Learning from Video: Using Cognitive Psychology to Improve Understanding in Multimedia Lessons

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Outline

- Theoretical Foundations in Cognitive Psychology
  - Cognitive Load Theory (Sweller)
  - Cognitive Theory of Multimedia Learning (Mayer)
- Some failures to replicate and what they might mean
  - Subtitles & redundancy
  - Segmenting & self-pacing
- Evidence for a few things that worked
  - Animations
  - Adjunct Questions
- Conclusions and Recommendations

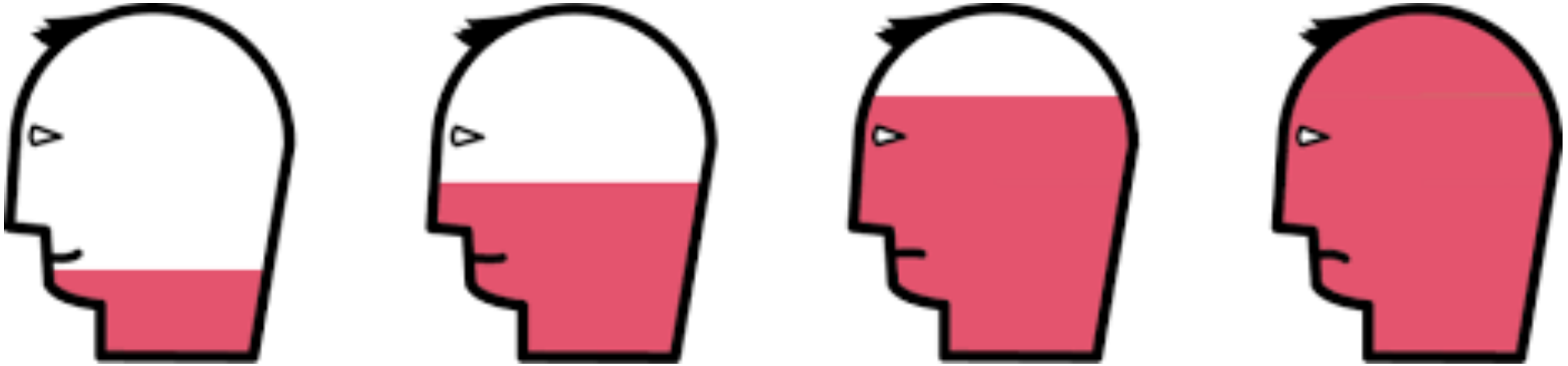
Theoretical Foundations in Cognitive Psychology

Instructional Video

- Studying instruction is hard
  - In educational settings: high validity but low control
  - In psych labs: high control by low validity
- Instructional video offers a compromise
  - Opportunity to study instruction in a systematic way
  - Video is becoming an instructional medium in its own right (different from in-person instruction)
- YouTube is a great source of instructional video
  - Literally THOUSANDS of lessons that people seek out on their own
  - Channels dedicated to educational material, such as Crash Course and Khan Academy

Cognitive Load Theory

- Students have limited cognitive capacity to engage in instructional tasks, and not all uses of that capacity benefit learning (Sweller, 1988)
- To best support learning, we should try to manage *intrinsic* load, reduce *extraneous* load, and foster *germane* load

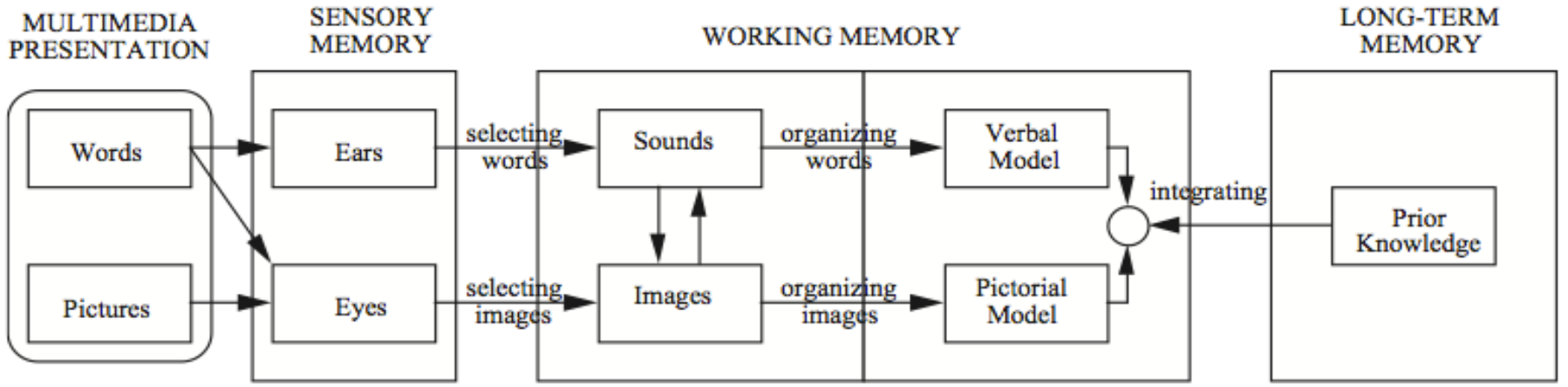


The Cognitive Theory of Multimedia Learning

(Mayer, 2008)

- What is learning?
  - Selecting, organizing, & integrating information with prior knowledge

- How does multimedia learning work?
  - Dual channels, limited capacity, and active processing



Mayer's Principles of Multimedia Instruction

(Mayer, 2008)

