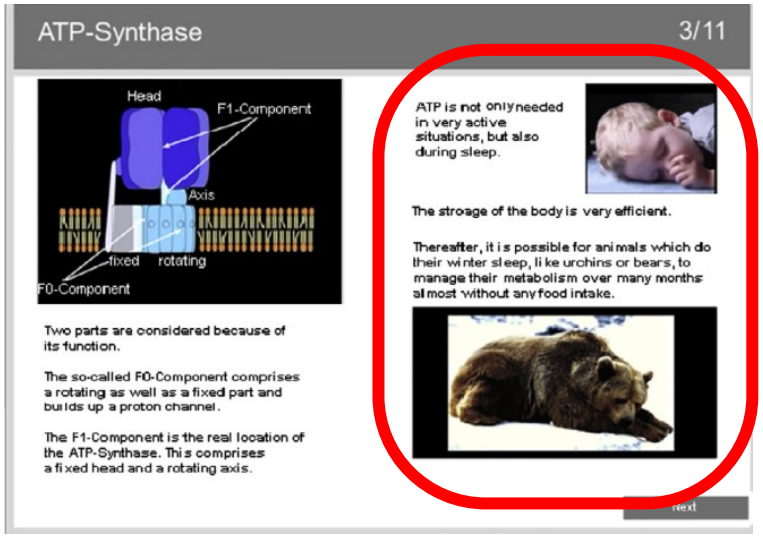
(McTigue 2009 Cogn Instr)

Now it will be explained, how biological wastewater treatment works. A textile mill that dyes fabrics and releases AZO DYES into the river. Azo dyes are SLIGHTLY TOXIC for aquatic organisms and can cause mutation.

(Brom et al. 2017 Compr & Edu)

Seductive details principle

- Interesting
  - but not central
- Text, sound, image



(Park et al. 2015 Comp Hum Beh)

- Do not: **"include seductive details"**

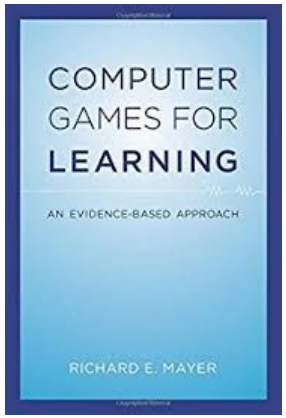
- Retention: *d* = **-0.30** [-0.39 – -0.20]
- Transfer: *d* = **-0.48** [-0.34 – -0.61]

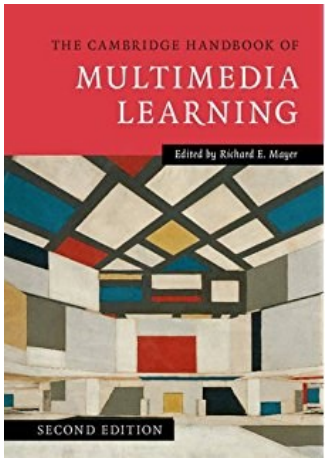
(Rey 2012 Edu Res Rev)

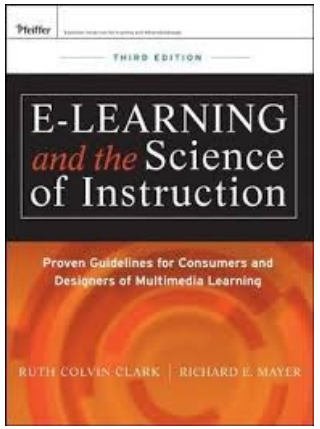
Principles of multimedia learning

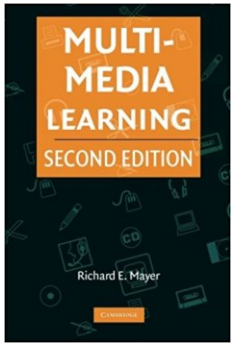
(e.g. Mayer 2014; Renkl & Scheiter 2015 Edu Psy Rev)

- Do this:
  - "Highlight key information"
  - "Use voice rather than text"
  - "Position corresponding text and picture near each other"
  - …









1st challenge: Boundary conditions

National replications:
General picture

- Non-representative samples
  - > 50% educational sciences or psychology
  - > 50% female students
- USA, Germany

- Lacking:
  - children, older populations
  - national replications
  - (different subjects)

Personalization principle

[Now I will tell you,] Now it will be explained, how biological wastewater treatment works. [Imagine you are standing on the bank of a muddy river. Next to the river is a] A textile mill [that] dyes fabrics and releases azo dyes into the river.

- Do this: **"write text in a conversational style"**

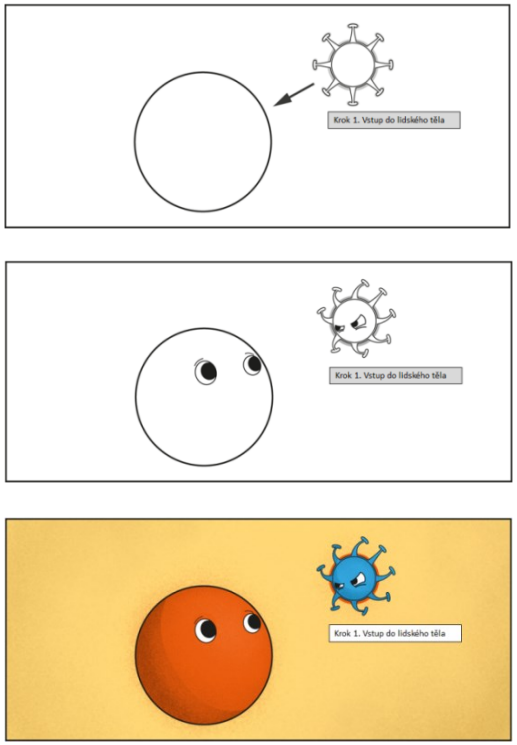
- Retention: d = **0.30** [0.18 – 0.41]
- Transfer: d = **0.54** [0.25 – 0.83]

(Ginns et al. 2013 Edu Psychol Rev)

- But this does not work in Czech (N ~ 400)

(Brom et al. 2014 Comp & Edu; Brom et al. 2017 Comp & Edu)

Anthropomorphisms & color principle



(Mayer & Estrella 2014 Ln Instr; Starkova et al., submitted)

- Do this: **"Use pleasant colors & anthropomorphisms"**

- Retention: d = **0.37** [0.11 – 0.62]
- Transfer: d = **0.33** [0.19 – 0.47]

(Brom et al., submitted)

- But this does not work in Czech (N = 181)

(Starkova et al., submitted)

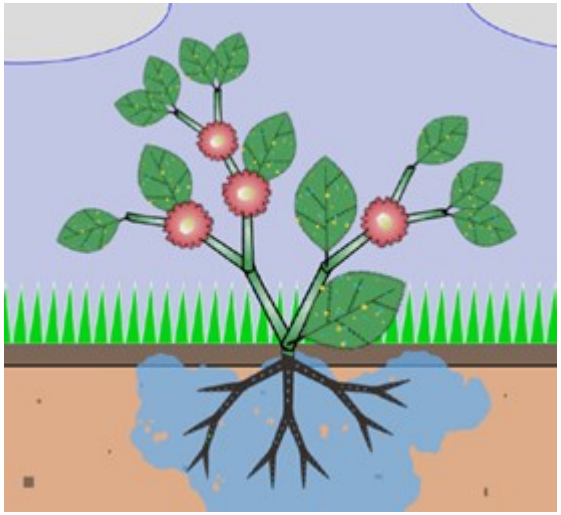
“Nice” graphics with children?

preference

>>

learning

≤



(Javora et al. 2019 BJET)

- 20 min long learning game
- Photosynthesis, water transport
- $N = 53$; $M_{age} = 9.45$, $SD_{age} = 0.75$