Table 1
Five Evidence-Based and Theoretically Grounded Principles for Reducing Extraneous Processing

Principle	Definition	Effect Size (*d*)	Number of Tests
Coherence	Reduce extraneous material.	0.97	13 of 14
Signaling	Highlight essential material.	0.52	6 of 6
Redundancy	Do not add on-screen text to narrated animation.	0.72	5 of 5
Spatial contiguity	Place printed words next to corresponding graphics.	1.12	5 of 5
Temporal contiguity	Present corresponding narration and animation at the same time.	1.31	8 of 8

Table 2
Three Evidence-Based and Theoretically Grounded Principles for Managing Essential Processing

Principle	Definition	Effect Size (*d*)	Number of Tests
Segmenting	Present animation in learner-paced segments.	0.98	3 of 3
Pretraining	Provide pretraining in the name, location, and characteristics of key components.	0.85	5 of 5
Modality	Present words as spoken text rather than printed text.	1.02	17 of 17

Table 3
Two Evidence-Based and Theoretically Grounded Principles for Fostering Generative Processing

Principle	Definition	Effect Size (*d*)	Number of Tests
Multimedia	Present words and pictures rather than words alone.	1.39	11 of 11
Personalization	Present words in conversational style rather than formal style.	1.11	11 of 11

Many of these studies use animations and lessons that are quite different from what we think of as video instruction today.

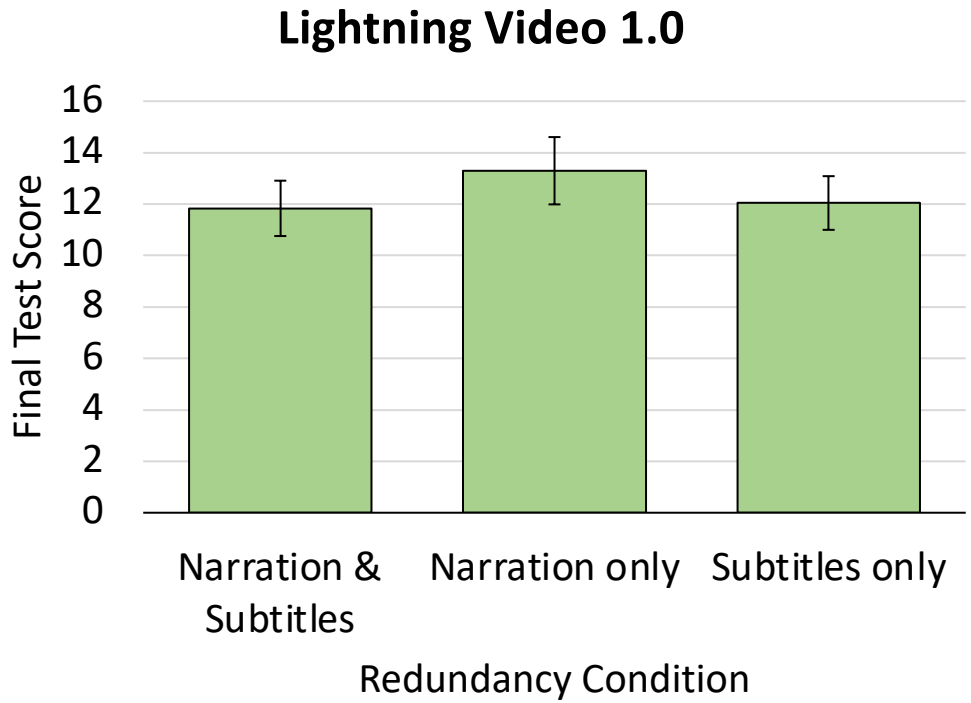
Do these principles generalize?