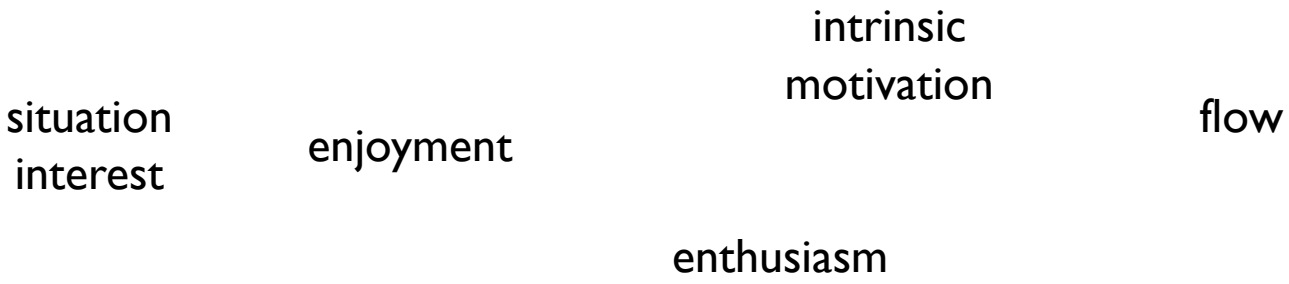
I st challenge: Summary

- Multimedia learning principles:
  - useful
  - but caution is needed (generalization)

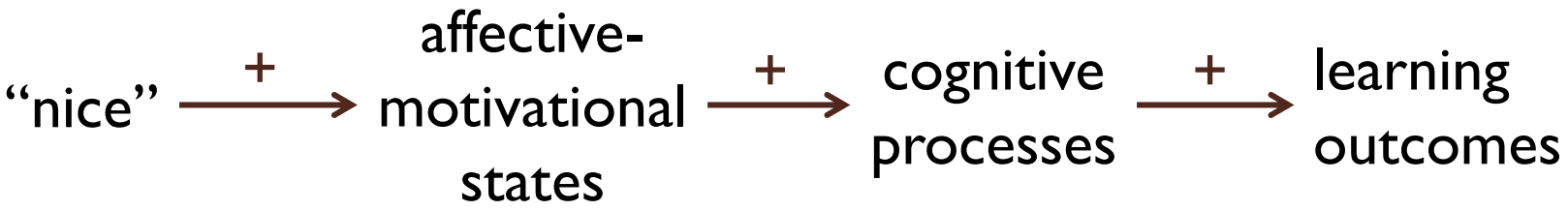
2nd challenge: Emotions

Emotions in Multimedia learning

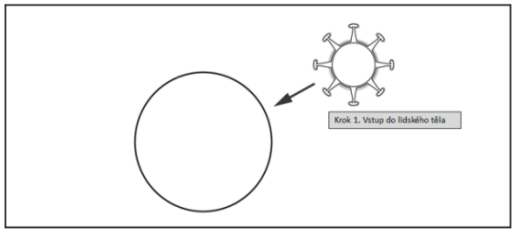
- Neglected
- **Positive-activating activity-related** affective-motivational **states** (Pekrun 2006 Educ Psychol Rev)

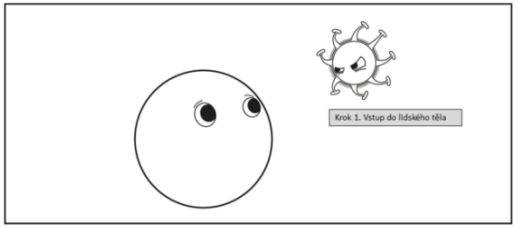


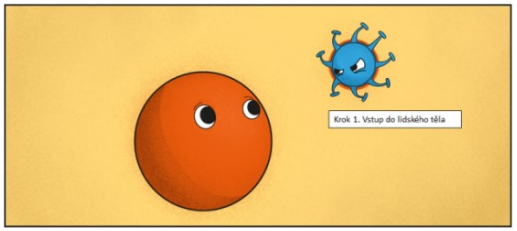
Emotions in Multimedia learning



Anthropomorphisms & color principle







(Mayer & Estrella 2014 Ln Instr
Starkova et al., submitted)

- Do this: **"Use pleasant colors & anthropomorphisms"**

- Retention: *d* = **0.37** [0.11 – 0.62]
- Transfer: *d* = **0.33** [0.19 – 0.47]
- **Enjoyment: *d* = 0.11** [0.01 – 0.21]

(Brom et al., submitted)

Personalization principle

[Now I will tell you,] Now it will be explained, how biological wastewater treatment works. [Imagine you are standing on the bank of a muddy river. Next to the river is a] A textile mill [that] dyes fabrics and releases azo dyes into the river.

- Do this: **"write text in a conversational style"**

- Retention: d = **0.30** [0.18 – 0.41]
- Transfer: d = **0.54** [0.25 – 0.83]
- **Interest: d = 0.15** [-0.13 – 0.44]

(Ginns et al. 2013 Edu Psychol Rev)

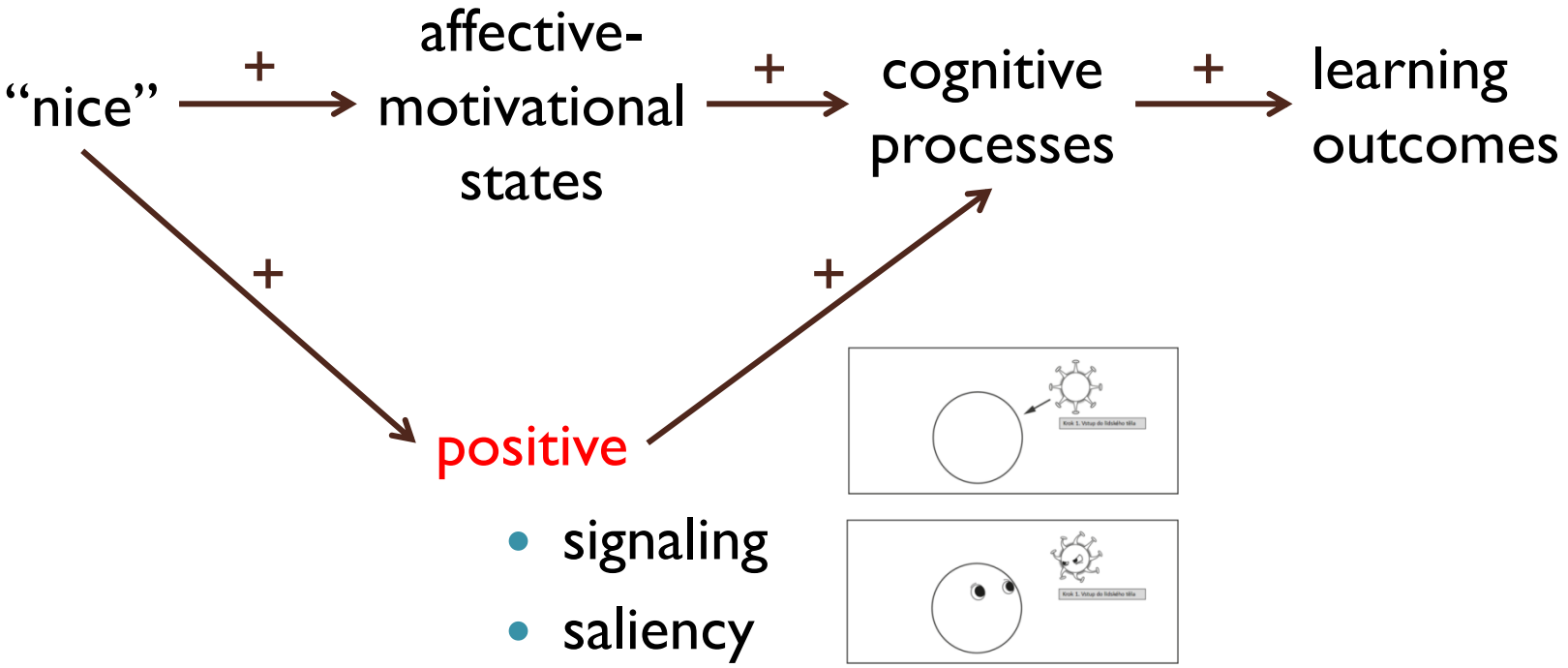
Digital learning games vs. "traditional" teaching