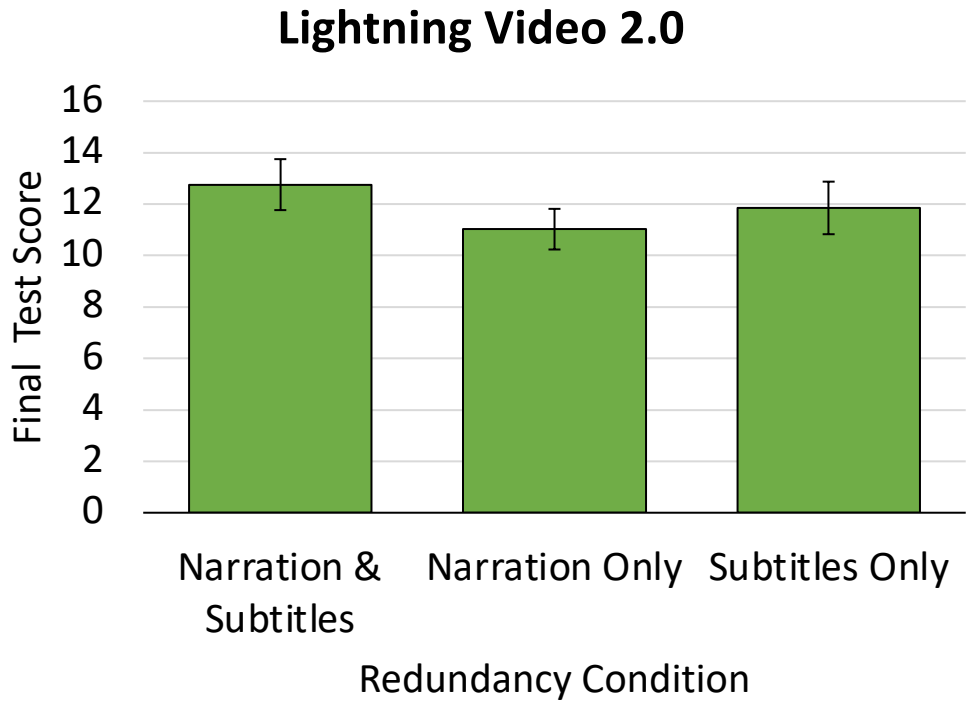
Some failures to replicate

And possible reasons why

The Redundancy Principle

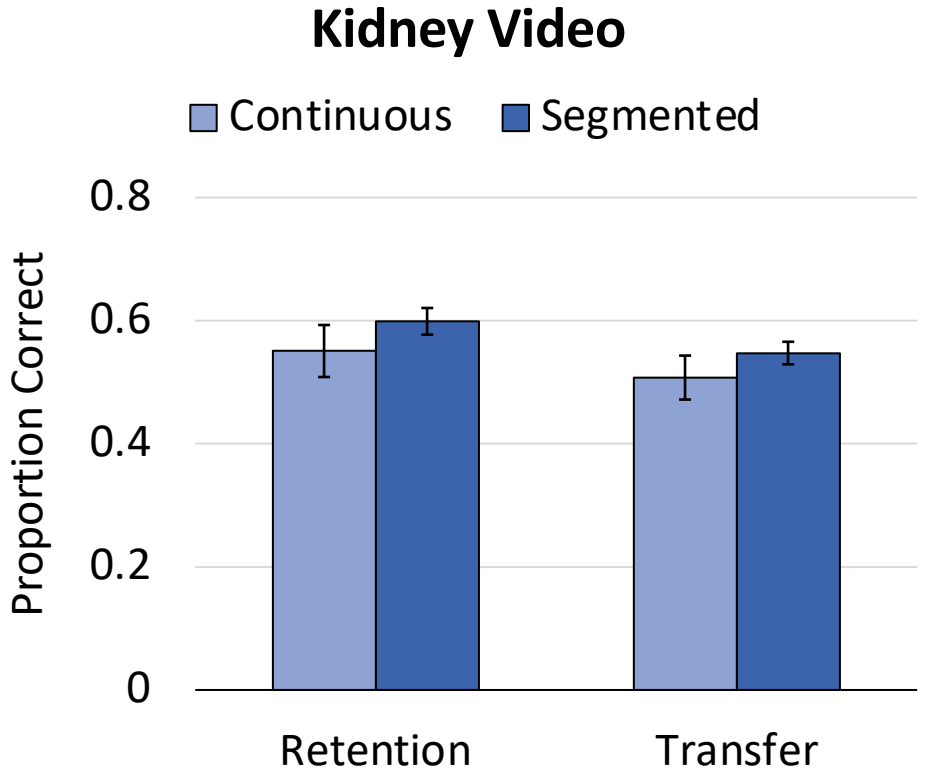
- *Mayer (2008): Do not add on-screen text to narrated animation*
  - Text + images overloads the visual channel, while text + narration makes better use of the dual channel system

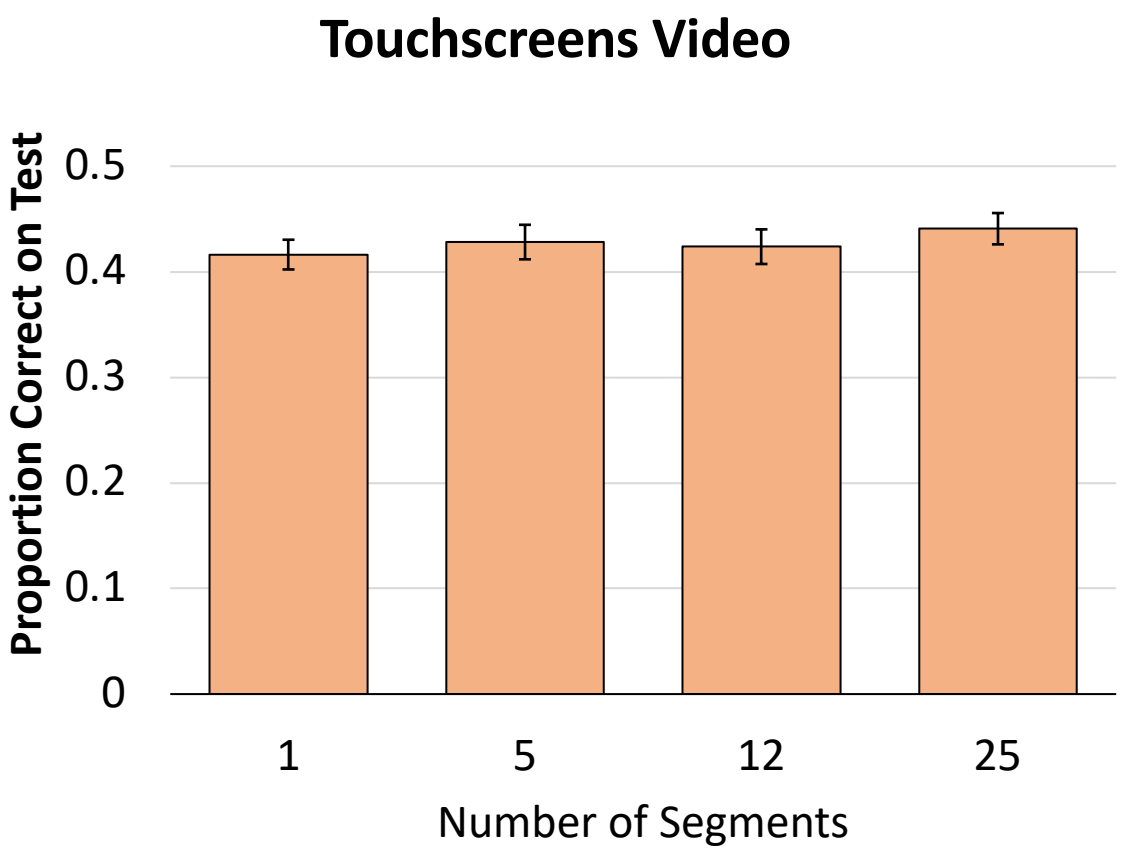




The Segmenting Principle

- *Mayer (2008): Present animation in learner-paced segments*
  - Allowing students to pause the animation gives time to process transient info