- Learning outcomes: d = **0.29** [0.17, 0.42]
- Motivational outcomes: d = **0.26** [-0.03, 0.56]

- Learning outcomes
  - with randomization: d = **0.08** [-0.13, 0.29]
  - without randomization: d = **0.44** [0.29, 0.60]

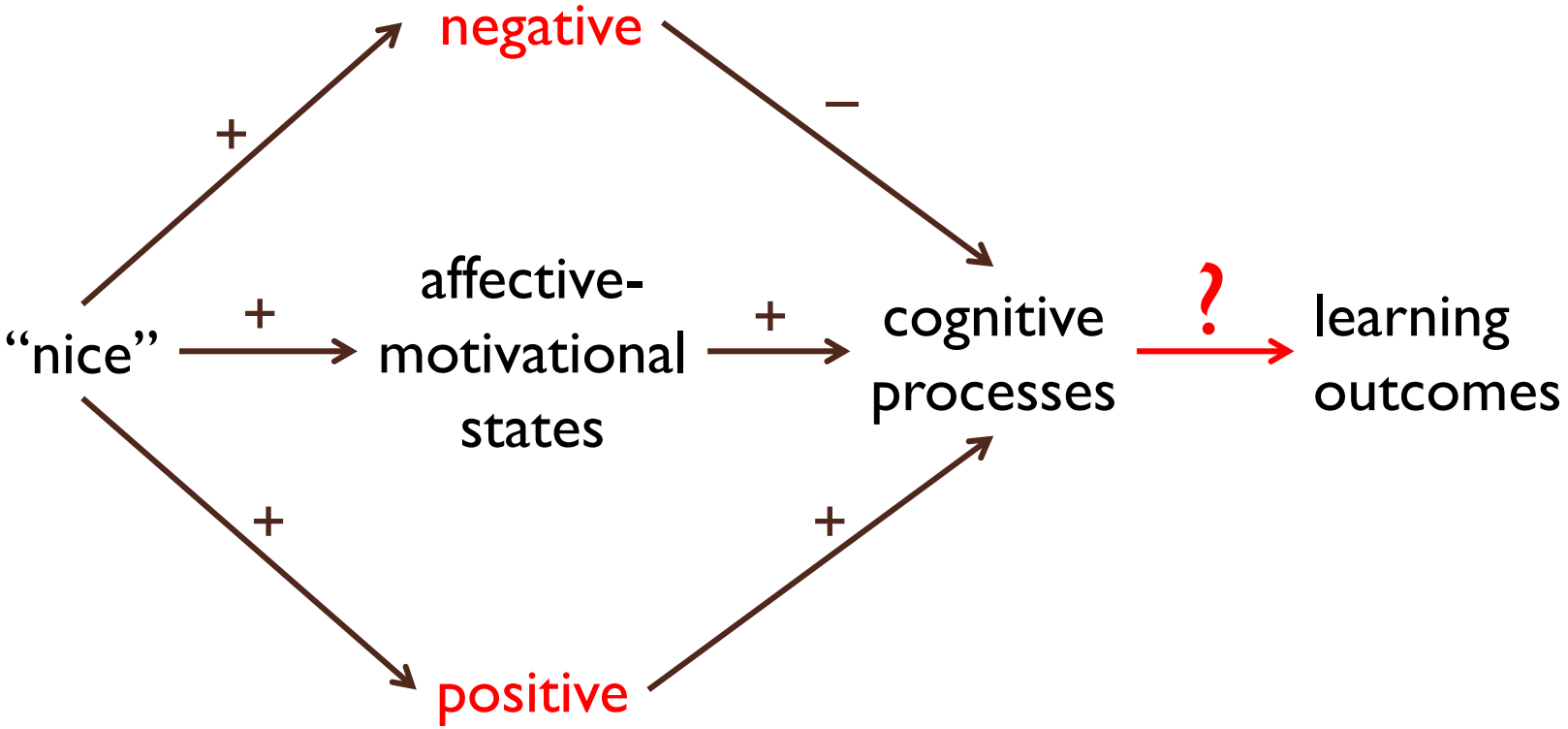
(Wouters et al. 2013 J Edu Psy)

2nd challenge: Summary



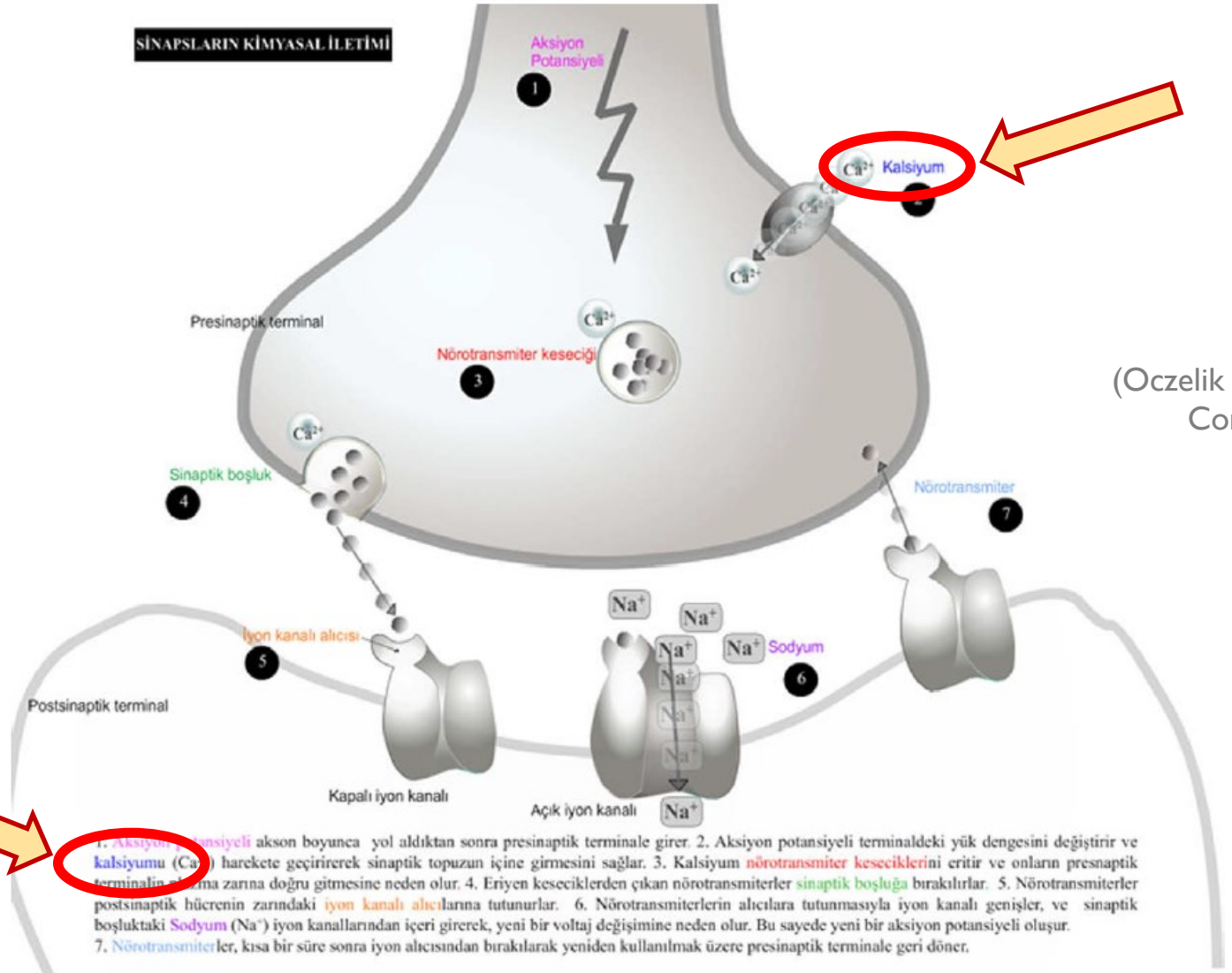
2nd challenge: Summary

- distraction



3rd challenge: Process (and objective) measures

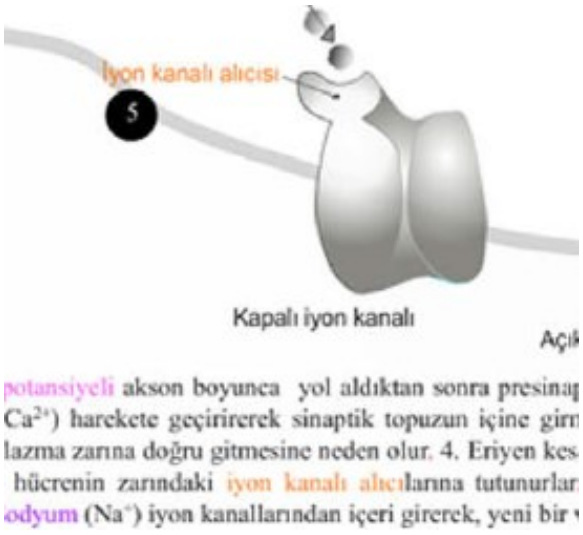
Eyetracking



(Oczelik et al. 2009 Comp & Edu)