Translating findings is challenging

- It can be hard to know how much a published finding depends on some non-manipulated aspect of the materials

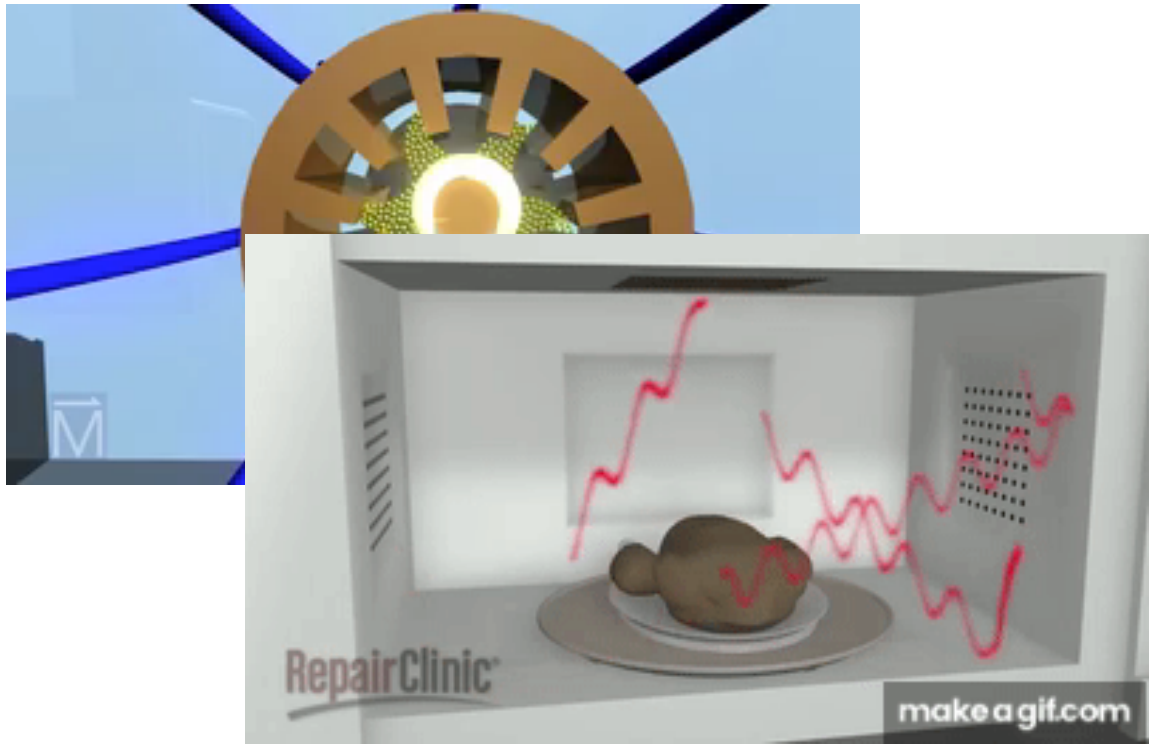
- If a particular video lesson is not overly complex to begin with, instructional changes aimed at reducing extraneous load may not have meaningful or measurable effects (Sweller, 1994)

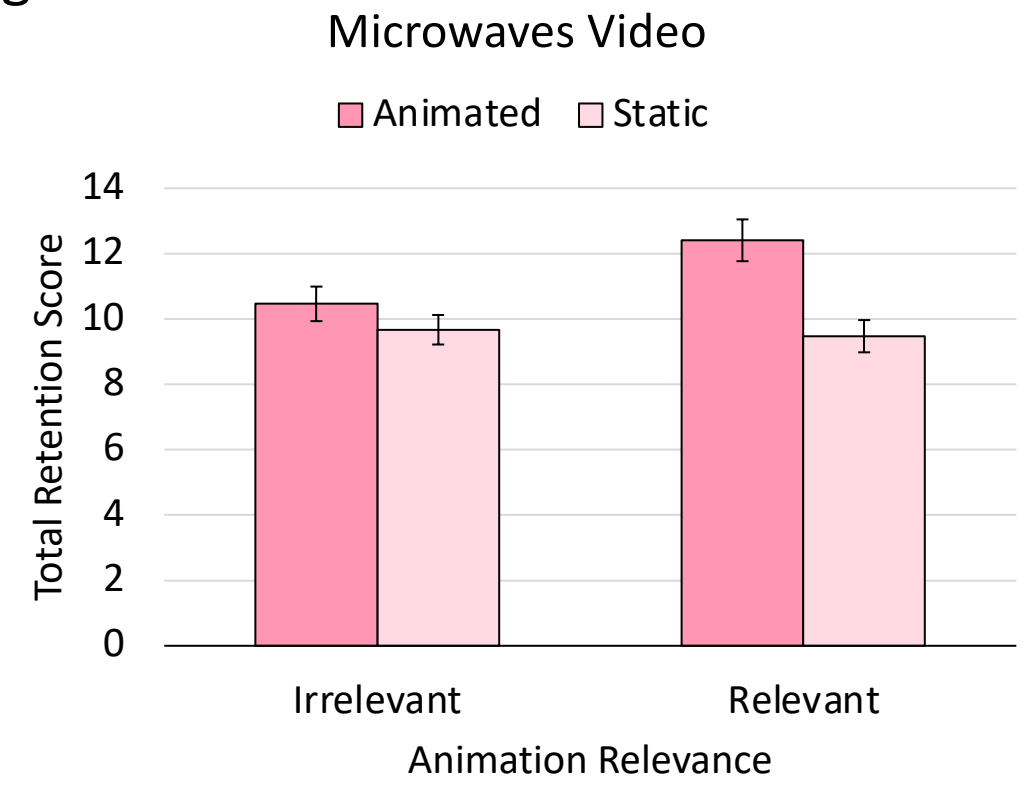
- Future work should be aimed at **identifying boundary conditions** for these principles, so that we have more guidance about *when, why, and how* to implement them effectively