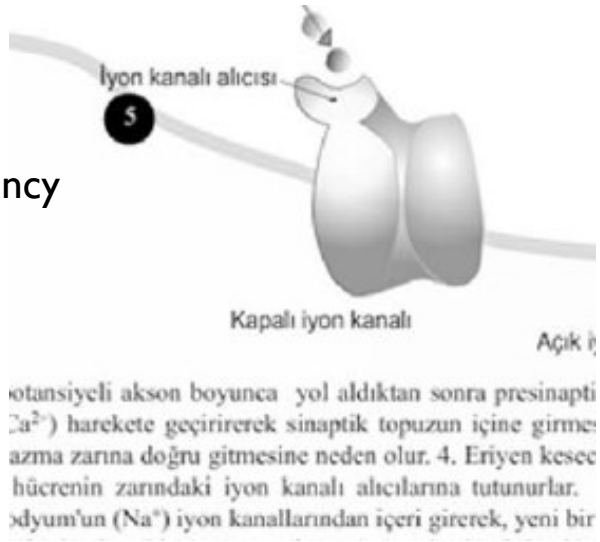
Eyetracking

- Color coding



retention
transfer
visual search efficiency

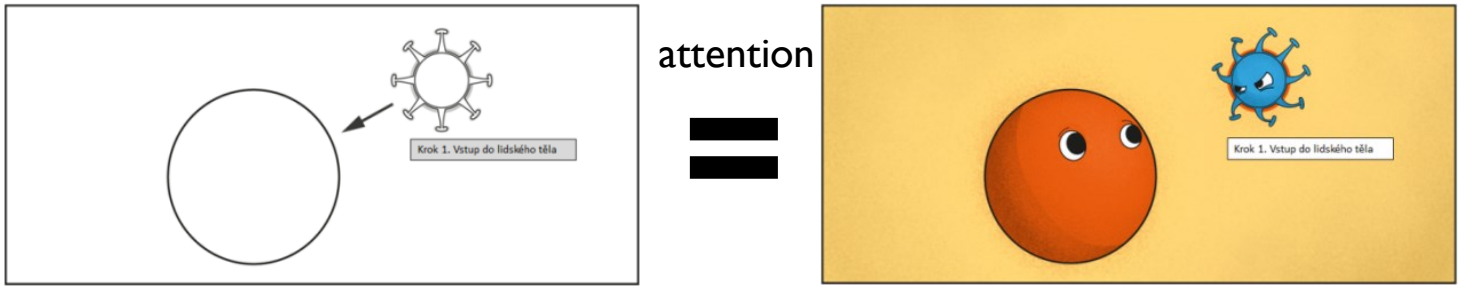
>



(Oczelik et al. 2009 Comp & Edu)

Eyetracking

- Do anthropomorphisms attract more attention?
  - unknown

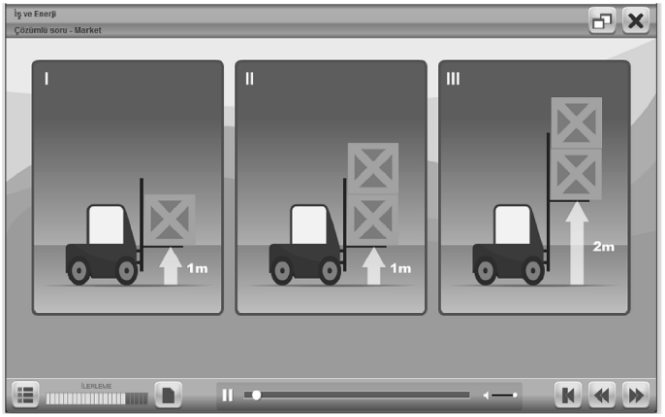


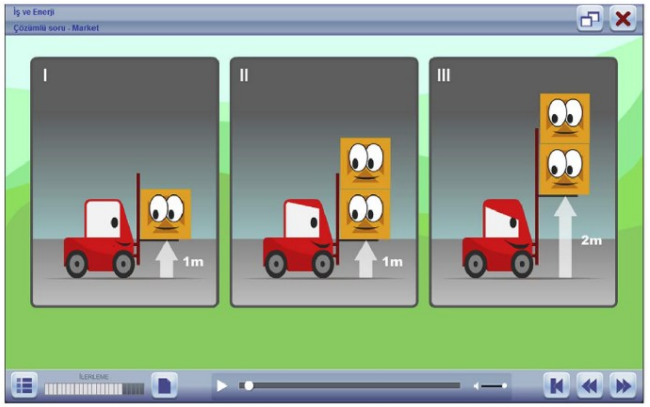
(Starkova et al., submitted;
Park et al. 2015 Com Hum Beh)

Emotion/arousal detection

- Detection of facial emotions
  - e.g., game-based learning (Ninaus et al. 2018 SIG8)

- Biofeedback
  - e.g., HRV (Uzun & Ildirim 2018 Comp & Edu)





Salivary cortisol

- "Stress" hormone
- Differing predictions with respect to **flow levels** (Keller et al. 2011 J Exp Soc Psychol; Peifer et al. 2014 J Exp Soc Psychol)

- Unrelated to flow
- Related to the trait level of social interaction anxiety in the case of males (Brom et al., 2014)

Conclusions

- Principles of multimedia learning are useful
  - from textbooks to digital games
- Boundary conditions are numerous
  - from different topics to different populations
- Affective-motivational factors must be considered
  - results not promising so far
- Process (and objective) measures may be useful
  - but have their own limitations
- **"Psychological research in multimedia learning"**

Questions?

Lenka Gemrotová
Tomasz Z. Majkowski
Jan Frydecký
Josef Kubias
Jiří Hoppe
Dan Heuer
Ondřej Paška
Veronika Trčková
Eva Nečasová
Lukáš Masner
Stanislav Koukal
Richard Alexander
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Markéta Tomková
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LABELs
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