Some things that have worked

Effective Animations

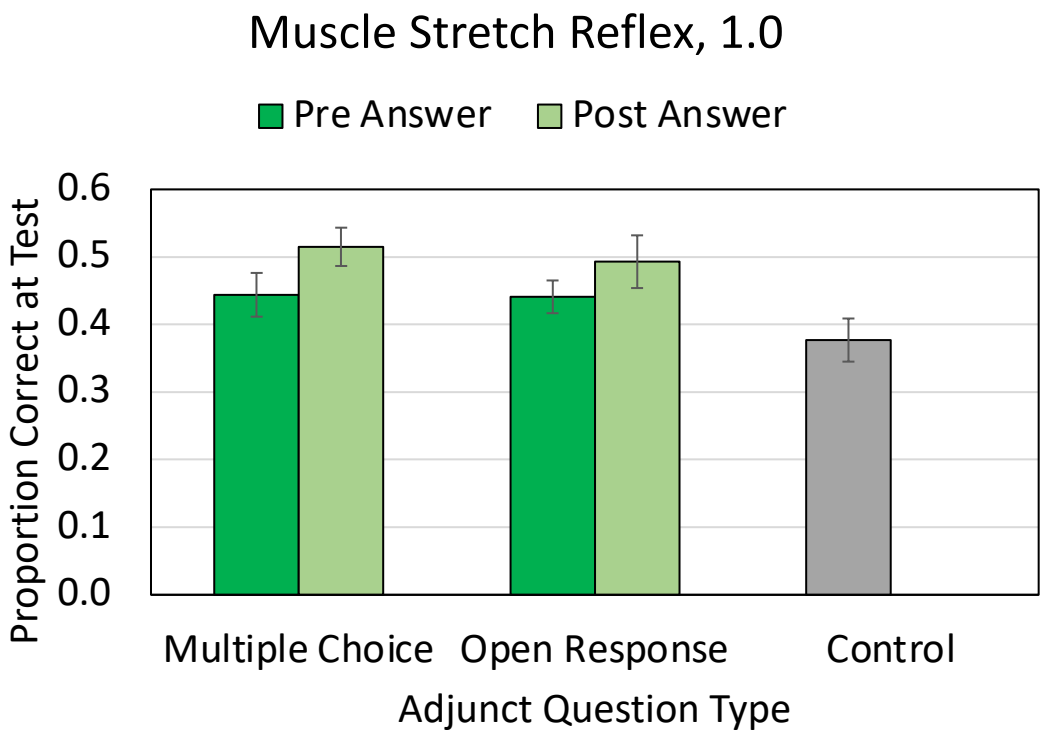
- Coherence principle (Mayer, 2008): Reduce extraneous material
  - Do extraneous animations reduce learning?

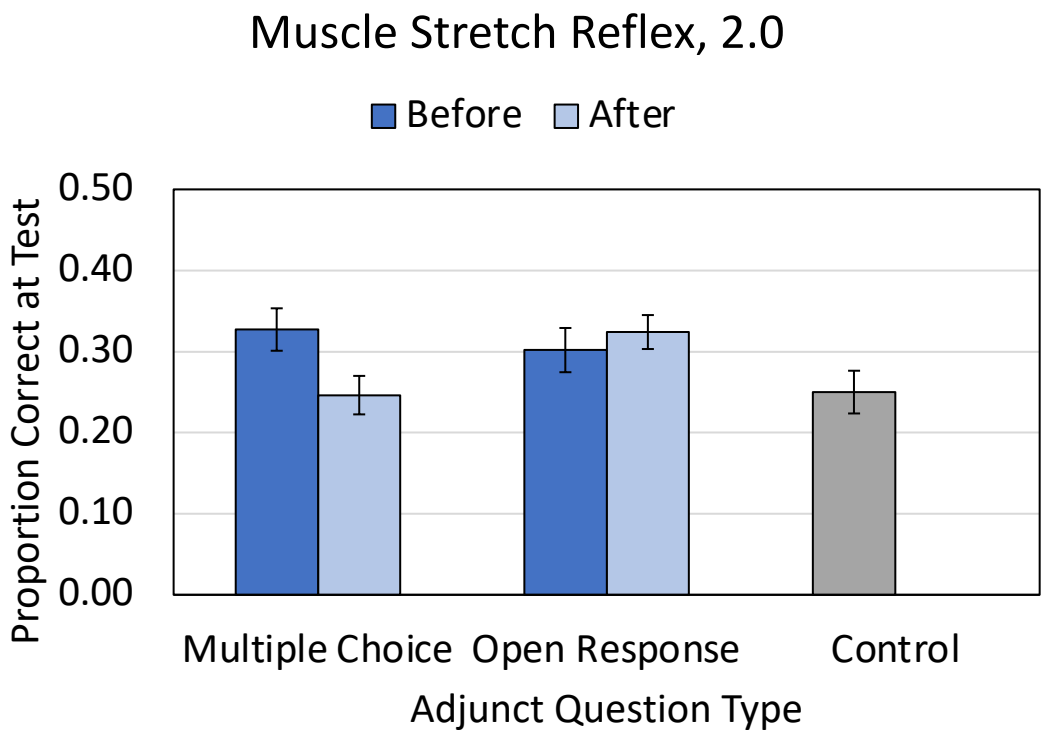




Adjunct Questions

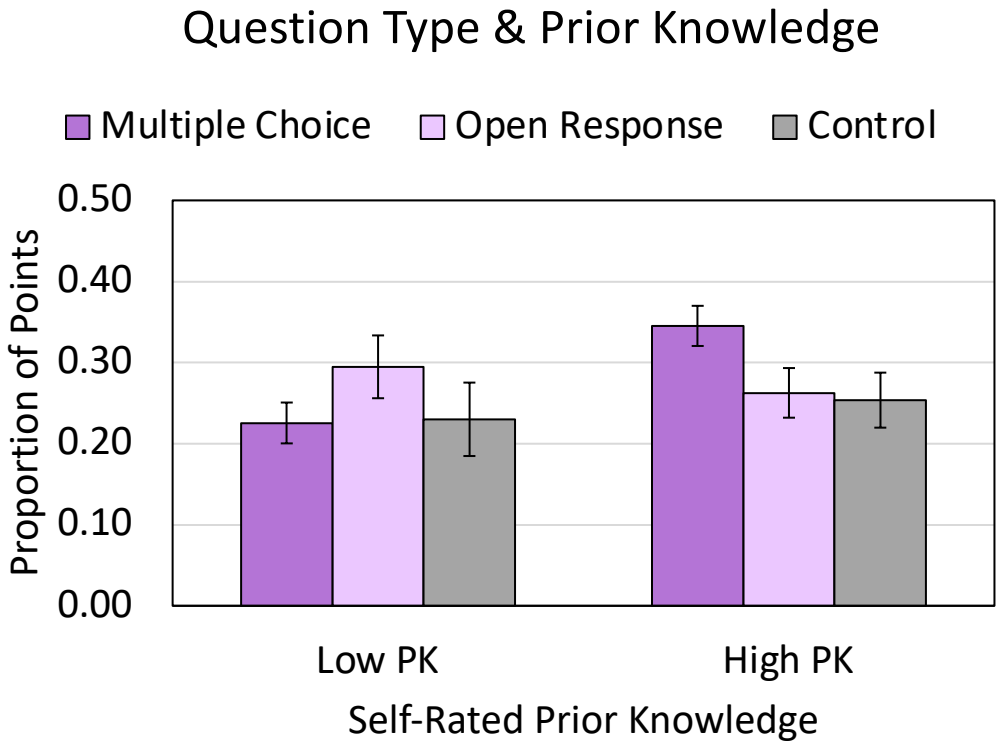
- Adjunct questions = questions embedded in a lesson to guide and improve learning (Hamaker, 1986; Hamilton, 1985; Rothkopf, 1966)

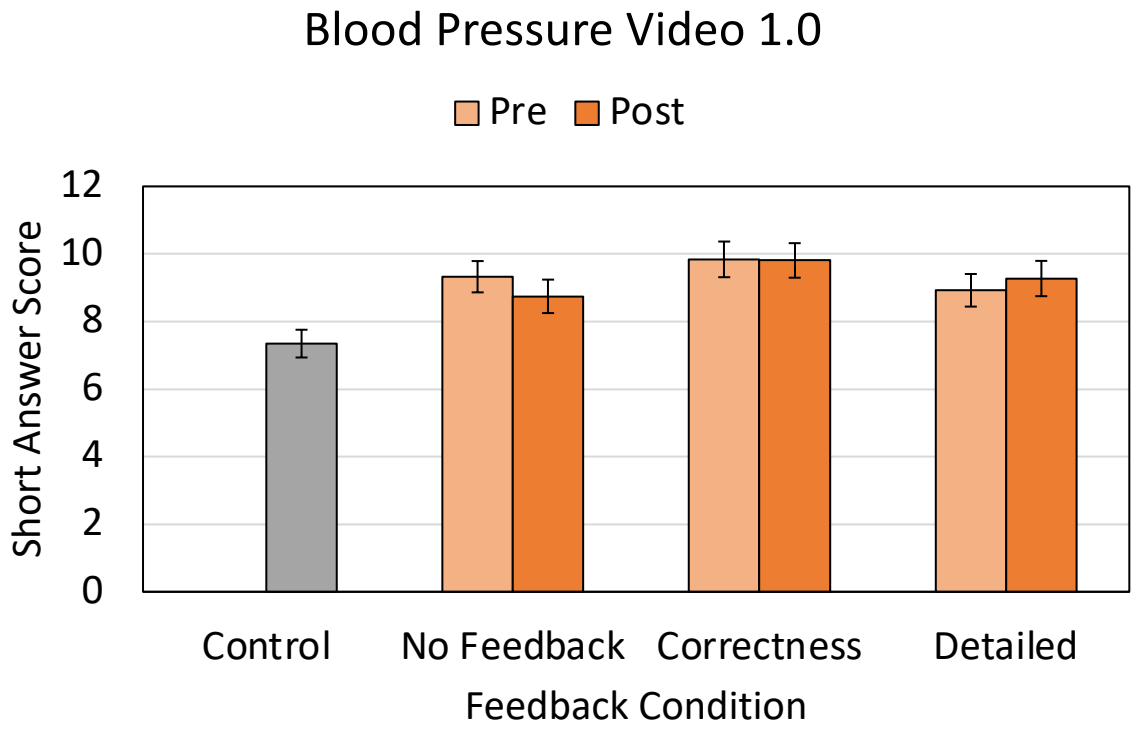




Prior Knowledge & Feedback

- Question features may interact with learner characteristics





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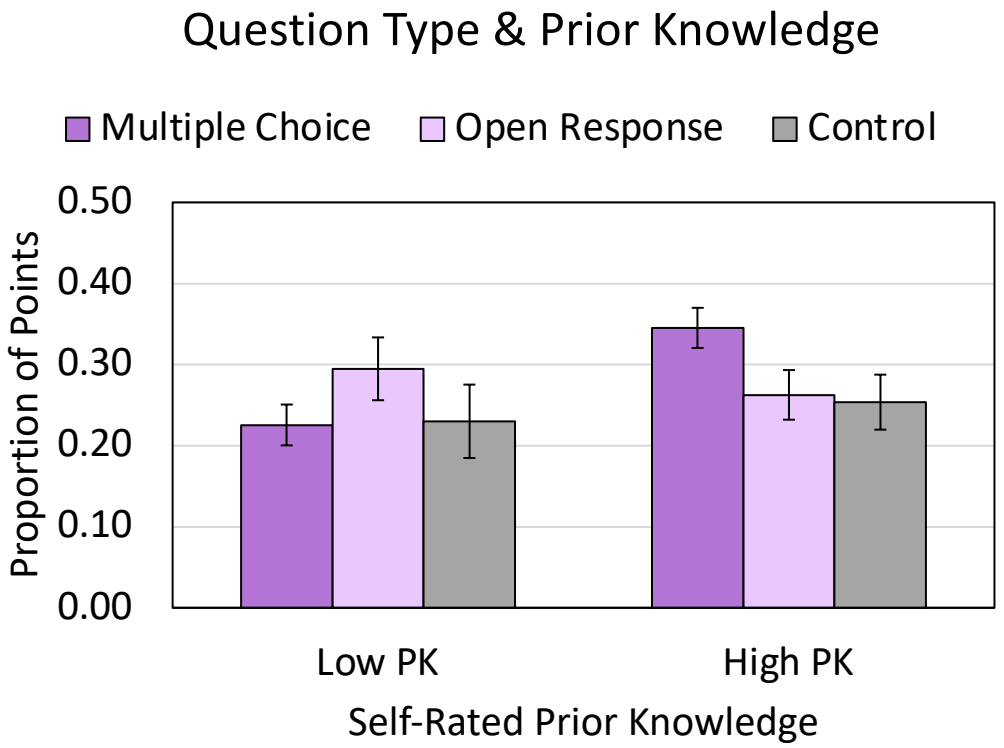

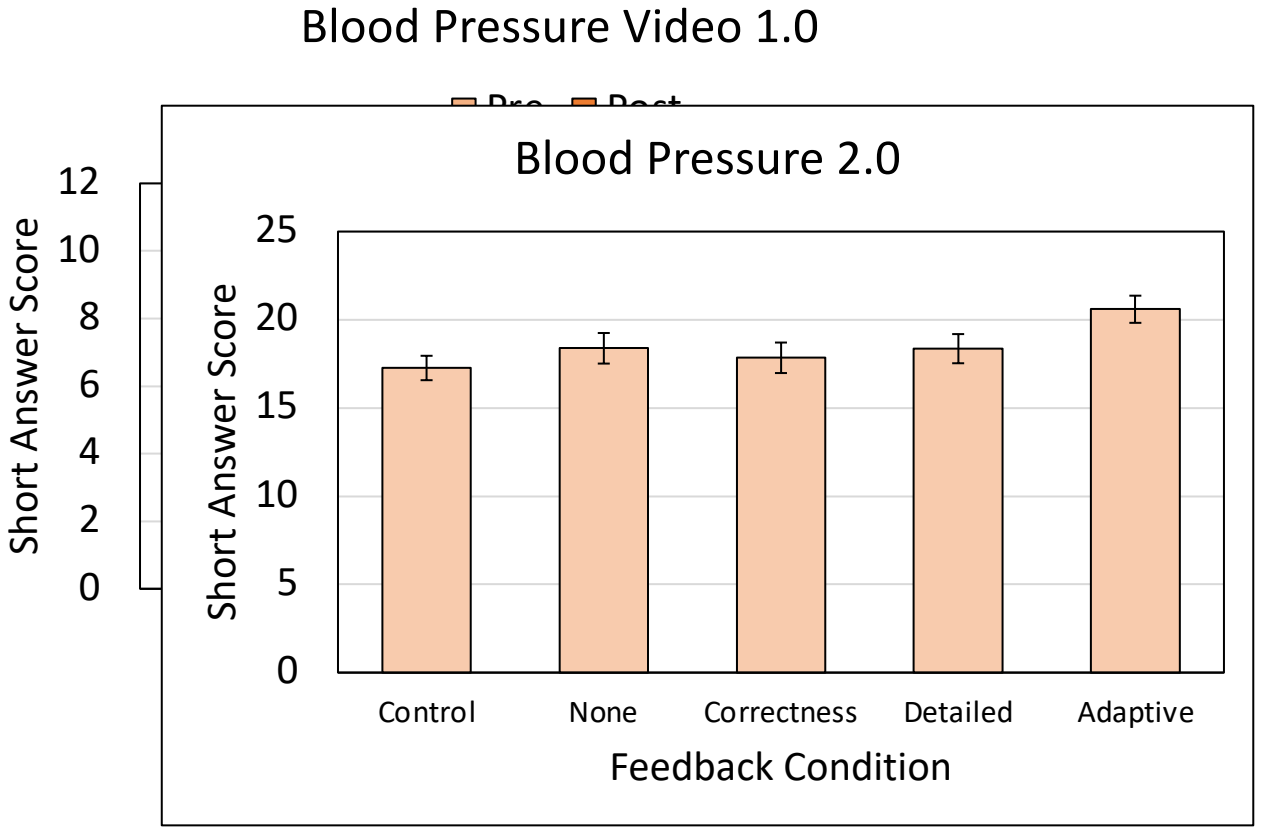

What to take away from this?

- Take individual findings with a grain of salt!
- Animations support learning when they are purposeful
  - Create or choose visuals that support the core concepts of the lesson
  - Animation for entertainment may not hurt learning, but probably won't help
- In general, adjunct questions help students learn
  - Particular question formats might be better suited for students of different levels, but there is little danger of *hurting* learning
  - Feedback is only useful if the students read it!
- More work is needed to study these effects in real courses!

Conclusions & Recommendations

- Approaching instruction from the perspective of cognitive psychology can help you appreciate the limitations and affordances of our information processing capacity

- Published findings may not translate easily to new contexts
  - There are likely boundary conditions for each effect that have yet to be specified
  - Consider the cost-benefit trade-offs when implementing a design principle

- Effective video instruction probably has more to do with what *students* are doing (cognitively) than with what *instructors* are doing technologically

Thank you!

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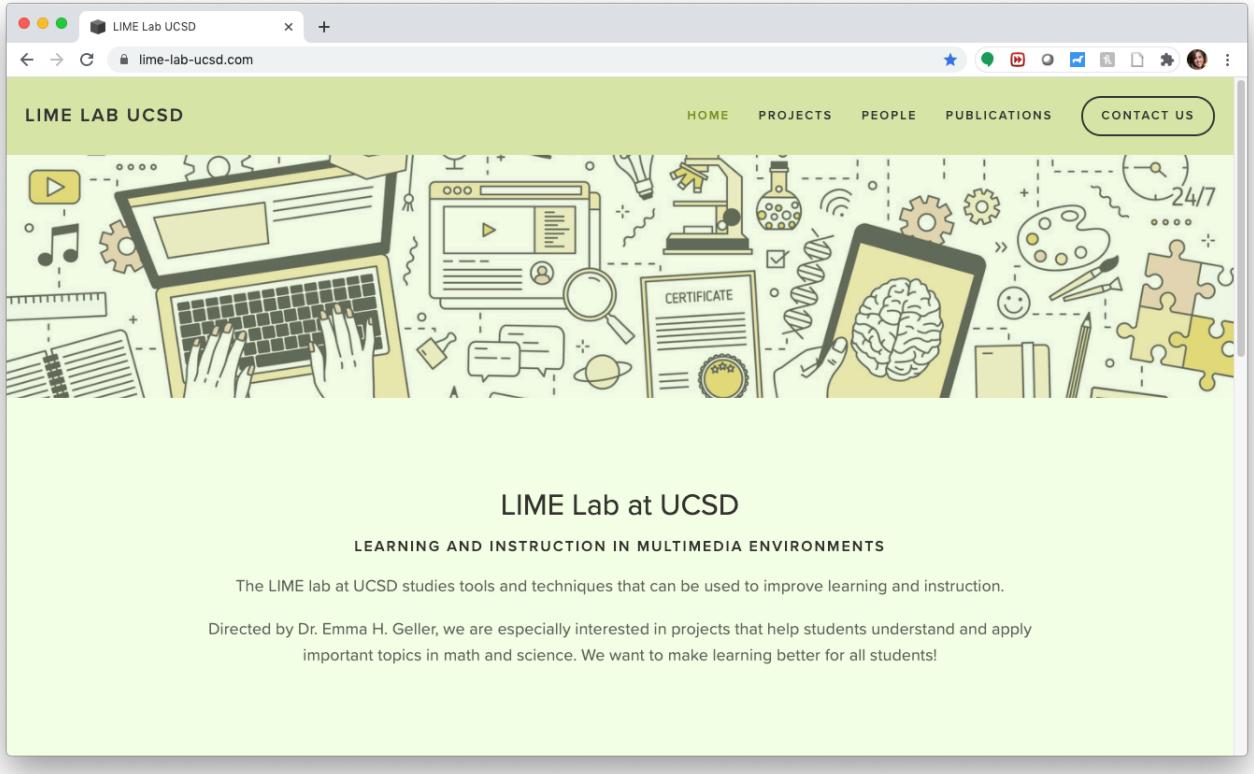
  - Fangzheng Zhao



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Zoom Q&A:

Wed Oct 7 @ 2pm Pacific (4pm Central)

Zoom ID: 927 0179 4540